This user manual is designed to allow owners and users of Metso products to familiarize themselves with the use of their equipment. It contains important instructions for safe, optimal and economical use of the equipment. Follow these instructions to avert possible hazards, cut repair costs and the number of failures, increase the equipment's reliability and prolong its service life.

This manual should be completed with local safety and environmental protection regulations.

A copy of this user manual should always be available near the equipment.

In addition to this user manual and local safety and environmental protection regulations, the generally accepted technical rules governing safety in the workplace should be followed.

This user manual must be read and used by anyone working on the equipment, among other things during:

Installation, start up, operation, application engineering, loading and unloading raw materials, working on site, environmental protection and safety departments, inspection, repairs, transportation, handling the equipment.

There may also be optional pieces of equipment that have separate user manuals. These manuals must be used by anyone working with the equipment.

Due to constant development of the products and improvement in their design, your new machine may include changes that have not been included in this edition. However, each edition is reviewed and revised if necessary, to update the changes in the latest editions.

The description and specifications in this manual were accurate when it was approved for publishing.

Metso reserves the right to discontinue its models at any time, and change the specifications or drawings, without notice or any obligation.

Should you have any questions regarding the machine or this publication, please contact your Metso sales representative to get the latest available information.
CONE CRUSHERS HP
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Section A

INTRODUCTION

1.1 - General ............................................................ A-1
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1.1 General

This manual, together with specific instruction manuals for individual equipment, has been prepared by Metso Crushing and Screening Business Line to increase the knowledge and awareness of all persons involved in the operation, supervision, service and maintenance of crushing and screening equipment with regard to safety and operations. A copy of this manual must be provided to and studied by each person entering the machine areas of the Crushing Plant, or otherwise involved in the operation of the Crushing Plant. It is the responsibility of the Owner to always keep this manual and other written instructions either in the Crushing Plant or its vicinity for Operator reference.

Knowledge of the machines and the potential hazards they present are essential to a safe workplace. Knowledge of and compliance with all state, provincial, and federal safety laws, safety regulations, and Crushing Plant safety procedures, warnings and instructions also are essential to a safe workplace. Failure to do so can result in serious injury or death.

When in doubt - don’t! Never bypass instructions or procedures to save time. Never place foreign items, tools, rods, or any part of your body into an operating machine. Never reach over, around or beyond safety devices. Never operate a machine if safety devices are missing or disabled. Never replace an OEM safety device with a non-OEM device.

Never service equipment until all potentially moving parts are secured and power has been locked out and tagged out to prevent unexpected movement.

The Operator is responsible for using care and common sense at all times.

Remember, safety is everyone’s business. You are responsible not only for your safety, but for the safety of those around you.

Please read this manual carefully. Know its contents. If you have any questions, contact your Metso representative without delay for advice. Keep in mind that there are different types of risks, hazards and injury types (see Section 2.3 «Typical risks in crushing plant working environment»), which are related to each other. Foresee and prevent such risks and hazards as well as resulting injuries and other consequences from occurring by all available means. Never compromise when the question is about safety!

Metso, as the machinery manufacturer and supplier, regards safety as of the utmost importance, and deems the following as essential prerequisites to the safe operation of the Crushing Plant:

- That the Owner makes available this manual, before using the machinery, to each person involved with the operation, supervision, service, or maintenance of the Crushing Plant.

- That compliance with and adherence to this manual be mandated and supervised by the Owner.

- That all personnel involved in the operation, supervision, service, or maintenance of the Crushing Plant become familiar with the contents of this manual prior to such involvement.
That every person involved in the operation, supervision, service, or maintenance of the Crushing Plant be properly trained and have adequate professional skills as required for the performance of the respective tasks.

That all visitors to the Crushing Plant be properly informed of applicable safety precautions and risks, and that safety precautions be adequately maintained and in connection with any such visits, including, but not limited to, adherence to this manual.

No changes shall be made in the operation of the machinery supplied by Metso or the contents of this manual without express written approval of Metso. All operation, service, maintenance, handling, modifications, or other use of Crushing Plant equipment and/or systems is the responsibility of the Owner.

Metso shall not be liable for any injury, death, damage or cost caused by any act or omission on the part of the Owner, Operator or other personnel, agents, contractors, vendors, or others. All applicable safety rules, regulations, standards, instructions, and procedures must be complied with; as must be those of this manual as well as any other instructions, specifications, and recommendations by Metso.

This manual is based upon the safety laws, rules and regulations in effect on the date hereof. The owner and operator bear sole responsibility for complying with any amendments, additions or other changes to safety law, rules or regulations arising subsequent to the date on which this manual was drafted.

Although these instructions are intended to be as comprehensive as possible, there may be hazards that cannot be anticipated, hazards associated with a particular work-site or hazards covered by special company safety programs. The information may also not include all practices that must be observed, such as insurance requirements or governmental regulations.

If you have questions or concerns regarding safety aspects of machinery supplied by Metso, contact us before using, operating, servicing or repairing the machinery.

**IMPORTANT!**

Safe operation of the machine requires alertness and safety-consciousness on the part of all operating personnel. It should be operated only by knowledgeable and trained personnel.

### 1.2 Definitions

“Crushing Plant” means a combination or part of various equipment, components, systems and parts for crushing and/or screening of rock, minerals, recycling or other crushable materials. For the purposes of this manual, the Crushing Plant means also stand-alone crushing or screening equipment as applicable. Throughout this manual, words such as “machine”, “machinery”, “equipment” and “crusher” are used interchangeably to refer to the Crushing Plant and its component parts.

“Owner” means the entities or individuals who own or lease the Crushing Plant and/or the entities or individuals who are in charge of operating and/or servicing the Crushing Plant.

“Operator” means the individuals who either operate the Crushing Plant or perform actual maintenance, service, repairs, supervision or any other activity on or for it.

“This manual” means, as applicable, this general safety instructions, together with any specific instructions for individual equipment, as amended from time to time, provided by or on behalf of Metso.
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2.2 - Safety and you .......................................................... B-2
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2.3 - Typical risks in crushing plant working environment ........ B-6
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2.1 Safe products and the crushing plant

All machines require human involvement. Like any other heavy machinery, a crushing plant has inherent dangers that must be identified, understood and taken into account in order to avoid accidents and injuries. Metso, as machinery manufacturer and supplier, is committed to promoting safety at the crushing plant by providing safety devices and features, and by providing training, services, manuals and instructions.

2.2 Safety and you

Safety is everyone's responsibility; safety is your responsibility.

To assure safe operation, all personnel must be alert when operating or working on or around the machine. Be aware of real and potential hazards. Only properly trained personnel should operate, supervise, maintain, or service the machine.

Personnel must carefully study all aspects of the specific machine, including:

- operating instructions
- service, diagnostic and maintenance instructions
- automated features and motions of the machine
- specific safety features and instructions

IMPORTANT!

- If unsure of any procedure, check the operation manuals and/or contact your supervisor before proceeding.
- Follow all lockout and safety procedures before entering the machine.
- Be constantly aware of the location of each worker on or around the machine.
- Observe all safety instructions.
- Do not remove or disable any guard, safety device, sign or warning.

Safety is the concern of all personnel. With your actions, you participate in establishing the safety of the working environment.

Metso products are designed and constructed with safety in mind. The machines incorporate high quality safety features used.
2.2.1 Objective

The objective of these instructions is to minimize risks and to avoid or prevent accidents and injuries. Accidents are often caused by carelessness or disregard of important instructions.

Knowledge of the machine operation and continuous safety training are necessary for a safe working environment.

Safety can be summarized in three main themes:
- MACHINE KNOWLEDGE
- SAFE OPERATION AND MAINTENANCE
- GOOD HOUSEKEEPING

2.2.2 Safety Signs, Labels And Symbols

The following symbol is used in this manual and on the machine to call attention to instructions, which will help prevent machine related injuries.

When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

This manual uses the alert symbol, with words such as DANGER, WARNING or CAUTION, to alert you and other Crushing Plant personnel of actions or conditions that pose a potential safety hazard, with an attending risk of personal injury (including death) or property damage. The machine also displays safety signs, labels and tags at appropriate points to show safety risks that may exist.

<table>
<thead>
<tr>
<th>Sign</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Immediate hazards or unsafe practices that will result in severe personal injury or death.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Hazards or unsafe practices that could result in severe personal injury or death.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Hazards or unsafe practices that could result in minor personal injury or equipment damage.</td>
</tr>
</tbody>
</table>

Figure 2-1 Alert symbol

Figure 2-2 Danger, Warning, Caution Signs And Their Meaning
2.2.3 Some General Safety Instructions

1. Do not remove, cover or disable any installed safety devices, guards, warning signs or tags. They are attached to equipment to warn personnel of possible danger and prevent injury. Use OEM replacements in the event any safety devices, warning signs or tags become damaged or unreadable. Observe all instructions. Keep warnings signs and tags clean, visible and readable (Warning signs are listed and their locations described in the machine safety instructions).

2. Make sure that all required walkways, handrails, barriers, safety devices, and guards are in place before starting the machine. Do not use non-OEM walkways, handrails, barriers, safety devices or guards, when such items are available from OEM.

3. Keep the machine itself and the area around the machine clean and clear of obstructions. Be aware of dust, smoke or fog, which may obscure your vision.

4. Wipe up any substance, such as spilled oil, grease, water or ice, which may cause a person to slip or fall. Good housekeeping practices prevent injuries. Be a good housekeeper. Keep the machine environment and walkways clean and free from oil, grease, rags, cables, chains, buckets, rocks and other obstructions. Keep loose parts in a toolbox or return them there promptly.

5. Keep clothing and all parts of the body away from nip points and rotating or moving equipment. Be especially alert to avoid contact with parts that move intermittently.

6. Know the weight limitations of lifting devices and their loads. Never detach a lifting device from a load until the load is stable and secured from unintended movement.

7. Do not climb or stand on equipment other than in areas, which are designed for that purpose. Do not overreach.

8. Emergency-Stop buttons should be tested on a regular schedule for proper operation, as should electrical interlocks and related limit switches. Safety defects should be repaired prior to continuing operation, and thereafter tested and certified for appropriate operation by skilled personnel.

9. Personal protective equipment and safety uniforms, safety shoes, helmets, safety glasses, heavy gloves, ear protection devices etc. should be used at all times. Safety shoes should be used by all personnel entering into the Crushing Plant. Persons with loose clothing, neck ties, necklaces, unprotected long beard or long hair should not go near the machine. Wrist watches and rings can be dangerous. Rings should be removed or covered with tape. Keep your pockets free of loose objects.

10. Keep all non-operating and non-trained personnel clear of the Crushing Plant at all times. Injury or death may result if this is not done.

11. The equipment at the control panel should be handled with care. Do not place objects on the keyboard, color disgap or other equipment. All equipment can fail if put in contact with liquids, or excessive heat or excessive humidity. Allow good air flow around the equipment at all times. Keep magnets away from computer components, particularly hard drives and PLC cabinets.

12. A knowledgeable and properly trained Operator familiar with this manual, safety requirements, and automatic operation of the machine should be stationed at the controls whenever the machine is operating.
13. Do not consume any alcoholic beverages or other intoxicants before coming to work or while on the job. Do not operate the Crushing Plant after taking any medicines, tranquilizers or other drugs, which can impair the senses.

14. Familiarize yourself with the safety signs on the Crushing Plant. Never remove or damage any safety signs, nameplates or other safety related warnings, symbols or components. Replace them as necessary with OEM equipment.

15. Do not paint over safety signs, nameplates or warnings.

**WARNING**

Only qualified and properly trained operators and servicemen should operate or service the machine. Everyone else should stay clear of the machine when it is operating, or under service or maintenance!

### 2.2.4 Blasting

The use of the Crusher Plant’s radio control device is strictly forbidden during blasting operations, as it may cause a premature explosion. Move the mobile Crushing Plant far enough away from dangerous area when blasting. Do not store or transport explosives on mobile crushing plant or screening plants.

### 2.2.5 Portable Plants

If the Crushing Plant includes of portable equipment (i.e. crushing and screening equipment mounted on trailers), trailer footing or cribbing is extremely important for safe operation. Your machine must be on as solid and level footing as possible. If the ground is not naturally level, it must be leveled so that the unit will operate safely and effectively. The ground must support the weight of entire unit and keep it from sinking or shifting. Use heavy timber mats as needed. Trailers must be raised so that trailer wheels do not touch the ground.

Place jacks at each corner of the trailer or as near the corner as possible and to other suggested support points at mid-frame. All corner jacks must be at an equal distance from each end. Adjust each jack until the unsupported portion of the trailer beams stops vibrating or until vibrations are reduced to a minimum. Lock jacks and adjustable support legs mechanically with locking pins when applicable.

Periodically recheck trailer footing for stability.

### 2.2.6 Mobile Equipment Transportation

Use only appropriate transportation and lifting equipment with adequate capacity. Provide a supervisor to direct lifting operations. Follow all disassembly and assembly instructions carefully. Disconnect all external power supplies before moving any part of the equipment. Transport or hoist components and handle any parts in accordance with the instructions and advice provided. Fasten the lifting equipment only to the points meant for lifting.
Use only proper means of transport with adequate transporting capacity. Fasten the load carefully. For lifting use only the fastenings shown in instructions. Secure all component parts of the equipment immediately after loading to avoid any accidental shifting. Attach required warning signs to the load.

When moving your trailer, check bridges before crossing. Make sure they will support the weight of the machine. Check clearances under bridges, for overhead lines or any overhead obstruction. Never travel with near capacity loads. Check local laws, especially on weight limitations. When travelling on the highway make sure all headlights, clearance lights and tail lights are on, as applicable. Use proper traffic warning flags and signs.

Remove all shipping brackets before re-starting the Crushing Plant. Carefully assemble all of the parts previously disassembled. Perform any start up in accordance with the instruction manual.

After the system is running, check all gauges and instruments to see that they are working correctly. Check that all controls function normally and properly. Listen for unusual noises. Shut system down immediately if any component of the system does not operate normally.

2.3 Typical risks in crushing plant working environment

Even though every Metso machine is designed with many safety features, it is impossible to design out all safety risks. There are potential hazards, that must be recognized and avoided. Noise levels may interfere with normal discussion when the machine is operating. By their nature, Crushing Plant and auxiliary equipment can create dust. Crushing itself and some other machine processes may momentarily obstruct the view of some machine parts. In general, high levels of respirable silica and other dust in the air may expose Operator to health risks for lung disease depending upon the length and amount of exposure and type of material being crushed. In addition, there are some risks or hazards which cannot be completely guarded or avoided because of interference with machine operations. Accordingly, working on the Crushing Plant requires constant alertness by all personnel in the area. Accidents happen unexpectedly. Below are some typical hazards and types of accidents that everyone working at, on or around the Crushing Plant should be aware of.

Typical Hazards:

- nips, gaps, and pinch points
- poor housekeeping
- elevated or narrow working areas
- lifting and shifting heavy loads
- cranes and mobile cranes
- sharp edges
- high-pressure hydraulic equipment
SECTION B - GENERAL SAFETY INSTRUCTIONS

- electrical equipment
- automatic functions and unexpected start-ups
- toxic and corroding agents
- machine inertia
- hot surfaces and fires
- zinc
- conveyor belts
- dust
- noise and vibration
- improper work methods
- rotating equipment and moving components
- ejection of material from the crusher
- falling material from conveyors, and from loading, unloading and feeding operations
- crushing cavity

These typical hazards are discussed more fully in section 2.3.1 «Typical hazards» of this chapter. Be aware of these hazards. All personnel working on or around the machine should be properly trained in avoiding these hazards.

Typical Injury Types:
- crushing
- slipping, tripping and bumping
- falling
- cutting
- entanglement
- burns and electrical shocks
- respiatory organ illnesses
- asphyxiation

2.3.1 Typical hazards

Nips, Gaps, and Pinch Points

An ingoing nip is formed by drive devices such as belt and pulley, chain and sprocket or gears. Similarly, a pinch point may be formed by rotating or moving equipment.

DANGER

Nips and gaps are serious hazards in a Crushing Plant. They are usually guarded by nip guards, railings, or location. In all cases, extreme care must be taken to avoid nips, gaps, and pinch points or serious injury or even death may occur.

Poor Housekeeping

Promote good housekeeping. Keep machine environment, walkways, platforms etc. clean and dry and free of debris. Oily or wet machine environment, walkways, platforms, steps and hand rails are slippery. In cold weather, watch out for ice and snow. Wet spots, especially near electrical equipment, are dangerous. Return tools to their proper place after use. Even then extreme caution should be used. Follow established Crushing Plant safety procedures. Clean slippery deposits from walkways, ladders and floors. Tidiness provides a safer working environment by preventing or helping reduce tripping, slipping, fire hazards and electrical shocks.
**Elevated or Narrow Working Location**

Crushing Plants are tall structures. The walkways and platforms, designed to be used during machine operation, are furnished with railings to help prevent falling.

When working on an elevated surface be aware of machine movements and other activities in the area. Do not run on the walkways. Do not reach over or beyond walkway railings while the machine is running. Do not stand on railings or toe plates.

There may be narrow access routes for maintenance purposes. Do not use these routes while the machine is operating.

Do not enter any close quarters within the Crushing Plant when the machine is operating.

**Lifting And Shifting Heavy Loads**

- **Cranes**

Crushing Plants, like any other type of mechanical equipment, require regular periodic maintenance. One of the most flagrant Crushing Plant safety violations is the use of inadequate and unsafe lifting equipment. Although a Crushing Plant is a finely tuned piece of equipment, the internal parts of a Crushing Plant should be assembled and disassembled with crane facilities that have the capability of gently and slowly lifting and lowering the various parts that make up a Crushing Plant.

Do not use chain hoists (chain blocks) to assemble or disassemble a Crushing Plant. These lifting devices lack the stability and robustness required in lifting and positioning heavy components.

Do not use impact hammer boom or any other equipment which are not designed for lifting, for assembly or disassembly purposes.

Affix the load securely to its destination. Never detach a lifting device from a load until the load is stable and secured from unintended movement.

When it comes to safety, don't compromise!

**IMPORTANT !**

When using a crane, always operate within the rated capacity of the crane. The safe rated capacity includes weight of hook, block and any materials handling devices such as cables, slings, spreader bars, etc. Subtract the weight of all these items from the rated capacity to find the true weight of the load that can be handled safely. Always follow the crane manufacturer's operational and safety instructions.

**IMPORTANT !**

The weight indicated in machine plates tells the weight of standard configuration. In many cases the actual weight may differ greatly from that indicated in machine plate due to, e.g., options or ancillary equipment. Always verify the weight of the object you are lifting before attempting to lift it.
• Mobile cranes
Safe ratings are based on operating the crane on firm, level ground; outriggers must be properly extended and/or lowered whenever required. Avoid fast swings, hoists or sudden braking; these can cause overloads. Do not handle large, heavy loads in strong winds. When moving your crane, check bridges before crossing, make sure they will support the total weight in question. Check clearances under bridges for overhead electrical lines and any overhead obstruction. Be sure your hitcher is clear before starting lift. Make sure the load is securely attached.

**IMPORTANT !**

When using a mobile crane, always operate within the rated capacity of the machine to avoid buckling the boom or tipping.

Take the following precautions when lifting heavy loads:

- Follow all established Crushing Plant procedures.
- Follow all instructions and safety procedures recommended by the crane manufacturer.
- Plan the lifting and maintenance procedures in advance. Read and understand specific instructions for proper use of lifting equipment prior to using (e.g. instructions of the machine, lifting device and local regulations).
- Clean the working environment beforehand to prevent slipping and tripping hazards.
- Make sure that the crane and other lifting devices such as chains and slings have sufficient capacity and are in good working order.
- Do not attempt to ride or sit on moving loads.

- Be sure that crane operators, riggers and other personnel have been properly trained.
- Rig the load firmly to prevent any unintended movement and assure stable and accurate positioning.
- Make sure nobody is below or on the path of the load and that the transfer routes are clear and proper protective clothing and gear are used.

**Sharp Edges**

Sharp edges may occur on any metal structures. Equipment damage may uncover or produce unexpected sharp edges. Sharp edges may inflict deep and serious cuts. Wear protective gloves when handling materials, parts, etc. with sharp edges. Repair or guard detected sharp edges immediately.

**High-pressure Equipment – Hydraulic or Air**

High pressure oil can be dangerous. Relieve all pressure before opening or removing any hydraulic or air pressure lines, valves, fittings, etc. Do not touch pressurized components since the pressure from a pin hole leak is so strong that it can easily penetrate the skin or
eyes. Always exercise caution when handling hydraulic devices.

Regularly check the condition of hoses, pipes, valves and various connections. Replace them as necessary.

Before starting any maintenance work, stop all hydraulic pumps, lock out pump motors, and depressurize the system, bringing all components to a zero energy status. Remember to also depressurize the accumulators through the bleed valve for each accumulator. Do not disconnect any hoses until the actuator has been brought to a zero energy status and properly secured.

Bleed the hydraulic system regularly to remove entrapped air that may interfere with normal expected machine operation or cause a hazard during maintenance.

**Electrical Equipment**

Be especially cautious when working with or near electrical equipment. An electric shock can be fatal. Crushing Plant electrical outlets must be grounded and have ground fault interruption protection. Tools plugged into the outlets must be double insulated. Never expose electrical equipment to mechanical damage or humidity. Protect all electrical equipment from direct contact with water or high humidity.

Protect electrical devices that move as part of the machine from dirt and mechanical damage. Regularly check the operability of these devices.

**AVERTISSEMENT**

Poorly tightened or damaged hydraulic components may inject dangerous jets of fluid. Before restarting the machine, be sure that the hydraulic system is ready for operation, and personnel are clear of affected areas.

**AVERTISSEMENT**

Machine parts may move unintentionally and cause a risk of injury. Before restarting the machine, make sure that all personnel are clear of affected areas where machine movement may occur.

**DANGER**

There is a risk of an electric shock, if sufficient precautions are not taken. An electric shock can be fatal.

For maintenance work, disconnect all devices from electric and hydraulic power sources and follow Crushing Plant lockout procedures.

The lockout program, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:

- Follow procedures.
- Stay alert.
- Do not take anything for granted.
- Verify lockout.
- Each person working on the unit must have his own lock with only 1 key.
Tag must identify the work being done and the person(s) who locked and tagged the control.

Locks and tags are changed with each shift that comes on.

Work to prevent injury or death. Follow proper procedures at all times!

Maintenance, repair and installation of electrical equipment must be performed only by qualified personnel who are familiar with the machinery and equipment in question.

**Automatic Functions and Unexpected Start-ups**

**WARNING**

Machine parts may move unintentionally and cause a risk of injury. Absence of safety functions may cause dangerous machine movements.

Do not tamper with limit switches or other safety devices included in the system.

**DANGER**

If danger zones are not respected during machine operation or manoeuvres there is a risk of serious injury or death.

Many devices operate automatically, following certain sequences which have been programmed into the logic system (i.e. programmable logic controller, microcontroller, relay system or similar). The danger zone is any area within the confines of moving machine elements, feed material or beneath any objects being lifted. Do not enter these danger zones unless the machine has been properly safeguarded according to the Crushing Plant lockout procedure and manufacturer’s instructions.
Welding Equipment

Weld repairs are to be performed only by qualified personnel. Welders and welder’s helpers must wear protective clothing and equipment.

Precautions must be taken when torch cutting and/or welding due to the health hazards posed by many metals. Anyone performing these types of procedures should avoid breathing the fumes. Such procedures should be done outdoors or in a well ventilated area with either a separate clean air supply provided to the mechanic or with local exhaust of fumes. Please refer to EU, OSHA, MSHA or other applicable standards as appropriate. One of the most frequently used tools around the Crushing Plant is the cutting torch.

Crushing Plants which are equipped with hydraulic components and/or conveyor belts and/or v-belts should have these components depressurized and adequately covered with flame-proof material so that sparks, weld spatter, etc., cannot reach these areas. Ruptured high pressure hydraulic lines will quickly vaporize the hydraulic fluid as it reaches the atmosphere. This vaporized fluid can quickly become a mass of flames, resulting in severe burns for personnel in the immediate area. Adequate precautions should be made to avoid contact with these components. Never perform welding or torch cutting activities in the presence of flammable materials.

**WARNING**

Risk of injury. Fire may break out. Never perform welding or torch cutting activities in the presence of flammable materials.

**IMPORTANT !**

All maintenance personnel who use cutting and/or welding torches should be advised if there are hydraulic components in the immediate area in which they are working.

**IMPORTANT !**

Contact Metso or its authorized representative prior to any welding of major Crushing Plant components such as main frame, adjustment ring, bowl, etc. Performing welding on the Crushing Plant components can be detrimental. Before welding, always verify that material is weldable! Failure to do so may result in weldment failure and present a risk of injury and/or property damage.

**Toxic, Corroding and Irritating Agents Hot Surfaces and Fires**

Before handling chemicals, carefully read the safety instructions from the supplier of the respective chemical. Hazardous chemicals may be in use. Wear protective clothing, gloves, boots, glasses, and respirator when necessary.
SECTION B - GENERAL SAFETY INSTRUCTIONS

Refer to the MSDS (Material Safety Data Sheets) and Crushing Plant procedures for handling of these materials.

Avoid prolonged contact with fluids, such as gasoline, diesel fuel, hydraulic oil and cleaning solvents, which may cause skin irritation or other reactions.

**Machine Inertia**

Due to the large inertial forces of the Crushing Plant and Crushing Plant components, the machine can not be stopped abruptly. This is potentially hazardous to personnel. All personnel must stay clear of rotating elements and other moving parts until the machine has come to a complete stop. Regularly inspect the structural elements to maintain safe operation.

**Hot Surfaces and Fires**

There are hot surfaces on Crushing Plants. Protective gloves and coveralls help protect against burns. Be aware of hydraulic system, hoses, fittings, and pipes. Regularly inspect and observe high temperature lines, and fluid lines for leaks or damage. On mobile equipment be cautious around the engine because of exhaust gases.

When in contact with hot temperatures, or when heated themselves, some hydraulic oils may ignite at around 392°F (200°C). Attention must be paid to the condition of hydraulic hoses and couplings. Remove immediately oil spills from floor, walkways, and pits. Fix all sources of oil leaks and clean up spills.

In case of fire it is recommend to equip the Crushing Plant with manual extinguishing equipment. Legislation and regulations about suitable equipment may vary by country. Familiarize yourself with applicable standards. Personnel must also be trained properly to be able to use fire extinguishing equipment.

A trained person with sufficient fire extinguishing equipment must be present during welding maintenance work. Cold water on hot metal surfaces may cause a violent explosion. Monitoring after welding must be arranged as required by laws and regulations. If no other regulations apply, monitoring time is a minimum of one half hour.
Fire Hazards

- Do not smoke while refueling, or when handling fuel containers.
- Shut off engine when refueling and use extra caution if engine is hot.
- When pouring fuel into the tank, ground the funnel or spout against the filler neck to avoid static electric spark.
- Do not use gasoline or diesel fuel for cleaning parts. Good commercial, nonflammable solvents should be used.
- Do not smoke while using flammable cleaning solvents. Whenever possible, use non-flammable cleaning solvents.
- Do not let greasy, oily rags accumulate in a poorly ventilated area. Store oily rags and other combustible material in a safe place.
- Never use an open flame to check fuel, battery electrolyte or coolant levels, or to look for hydraulic leaks anywhere on the equipment. Use a flashlight. Know where fire extinguishers are kept, how they operate, and for what type of fire. Check regularly, at least monthly, to be sure they are in the working area.
- Do not weld or cause open flame in the presence of flammable materials.

- In the event of a fire, shut down the Crushing Plant, hydraulic power unit and lubrication system if this can be safely done. Warn other people in the area and commence fire fighting activities according to applicable rules. It is the responsibility of the Owner to maintain proper training and instructions in these respects.

Epoxy Versus Zinc

Many Crushing Plants require some type of backing when replacing the crushing members. Epoxy resin backing compounds have almost completely eliminated the possibility of workers being accidentally burned due to molten zinc either spilling or exploding when it comes in contact with wet surfaces. When epoxy backings are used, care should also be taken when removing the liners with a cutting torch. Do not use molten zinc as backing material. Use epoxy only according to specific instructions from the manufacturer.
By their nature, Crushing Plant and auxiliary equipment such as chutes, transfer stations, screens, etc. can create dust and, if not contained, the dust can escape into the air. In general, high levels of dust (particularly, respirable silica) in the air can create a hazard of lung disease, depending upon the concentrations of dust, the length of exposure, and the type of material being crushed. Dust protective devices and dust warnings may be required by OSHA, MSHA or local laws.

The Owner and Operator of the Crushing Plant must identify the material being crushed and ascertain whether respirable dust from the application poses a health hazard to personnel in the vicinity of the Crushing Plant. If the material presents such a hazard the Owner and Operator must take all necessary measures to ensure that personnel are protected from the dust. Such measures include, but are not limited to providing dust collection system, using water spray bars at the feed and discharge points, crusher transfer points and screens and providing adequate personal respiratory protection devices to workers.

Crushing with a choke level may also reduce the amount of dust issuing from the Crushing Plant itself. Because the configuration of each rock crushing installation is different, Metso recommends that the Owner and Operator consult Metso or a dust consultant about possible alternative means of dust reduction.
Noise and Vibration

**IMPORTANT!**

Metso highly recommends that dust protective devices such as an appropriate respirator be worn by anyone exposed to airborne dust to prevent its inhalation.

**WARNING**

Breathing dust may be hazardous to the health of anyone working at, on, or around the Crushing Plant. It can cause serious or fatal respiratory diseases including silicosis! It is the responsibility of the Owner and Operator to determine the necessity and adequacy of protective devices and warnings, to provide them, and to ensure that they are used and followed!

**Noise and Vibration**

- Crushing Plant Noise

Crushing Plant by its very nature is noisy and the auxiliary equipment found at, on or around the Crushing Plant such as chutes, transfer stations, screens, etc., can at times be noisier than the Crushing Plant itself. Typical Crushing Plant noise level while crushing range from 100 - 110 dB measured at 1 m (3ft) from the Crushing Plant.

Metso recommends wearing ear protection at, on and around Crushing Plant, particularly when the noise level exceeds 85dB. It is recommended that the Owner develop a signaling communication system in noisy environments to reduce the risk of accidents. Proper machine maintenance and replacement of worn parts can help reduce noise.

The most commonly applied noise reduction procedures are:

- use of isolation techniques
- equipment enclosures
- operator enclosures
- silencers

Allowable noise levels and exposure limits are regulated by various agencies such as ISO, OSHA, MSHA, etc. Refer to applicable safety regulations for permissible noise exposures, and take steps to ensure compliance with those regulations.

- Vibration

Long term exposure of Operator to vibration may result in detrimental health effects. There is an increased risk of falling on a vibrating platform. Avoid standing on a vibrating Operator's platform or walkway.

Unexpected or excessive vibrations may be a sign of wear and/or maintenance needs. Excessive vibrations associated with a portable crushing or screening plant is frequently caused by improper cribbing.

It is recommended to regularly monitor vibration levels of machine components including, but not limited to:

- bearings
- shafts
- rollers
- structural members (including conveyor frames, walkways, platforms, hoppers, chutes, etc.)
**Improper Work Methods**

Improper work methods and motions may cause physical injuries. Use suitable tools, cranes or jacks for moving large and heavy objects. Overreaching and improper support for loads may lead to injuries to the back or other parts of the body. If you are unsure of proper work methods, contact your safety director or other person responsible for ensuring the safety at your workplace.

When lifting equipment by hand, protect your back by lifting close to your body and using your legs without twisting. Use hoists whenever possible. Stand clear of hoisted loads and lifting cables.

**Rotating Equipment and Moving Components**

Rotating and moving components provide pinch points, snagging possibilities and other potential hazards. Keep clear of all moving parts until they come to a complete stop. Do not use any body part, tool or other foreign object to attempt to stop, adjust, clear, or clean any area in proximity to moving equipment such as vibrating feeder, conveyor belts, drives or other rotating parts of the crusher. Engaging in such activities can result in severe personal injury, including death.

**Crushers, designed to operate within a specific RPM range for maximum efficiency, are typically checked with a tachometer. Make sure that any access openings have a protective cover in place at all times except when RPM readings are being taken. Never change sheave combinations without first consulting your Metso representative.**

**Ejection of Objects from the Crushing Plant**

Ejected objects from the Crushing Plant may cause bodily injury. For example rock can be thrown several meters (several yards) into the air out of the crushing cavity during operation. Ejected materials may include rock, tramp metal, metal rods and work implements. Do not look into crushing cavity while crusher is in operation. Never attempt to clear jam on feeder, crushing cavity or conveyors when system is energized.
Falling Material from Conveyors, Loading, Unloading and Feeding Operations

Rocks or other objects may fall from conveyors during loading, unloading and feeding operations. Impact of falling material may cause serious bodily injury. To assure safe operation, all personnel must be alert when operating or working at or around the machine. Wear proper protective clothing (including also helmet) and protective devices. Keep all non-operating and non-trained personnel clear of the Crushing Plant at all times.

Never walk under any equipment included in loading, feeding, crushing, conveying, discharging or stockpiling material.

2.3.2 Typical injury types

Crushing

In general, avoid areas where you may be exposed to expected or unexpected machine movements. Crushing injuries typically occur either between two rotating or moving parts, or between a moving component and a stationary object.

Keep all body parts, clothing and tools away from areas where they may get trapped, pinched, or crushed, or otherwise come into contact with moving parts on the Crushing Plant. When moving equipment, be sure the path is clear. Horns and lights, where provided, are for your safety to alert you of moving objects. Pay attention to all such devices.

Slipping, Tripping, and Bumping

Items such as hoses, tools, etc., on walkways and Crushing Plant floors impede movement and create a tripping and slipping hazard. Good housekeeping reduces the risks considerably.

Personnel should wear safety shoes that reduce the risk of slipping and provide protection against falling objects or crushing. Hydraulic oil leaked or spilled on the floor must be cleaned up immediately.

To help avoid injury, be aware of parts positioned close to the floor level or protruding machine components, changes in elevation of platforms, walkways, and narrow access points. It is recommended that safety shoes be worn at all times. Wear safety helmets and other safety equipment as appropriate.

Falling

Use only designated access routes designed for the purpose, for example walkways and platforms. Walkways and platforms are furnished with railings designed to meet applicable standards. However, in some work phases, railings or platforms may have to be temporarily shifted aside. In those cases, special caution signs or temporary barriers must be used when working on the machine. Use personal fall protection gear, temporary
barriers, interlocks, or other warning devices where appropriate. Never attempt to operate, service, or repair the Crushing Plant without first ensuring proper protection against falling. Guards that are moved aside must be installed immediately after maintenance work and before the machine is returned to operation. Never climb or stand on areas of the Crushing Plant not specifically designated for that purpose.

**WARNING**
Do not operate any equipment until all guard rails and safety devices have been re-installed or returned to their proper operating condition. Failure to do this could result in serious injury or death.

**KEEP THE AREA CLEAN!**

**Cutting**

Do not reach in or enter:
- the movement paths of cutting equipment
- between moving machine components
- between moving loads and machine structures

**Entanglement**

To avoid entanglement, avoid wearing loose clothing that could be caught by rotating shafts, conveyors, and other moving parts and materials. Remove neckties, necklaces, rings, and other jewelry before performing work assignments. Also protect a long beard or hair from entanglement.

Do not touch a rotating roller, sheave, pulley, idler or moving conveyor belts with any body part or work implement, as you may become entangled and pulled into a hazardous area.

Never attempt to service, repair, or troubleshoot any moving part of the Crushing Plant while it is energized or otherwise capable of movement.

**WARNING**

Keep safety gates, shrouds, guards, and other protective devices in place and in good working condition at all times. Test emergency stop, electrical interlocks, and related limit switches frequently.

**Burns and Electrical Shocks**

Protective gloves and coveralls help protect against burns. Be cautious around and near hydraulic system hoses, fittings and pipes. Regularly inspect and repair leaking or damaged high temperature lines and fluid lines.

To avoid electrical shocks:
- Power must be shut off and locked out before any servicing or maintenance work is done. Unplug or disconnect all auxiliary motors and equipment.
- DO NOT drill blindly into beams, electrical cabinets or other enclosures.

Avoid any contact between moisture or other fluid and electrical equipment.
Impact from Ejected Materials

There are several hazards related to falling, flying or otherwise ejected materials when the Crushing Plant is being operated or serviced. For example, rock can be thrown several meters (several yards) into air out of crushing cavity during operation. Ejected materials may include rock, tramp metal, metal rods and work implements. Keep the safety grate down during the operation. Wear proper protective clothing (including helmet) and protective devices. Always use properly maintained and approved tools and work methods. Stay clear from the path of ejected materials, also during lifting, assembly and disassembly operations.

Removal of tramp iron jammed between the crushing members is extremely dangerous. Follow the instructions in the instruction manual.

Do not look into crushing cavity while crusher is in operation.

2.4 Personal protective equipment and clothing

Personal protective equipment and clothing such as foot protection, helmet, hearing protection, dust protective devices, safety glasses or other personal protective clothing and equipment should be worn at all times. All equipment should be maintained in accordance with applicable standards. Respirators, goggles, protective masks, gloves, boots, and other such equipment shall be cleaned and disinfected before being used by another employee. The Owner and Operator are responsible for ensuring that all eye, head, respiratory, and ear protection conforms to applicable standards.

Hearing Protection

Noise level in the machinery area may exceed 85 dB, and exposure to the machinery area in such circumstances without adequate hearing protection may lead to hearing loss. Therefore, users must be provided with appropriate hearing protection of the type and to the extent required by law.

Eye And Face Protection

General requirements should include:
- The Owner should ensure that personnel for the machine area use appropriate eye or face protection when exposed to eye or face hazards such as flying material, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors.
– The Owner should ensure that affected personnel use eye protection that includes side protection from flying objects.

– The Owner should ensure that affected personnel who wear prescription lenses while engaged in operations that involve possible eye hazards wear eye protection that incorporates the prescription in its design, or wear eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

Respiratory Protection

Respiratory protection is required when the air contains contamination such as harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. The primary objective is to protect the health of workers.

Respiratory protection must be provided by the Owner when such equipment is necessary to protect the health of personnel. The Owner shall provide the respiratory protection and training programs, which are applicable and suitable for the purpose intended and comply with the latest requirements and recommendations of health authorities and regulatory agencies.

IMPORTANT!
The enormous degree of convenience as well as the high safety factor involved when using plastic backing agents has made the use of molten zinc for Crushing Plant liner backing obsolete. See section 2.3.1 «Typical hazards».

IMPORTANT!
The area should be well ventilated. Epoxy fumes can cause nausea or eye or skin irritation.

IMPORTANT!
Breathing dust may be hazardous to the health of anyone working at, on, or around the Crushing Plant.

IMPORTANT!
Metso highly recommends that adequate dust-protective devices such as a respirator be worn by anyone exposed to airborne dust, particularly silica dust, to prevent its inhalation.
Foot Protection

The Owner shall ensure that affected personnel use protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects piercing the sole, and where feet are exposed to electrical or chemical hazards.

Head Protection

The Owner should ensure that affected personnel wear a protective helmet approved by OSHA, MSHA (or by other applicable authority) when working in areas where there is a potential for head injuries from falling objects or walking throughout areas with low head clearance.

The Owner should ensure that a protective helmet designed to reduce electrical shock hazard is worn by personnel when near exposed electrical conductors which could contact the head.

Hand Protection

The Owner should ensure that personnel use properly sized appropriate hand protection when hands are exposed to hazards such as those from skin absorption of harmful substances, cuts or lacerations, abrasions, punctures, chemical burns, thermal and electrical burns, and harmful temperature extremes.

Safety Harnesses

The Owner should ensure that any person working on elevated areas not protected by railings, or on hazardous places must wear suitable safety equipment, including safety harnesses, if there is a risk of falling. Confined spaces may also require safety harnesses.
SECTION B - GENERAL SAFETY INSTRUCTIONS

Work Clothing

The Owner should ensure that personnel wear appropriate clothing to help protect against hazardous material and hot surfaces. Loose clothing can get caught in a nip, shaft, or other moving machine components.

Tools

The Owner should ensure that personnel use appropriate tools for the job. Use tools that are specially designed to break away or are easily released to help avoid certain accident situations such as unexpected movement at a nip point or a rotating shaft. Under no circumstances must tools be allowed to come into contact with moving parts while the Crushing Plant is energized.

When working in humid or damp environments, use hydraulic tools or electrical tools that are suitably grounded, double insulated, or have ground fault interruption circuits.

Safety Locks And Tags

Follow all lock-out tag procedures. Refer to appropriate standards and instructions provided by Metso.

DANGER

For maintenance work, disconnect all devices from electric power sources. Bring all hydraulic gravity or spring loaded devices to a zero-energy status. Follow lockout procedures.

The lockout program, locks, tags and the blocking/restraining devices provided are designed for Operator’s protection. Operator’s responsibility is to follow the program and use the proper equipment.

Remember:

- Follow procedures.
- Stay alert.
- Do not take anything for granted.
- Verify lockout.
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death. Follow proper procedures at all times!
### Section C

**MACHINE SAFETY**

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3.1 Protective devices and accessories for machine safety

3.1.1 Overview
The machine system has many built-in safety features. Owners and Operators should make themselves familiar with the function and purpose of each feature and make sure all of the features are enabled. Owners and Operators should never attempt to defeat, bypass or disable any safety features. If any of the features are defeated or become disabled, the machine should not be operated until corrective action is taken and all safety features are restored.

3.1.2 Emergency-Stop (E-Stop)

Use the emergency stop when injury may occur or human life is in danger from continued operation of the machine. This provides the quickest, most sure way to stop the machine. Due to the large inertial forces of the Crushing Plant and Crushing Plant parts and components, the machine can not be stopped abruptly.

Large red emergency stop buttons are typically located in control panels near the vicinity of danger points.

Emergency stops can be, and often are, in the form of pull cords that run parallel to conveyors and surround hazards.

WARNING
On large complex systems, the E-stop may control only those components that are in the immediate area.

CAUTION
Emergency stop not only stops the machine but often it may initiate other protective sequences.

Note: It may be necessary to engage reset switches before movement can resume.

3.1.3 Safety interlocks
A safety interlock is a device that will interrupt the supply of electricity, hydraulic oil or compressed air to an actuator or motor. A machine already in operation may need to stop quickly due to Operator error, safety violations, or an unexpected machine event. For example, a safety gate may be interlocked to stop a machine if the gate is opened while the machine is running.

Interlocks can also be used to prevent sudden unexpected movement of a machine function or component.

During operation, the logic system (i.e. programmable logic controller, microcontroller, relay system or similar device) controls the functions of the machine. Interlocks built into the system employ limit switches and other sensors to help assure proper machine operation.

THEREFORE IT IS IMPORTANT THAT INTERLOCKING ARRANGEMENTS ARE NOT REMOVED, MODIFIED OR BYPASSED, AND THAT THEY ARE CORRECTLY ADJUSTED. LIMIT SWITCHES, AND OTHER SENSORS MUST BE KEPT IN GOOD WORKING ORDER.
Electric Motors

Electric drives and motors may be controlled to stop or reduce speeds, as determined by the safety interlocks at a particular location.

Hydraulic System

Components that help protect the hydraulic system include certain valves, such as hose burst valves, pressure relief valves, counterbalance valves and pilot-controlled throttle valves as well as pressure transducers and drain valves for pressure accumulators. Metso uses these components where applicable in the hydraulic systems to minimize the potential for hazardous situations to occur.

A hose break valve functions to lock up if fluid flow is discharged too rapidly from an actuating cylinder, as happens if a hose breaks and the loads react to gravity.

The pressure relief valve prevents the system pressure from rising beyond system capabilities. It helps protect the entire fluid system and any operators in the vicinity from bursting hoses and components.

The pilot-controlled throttle valve helps prevent uncontrolled actuator movements.

Pressure transducers monitor the system pressure for information or control purposes.

Safety Gates

Some safety gates are designed so that opening or closing of the gates will prevent or stop a specific machine function in that area. Hydraulic, hydraulic or electric limit interlock switches may cut off the drive or actuator power or initiate an emergency stop mode.

For specific operation, see later sections of this manual.

WARNING

Safety gates must not be opened during normal machine operation. Exceptions to this rule are defined in the operating instructions.

Safety gates may also be opened for maintenance purposes when the machine has been stopped. Follow all lockout procedures.

Cable Switches

Cables or ropes connected to the electrical switches can be used as interlocks also. They may stop machine function in areas where control panels cannot be closely located but where Operators may be working. Know the locations of e-stop pull cords for conveyors.
3.1.4 Additional warning devices
Horns and Lights

If visual contact between work places is obstructed or if communication is difficult, sound and/or light signaling devices may be used before starting the machine or a machine function. The warning device for start-up should operate so that personnel are given sufficient time to move to a safe distance from the machine. It is the responsibility of the Owner to ensure that the Crushing Plant is always equipped with required horns and lights.

Safety Signs and Labels

Safety signs have colors to determine the degree of hazard in particular areas. These signs must not be removed. Temporary placement of safety signs and danger tags should also be used on the control panels to warn of maintenance work and lockout situations.

Obey all warning and safety signs on the machine and in the manual.

Safety Warning Colors
Color of safety warnings are typically safety yellow.

3.1.5 Walkways, service platforms, ladders and railings

The design of walkways, ladders and railings follow standards and regulations for the application. The walkways provide access to the machine. Safe operating procedures must be followed when on walkways. Never stand, walk or climb in or on any area of the Crushing Plant not designated for such activity. If an area of the Crushing Plant must be accessed and cannot be reached by designated walkways, ladders, or platforms, then the Owner and Operator must make all necessary arrangements for safe access to the area, including but not limited to safe lifting devices and fall protection.

CAUTION

Extreme caution must always be used on machine walkways.

3.2 Transport

Observe the following precautions before transporting the Crusher Plant:

1. Chock chassis tires securely whenever connecting or disconnecting chassis from tractor or dolly.
2. Check tire pressure. Use a protective cage or a clip-on type air chuck and remote in-line valve and gauge when inflating tires. Never exceed maximum inflation pressures of the tire or rim.
3. Check tightness of wheel lug nuts before transport and check frequently during transport.
4. Check that brake system operates correctly.
5. Observe maximum axle and tire loading capacities.
6. Protect components being transported using appropriate shipping braces and blocking material.
7. Travel may be limited to daylight hours only, depending on your specific plant and applicable status regulations.
8. Follow recommended limits on towing speed.
9. Make sure all lights are on and that they are operating correctly.
10. Use traffic warning flags, signs and lights as required.
11. Before moving the Crushing Plant, check all roadways and bridges on the route for weight limits.
12. Check clearance of bridges, overhead lines and other overhead obstructions.
13. Follow all applicable laws and regulations.

3.3 Towing
Observe the following precautions before towing the Crusher Plant or its components:
- Check if towing is allowed for each individual equipment.

3.4 At the work-site

3.4.1 Precautions
Observe the following minimum precautions at the work-site:
1. Know the locations of underground and overhead powerlines and other potential hazards.
2. Select the work-site with care. The ground must be firm, level and able to support the weight of the entire plant. Make sure there is enough room for loading ramps, loaders, conveyors, etc. and for safe maneuvering of trucks and loaders.
3. Check that cribbing is secure and that plant has not shifted or settled.
4. Make sure that electrical cables are protected from wear and traffic.
5. Follow pre-operation checks and start-up procedure covered in the individual manual supplied with your specific unit equipment.

3.4.2 During operation

Keep watch
Do not rely too much on automated systems. Observe Crushing Plant equipment while the system is running. Pay attention to unauthorized persons approaching the site as well as any unusual behavior of the equipment (uncommon noise, vibration, smell, reduced output, etc.).

Clearing
Crushers Plant equipment can become plugged and stall because of power failures, surges of material or other unplanned events. Clearing Crusher is potentially very hazardous. Shut down the system completely, lock and tag out all applicable controls and follow all instructions in the instruction manual of your specific crusher.
Section D

SAFETY DURING MAINTENANCE AND REPAIR

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4.1 **General information and safety lockouts**

Detailed instructions for the operation of the machine can be found in following sections of the manual. Because each machine section may incorporate unique functions, some of which may be automated, maintenance personnel should be knowledgeable of the operation of the machine sections in order to perform the maintenance and repair work as safely as possible.

**DO NOT COMPROMISE SAFETY DUE TO TIME PRESSURES.**

**FOLLOW ALL CRUSHING PLANT SAFETY AND FIRE PREVENTION PROCEDURES.**

Before starting any repair, maintenance or troubleshooting work on the machine, ensure the following:

- If you have not been trained to perform the required repairs, maintenance or troubleshooting, or you are unsure how to safely perform the activity - STOP! Never attempt to repair, maintain or troubleshoot any aspect of the Crushing Plant unless you are thoroughly trained for the activity and understand how to perform the activity in a safe manner.

- Be sure to coordinate all repair and maintenance work with other Crushing Plant operations.

- Use lockout and warning signs to inform others that maintenance and repair work are in progress. These signs should only be removed (after all work has been completed) by the person who has placed them there.

- Transmit all knowledge of the maintenance work to the succeeding shift.

- Know the whereabouts of all personnel in, on, at and around the machine.

- Never service any machine or component without first referencing its maintenance manual.

- Before handling chemicals, refer to the MSDS (Material Safety Data Sheets) and Crushing Plant procedures for handling of these materials.

4.2 **Mechanical safety during maintenance and repair**

4.2.1 **General**

**DANGER:** FOLLOW ALL ESTABLISHED LOCKOUT PROCEDURES. REFER TO THE APPROPRIATE STANDARDS.

For repair, maintenance or troubleshooting work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures. The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the instructions and use the proper equipment.

Remember:
- Follow procedures.
- Stay alert.
- Do not take anything for granted.
- Verify lockout.
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death. Follow proper procedures at all times!
4.2.2 Fire Safety During Maintenance And Repair

Observe all regulations on fire safety. Sources for fires include, but are not limited to the following:

- sparks from grinding
- flames and molten metal from welding or torching
- electrical arcing
- spontaneous combustion
- smoking.

Before starting any work take the following steps to prevent a fire hazard:

- Properly dispose of rags with combustible material to avoid spontaneous combustion.
- Move flammable materials 10m (33ft) or more away from any fire hazard.
- Clean up all debris.
- Clean up all oil spills and leaks.
- Remove any source of flammable gases, liquids or solids.

- Use proper electrical grounding techniques for welding.
- Provide adequate fire extinguishing equipment; inspect such fire equipment regularly.
- Arrange for qualified personnel to guard against fire while welding, cutting, or heating operations are being performed, as well as a sufficient period of time after the work is completed.
- Protect yourself and others from sparks with proper personal protective equipment and clothing.

4.2.3 Preventive Maintenance

Preventive maintenance will both increase safety and be economically beneficial. It is more safe and economical to replace a worn part during a scheduled shut-down than to repair a broken device in the middle of a production cycle. A machine or device that is not in proper condition, and that has been left without regular maintenance and inspections, is a safety risk for its user. For instance, without lubrication a bearing may fail, bringing a production line down. Furthermore, the hot bearing may present a fire hazard or cause skin burns.

Some preventive maintenance suggestions for a machine include:

- observing the maintenance and lubrication instructions of the machine and equipment suppliers
- keeping the machine and surrounding area clean and orderly
- monitoring the vibration levels of the machine and to help predict bearing failures
- monitoring the power consumption of motors to help detect early failures
- repairing all leaks as soon as possible to prevent more serious conditions that eventually may occur
- monitoring the condition of pipes and tubes enclosed in ducts; repairing possible leaks

IMPORTANT!
Be sure all mechanical components are brought to a zero energy status including all spring driven devices, cylinders, accumulators, drive shafts, pulleys, rollers, gears, etc., prior to entering the machine and performing the work. Never attempt to perform repair, maintenance, or troubleshooting work on or in proximity to energized mechanical components.

IMPORTANT!
Block up and support parts as necessary to prevent any unexpected motion when performing maintenance.
4.2.4 Confined Spaces

A confined space means a space that:
1. is large enough and so configured that a person can enter and perform assigned work; and
2. has limited or restricted means for entry or exit (for example, the crushing cavity, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
3. is not designed for continuous employee occupancy.

Certain confined spaces may require an entry permit program to allow entry. Be sure that all applicable procedures are followed. If you have questions contact your Crushing Plant supervisor for more information.

4.3 Electrical safety during maintenance and repair

DANGER

Confined spaces may contain high concentrations of gases which may cause injury or death. Follow all established safety procedures.

4.3.1 General

DANGER

Follow all established lockout procedures.

For maintenance work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures. The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:
- Follow procedures
- Stay alert
- Do not take anything for granted
- Verify lockout
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

WORK TO ELIMINATE INJURY AND DEATH. FOLLOW PROPER PROCEDURES AT ALL TIMES!

Be sure all electrical components are brought to a zero energy status including capacitors and similar electrical devices.

Before maintenance work:
- Be sure all control power supplies are turned off, disconnected, and lock out procedures have been followed.
- Confirm that ALL power sources are disconnected. Some electrical devices may be supplied by more than one power source.
- Be aware that multiple voltage levels may exist in some junction boxes.
Ensure that during lockout procedures, locks and signs are appropriately attached, and subsequently removed only by the person who installed them after all work is completed. Follow Crushing Plant lockout instructions for placement and removal.

For testing and troubleshooting, clear all personnel from the machine just as though the machine were being returned to production mode. Reactivate the necessary power supplies and perform the tests. Then again disconnect all power supplies and follow lockout instructions before further maintenance work is performed.

Be sure electrical supply voltage is disconnected before drilling into any structural frame members. Electrical cables may be inside.

Verify that electric motors are disconnected before starting any maintenance work, thereby preventing the supply of electricity to the motor. Generally the disconnects are located in the drive control room. Each person performing maintenance work should install their lock and sign the lockout tag.

**4.3.2 Electrical Fault Situations**

Electrical faults may be caused by component failures such as loose or damaged wiring. Diagnostics are provided through pilot lights, alarms, and help messages.

**IMPORTANT !**

Electrical connections can and do loosen due to vibration in transit and thermal expansion of the wires and lugs in operation. This is especially true after initial delivery, break in and after major relocation. Loose connections increase current draw, which can result in false trips, intermittent circuits, and burned-out components. As part of the start-up, check and retighten as necessary all electrical connections in the electrical enclosure. Repeat after the first forty to fifty hours of operation. This work must be performed by properly trained personnel.

**IMPORTANT !**

Improper phasing will damage backstops in conveyor drive reducers and may damage hydraulic system components.

**4.3.3 Program Changes**

**WARNING**

Changes to Metso supplied control program should be made only by Metso personnel. Faulty program code may cause the machine to behave unexpectedly. Any changes to interlock circuitry must be made with extreme caution and be reviewed and approved in writing by Metso before implementation.

An electric outlet may be supplied in the logic center and control cabinet for programming purposes only. Do not connect any electrical tools to this outlet. The tool may cause electrical disturbances in the machine control system. This could alter the machine control program and cause unpredictable machine operation.

**NOTE :** Do not use the logic center or control cabinet’s outlet for anything other than a programming device!
4.4 Hydraulic safety during maintenance and repair

DANGER
Follow all established lockout procedures.

For maintenance work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures.

The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:
• Follow procedures.
• Stay alert.
• Do not take anything for granted.
• Verify lockout.
• Tag must identify the work being done and the person(s) who locked and tagged the control.
• Locks and tags are changed with each shift that comes on.

WORK TO ELIMINATE INJURY AND DEATH. FOLLOW PROPER PROCEDURES AT ALL TIMES!

Before proceeding with any repair, maintenance or diagnostic procedures on the hydraulic system, bring all components to a zero energy status, including cylinders, accumulators, spring loaded hydraulic devices, circuitry between valves and actuators, etc.

- Mineral and other oils and additives can cause skin irritation. Inhaled oil mist can also cause internal irritation, headache or nausea. Avoid repeated exposure to these materials. Use appropriate personal protective equipment.

- Purge entrapped air from the hydraulic system. Entrapped air in the hydraulic system can cause erratic and unexpected movements.

- Oil mist in the work area or oil leaking onto floors and walkways will cause a serious risk of slipping. Clean up all spills and repair leaks immediately.

- Hydraulic oil temperature may be extremely high.

WARNING
Elevated temperatures levels can be hazardous and may cause severe burns. Wait until machine cools down before doing maintenance or repair.

- A mixture of air and oil mist may explode at higher temperatures. Hydraulic oil spilled on hot machine surfaces may start a fire.

- Pressurized hydraulic hoses should not be handled with bare hands since high-pressure leaks may easily penetrate the skin. Hydraulic fluid pressure in the hoses may exceed 3000 PSI/210 bar/21MPa.

WARNING
Risk of personal injury due to high pressure fluid jets. Do not check for pressurized leaks with bare hands. Use cardboard or other appropriate techniques.

Hydraulic hoses are subject to wear and tear. Pressurized hoses tend to straighten up, bend or twist due to reaction forces. Replace all weakened or deteriorated hoses promptly. Keep hoses properly clamped and secured to help prevent being whipped by broken hoses.

- Avoid letting dirt and other impurities into the system while doing maintenance work. Use lint free cloths for cleaning the hydraulic components system.

- When changing a cylinder, or other hydraulic device, plug all open ports and hose ends. Catch spilled oil in a suitable storage device and avoid introducing dirt into the system. Dispose of all waste fluids as presented by law.
Tighten disconnected pipe and hose couplings immediately after reinstallation. Before finishing the work, check all parts and connections that have been serviced or repaired.

Before starting up the pumps, make sure that maintenance work is completely finished in all work areas. When starting up the pumps, stay at a distance from the areas which were repaired.

Before opening the main valves, make sure that there is no one working between any parts of the machine, since pressurization of the system may cause machine motion.

Once the system is in the pressurized status, test repaired system for proper operation before putting system back into production.

Check the system for possible leaks after repair. Leaking fittings must not be tightened when under pressure. To seal threaded fittings, use appropriate sealing rings or a sealing compound suitable for hydraulics.

4.5 General maintenance work

The following are some of the do's and don'ts to be followed as part of normal Crushing Plant procedures:

- Do not perform any maintenance on moving machinery. This includes such items as adding lubricating oil or greasing parts while the crusher is in operation.
- Never clear a jam on or in the feeder, crushing cavity or conveyors when system is energized.
- Do not put hands or feet on the release cylinders, which protect the crusher from tramp iron overloads while the crusher is in operation.

- Do check the manufacturer's recommendations for periodic maintenance procedures. These maintenance procedures are designed to not only avoid damage to the equipment but also to avoid harm to the Operator.
- Do avoid spillage around the crusher. Operator should make it a habit to keep the area immediately adjacent to the crusher free from spillage, which could cause people to trip and fall.
- Never look into the crushing cavity while crusher is in operation.
- When using a crane or other lifting device to raise or lower a load keep all personnel clear of the area.
- Never detach a lifting device from its load until the load is securely affixed at its designation, or steps have been implemented to prevent the load from unintended shifting or falling.
- Never walk, stand, crawl or lay under any load hanging from a crane or other lifting device.
Section 0

SAFETY

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0.1 Personnel safety

0.1.1 General

This portion of the instruction manual is intended to illustrate only basic safety procedures. Additional precautions may be necessary for the safe operation of a crusher. The information contained in this manual is not intended to replace safety codes, insurance requirements, federal, state and local laws, rules and regulations.

SAFETY of the operator and maintenance personnel is of prime concern. These paragraphs are presented as a helpful guide to construction equipment personnel and shows some of the daily work problems which they may encounter.

It is the responsibility of the operator to know what specific requirements, precautions and work area hazards exist and to discuss them with his supervisor. A common understanding should be reached by all personnel to assure safe performance in operating the equipment.

The operator is the key to safe job performance and should study these safety tips to be aware of basic safety precautions to help prevent serious injury and damage to property.

0.1.2 Stop accidents before they stop you!

In order to alert you, the user, and those entrusted as operators and maintenance personnel, dangerous or hazardous operations are shown in this instruction manual with WARNING notes.

The safest machine must still be operated with care and with knowledge of its performance capabilities. The most comprehensive safety program must still be followed.

Remember that on any job, you are the key to safety. Good safety practices not only protect the men around you, they are your own best protection. Study this manual and any manufacturer’s operator’s manuals covering your specific equipment. Read all "WARNING" and "CAUTION" instructions.

Practice safe operation.

INSIST THAT YOUR FELLOW WORKERS DO, TOO. BE ALERT TO POSSIBLE HAZARDS BEFORE THEY CAUSE TROUBLE, AND REMEMBER . . . SAFETY IS UP TO YOU!!!

0.1.3 Do you know your employer’s safety program?

Company safety records show that the greatest percentage of accidents are caused by disregard of simple safety rules. Know observe the overall program and consult your supervisor for specific instructions when starting a job.

0.1.4 Are you dressed properly for the job?

You may need any number of special items: safety hat, safety shoes, safety glasses, goggles, heavy gloves, ear protective devices, etc..., for your own protection. Find out what items are required and wear them!

Loose clothing can catch in moving parts. Keep sleeves buttoned, jackets belted and wear your special safety equipment. Keep warm without restricting your movement. Wrist watches and rings can be dangerous. Keep your pockets free of objects which may fall out.

0.1.5 Do you understand your machinery?

READ THE MANUAL furnished with your equipment to learn its operating and maintenance characteristics, capacities and limitations. Learn the location and function of all controls, indicators, warning devices and caution instructions. Learn to recognize the machine’s warning and safety devices. They will alert you to conditions such as low pressure or high temperature that may make it hazardous to continue operating.

0.1.6 Do you have knowledge of working areas?

Learn beforehand as much about your working area as possible:

Be a good housekeeper. Keep the floor clean, free of oil, grease, rags, cables, chains, buckets, rocks and other hazards. Keep loose parts in a tool box. Use only non-flammable solutions for cleaning.
Know the weight limitations for any floors on which you will operate.

Know the clearances in the work area. A little time spent checking side and overhead clearances, including power lines, can save a lot of trouble later.

Be careful of dust, smoke or fog, which may obscure your vision.

**0.1.7 Are you prepared for emergencies?**

Plan ahead, stay alert, operate sensibly and you will avoid both having and causing personal injury and accidental equipment damage. If a careless moment does cause an emergency react quickly with the tools and skills at hand. Know the location of and how to use a fire extinguisher and a first aid kit.

Know where to get prompt assistance. An emergency calls for fast action.

Don’t stop your safety program with these general rules. Be equally conscious that specific working conditions and your particular equipment can require additional precautions.

**0.1.8 Before starting check**

Equipment not properly prepared for operation is unsafe equipment. Run a careful check at the beginning of your shift. If you find something that needs attention, THINK TWICE before deciding to "let it go this time". Even minor mechanical defects can lead to personal injury and accidents.

1. **DO NOT** allow unauthorized personnel to operate the crusher!
2. **MAKE SURE** all guards and other protective devices are in place, secured and not damaged.
3. **CHECK** fluid systems: Are they at the correct level and completely leak free?
4. **CHECK** every drain cock, valve and fitting to be sure it is in place and secure.
5. **LOSS of pressure** from low fluid levels may lead to serious hydraulic failures.

6. **CRUSHER SEIZURE** from lack of oil or grease is a problem that may cause accidents.
7. **NEVER** adjust pressure relief valves to get higher operating pressures. The manufacturer’s recommended pressures give the safest performance with the longest life.
8. **NEVER tamper with safety devices.**
9. **CHECK** the crusher thoroughly for visual defects, such as leaks, worn hoses or loose parts.
10. **INSPECT** your machine according to the operator’s manual and your supervisor’s instructions.
11. **BEFORE STARTING** walk completely around your machine. Make sure there is no-one next to, under or on the machine. Warn any personnel nearby that you are starting up.

REPORT ANY DEFECTS TO YOUR SUPERVISOR.

**0.1.9 Start-up safely**

1. **CHECK** equipment for warning tags.
2. **FOLLOW** the recommended starting procedures as outlined in Section 3, "Operating instructions".
3. **AFTER** crusher has been started, check all gauges and instruments to be sure that everything is operating properly.
4. **SHUT DOWN** immediately if any improper readings are observed.
5. **TEST** all controls for proper functioning.
6. **LISTEN** for and report any unusual noises.
7. **RECHECK** alarms or other warning and safety devices.
8. **DO NOT stand** on the adjustment ring while the crusher is running.
9. **DO NOT lean** or place your hands on or against the tramp release cylinders or between the adjustment ring and main frame while the crusher is in operation.
10. **DO NOT** take a chance with a defective machine. REPORT IT TO YOUR SUPERVISOR.

11. **DO NOT** look into crushing chamber while crusher is operating without protection.

### 0.1.10 Report a defective machine

Inspect your machine daily, check for loose, worn or damaged parts. Report or correct any unsafe conditions immediately and do not operate the machine until they have been corrected.

Even a minor defect can become serious, report any machine defects to your supervisor.

### 0.1.11 Stopping safely

Be sure crusher is stopped before cleaning, servicing, lubricating, checking belt tension, removing housing covers, working on the hydraulic system, making repairs, or attempting to clear a plugged cavity. MAKE NO CHECKS, ADJUSTMENTS OR REPAIRS OF ANY KIND WHILE THE CRUSHER IS IN OPERATION.

### 0.2 Tips for safe maintenance

Perform maintenance with care.

#### 0.2.1 Read and understand

1. Instruction manual furnished with the crusher, especially section 3, "Operating instructions".

2. Instructions for inspection and maintenance located at the rear of section 3, "Operating instructions".

3. Warning plates provided on the machine.


5. Lubrication guides for periodic servicing also at the section 4.

#### 0.2.2 Warning tags

Before working inside a crusher, be sure to tag and lockout the electrical controls so no one else will start it.

Attach warning tags to prevent accidents:

1. If crusher is unsafe for operation.

2. If controls are being serviced.

3. If machine is being repaired.

### 0.2.3 Lockout electrical service

1. Always lockout all electrical controls before performing any type of maintenance work on the crusher.

2. When servicing the hydraulic power unit, lockout the electrical service to the power unit as depressing the "STOP" button will only stop the motor.

3. Provide each maintenance man with his own personal padlock and ONE key.

### 0.2.4 Clothing - safe practice

1. KEEP HANDS AND CLOTHING AWAY FROM MOVING PARTS. Do not take chances by wearing loose sleeves, floppy ties, watches and rings.

2. WEAR EYE PROTECTION when handling fuel, cleaning fluid, oil or brake fluid. THESE MATERIALS CAN DAMAGE YOUR EYES.

3. WEAR A RESPIRATOR when required.

4. WEAR SAFETY GLASSES when drilling, grinding or hammering metal.

5. KEEP YOUR POCKETS FREE of objects which can fall out and into machinery.

6. WEAR HARD HAT AND SAFETY SHOES, when required.

7. WEAR GLOVES to protect your hands when changing cables.

8. WEAR SAFETY GLASSES AND PROTECTIVE CLOTHING when using high pressure air.

9. WEAR GOGGLES AND PROTECTIVE CLOTHING when handling molten metals; zinc, babbitt, lead, etc...
10. **Wear ear protective devices** when required or reduce exposure time as required.

### 0.2.5 Alcoholic beverages and medication

1. Do not use alcoholic beverages before coming to work or while on the job.
2. Beware of medicines, tranquilizers or other drugs which can make you sleepy or less alert.

### 0.2.6 Work area

1. Promote good housekeeping, keep the floor clean and dry, free of debris and tools. Oily and wet floors, steps and hand rails are slippery. In winter, watch out for ice and snow. Wet spots, especially near electrical equipment, are dangerous.
2. Do not let material lay and build up on or around the crusher.
3. Store dangerous fluids in a suitable place away from unauthorized personnel.
4. Never start a diesel or gasoline engine within an enclosed area unless there is adequate ventilation. Exhaust fumes can kill.
5. Take appropriate precautions when torch cutting or welding. Anyone performing these types of procedures should avoid breathing the fumes because they may pose a health hazard. Such procedures should be done outdoors in a well ventilated area with either a separate clean air supply provided to the mechanic or with local exhaust of fumes. Please refer to the local legislations.

### 0.2.7 Equipment

1. Use the proper tools; handle tools and heavy parts sensibly.
2. Keep all tools and equipment free of dirt, oil and grease. Do not drop or toss them.
3. Use hoisting equipment for heavy lifting. Save your back.
4. Lower parts, do not drop them.
5. To prevent slipping, wipe hand levers and knobs clean of oil or grease.
6. Do not use sheaves with cracked rims or spokes.
7. Check for missing, cracked or frayed V-belts.
8. Check for broken, defective or missing parts and replace them. Keep equipment clean and free of dirt and oil so you can spot loose or defective parts.
9. When using cables to move a load, be sure cables are of adequate size and replace any worn, badly frayed, broken or kinked ones.

### 0.2.8 Fire hazards

1. Do not smoke while refueling or when handling fuel containers.
2. Shut off engine when refueling and use extra caution if engine is hot.
3. When pouring fuel into the tank, ground the funnel or spout against the filter neck to avoid static electric spark.
4. Do not use gasoline or diesel fuel for cleaning parts. Good commercial, non-flammable solvents are preferred.
5. Do not smoke while using cleaning solvents.
6. Do not let greasy, oily rags accumulate in a poorly ventilated area. Store oily rags and other combustible material in a safe place.
7. Never use an open flame to check fuel, battery electrolyte or coolant levels or to look for hydraulic leaks anywhere on the equipment. Use a flashlight!
8. Know where fire extinguishers are kept and how they operate and for what type of fire. Check regularly at least monthly to be sure it is in the working area.
9. In the event of a fire, shut down the crusher hydraulic power unit and lubrication system if this can be safely done.

0.2.9 Pressurized systems - hydraulic or air
1. Relieve ALL pressure before opening or removing any hydraulic or air pressure lines, valves, fittings, etc...
2. Check for worn hoses or damaged lines.
3. High pressure oil can be dangerous.
   The machine is fitted with hydro-pneumatic accumulators governed by national regulation obliging sometimes with periodic controls.

0.2.10 Use quality parts
A replacement part for any item should always be of comparable SIZE, TYPE and QUALITY as the part being discarded.

0.2.11 Report necessary repairs
If your daily check uncovers any item that needs attention repair, replacement or adjustment REPORT IT NOW!
The most minor defect could result in more serious trouble IF THE MACHINE IS OPERATED.
Only perform the work you’re authorized to do. Do not attempt repairs you do not understand.
Only work on equipment you thoroughly understand a pressure-loaded part, if carelessly released, could injure anyone in its path.
Remember you are entrusted with the operation and maintenance of a highly valuable piece of equipment. TREAT IT AS SUCH!

0.3 Plant safety

0.3.1 General
The safety procedures mentioned here do not eliminate all safety hazards found in the area of crushing plants. However, they do highlight some of the procedures which have been found through long experience to improve safety conditions around crushers and crushing plants. Metso Minerals will welcome inquiries regarding other suggested safety procedures to use around their crushers and related equipment.

0.3.2 Drive Guards
Proper safety precautions start with the initial installation of the crusher. Crushers are driven either by V-belts or by direct couplings to motors. THE BELT DRIVE OR COUPLING SHOULD HAVE A PROTECTIVE GUARD AROUND IT.
Crusher sheaves in particular are designed for maximum rim speeds. If these speeds are exceeded, it is possible that the sheave could explode and cause severe injury or even death.
Since the speed of the crusher is quite important for proper operation, most V-belt drive guards usually have a small opening immediately opposite the center of the crusher drive shaft so that a tachometer can be inserted to occasionally check the speed of the countershaft. This opening should be covered with an access door or hatch.

0.3.3 Operator’s platform
Since periodic inspection and maintenance must be performed on each crusher, IT IS IMPORTANT THAT SOME TYPE OF PLATFORM BE ERECTED AT A LEVEL CONVENIENT FOR THE MAINTENANCE MEN WHO MUST INSPECT AND WORK ON THE CRUSHER. A good operator’s platform constructed of «solid» floor plate should have hand railings, toe plates and wire mesh or expanded metal between the platform and the top of the hand railing to prevent tools from dropping off the platform and hitting someone working below. Do not fasten the operator’s platform to the adjustment ring as the entire adjustment ring raises or lifts very quickly when trap iron passes through the crusher.
0.3.4 Electrical lockout
THE ELECTRICAL POWER SOURCE FOR THE CRUSHING EQUIPMENT SHOULD BE LOCKED OUT WHENEVER ANYONE IS WORKING ON IT.

Each maintenance man who normally works on a crusher should be provided with his own personal padlock with only one key. When he works on any assembly of the crusher, he should use this padlock to lock out the electrical controls for the crusher. It is most important that only one key be provided for the lock and that key must be in the pocket of the person who is working on the crusher. If more than one person works on the crusher, each should have his own lock and key at separate lockout stations for the controls of the crusher. Accidental start-up of crushing equipment with men in the immediate area can be responsible for many accidents on what was supposedly a "clear" machine.

0.3.5 Cranes
Crushers, like any other type of mechanical equipment, require normal periodic maintenance if the operator is to get the most for his money from the use of the machine. One of the most flagrant crusher safety violations is the use of inadequate and unsafe lifting equipment. Although a crusher is not a finely tuned piece of equipment, such as an automobile engine, the internal parts of a crusher should be assembled and disassembled with crane facilities that have the capability of gently and slowly lifting and lowering the various parts that make up a crusher. WHEN USING A CRANE, ALWAYS OPERATE WITHIN THE RATED CAPACITY OF THE CRANE. THE SAFE RATED CAPACITY INCLUDES WEIGHT OF HOOK, BLOCK AND ANY MATERIALS HANDLING DEVICES SUCH AS CABLES, SLINGS, SPREADER BARS, ETC. SUBTRACT THE WEIGHT OF ALL THESE TO FIND THE TRUE WEIGHT OF THE LOAD THAT CAN BE HANDLED SAFELY. Chain falls should be considered only as a last resort to assemble and disassemble a crusher.

When it comes to safety, the best should be used.

0.3.6 Mobile cranes
WHEN USING A MOBILE CRANE, ALWAYS OPERATE WITHIN THE RATED CAPACITY OF THE MACHINE TO AVOID BUCKLING THE BOOM OR TIPPING.

Safe ratings are based on operating the crane on firm, level ground; outriggers should be properly extended and/or lowered whenever possible. Avoid fast swings, hoists or sudden braking; these can cause overloads. Do not handle large, heavy loads in strong winds.

When moving your crane, check bridges before crossing, make sure they will support the weight of the machine. Check clearances under bridges, for overhead electrical lines or any overhead obstruction.

Check your hitcher, be sure he’s clear before starting lift. Make certain he securely attaches the load.

0.3.7 Welding equipment
Precautions in general must be taken when torch cutting and/or welding due to the health hazards posed by many metals. Anyone performing these types of procedures should avoid breathing the fumes. Such procedures should be done outdoors or in a well ventilated area with either a separate clean air supply provided to the mechanic or with local exhaust of fumes. Please refer to the local legislations.

One of the most frequently used tools around the crusher is the cutting torch. Crushers which are equipped with hydraulic components should have these components depressurized and adequately covered with flame-proof material so that sparks, weld spatter, etc., cannot reach these areas. Ruptured high pressure hydraulic lines will quickly vaporize the hydraulic fluid as it reaches the atmosphere. This vaporized fluid can quickly become a mass of flames, resulting in severe burns for personnel in the immediate area.

ALL MAINTENANCE PERSONNEL WHO NORMALLY USE TORCH CUTTING EQUIPMENT SHOULD BE ADVISED IF THERE ARE HYDRAULIC COMPONENTS IN THE IMMEDIATE AREA IN WHICH THEY ARE WORKING. Then adequate precautions should be made to avoid contact.
with these components. Rubber lined hoses are not immune to the torch cutting equipment which is used in normal plant maintenance procedures.

**0.3.8 Lift gear**

All crusher components must be lifted by equipment permitting slow, even movements. **ALWAYS COMPLY WITH MAXIMUM LOAD REGULATIONS** for the equipment and remember to add the weights of hoisting accessories (such as chain, hooks, etc...) to the crusher weight.

**0.3.9 Conveyor belts**

**DO NOT WALK ON THE BELTS OF CONVEYORS.**

There must be footbridges with hand rails all along the conveyors.

**0.3.10 Portable plants**

If your crushing plant consists of portable equipment, that is, crushing and screening equipment mounted on trailers, trailer footing or cribbing is extremely important for safe operation. Check your footing. Your machine should be on as solid and level a footing as possible. Use heavy timber mats as needed. Trailers must be raised so that trailer wheels do not touch the ground. Place screw jacks at each corner of the trailer or as near the corner as possible. All four jacks must be an equal distance from each end. Adjust each jack until the unsupported portion of the trailer beams stop vibrating or until vibrations are reduced to a minimum. **NEVER leave your trailer in a low spot where rains may wash out your footing.** PERIODICALLY RECHECK TRAILER FOOTING FOR STABILITY.

When moving your trailer, check bridges before crossing, make sure they will support the weight of the machine.

Check clearances under bridges, for overhead lines or any overhead obstruction. **NEVER TRAVEL WITH NEAR CAPACITY LOADS, CHECK LOCAL LAWS, ESPECIALLY ON WEIGHT LIMITATIONS.** When traveling on the highway make sure all headlights, clearance lights and tail lights are on. Use proper traffic warning flags and signs.

**0.3.11 Crushing plant «noise»**

Crushing equipment by its very nature is noisy and the auxiliary equipment found in and around crushing equipment such as chutes, transfer stations, screens, etc..., can at times be noisier than the crusher itself.

Typical crusher acoustic power level while crushing is between 100 and 130 DBA. Ear protective devices may be required if noise levels are higher than those allowed by law. If ear protective devices are undesirable, consideration should be given to reducing the amount of noise exposure that an operator or maintenance man may be subjected to. In other words, shorter working hours.

Although alteration of the machinery to change its noise characteristics may be economically impossible, many operators have found that the installation of a relatively inexpensive operator’s station can improve noise conditions. The operator can see the equipment in operation and still be protected from the noise through the installation of accoustical tile, double windows, air conditioning equipment, etc. These working conditions will normally result in a more efficient operation and reduce potential injuries from noise.

Many plant operators are finding that an operator’s tower erected at an elevation above most of the equipment provides both safety features for the operator and increased efficiency in plant operation.

**0.3.12 Epoxy backing material versus zinc**

All crushers require some type of backing when replacing the crushing members. Resins such as Epoxy Backing Material have all but eliminated the possibility of workmen being accidentally burned due to molten zinc either spilling or exploding when it comes in contact with wet surfaces.

THE ENORMOUS DEGREE OF CONVENIENCE AS WELL AS THE HIGH SAFETY FACTOR INVOLVED WHEN USING PLASTIC BACKING AGENTS HAS
MADE THE USE OF MOLTEN ZINC FOR CRUSHER LINER BACKING OBSOLETE!

When epoxy backings are used, care should be taken when removing the liners with a cutting torch.

THE AREA SHOULD BE WELL VENTILATED BECAUSE EPOXY FUMES CAN CAUSE NAUSEA OR POSSIBLE EYE OR SKIN IRRITATION.

0.3.13 Crushing plant "Dust"

Crushing equipment and auxiliary equipment such as chutes, transfer stations, etc., can create dust. Breathing dust may be hazardous to the health of anyone working at, on, or around the equipment.

In general, high levels of dust in the air create a hazard of lung disease, depending upon the concentrations of dust, the length of exposure, and the type of material being crushed.

Metso Minerals highly recommends that dust-protective devices such as a respirator be worn by anyone exposed to airborne dust to prevent its inhalation.

It is the responsibility of the operator to determine the necessity and adequacy of such protective devices and warnings, to provide them, and to ensure that they are used and followed.

It is possible to reduce the amount of airborne dust by making alterations to the crushing circuit, such as the addition of a dust collection system, or the use of water spray bars at the feed and/or discharge conveyor. Crushing with a choke level may also reduce the amount of dust issuing from the crusher itself.

0.3.14 General maintenance work

A certain amount of work must be done in the immediate area of the crusher during the normal course of operations on a day-to-day basis.

1. DO NOT perform maintenance on moving machinery. This includes such items as adding lubricating oil or greasing parts of the crusher while it is in operation.

2. DO NOT put hands or feet on the tramp release cylinders which protect the crusher from tramp iron overloads while the crusher is in operation.

3. DO check the manufacturer’s recommendations for periodic maintenance procedures. These maintenance procedures are designed to not only avoid damage to the equipment but also avoid harm to the operator as well.

4. DO avoid spillage around the crusher. Crushers seem to attract odd size pieces of rock, gravel, etc... Plant operators should make it a habit to keep the area immediately adjacent to the crusher free from this type of spillage which could cause unsuspecting personnel to trip and fall.

5. NEVER LOOK into the crushing cavity while the crusher is in operation without protection from possible flying material.

6. WHEN USING A CRANE to raise or lower a load keep all personnel clear of the area.

7. NEVER walk, stand, crawl or lay under any load hanging from a crane.

0.3.15 Thermal Procedures

Follow appropriate safety precautions when handling dry-ice, liquid nitrogen, or any other cryogenics coolant when cooling various parts of the crusher.

Severe bodily injury can occur when proper precautions are not followed.

REMEMBER - SAFETY IS UP TO YOU!
Section 1

GENERAL INFORMATION ON THE CRUSHER

1.1 - Introduction .......................................................... 1-1
1.2 - HP cone crushers .................................................... 1-1
1.3 - Initial inspection ..................................................... 1-1
1.4 - Information included in this manual. ......................... 1-1
1.5 - Spare parts ............................................................. 1-1
1.6 - Terminology ............................................................ 1-2
1.7 - Crusher capacity ...................................................... 1-2
1.8 - Choice of liner and mantle. ................................. 1-3
1.1 Introduction

This maintenance manual is designed to help users and operators at crushing facilities on the operation and servicing of HP cone crushers. This manual explains how it is constructed and provides you with the information needed to operate it properly.

All our crushers are fully assembled and tested before shipment. However, certain precautions should be taken when using the crusher. These precautions, which are detailed below, are intended to prevent problems caused by improper use of the crusher.

You are strongly advised to read all sections of this manual, understand them and put them into practice.

1.2 HP cone crushers

This instruction manual applies to the following cone crushers: HP100, HP200, HP300, HP400 and HP500.

1.3 Initial inspection

A full check of the crusher should be carried out when it is delivered to identify any damage sustained in transit and check that all the parts are present. One should also check that nothing has been mislaid. The supplier should be notified immediately of any missing or damaged parts so that they can be replaced or repaired without delay.

1.4 Information included in this manual

The following diagrams of your crusher come with this manual:

1. Sketch of the foundations.
2. Pipework diagram for the crusher and lubrication system.
3. Diagram of auxiliary installations supplied with the crusher.
4. Any other drawings and information relevant to your facility.

A catalogue of spare parts together with all the assembly plans will be sent separately in due course, usually after delivery.

This manual presents and identifies the parts used to assemble the crusher.

1.5 Spare parts

Metso Minerals does its utmost to have a large stock of parts available at all times for rapid and efficient servicing, repairs and replacements. To avoid prolonged delivery times and incorrect shipments, please specify the following:

1. Size of the crusher.
2. The crusher's serial number stamped on its ID plate and on the spare parts manual.
3. The precise quantity of each requested part.
4. The full code name and code of the part as specified in the spare parts manual.
5. Comprehensive delivery instructions for the parcel by sea, rail, road or air.

If you have lost your manual, we will supply you with another one on request.

Only genuine Metso Minerals parts are mounted for optimal performance. They are guaranteed to be compliant, carefully manufactured and of quality.
1.6 Terminology
To avoid any confusion or misunderstanding, all the terms used throughout this manual to describe the crusher and its operation are defined below:

**FEED (or infeed):** the material to be crushed.

**BOWL LINER AND MANTLE:** the parts that crush.
- Fixed bowl liner.
- Mantle on the head.

**CRUSHING CHAMBER (or CAVITY):** the inner area enclosed by the bowl liner and mantle.

**PARALLEL ZONE:** when the bowl liner and mantle are closed, during rotation, their lowest parts are parallel over a short distance. This surface is known as the parallel zone.

**GRIP (closed end):** the shortest distance between the liner and mantle’s summits when they are closed during gyration.

**GRIP (open end):** the longest distance at the liner and mantle’s summits when they are open during gyration.

**GRADATION:** the distance between the bottom of the liner and mantle at the point where they are the closest to each other during gyration. This determines the size of the crushed product.

**MINIMUM GRADATION:** the shortest permissible distance between the bottom of the liner and mantle when they are closed.

**DISCHARGE OPENING:** the distance between the bottom of the liner and mantle in open position during gyration. This enables rapid discharge of the crushed material.

**PRODUCT SIZE:** size of the screened product after crushing.

**CAPACITY** (*output/yield/throughput*): crusher output expressed in tons per hour (TPH).

**OPEN-CIRCUIT OPERATION:** when regular product size does not matter, the product only passes through once.

**CLOSED-CIRCUIT OPERATION:** when regular product size matters; the product is screened at the crusher outlet and oversize particles are redirected to the crusher.

1.7 Crusher capacity
Factors to consider for optimal throughput and performance:
1. Choice of the crusher cavity (materials to crush).
2. Minimal segregation of grain size on intake.
3. Feed control
4. Even distribution of the material 360° around the cavity.
5. The discharge conveyor belt should be adequately sized.
6. Appropriate scalping and screening.
7. Automatic feed control
8. Adequate discharge area.

Factors impairing throughput and yield:
1. Sticky material in the feed.
2. Fines in the feed (over 10% of the material is undersize).
3. Excessively damp product.
4. High segregation rate on intake.
5. Uneven feed distribution.
6. No in-feed control
7. Inadequate motor power rating.
8. Inadequate conveyor capacity.
9. Insufficient scalping and screening.
10. Inadequate discharge area.
11. Very hard material that is difficult to crush.
12. Inadequate speed.

Throughput ratings in the sales catalogue are based on tests of numerous plants processing a wide range of materials. For a precise rating of your particular plant, please contact Metso Minerals.
1.8 Choice of liner and mantle

After intensive research and studies, Metso Minerals has developed a wide range of liners and mantles for a variety of products. However, working conditions vary so much that one cannot say with certainty what type of liner/mantle is best suited to a particular type of material or process.

If excessive wear of the bowl liner and mantle occurs for any reason whatsoever, we suggest that the bowl liner and mantle be cut and their outline traced on a sheet of paper and sent to Metso Minerals in order to determine the exact cause of the wear (see Figure 1-1).

Other liners and mantles of different shapes may be recommended.

In order to best advise you on the type of liner/mantle you require, we need to have the following details:

1. Dimension of the feed product.
2. Type of feed.
3. Desired size of the crushed product.
4. The circuit of the installation, with the square mesh of the screens and the gradation of the crushers.
5. Identification of the bowl liner and mantle.
6. Installed capacity.
7. Crusher throughput rates.

The crusher can be damaged by constantly working with an inadequately sized cavity in the liner and mantle.

---

**Table 1-1 Wear check**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cut out the mantle or bowl liner</td>
</tr>
<tr>
<td>2</td>
<td>Cardboard or thick paper</td>
</tr>
<tr>
<td>3</td>
<td>Trace the outline on a sheet of paper inserted in the cutout</td>
</tr>
</tbody>
</table>

---
Section 2

GENERAL INSTALLATION INFORMATIONS

2.1 - Installation plan ................................................................. 2-1
2.2 - Layout ................................................................................. 2-1
  2.2.1 - Installing the machine ................................................. 2-1
  2.2.2 - Anchoring ................................................................. 2-1
2.3 - Feed .................................................................................. 2-2
2.4 - Removing the crushed material. ................................. 2-3
2.5 - Control drive ................................................................. 2-4
2.6 - Installing a V-belt drive for the first time ................. 2-4
2.7 - Tautening the V-belts ....................................................... 2-7
  2.7.1 - Tension-Bending ....................................................... 2-7
  2.7.2 - Relative elongation ................................................. 2-8
2.8 - V-belts - precautions ....................................................... 2-10
2.9 - Initial alignment of a flexible coupling sleeve ......... 2-10
2.10 - Crusher drive motor. ...................................................... 2-12
2.11 - Piping information ........................................................... 2-12
2.12 - Information on assembling and dismantling the crusher ... 2-12
2.13 - General information on servicing. ......................... 2-13
2.14 - List of minimum recommended spare parts ......... 2-14
2.15 - Special tools ................................................................. 2-14
2.16 - Protecting the crusher against corrosion. ............. 2-23
2.1 Installation plan

Concrete blocks or steel constructions must be calculated and sized according to the dimensions and load factors specified in the installation documents.

The said calculations should also factor in the results of a preliminary study of the soil’s elasticity at the point of casting or construction.

2.2 Layout

2.2.1 Installing the machine

The frame’s bearings should rest on a flat, even surface.

Be sure to make allowance for:

- enough height to dismantle bowl and head assemblies.
- enough width to dismantle the regulator assembly.
- enough room for a hopper feed, chute and other auxiliary equipment, and for removal of crushed material, hopper, conveyors, servicing the crusher, etc.

2.2.2 Anchoring

When installing on a concrete block, the machine should be anchored to it with several fish-tail or hook anchor bolts.

These bolts transmit their tractive force to the concrete bonding by adhesion.

The concrete bonding transmits the force from the bolts to the concrete block. This force should travel from one concrete to the next through their dividing surface.

The anchoring key (where relevant) is only used to maintain the bolt and the part to be bonded until the concrete sets.

Concreting should be completed as soon as possible for slender constructions exposed to wind, in any event before the crusher is brought into service, because a hook anchor bolt is twelve times weaker before the concrete sets.

The anchoring key plays no part in the anchoring strength and a properly set bolt cannot buckle or stretch when the nut is tightened up.

As a general rule, concreting should be done in accordance with good practice and local regulations.
2.3 Feed

Crusher performance is directly proportional to the feed method; it can only achieve optimal performance if fed with an adequate amount of material evenly distributed in the cavity. For best performance, certain precautions should be taken in laying out the feed plant; for instance, it should be easy to dismantle to facilitate repair work on the crusher itself.

INCORRECT FEED
Here, the material is unevenly distributed, only falling down one side of the feed opening.
Uneven distribution causes:
1. Reduced output.
2. Irregular grain size of the crushed material.
3. Excessive adjusting ring bounce.
4. Excessive power consumption.

CORRECT FEED
Here the material is evenly distributed.
Uneven distribution causes:
1. Optimal output.
2. Properly graded material.
3. No minimum adjusting ring bounce.
4. Optimal power consumption.

Figure 2-1 Feed
Well-designed feeds should stop the material when it reaches the feed ramp so that it bounces up and falls vertically into the feed chute. This ensures even distribution over the feeder cone. Well-designed feed assemblies that take the feeder cavity into account ensure even distribution throughout the cavity. Segregation must be avoided at all costs to ensure even wear of the liner and mantle and thus maximum wear life. For short-head crushers, feed should be adjusted so that the material covers the cone feed plate. The material should spread across the entire crusher cavity. This feed system ensures high yield or better formed crushed product of a smaller grain size and considerable power savings. Feed intake assemblies are not supplied with the crusher because their design depends on the layout of each crusher.

**IMPORTANT:**

WHEREVER POSSIBLE, INSTALL A SIEVE UPSTREAM OF THE CRUSHER TO REMOVE FINE OR STICKY MATERIAL. THIS PREVENTS JAMMING WHICH CAUSES EXCESSIVE RING BOUNCE AND TIME LOSS. A MAGNETIC SEPARATOR MAY ALSO BE USED TO ANY REMOVE METALLIC PARTICLES THAT COULD CAUSE ADJUSTMENT RING BOUNCE.

THE CHARACTERISTICS OF THE FEED SYSTEM SHOULD BE SUCH AS TO MAINTAIN THE CRUSHER IN OPTIMAL OPERATING CONDITIONS.

IT IS IMPORTANT TO CONTROL THE FEED INTAKE SPEED IN THE CRUSHER. NEARLY ALL THE MATERIAL FALLING INTO THE CRUSHER CAN PASS THROUGH THE CAVITY ON THE OPEN SIDE. MATERIAL FALLING TO THE BOTTOM OF THE CHAMBER WITHOUT BEING CRUSHED WILL CAUSE RING BOUNCE AND DAMAGE THE SPAN OF THE FRAME. AN ADEQUATE HOPPER MAY BE USED TO SLOW DOWN THE SPEED OF THE FALLING MATERIAL IF THE FALLING DISTANCE IS TOO LONG. Figure 2-1 shows what to do and what not to do.

### 2.4 Removing the crushed material

The crushed material removal system is not supplied with the crusher because it too depends on operating conditions, which vary according to layout. The system in question, be it a hopper or dead-bed, should match the installation plan’s instructions. It should include a manhole to allow easy access for cleaning or inspection purposes. Wherever possible, a dead-bed is preferable to a hopper because it absorbs most of the kinetic energy before the material reaches the conveyor.

If a chute is used, it should be angled at more than 45°, or an even steeper gradient for very sticky material.

As indicated on the layout plan, there should be enough clearance for material removal between the crusher and the hopper on the one hand and the hopper and take-up conveyor on the other. This gap should allow the crushed material to flow freely.
2.5 Control drive

We normally recommend V-belt drives due to their ability to "filter" shocks transmitted from the crusher to the motor and withstand jerks without slowing down the crusher.

The drive belts may be 8V or SPC type and be separate or twinned. See Figure 2-2.

![Figure 2-2 Cross-section of belts](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single belt</td>
</tr>
<tr>
<td>2</td>
<td>Twin belt</td>
</tr>
</tbody>
</table>

Narrow belts have been designed to reduce the space required by the drives, thereby making savings on installation and reducing the load’s overhang at the shaft ends. Twin belts consist of single belts joined by a band to prevent whiplash and twist. They can be mounted on standard pulleys.

If the motor pulley is directly under the crusher or angled 30° from the vertical, the factory should be informed so that the countershaft ring can be correctly positioned.

Power can be supplied by an electric motor, a diesel engine or a hydraulic motor.

The crusher can also be directly coupled to the motor. All specific questions regarding the crusher drive should be referred to us.

2.6 Installing a V-belt drive for the first time

When installing for the first time or when changing belts, please follow these instructions:

1. Remove all traces of oil, grease or rust from pulley grooves.
2. Make sure the pulleys are properly aligned and the shafts are parallel.
3. Never force a belt around the pulleys. The pulleys should be sufficiently close together to allow the belts to pass easily.

To determine the minimum tolerances for shortening or lengthening the centre-to-centre distance between the pulleys. See Table 2-1.

Calculate the centre-to-centre distance for a standard length and slope, then make sure the resulting distance can be shortened by the length indicated in Table 2-1, for easier installation of the belts and to avoid any damage. A longer distance than the centre-to-centre distance should be possible to allow for lengthening and wear. This extra length is given in the last column of the table.
### SECTION 2 - GENERAL INSTALLATION INFORMATIONS

#### Figure 2-3 Installing the belts

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crusher pulley</td>
</tr>
<tr>
<td>2</td>
<td>Bring closer to the motor to mount the belts</td>
</tr>
<tr>
<td>3</td>
<td>Drive pulley</td>
</tr>
<tr>
<td>4</td>
<td>Move away from the motor to mount the belts</td>
</tr>
<tr>
<td>5</td>
<td>Spacing</td>
</tr>
</tbody>
</table>

#### Table 2-1 Installing belts, and tolerances

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crusher pulley</td>
</tr>
<tr>
<td>2</td>
<td>Bring closer to the motor to mount the belts</td>
</tr>
<tr>
<td>3</td>
<td>Drive pulley</td>
</tr>
<tr>
<td>4</td>
<td>Move away from the motor to mount the belts</td>
</tr>
<tr>
<td>5</td>
<td>Spacing</td>
</tr>
</tbody>
</table>

<p>| Minimum distances mm (inches) for mounting or dismantling the belts |</p>
<table>
<thead>
<tr>
<th>Length of belts * mm (inches)</th>
<th>Cross-section of belts</th>
<th>Minimum distance to tauten the belts</th>
</tr>
</thead>
<tbody>
<tr>
<td>from 2000 (79) to 2749 (108)</td>
<td>40 (1 1/2) 85 (3 3/8) 35 (1 3/8)</td>
<td>40 (1 1/2)</td>
</tr>
<tr>
<td>from 2750 (108) to 3499(138)</td>
<td>40 (1 1/2) 85 (3 3/8) 35 (1 3/8)</td>
<td>45 (1 3/4)</td>
</tr>
<tr>
<td>from 3500 (138) to 4499 (177)</td>
<td>40 (1 1/2) 85 (3 3/8) 35 (1 3/8)</td>
<td>55 (2 1/8)</td>
</tr>
<tr>
<td>from 4500 (177) to 5499 (216)</td>
<td>45 (1 3/4) 90 (3 1/2) 35 (1 3/8)</td>
<td>65 (2 1/2)</td>
</tr>
<tr>
<td>from 5500 (216) to 6499 (256)</td>
<td>45 (1 3/4) 90 (3 1/2) 40 (1 1/2)</td>
<td>85 (3 3/8)</td>
</tr>
<tr>
<td>from 6500 (256) to 7999 (315)</td>
<td>45 (1 3/4) 90 (3 1/2) 40 (1 1/2)</td>
<td>95 (3 1/2)</td>
</tr>
<tr>
<td>from 8000 (315) to 9999 (394)</td>
<td>50 100 45 (1 3/4) 45 (1 3/4)</td>
<td>110 (4 3/8)</td>
</tr>
<tr>
<td>over 10,000 (394)</td>
<td>50 100 45 (1 3/4) 45 (1 3/4)</td>
<td>140 (5 1/2)</td>
</tr>
</tbody>
</table>

* First length included up to last length not included.
4. Only use new, matching belts from the same source. Never use new and used belts together.

5. Fit the belts and make them run for a few minutes. Tauten the belts until the slack strand bends slightly during operation. See Figure 2-4. The slack strand depends on the position of the motor and the direction of rotation. An example of a taut and slack strand is shown in Figure 2-4. The slack strand side is determined by the position of the motor.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crusher pulley</td>
</tr>
<tr>
<td>2</td>
<td>Taut strand</td>
</tr>
<tr>
<td>3</td>
<td>Drive pulley</td>
</tr>
<tr>
<td>4</td>
<td>Slack strand (make a note of the deflection or sag of the belts)</td>
</tr>
</tbody>
</table>

*Figure 2-4 Determining the slack strand*
2.7 Tautening the V-belts

Tautening the drive is the term used to define the method consisting in creating a corner effect between the belt and the pulley’s groove. This corner effect lets the belts transmit the motor pulley’s force to the crusher pulley.

There are several ways of tautening the belts. We describe two simplified methods in the following paragraphs: Tension-Bending, and relative lengthening. Either method gives satisfactory results if properly implemented, and both have certain advantages for a particular type of belt.

2.7.1 Tension-Bending

1. Place a ruler at a tangent to the two pulleys. See Figure 2-5.

2. Measure the length of the tangent (free length of the belts).

3. With the aid of spring scales hanging from the centre of one belt, apply a perpendicular force to the belt in such a way that the belt's sag equals 0.016 (1/64) times the length of the tangent.

---

**Figure 2-5 Tension method**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ruler</td>
</tr>
<tr>
<td>2</td>
<td>1/2 length</td>
</tr>
<tr>
<td>3</td>
<td>Length</td>
</tr>
<tr>
<td>4</td>
<td>Sag = length/64</td>
</tr>
<tr>
<td>5</td>
<td>Traction</td>
</tr>
<tr>
<td>6</td>
<td>Drive pulley</td>
</tr>
<tr>
<td>7</td>
<td>Belt</td>
</tr>
<tr>
<td>8</td>
<td>Balance</td>
</tr>
<tr>
<td>9</td>
<td>Force (see table)</td>
</tr>
<tr>
<td>10</td>
<td>Crusher pulley</td>
</tr>
</tbody>
</table>
4. The force should be as indicated in Table 2-2.

Example
8V belt = SPC belts
Length of tangent (centre distance) = 1,575 mm
Bending force (table) = 15 - 22 Kg
Sag = 1,575 mm x 0.016 = 25 mm

Consequently, a new 8V-belt drive with a centre-to-centre distance of 1,575 mm should be tautened in such a way that it sags by 25 mm when a force of 15-22 Kg is applied.

5. After running for 2 to 4 hours, the drive should be tautened again to the upper limit of bending force.

6. After 24-48 hour, check that bending force is within the range given in Table 2-2. Tauten again if necessary. Excessively slack or taut belts will reduce durability and impair proper functioning of the drive.

AN ADEQUATELY TAUT V-BELT DRIVE MAY APPEAR TOO SLACK. HOWEVER, IT IS BETTER TO TRUST THE SPRING SCALES THAN YOUR IMPRESSION.

2.7.2 Relative elongation
This belt tensioning method has been devised for tensioning twin belts.

1. Tauten until the slack disappears (when stationary).

2. Wind a 10-15 metre tape measure around the belts and measure their length to within 1 mm. Make a note of it. See Figure 2-6.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length reading</td>
</tr>
<tr>
<td>2</td>
<td>Tape measure</td>
</tr>
<tr>
<td>3</td>
<td>Belt</td>
</tr>
</tbody>
</table>

Figure 2-6 Belt tension using the relative lengthening method


SECTION 2 - GENERAL INSTALLATION INFORMATIONS

Table 2-2 Bending forces

3. Multiply the measured length by the ratio given in Table 2-3, and add the result to the initial figure.

4. Tauten until the belt reaches this new length.

Example
SPC belt = 8V belt
Initial length = 3 048 mm (120")
Elongation ratio (see table) = 0.009 or 0.9%
New length = 3048 mm (120") initial length x 0.009 elongation ratio = 3048 (120") + 27 mm (1-1/16") or 3075 mm (121-1/16").

Table 2-3 Elongation factor

* Multiply these figures by the number of belts on the ply

*Single or twinned belts

Consequently, a new drive with belts having an overall length of 3 048 mm should be tautened until it is 3 075 mm long.

5. Check tension periodically and tauten if necessary, using the above method. We should point out however that the tension-bending method is the easiest.

Usually, slipping is the first sign of incorrect tension. Slipping causes a loss of power and speed at the crusher pulley and accelerated wear of the pulley grooves. Such conditions are usually accompanied by creaking and overheating of the belts and pulleys. These symptoms are clearly visible, audible and tangible.
2.8 V-belts - precautions

Here is a list of do’s and don’ts regarding the proper use of V-belts:

1. **Do's**. Check belt tension frequently during the first few days of operation. New belts are relatively stiff and require greater tension.

2. **Don'ts**. Excessive or insufficient tension also shortens the lifetime of belts and bearings. The tension should be uniform. The belts should appear taut when stationary. When in operation, the slack strand should be visible.

3. **Do's**. Ventilate the drive if it exceeds 60°C, otherwise it could suffer damaged. In this respect, the drive housing should have perforated or expanded metal side plates.

4. **Don'ts**. Oil makes the rubber swell and impairs its properties. Never let oil or grease come into contact with the belts.

5. **Do's**. Check the drive at regular intervals, in particular the following points:
   a. Crusher slows down: check tension.
   b. Uneven tension: check each belt.
   c. Excessive stretching: make sure it is not overloaded.
   d. The belts soften or swell: make sure it is not overloaded.
   e. The belts stiffen or crack: check for overheating.

2.9 Initial alignment of a flexible coupling sleeve

For direct control drives, when first mounting or remounting a flexible coupling sleeve, it is always advisable to align it for greater durability and minimum vibration. After mounting the two half-sleeves on their shaft ends, assemble and align them as follows:

1. Check the gap and angular alignment between the two half-sleeves at four points spaced out at regular intervals around the edge. See *Figure 2-7*. To take this measurement, use thickness gauges, a calliper rule or a comparator mounted on a magnetic base. The differences between the measured gaps should not exceed 0.38 mm. If any of the four measurements exceeds the others by more than 0.38 mm, this means that the sleeve is incorrectly aligned at an angle.

2. Check the alignment by placing a ruler on the lines of the outer diameters of the half-sleeves. Check at four equally spaced intervals. See *Figure 2-7*. Use thickness gauges or a comparator to check that the non-parallelism does not exceed 0.38 mm.

3. The gap, angular alignment and parallelism of the coupling sleeve are greater for direct control drives.

A safety clamp should be mounted on the countershaft to retain axial clearance.
SECTION 2 - GENERAL INSTALLATION INFORMATIONS

Figure 2-7 Aligning the coupling

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal gap</td>
</tr>
<tr>
<td>2</td>
<td>Use the gauge to check the gap</td>
</tr>
<tr>
<td>3</td>
<td>Hold the thickness gauge against the half-sleeves here</td>
</tr>
<tr>
<td>4</td>
<td>At 4 points spaced out 90°, check parallelism using a thickness gauge</td>
</tr>
<tr>
<td>5</td>
<td>Half-coupling at the motor end</td>
</tr>
<tr>
<td>6</td>
<td>Half-coupling at the crusher end</td>
</tr>
<tr>
<td>7</td>
<td>Ruler</td>
</tr>
<tr>
<td>8</td>
<td>Place the ruler on the half-coupling here</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>At 4 points spaced out 90°, check parallelism using a thickness gauge</td>
</tr>
<tr>
<td>10</td>
<td>Gap</td>
</tr>
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<td>11</td>
<td>Angular misalignment</td>
</tr>
<tr>
<td>12</td>
<td>Maximum variation 0.38 mm</td>
</tr>
<tr>
<td>13</td>
<td>Maximum non-parallelism should be 0.38 mm</td>
</tr>
</tbody>
</table>

CORRECT SPACING AND ANGULAR ALIGNMENT

INCORRECT SPACING AND ANGULAR ALIGNMENT
2.10 Crusher drive motor
The crusher’s electric motor may be a squirrel cage rotor motor or a wound-rotor induction motor (continuous run) having a starting torque of around 1.3 times the rated torque. Admissible voltage change: 10%.

Abrasion-resistant insulation and protection of the stator with thermostatic sensors or CPT may be required. Motor protection may be of the protected type (IP 23) or enclosed (IP 44).

In order to work non-stop at the power rating stated on the layout plan, the motor must have a service factor of 1.15. If the motor’s service factor is 1, the rated output as stated on the motor’s plate should be 15% more than the rating stated on the layout plan. However, absorbed power should not exceed the power stated on the layout plan.

If a V-type belt drive is used, make sure the motor shaft end and bearings can bear the pulley off-centre weight and the belts’ off-centre tractive force. The motor must be able to bear these loads over 360°. The motor shaft end must be able to transmit torque peaks and the simultaneous flexing caused by the belts’ tension and the weight of the pulley. The motor shaft end should be long enough to allow the pulley hub to be mounted and prevent its rim from rubbing against the motor housing.

For V-type belt drives, the motor should be mounted on two runners so that the centre-to-centre distance can be adjusted when mounting and tightening the belts.

For direct drive motors, check that the dimensions of the motor shaft end allow a coupling sleeve to be mounted.

The documented power ratings apply to electric motors. If a combustion engine is used, please inform the manufacturer, who will calculate the power requirement matching the electric power rating and speed specifications provided in the layout documents.

2.11 Piping information
The additional "Lubrication/Hydraulics" manual gives detailed specifications for the type of oil, temperature and temperature regulation and any equipment that is or can be used in the lubrication system. Please note that the latter is designed for a maximum pressure of 8.6 bars.

Please refer to the documents showing the pipes, accessories and other equipment supplied with the crusher.

Two key factors should be considered: piping should be as short and direct as possible, with no high or low points or obstacles, and the return pipes to the tank should have a downward gradient of at least 10%.

Make sure the insides of the pipes are thoroughly clean. Remove any shavings from threaded ends to protect the oil pump and all wear surfaces inside the crusher.

Couplings should be designed to allow all lubrication parts (pump, filter, coolant, etc.) to be dismantled easily.

Check that there are no oil leaks at couplings. Oil suction pipes must be fully sealed, otherwise output and pressure will fall and could damage the crusher. Leaks from suction pipes are particularly dangerous because unlike pressurized pipes they cannot be detected.

2.12 Information on assembling and dismantling the crusher
HP cone crushers are shipped fully assembled or in separate subassemblies, depending on the size of the crusher. For road consignments, small crushers are generally shipped complete, ready to lay on their base.

In certain cases, these small crushers are dismantled for sea or road transportation if gauge restrictions apply. As for large crushers they are dismantled in most cases for shipping purposes.

The following sections provide instructions for assembling and dismantling the crusher's components. Starting with the bowl, the components are presented in the normal dismantling order. Whether the crusher is shipped assembled or dismantled, it must be assembled according to the instructions in these sections.
Before fitting any part onto the crusher, check that the rust protection of machined surfaces and all traces of sand or dust have been removed, in particular on lubricated areas and in pipes.

Any machined parts or threads that may have been damaged in transit must be repaired before assembly. After cleaning the contact surfaces, apply a thin coat of oil.

Special care should be taken when moving or installing certain components. Strict observance of safety rules is mandatory when lifting equipment, including the appropriate hand signals. You should also ensure that the capacity of all lifting equipment and related parts such as cables, hooks etc. is sufficient to bear the stated weights.

Use tools specific to each size of crusher for repairs or maintenance, and heed the information provided further on in this chapter.

Refer to Figure 2-10 for the tools required to handle cone crushers HP400 and HP500.

2.13 General information on servicing

The following precautions must be observed for all maintenance work and servicing of the crusher:

1. If parts with machined surfaces or bearing surfaces are removed, they should be oiled or covered with a protective film if put in storage for any length of time.

2. Handle machined parts with great care because their tolerance ranges are small.

3. When dismantling parts with machined surfaces, place them on wooden blocks to make sure they do not touch the ground.

4. Bronze parts must be handled with special care. Any shock to this soft material could damage such parts.

5. Clean and oil all machined parts thoroughly before mounting them on the crusher. Apply a coat of oil to load-bearing surfaces before replacing them.

6. When assembling two parts that need to be tightened using a press, cover the contact surfaces with a thin layer of oil. This will act as a lubricant and prevent rust forming.

7. The head bushings and eccentric thrust bearings must be stored vertically. Otherwise they could become distorted into an elliptical shape. This could lead to huge difficulties when installing future parts on the crusher; Sometimes, installation is impossible.

8. All threaded parts should be rubbed with a cloth soaked in molybdenum disulphide powder then coated with grease or oil. If that powder is not available, simply greasing them may suffice.

9. Incorrect heating procedures can damage certain parts; please observe the following instructions.
   a. Whenever possible, it is better to mount hot parts by immersing them in an oil bath or an oven.
   b. Never exceed the required temperature; This could damage the parts.
   c. Do not use a blowtorch to mount hot parts because the heat would not be evenly distributed.
   d. Propane or acetylene equipment should be used to raise the temperature in special cases.
   e. If a blowtorch is used to assemble the gear, avoid the flame coming into direct contact with the parts being treated. Let the heat escape first.
   f. When dismantling parts, heat them quickly and evenly. Dismantle them quickly.

10. Screw fastenings
   - Screws used without thread brake:
     All screws and holes must be cleaned, the screws fitted with grease and tightened to their rated thread torque.
- Screws used with thread brake:
  All screws and holes must be cleaned and degreased before fitting the thread brake onto the screws. In addition, if a part has been heated for mounting purposes, the screws must be fitted without thread brake. When the part's temperature has fallen to ambient temperature, remove the screws, apply the thread brake then tighten them to their rated thread torque.

2.14 List of minimum recommended spare parts
Here is a list of critical spares one should always have to hand to guarantee minimal downtime or when faced with problems.
1. Bowl liner.
2. Bowl liner bolts.
3. Mantle.
4. Ring spacer.
5. Cone feed plate + screws.
Obviously this is only a minimum list of spares; if the factory has several crushers, this list should be adjusted accordingly. Please consult Metso Minerals for a list of spares specific to your facility.
Before checking spares into the storeroom, check that the protective film applied prior to shipment is still intact.
Before replacing a bearing or other important part, or when the crusher functions for the first time, refer to section 3 "Instructions for use".

2.15 Special tools
Special tools are supplied with the crusher. These include all the hoisting rings; the head lifting washer, the coupling for nitrogen cylinders, alignment studs for the sleeve, the eccentric lifting washer, tightening screw, etc.
All these tools are painted in the same colour as the crusher and shipped in a separate crate.
Option:
An inflator gauge and coupling for the nitrogen cylinder can optionally be supplied.
SECTION 2 - GENERAL INSTALLATION INFORMATION

Figure 2-8 Special tools for HP100

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking wrench</td>
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<tr>
<td>2</td>
<td>Pinion wrench</td>
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<td>3</td>
<td>Countershaft wrench</td>
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<td>4</td>
<td>Eccentric lifting ring</td>
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<td>5</td>
<td>Lifting ring</td>
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<td>6</td>
<td>Head lifting ring</td>
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<td>7</td>
<td>Hexagonal nut</td>
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<td>9</td>
<td>Bolt</td>
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<td>Lifting ring</td>
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<td>Threaded rod</td>
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<td>18 to 23</td>
<td>Washer</td>
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<td>24</td>
<td>Safety wedge</td>
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</tbody>
</table>

2-15 HP100/200/300/400/500 CONE CRUSHERS INSTRUCTION MANUAL
### Parts to handle for HP100

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<tr>
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<td>Imbalance</td>
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<td>Gear</td>
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<td>Imbalance liner</td>
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<tr>
<td>Sleeve</td>
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<tr>
<td>Head assembly (head, liner, locking bolt, etc.)</td>
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<td>Head</td>
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<td>Head ball</td>
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<td>Locking nut</td>
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<td>Bowl assembly (bowl liner and adjustment cap)</td>
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</table>
## SECTION 2 - GENERAL INSTALLATION INFORMATIONS

**Figure 2-9 Tools required for HP200, HP300, HP400 and HP500**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Inflator gauge set (optional)</td>
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<td>2</td>
<td>Teat screws</td>
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<tr>
<td>3</td>
<td>Rod with threaded end sleeve position</td>
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<tr>
<td>4</td>
<td>Washer</td>
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<tr>
<td>5</td>
<td>Lifting ring</td>
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<td>Eccentric lifting ring</td>
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<td>Head nut wrench</td>
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<td>45° minimum</td>
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<td>Correct lifting method.</td>
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<td>10</td>
<td>Head lifting washer</td>
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<tr>
<td>11</td>
<td>Adaptor for nitrogen cylinders (optional)</td>
</tr>
</tbody>
</table>

2-17 HP100/200/300/400/500 CONE CRUSHERS INSTRUCTION MANUAL
## Parts to handle for HP200

<table>
<thead>
<tr>
<th>Component</th>
<th>HP100/200/300/400/500 Cone Crushers Instruction Manual</th>
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</thead>
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<td>Eccentric assembly (eccentric, gear, imbalance, etc.)</td>
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<td>Head assembly (head, liner, locking bolt, etc.)</td>
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<td>Head</td>
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<td>Lower head bushing</td>
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<td>Locking nut</td>
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<td>Bowl assembly (bowl liner and adjustment cap)</td>
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### Parts to handle for HP300

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<tr>
<th>Parts to handle</th>
<th>Eccentric lifting washer + 3-M12</th>
<th>Eccentric lifting washer + 4-M16</th>
<th>4 - Lifting eyebolt on adjustment cap</th>
<th>4 - Lifting hook</th>
<th>2 - M8 lifting ring</th>
<th>2 - M10 lifting ring</th>
<th>2 - M12 lifting ring</th>
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<th>2 - M20 lifting ring</th>
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<th>2 - M24 lifting ring</th>
<th>1 - M30 lifting ring</th>
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Figure 2-10 Tools required for handling the HP400 and HP500

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lifting ring</td>
</tr>
<tr>
<td>2</td>
<td>Washer (if necessary)</td>
</tr>
<tr>
<td>3</td>
<td>Head lifting washer</td>
</tr>
<tr>
<td>4</td>
<td>Eccentric lifting ring</td>
</tr>
<tr>
<td>5</td>
<td>Washer</td>
</tr>
</tbody>
</table>
### Parts to handle for HP400

<table>
<thead>
<tr>
<th>Frame</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main shaft</td>
<td>X</td>
</tr>
<tr>
<td>Adjustment ring</td>
<td>X</td>
</tr>
<tr>
<td>Locking ring</td>
<td>X</td>
</tr>
<tr>
<td>Eccentric assembly (eccentric, gear, imbalance, etc.)</td>
<td>X</td>
</tr>
<tr>
<td>Eccentric</td>
<td>X</td>
</tr>
<tr>
<td>Imbalance</td>
<td>X</td>
</tr>
<tr>
<td>Gear</td>
<td>X</td>
</tr>
<tr>
<td>Imbalance liner</td>
<td>X</td>
</tr>
<tr>
<td>Eccentric bushing</td>
<td>X</td>
</tr>
<tr>
<td>Upper ball washer</td>
<td>X</td>
</tr>
<tr>
<td>Lower ball washer</td>
<td>X</td>
</tr>
<tr>
<td>Sleeve</td>
<td>X</td>
</tr>
<tr>
<td>Spherical bearing</td>
<td>X</td>
</tr>
<tr>
<td>Head assembly (head, liner, locking bolt, etc.)</td>
<td>X</td>
</tr>
<tr>
<td>Head</td>
<td>X</td>
</tr>
<tr>
<td>Head ball</td>
<td>X</td>
</tr>
<tr>
<td>Lower head bushing</td>
<td>X</td>
</tr>
<tr>
<td>Upper head bushing</td>
<td>X</td>
</tr>
<tr>
<td>Locking nut</td>
<td>X</td>
</tr>
<tr>
<td>Locking nut wrench</td>
<td>X</td>
</tr>
<tr>
<td>Bowl assembly (bowl liner and adjustment cap)</td>
<td>X</td>
</tr>
<tr>
<td>Bowl</td>
<td>X</td>
</tr>
<tr>
<td>Bowl adaptor ring</td>
<td>X</td>
</tr>
<tr>
<td>Toothed crown</td>
<td>X</td>
</tr>
</tbody>
</table>
### Parts to handle for HP500

<table>
<thead>
<tr>
<th>Frame</th>
<th>Main shaft</th>
<th>Adjustment ring</th>
<th>Locking ring</th>
<th>Eccentric assembly (eccentric, gear, imbalance, etc.)</th>
<th>Eccentric</th>
<th>Imbalance</th>
<th>Gear</th>
<th>Eccentric bushing</th>
<th>Upper ball washer</th>
<th>Lower ball washer</th>
<th>Sleeve</th>
<th>Spherical bearing</th>
<th>Head assembly (head, liner, locking bolt, etc.)</th>
<th>Head</th>
<th>Head ball</th>
<th>Lower head bushing</th>
<th>Upper head bushing</th>
<th>Locking nut</th>
<th>Locking nut wrench</th>
<th>Bowl assembly (bowl liner and adjustment cap)</th>
<th>Bowl</th>
<th>Bowl adaptor ring</th>
<th>Toothed crown</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
2.16 Protecting the crusher against corrosion

To protect your crusher against rust during a seasonal stoppage, for shipment or storage outdoors (winter or summer), please observe the following recommendations:

1. Remove the bowl, head, cone feed plate, socket and eccentric assemblies.

Disconnect the oil return pipes to the tank under the main frame and the feed pipes under the main shaft. Plug these pipes with stoppers.

2. Use a brush to coat all the inside surfaces of the main frame with rust preventive oil.

Use a lubricant with a rust prevention agent designed to protect all the interior parts of enclosed assemblies such as combustion engines, compressors, pumps, reduction gears and hydraulic assemblies. Rust prevention repels water from metal surfaces by forming a water-resistant film over them and absorbing the water in the form of emulsion. Such products are 30 to 40 times more effective than quality lubricants that do not contain a rust prevention agent.

In most applications, the residual protective film left by such products does not need removing when the crusher is refilled with oil and restarted.

Usually 200 litres suffice to cover the crusher. The oil should have a viscosity factor of 32 to 66 cSt at 38°C.

3. Use a brush to coat the lower stop of the frame, the outer surface of the main shaft and all the pinion’s exposed surfaces with rust preventive oil. Remove the feed pipe from the countershaft. Insert a pipe into this hole and fill with oil as the countershaft rotates. A small leak may occur at the end of the countershaft; this is perfectly normal.

Then put the feed pipe back into the countershaft.

4. Fill the main shaft with oil until oil comes out of the drainage hole.

5. Coat the outer surface of the eccentric, the boring of the eccentric bearing, the gear and the upper eccentric stop with rust preventive oil.

6. Coat the spherical span of the head, the boring of the head bushing and all the surfaces of the head near the seal with special oil.

7. Reassemble the eccentric and socket assemblies. Apply a coat of oil to the bearing surface and all the socket’s exposed surfaces. Assemble the head assembly then the cone feed plate.

8. Fill the hydraulic unit tank with rust preventive oil having a viscosity of 32 cSt at 38°C. Make sure the oil used in the hydraulics is compatible with materials used, such as Neoprene rubber, polyurethane, bronze, nickel, chromium-plated, steel and cast iron.

Start up the hydraulic system, retaining cylinders, the bowl’s hydraulic adjustments (locking is achieved with an oil chamber in polyurethane on the HP 100) in order that all the hydraulic components are filled with rust preventive oil.

9. Paint or spray the machined surfaces of all the assemblies, bowl, adjusting ring, locking rings and the screw threads with a special asphalt product that becomes fluid with a solvent.

This additive provides a high degree of protection to wet metallic surfaces due to the presence of water. The solvent evaporates, leaving a transparent, greasy film. This affords long-life protection in severe conditions. The thin coat of oil does not need to be removed to restart the crusher. Then coat the screw threads with lithium-based grease (NLGI 1) mixed with 5-10% of disulphide molybdenum.

10. Reassemble the bowl assembly in the crusher and cover the adjustment cap and hopper with a 2-mm polyethylene sheet to prevent water penetrating and corroding the threads. These sheets come in 30-metre x 6-metre rolls. We recommend black rather than transparent film (longer lifetime). The end of the countershaft and the pulley should also be protected. The best way to fix the polyethylene sheet is with a metal sling.

11. Reconnect the oil inlets and outlets. The remaining oil on metal parts suffices to protect them against rust.
IF THE ABOVE INSTRUCTIONS ARE FOLLOWED, A CRUSHER STORED OUTDOORS WILL BE PROTECTED AGAINST RUST CORROSION FOR 6 TO 12 MONTHS.

If the crusher is stored dismantled, all its parts must be even better protected; because the aforesaid procedure applies to metal surfaces not exposed to the elements: sunshine, rain, snow etc.

The following protective measures are recommended when the crusher is stored with its various assemblies exposed to the elements:

1. Cover the sleeve and the outside of the main shaft with a polyethylene sheet. Wrap the sheet around the countershaft housing and stretch it across the adjusting ring.

This protects the inside of the crusher after it has already been treated with rust preventive oil. The sheet should be firmly attached.

2. Spray or paint the machined surfaces of all assemblies, the bowl, cone feed plate, head, socket and eccentric with a special asphalt product that becomes fluid thanks to a solvent. The solvent evaporates and leaves a dry, acid and highly resistant film. This affords long-life protection in extreme conditions, for instance in open air exposed to corrosive fumes. The film resembles a coat of paint and can easily be removed by rubbing hard with a solvent.

THE ABOVE RECOMMENDATIONS PROTECT PARTS STORED OUTDOORS AGAINST RUST CORROSION FOR AS LONG AS 24 MONTHS.
Section 3

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### Instructions for use

#### SECTION 3

#### 3.1 Checklist when starting up a new crusher

<table>
<thead>
<tr>
<th>Checks prior to start-up</th>
<th>OK</th>
<th>Not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have the wooden chocks between the bowl liner and mantle been removed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Crusher adjustment measured at.............mm (&quot;).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Drive tension and alignment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Position of the countershaft bushing’s oil groove in relation to the drive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. If the eccentric was delivered dismantled, check the play between the pinion/crown teeth. (see section 5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Crusher’s anchorage and fastening bolts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Does the design of the concrete block or dead-bed under the crusher allow the free flow of crushed material?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Lubrication:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Slope of return pipes at least 10% between the crusher and the tank.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Check the make and quality of the oil used and check the oil level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make and type of oil:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make:                             Type:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Pipes are installed according to the plans.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Accessories such as filters, fan, unit heater, immersion heater, pressure relief valves, thermostats or temperature sensors, pressure switches and breathers are correctly mounted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Alarm device, pressure switches, level controller and thermostat are correctly connected (see hydraulics instructions).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. The pressure limiter and related pipes are properly mounted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. The pump rotates in the right direction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Hydraulic couplings on the unit are correct.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Clean filter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Breathers in the countershaft housing and breather in tank correctly fitted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. Oil supply and return pipes do not contain foreign bodies. Before connecting, check the condition and cleanliness of the insides of the pipes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. Hydraulics.
   a. The right make and type of oil in the oil tank; check the oil level. Specify the name and type:
      Make: Type:
   b. The retaining system’s accumulators are properly filled with nitrogen.
   c. All connections between the hydraulic unit and the crusher are correct.
   d. Pipes have been blasted and tested for leaks.
   e. At least one adjustment should be made to ensure that the adjusting system and locking cylinders are working properly.

Starting up the oil pump:
1. Oil temperature should be at least 16°C (60°F).

Starting up the crusher’s hydraulics:
1. The countershaft rotates in the right direction.

Starting up the crusher:
1. The crusher must run idle for roughly 1 hour, until the temperature of the return oil reaches 27°C (80°F).
2. Crusher rotation speed: _____ rpm.
3. Seals underneath the crusher have been checked.
4. Absorbed current running idle (A) ______
5. Alarm devices (pressure switches, thermostats or temperature sensors) have been checked and conform.
6. The crusher has run at 50% load for 2 hours.
7. The crusher has run at 75% load for 4 hours.
8. The crusher has run at 100% load for 1 hour.
9. The shut-off valve stopped returning oil to the tank at: _____°C.
10. Is the material evenly distributed in the cavity?
11. The crusher shuts down in _____ seconds.
Six hours after initial start-up:

1. The temperature difference between the oil supply and return is: ____ °C.

2. The customer has been apprised of any recommendations regarding possible modifications to his installation.

3. The crusher has run at 75% capacity for 6 hours.

Mobile plant:

1. The support surface is properly installed.

2. If rubber wedges are used, they should be no more than 12 mm (1/2") thick. The crusher should not be clamped.

Notes:
3.2 Preparations prior to start-up

Carrying out inspections as a matter of routine will go a long way to ensuring optimal operation of the crusher for many years. Never rely on your memory when planning regular maintenance, use a maintenance logbook. Regular checks and inspections will avert stoppages and prolong the crusher’s lifetime. Before starting up the crusher, carry out the following operations:

1. Check that the right lubricating oil is used and that the lubrication system is properly fitted as explained in the lubrication manual.

2. Start the oil pump motor. Open the inspection hatch on the tank and check the oil return pipe to make sure the oil is circulating. In normal operation, the oil flowing out of the return pipe should fill half to two-thirds of the pipe.

3. Remove the wooden chocks between the liner and mantle for transportation.

4. Check the play at the end of the countershaft. The countershaft must be able to move leftwards and rightwards by 1.0 mm to 1.5 mm. See paragraph 9.2.13 ”Mounting the crusher bullwheel”.

5. Carry out a final check to ensure there are no tools or mechanical obstacles on the crusher. All joints must be properly fitted. Check for any leaks. Check for any other reasons that may prevent the crusher from starting.

6. Rotate the countershaft by hand to check that the mantle does not touch the bowl liner and that there are no other mechanical hitches. If the mantle touches the bowl liner, refer to the bowl adjusting instructions in this section.

7. Use the checklist at the beginning of this section to ensure all the important points have been checked.

8. When all these points have been checked, start the crusher following the detailed instructions in paragraph 3.6 "Initial start-up" of this section.

3.3 Countershaft speed

Speed (or revolutions per minutes) is essential to the proper functioning of the crusher. The admissible speed range is given in Table 3-1. The recommended dimensions of the pulleys driving the crusher are calculated for operation at full capacity. The countershaft will rotate a little faster when the crusher is running idle. Experience shows that running the crusher with the correct countershaft rotation speed produces a maximum amount of material at a constant grade.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>HP100</th>
<th>HP200</th>
<th>HP300</th>
<th>HP400</th>
<th>HP500</th>
</tr>
</thead>
<tbody>
<tr>
<td>rpm at full capacity</td>
<td>750 - 1200</td>
<td>750 - 1200</td>
<td>700 - 1200</td>
<td>650 - 1000</td>
<td>650 - 950</td>
</tr>
</tbody>
</table>

Table 3-1 Countershaft speed
The crusher's countershaft speed determines both the amount of material and the number of impacts a particle sustains in the cavity. If the crusher cannot run at the right speed (rpm), a higher rotation speed is preferable (no more than 10% over the rated speed), because if countershaft speed is reduced to much lower than the recommended rotation speed, performance will be greatly impaired due to jamming in the crushing chamber, which could block the crusher.

**Example**

A countershaft having a recommended speed of 950 rpm can be used at speeds of between 950 and 1045 rpm (950 rpm + 10%) without affecting crushing performance.

A different rotation speed is recommended in certain applications in order to improve the size or shape of the particles without affecting throughput. For such applications, contact the factory to find out the correct speed of the countershaft.

A **HIGHER SPEED CAN ALTER THE MATERIAL OF THE DRIVEN AND DRIVE PULLEYS.**

### 3.4 Countershaft rotation

All HP crushers are designed in such a way that their countershaft rotates clockwise, as viewed when facing the countershaft. The direction of rotation is important because the locking nut keeps the mantle tight against the head; we rely on correct rotation to ensure its self-clamping capacity.

**CAUTION**

The motor’s direction of rotation must be checked before mounting the belts. This should be clockwise when facing the end of the shaft.

**DANGER**

For HP100 and HP200.

If this precaution is not taken and it transpires that the direction of rotation is wrong, the pinion screwed onto the countershaft will come loose and serious damage will ensue.

### 3.5 Operation of the hydraulic unit

The unit should always be powered up when the crusher is running to ensure adequate retaining and support pressure. It should also be powered up for adjustment and clearing operations prior to starting up the crusher itself.

For further information, please refer to the hydraulic unit’s instructions.

### 3.6 Initial start-up

Although the crusher has been factory-tested, we recommend first running the crusher idle then at reduced capacity for several hours after the initial start-up or after fitting new rings. This runs in the crusher and ensures that all the parts are working properly and are well oiled. It is also advisable to check oil temperature more often during this period. Refer to paragraph OIL TEMPERATURE in the lubrication manual.

The initial start-up procedure after fitting a new head bushing or eccentric thrust bearing is as follows:

1. Before starting up the crusher, start up the lubrication system.
2. The hydraulic unit should also be powered up before the crusher.
3. Start up the crusher and let it run idle for 1 hour. Make sure the return oil temperature reaches at least 27°C (80°F).
4. After one hour of operation, start steadily feeding the crusher for 2 hours up to 50% of the amperage indicated on the motor’s nameplate.
5. After 3 hours of operation (paragraph 3 and 4), feed the crusher for 2 hours up to 75% of the amperage.

**CAUTION**

The motor’s direction of rotation must be checked before mounting the belts. This should be clockwise when facing the end of the shaft.

**DANGER**

For HP100 and HP200.

If this precaution is not taken and it transpires that the direction of rotation is wrong, the pinion screwed onto the countershaft will come loose and serious damage will ensue.
6. After completing the instructions in paragraphs 3, 4 and 5, the crusher can now run at full capacity up to 100% of the amperage or the adjusting ring’s bounce limit.

7. Take an oil sample after initial start-up and send it to the factory for analysis.

8. Start keeping and updating a "crusher event log", an example is provided at the beginning of section 4.

3.7 Daily crusher start-up and shutdown procedures

It is important to consult the logbook when the crusher has not been in use for a while.

NOTE DOWN ALL OPERATIONS AND POST THEM UP SO THAT ALL PERSONNEL ARE APPRISED OF THEM.

3.7.1 Daily start-up

1. Before starting up the crusher, start up the lubrication system and make sure the return oil temperature is at least 16°C (60°F).

NOTE: FOR PROPER LUBRICATION OF THE BUSHINGS, THE RETURN OIL TEMPERATURE SHOULD BE AT LEAST 16°C, OTHERWISE THE IMMERSION HEATERS START OPERATING TO HEAT UP THE OIL. WHEN CRUSHING AT EXTREMELY LOW TEMPERATURES, THE OIL MAY NEED HEATING CONTINUOUSLY, EVEN WHEN THE MACHINE IS NOT IN USE. USE ISO CC 150 OIL ALL YEAR ROUND.

2. The oil takes at least 1 minute to circulate before the crusher can start up.

NOTE: DO NOT LET THE CRUSHER RUN FOR MORE THAN 15 SECONDS IF THE OIL DOES NOT APPEAR IN THE COLLECTOR UNIT ON THE OIL TANK, BECAUSE THIS COULD CAUSE SERIOUS DAMAGE IN THE CRUSHER. NORMALLY THERE SHOULD BE ENOUGH OIL FLOWING THROUGH THE RETURN PIPE TO FILL IT UP TO BETWEEN ONE THIRD AND ONE HALF. LACK OF OIL MAY BE DUE TO SEVERAL CONDITIONS: LACK OF OIL IN THE LUBRICATION SYSTEM, A BROKEN OIL PUMP, A PRIMING FAILURE IN THE PUMP, A BLOCKED SUCTION PIPE OR AN INCORRECTLY ADJUSTED BYPASS VALVE. REFER TO THE LUBRICATION MANUAL.

3. The hydraulic unit should be powered up before the crusher. Check all the indicators on the control box to ascertain that the hydraulic unit is indeed powered up and the pressure in its circuits is normal. If holding pressure is abnormal, adjust the pressure of the circuit as instructed in the hydraulics manual.

4. Start up the crusher and let it run idle for 5 minutes.

5. Gradually start feeding the crusher until its maximum power requirement is reached (100% of the amperage or the adjusting ring’s bounce limit).

3.7.2 Daily shutdown

1. Stop the feed and let the crusher run for 2 to 3 minutes.

2. Shut down the crusher and check how long it takes to stop; this should be at least 30 seconds.

3. After shutting down the crusher, the oil pump should continue operating for 2 minutes. (Refer to paragraph 3.7.1 "Daily start-up" for instructions on reheating oil in extremely low temperatures)

4. Shut down the hydraulic unit.
3.8 Crusher adjustments

Crusher adjustments depend on the size of the product to process. In most cases, the bowl should be adjusted so that lower opening between the bowl liner and mantle is a little smaller than the maximum size of the desired end product. The bowl also needs adjusting to make allowance for liner and mantle wear.

**NOTE:** THE INITIAL SETTING, DETERMINED BY THE SIZE OF THE DESIRED END PRODUCT, IS NOT AN ABSOLUTE GUARANTEE OF MAXIMUM OUTPUT. THIS DEPENDS BOTH ON THE CHARACTERISTICS OF THE MATERIAL TO BE CRUSHED AND THE POWER OF THE DRIVE MOTOR. ADJUSTING RING BEHAVIOUR CAN ALSO BE A FACTOR.

The crusher is adjusted by either lowering or raising the bowl in the adjusting ring. To reduce the setting, lower the bowl by turning it clockwise (anticlockwise for the HP100). To increase the setting, raise the bowl by turning it anticlockwise (clockwise for the HP100). See Figure 3-1.

---

**Figure 3-1 Crusher adjustments**

Refer to the hydraulics manual to adjust the crusher.

AFTER A NEW ADJUSTMENT, CHECK VISUALLY THAT THE PINION PROPERLY ENGAGES THE CROWN ON THE ADJUSTMENT CAP, OTHERWISE THE BOWL COULD BECOME TIGHTER OR LOOSER DURING CRUSHING. See Figure 3.9.
3.9 Bowl rotation

Hydraulic method

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pinion</td>
</tr>
<tr>
<td>2</td>
<td>Hydraulic motor assembly</td>
</tr>
<tr>
<td>3</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>4</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>5</td>
<td>Adjustment cap</td>
</tr>
</tbody>
</table>

Manual method

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>2</td>
<td>Handling hook</td>
</tr>
<tr>
<td>3</td>
<td>Turn the cable</td>
</tr>
<tr>
<td>4</td>
<td>Handling lug</td>
</tr>
<tr>
<td>5</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>

Figure 3-2 Bowl rotation
3.9.1 Rotating the bowl using a hydraulic system

Turn the bowl in the adjusting ring using the hydraulic system, refer to the instructions in this section, paragraph 3.18 "Dismantling and installing the bowl".

3.9.2 Rotating the bowl using a cable

If no handling gear is available, the bowl can be screwed or unscrewed using a cable. To mount or dismantle the bowl, proceed as follows:

1. To allow the bowl to turn in the adjusting ring, set the locking pressure to 0 as explained in paragraph 3.18 "Dismantling and installing the bowl".
2. Attach a 20 mm (3/4") cable to a lug on the adjustment cap and wind it around the outside of the adjustment cap.
3. Wind it around the adjustment cap several times and attach the loose end of the cable to a winch, a truck or a loader. Make sure the cable is horizontal between the adjustment cap and the traction device.
4. Pull the cable gently until it is fully unwound. Repeat the operation if necessary.

3.9.3 Rotating the bowl using a hoist or crane

If a crane or other lifting gear is available, turning the bowl in the locking ring and the adjusting ring requires a bit more dexterity, but less effort. To turn the bowl using lifting gear, proceed as follows:

1. To allow the bowl to turn in the adjusting ring, set the locking pressure to 0 as explained in paragraph 3.18 "Dismantling and installing the bowl".
2. Attach the appropriate cables of the lifting gear to the hooks on the adjustment cap, then raise the bowl assembly slightly. By raising the bowl slightly in the threads of the adjusting ring, the bowl will float in the thread as shown in Figure 3-3 (floating position).

3. When the bowl is suspended in the floating position, two people can move the bowl in the adjusting ring and adjust it as required. After each quarter turn, lower or raise the assembly so that the bowl is again free in the adjusting ring.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crushing position</td>
</tr>
<tr>
<td>2</td>
<td>Release position</td>
</tr>
<tr>
<td>3</td>
<td>Floating position</td>
</tr>
<tr>
<td>4</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>5</td>
<td>Bowl</td>
</tr>
</tbody>
</table>

Figure 3-3 Bowl thread in the adjusting ring
3.10 Minimum settings

The crusher’s minimum recommended setting should never be reduced at any time, otherwise the adjusting ring could bounce and damage the frame’s spans.

Table 3-2 shows the minimum admissible setting. These settings are given for maximum yield and satisfactory crusher.

<table>
<thead>
<tr>
<th>Crusher size</th>
<th>Equipment</th>
<th>Minimum recommended setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>Extra fine</td>
<td>6 mm (1/4&quot;)</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>9 mm (3/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>9 mm (3/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>13 mm (1/2&quot;)</td>
</tr>
<tr>
<td></td>
<td>Extra coarse</td>
<td>21 mm (13/16&quot;)</td>
</tr>
<tr>
<td>HP200</td>
<td>Fine</td>
<td>13 mm (1/2&quot;)</td>
</tr>
<tr>
<td>Standard</td>
<td>Medium</td>
<td>16 mm (5/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>19 mm (3/4&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>Fine</td>
<td>14 mm (9/16&quot;)</td>
</tr>
<tr>
<td>Standard</td>
<td>Medium</td>
<td>17 mm (11/16&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>19 mm (3/4&quot;)</td>
</tr>
<tr>
<td></td>
<td>Extra coarse</td>
<td>25 mm (1&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>Fine</td>
<td>16 mm (5/8&quot;)</td>
</tr>
<tr>
<td>Standard</td>
<td>Medium</td>
<td>22 mm (7/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>25 mm (1&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>Fine</td>
<td>16 mm (5/8&quot;)</td>
</tr>
<tr>
<td>Standard</td>
<td>Medium</td>
<td>22 mm (7/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>30 mm (1-3/16&quot;)</td>
</tr>
<tr>
<td>HP200</td>
<td>Fine</td>
<td>5 mm (3/16&quot;)</td>
</tr>
<tr>
<td>short head</td>
<td>Medium</td>
<td>6 mm (1/4&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>Fine</td>
<td>5 mm (3/16&quot;)</td>
</tr>
<tr>
<td>short head</td>
<td>Medium</td>
<td>6 mm (1/4&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>Fine</td>
<td>6 mm (1/4&quot;)</td>
</tr>
<tr>
<td>short head</td>
<td>Medium</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>Fine</td>
<td>6 mm (1/4&quot;)</td>
</tr>
<tr>
<td>short head</td>
<td>Medium</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td></td>
<td>Coarse</td>
<td>10 mm (3/8&quot;)</td>
</tr>
</tbody>
</table>

Table 3-2 Minimum settings
3.11 Checking the screw adjustment of the crusher

Check the screw adjustment of the crusher by slowly lowering a piece of lead attached to a strong and flexible cable through the cavity while it is running idle. Make sure the piece of lead passes through the parallel zone of the bowl liner and mantle as shown in Figure 3-1. Quickly remove the piece of lead and measure the thickness of the spacing on the closed side of the crusher. When the crusher is running idle, the head turns anticlockwise at roughly 300 revolutions per minute. The crusher’s feed slows down the head and reverses the direction of rotation (clockwise) at roughly 10 revolutions per minute. For easier checking of the setting, the head must rotate as slowly as possible. See below:

1. Check the setting on start-up by lowering a piece of lead through the parallel zone between the liner and mantle as soon as the crusher reaches full speed.

2. While the crusher is loaded, stop the feed. Then lower a piece of lead into the parallel zone between liner and mantle as soon as the cavity empties.

Do not use zinc for this purpose. Zinc is not malleable enough and could cause the adjusting ring to bounce.

To determine whether the setting is the same around the entire circumference of the cavity, we recommend inserting a piece of lead at 4 points 90° from one another. Compare the 4 thicknesses to see if the adjusting ring is resting horizontally on the top of the frame or if it is off-centre due to wear on one of the crusher’s sides caused by uneven distribution of the feed material. See Figure 2-1 for the correct feed method.

An off-centre adjusting ring can substantially reduce crusher tonnage and cause the adjusting ring to bounce.

3.11.1 Recommendations for proper crusher operation

Crusher operation can be controlled by varying the flow rate of the material fed into the crusher. A higher feed rate results in higher power absorption and a lower feed rate results in lower power absorption. The crusher’s operating power should be as close as possible to its power rating, according to the form of the circuit and the capacity of the control system. Power peaks in excess of 110% of the power rating should be avoided. This can cause the regulating point to lower in order to keep power peaks within safety limits.

On no account should the crusher run with low power for more than a few seconds. Power absorbed during crushing should be kept at 40% more than the power rating. During the start-up and shutdown phases, operation at low power is acceptable, but operation with continuous stop-start of the feed must be avoided at all costs. If it transpires that the crusher needs to be without feed for more than 30 minutes, it should be shut down and only restarted when the feed is available.

When the feed rate exceeds the cavity’s volume capacity, a static level of feed starts to form above the cavity.

A higher feed rate will increase the level of the materials above the crusher cavity whereas a lower feed rate will reduce the level of the materials above the crusher cavity and with even lower rates the feed rate will fall below the volumetric capacity of the crushing chamber and the level of materials in the crusher cavity will start to reduce. For optimal performance, the level of material in the cavity should be about 300 mm (12") above the top of the cone feed plate.
This guarantees even distribution of the feed around the crushing chamber and avoids power peaks caused by minor changes in the feed rate. A level sensor can be fitted to monitor the level in the chamber and its signal can be used to adjust the crusher’s infeed rate.

The choice of chamber (the shape of the bowl liner and mantle) and the lower end setting create operating conditions with regular absorbed power of between 75% and 100% of nominal power. The crusher setting can serve to optimize the crusher’s working power requirement. Increasing the setting reduces absorbed power for a given level in the chamber while increasing the feed rate necessary to maintain the same level in the chamber. Decreasing the setting increases absorbed power for a given level in the chamber but reduces the feed rate required to maintain the same level in the chamber. Naturally a smaller opening also means that the size distribution of the product will be smaller.

A hydraulic motor is used for precise adjustment of the bowl. This adjustment is designed to correct the crusher’s feed setting with or without feed. This system can be used to correct the crusher setting and its absorbed power while the crusher is being fed.

We advise checking the feed before making any adjustments. The setting should be corrected to make allowance for liner and mantle wear and guarantee constant product grading.

This setting should not be adjusted more than once an hour.

### 3.12 Adjusting ring bounce

The ring should only bounce when processing tramp iron. If ring bounce persists, this may be caused by an overload.

Inefficient screening, segregation in the feed or uneven distribution may cause the ring to bounce. Increase the setting, reduce the feed or change the liner and mantle to eliminate bounce.

**Advantage of a ring without bounce:**
- Longer service life for the crusher’s parts.
- Constant throughput.
- Longer service life for the bowl liner and mantle.
- Less loss of power.
- Lower maintenance costs.

**If bounce is the cause of damage to the crusher, the warranty no longer applies.**

![Figure 3-4 Ring bounce](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Position of adjusting ring in case of bounce</td>
</tr>
<tr>
<td>2</td>
<td>Frame</td>
</tr>
</tbody>
</table>

Figure 3-4 Ring bounce
3.13 Determining liner and mantle wear

Use the following information to determine when the jaws (liner and mantle) are worn out and need replacing. Accurate records can be kept to record the degree of jaw wear without stopping the crusher. Keep such a record for the first set of jaws as follows:

1. When crusher adjustments are complete, make a mark on the toothed crown, where it comes into contact with a pinion tooth. This will mark the first setting. Turning the toothed crown by one tooth causes a very small vertical displacement of the bowl. See Figure 3-5.

2. Keep a record of the exact number of teeth used during the life cycle of the first set of jaws. Starting from the first position, note down each position until the bowl liner and mantle are completely worn.

BECAUSE NO TWO CRUSHING OPERATIONS ARE IDENTICAL AND BECAUSE OF THE WIDE RANGE OF LINERS AND MANTLES, ONE CANNOT PREDICT IN ADVANCE WITH HOW MANY TEETH A PARTICULAR LINER AND MANTLE SET WILL LAST BEFORE WEARING OUT.

IN NORMAL CONDITIONS IT IS GENERALLY THE CASE THAT A LINER WEARS OUT WHEN ITS WEIGHT DIMINISHES BY 50%. THIS CAN VARY ACCORDING TO THE APPLICATIONS.

DO NOT TIGHTEN THE BOWL UNTIL CONTACT IS MADE BETWEEN THE ADJUSTMENT CAP AND THE ADJUSTING RING.

3. When the bowl liner and mantle wear out, but before removing the bowl from the adjusting ring, count by how many teeth the crown turned, and paint a horizontal line on the protective apron just above the adjustment cap, see Figure 3-6, Figure 3-7 and Figure 3-8.
### Ref. | Description
--- | ---
1 | Adjusting ring
2 | Mark on the protective apron giving the position of the adjustment cap when the jaws are worn.
3 | Dimension "A", see Table 3-3
4 | Position of the adjustment cap with new bowl liner and mantle.
5 | Adjustment cap
6 | Protective apron
7 | Bowl

**Figure 3-6 Checking wear on the bowl liner and mantle - HP100**
Figure 3-7 Checking wear on the bowl liner and mantle - HP200 and HP300

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Mark on the protective apron giving the position of the adjustment cap when the jaws are worn.</td>
</tr>
<tr>
<td>3</td>
<td>Dimension &quot;A&quot;, see Table 3-3</td>
</tr>
<tr>
<td>4</td>
<td>Position of the adjustment cap with new bowl liner and mantle.</td>
</tr>
<tr>
<td>5</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>6</td>
<td>Protective apron</td>
</tr>
<tr>
<td>7</td>
<td>Bowl</td>
</tr>
</tbody>
</table>

Figure 3-7 Checking wear on the bowl liner and mantle - HP200 and HP300
### Figure 3-8 Checking wear on the bowl liner and mantle - HP400 and HP500

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>2</td>
<td>Bowl</td>
</tr>
<tr>
<td>3</td>
<td>Position of the adjustment cap with new bowl liner and mantle.</td>
</tr>
<tr>
<td>4</td>
<td>Dimension &quot;A&quot;, see <em>Table 3-3</em></td>
</tr>
<tr>
<td>5</td>
<td>Mark on the protective apron giving the position of the adjustment cap when the jaws are worn.</td>
</tr>
<tr>
<td>6</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>7</td>
<td>Protective apron</td>
</tr>
</tbody>
</table>

---

**Ref. Description**

- **Ref. 1**: Adjustment cap
- **Ref. 2**: Bowl
- **Ref. 3**: Position of the adjustment cap with new bowl liner and mantle.
- **Ref. 4**: Dimension "A", see *Table 3-3*
- **Ref. 5**: Mark on the protective apron giving the position of the adjustment cap when the jaws are worn.
- **Ref. 6**: Adjusting ring
- **Ref. 7**: Protective apron
4. Fit a new bowl liner and mantle, and taking account of the number of teeth the crown turned, the degree of liner and mantle wear can be determined by comparison with the number of teeth needed before the initial liner and mantle set wore out. The mark painted on the protective apron will also indicate when wear limit is approaching. Follow this procedure several times to establish an average, because two jaws do not wear out in exactly the same way.

To facilitate the operator’s task, the number of teeth available for each bowl rotation, as well as the change in vertical height and the adjustment per tooth are given in Table 3-3.

When the bowl liner and mantle are worn, see the minimum APPROXIMATE height between the top of the adjusting ring and the bottom of the adjustment cap as shown in Figure 3-6, Figure 3-7, Figure 3-8 and Table 3-3.

Because the setting varies depending on what the crusher is breaking up, the distance between the top of the adjusting ring and the bottom of the adjustment cap also varies.

Refer to Table 3-3, and apply the formula for determining distance "A".

**NB:** The state of wear of the first set of jaws should be monitored very closely.

When the first set of jaws has worn out and is removed, cut out a section roughly 100 mm wide from each of them.

Take these profiles into account when setting or correcting dimension "A" for the next set of jaws.

These sections of jaw can be sent to Metso Minerals for profile analysis.
<table>
<thead>
<tr>
<th>Crusher size</th>
<th>Number of crown teeth required for one complete bowl revolution</th>
<th>Vertical bowl displacement per cog</th>
<th>Setting variation per cog</th>
<th>Setting for a 1/4 revolution of the toothed crown</th>
<th>“A” Approximate minimum dimension when the jaws are worn out</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>106</td>
<td>0.36 mm (0.014&quot;)</td>
<td>0.27 mm (0.009&quot;)</td>
<td>7.1 mm (1/4&quot;)</td>
<td>A = 50 + (1.59 x CSS)</td>
</tr>
<tr>
<td>HP200 Short bowl</td>
<td>138</td>
<td>0.28 mm (0.011&quot;)</td>
<td>0.18 mm (0.007&quot;)</td>
<td>6.3 mm (1/4&quot;)</td>
<td>A = 37 + (1.58 x CSS)</td>
</tr>
<tr>
<td>HP200 Long bowl *</td>
<td>138</td>
<td>0.28 mm (0.011&quot;)</td>
<td>0.18 mm (0.007&quot;)</td>
<td>6.3 mm (1/4&quot;)</td>
<td>A = 50 + (1.58 x CSS)</td>
</tr>
<tr>
<td>HP300</td>
<td>156</td>
<td>0.33 mm (0.013&quot;)</td>
<td>0.23 mm (0.009&quot;)</td>
<td>8.73 mm (11/32&quot;)</td>
<td>A = 37 + (1.59 x CSS)</td>
</tr>
<tr>
<td>HP400</td>
<td>176</td>
<td>0.29 mm (0.011&quot;)</td>
<td>0.20 mm (0.008&quot;)</td>
<td>8.9 mm (0.352&quot;)</td>
<td>A = 26 + (1.69 x CSS)</td>
</tr>
<tr>
<td>HP500 Short bowl</td>
<td>192</td>
<td>0.26 mm (0.010&quot;)</td>
<td>0.18 mm (0.007&quot;)</td>
<td>8.5 mm (0.344&quot;)</td>
<td>A = 75 + (1.59 x CSS)</td>
</tr>
<tr>
<td>HP500 Long bowl *</td>
<td>192</td>
<td>0.26 mm (0.010&quot;)</td>
<td>0.18 mm (0.007&quot;)</td>
<td>8.5 mm (0.344&quot;)</td>
<td>A = 0+ (1.59 x CSS)</td>
</tr>
</tbody>
</table>

Table 3-3 Number of crown cogs and bowl displacement

(*) To determine the type of bowl on your crusher, measure the dimension of the box as shown in the figures below.

![Figure 3-10 HP200 Long bowl](image1)

![Figure 3-11 HP500 Long bowl](image2)
3.14 Lubricating the threading

It is very important to lubricate the threads of the bowl and adjusting ring on a regular basis to ensure the bowl continues to move freely in the adjusting ring.

Grease fittings around the side of the adjusting ring lubricate the threads, the bowl remaining engaged in the adjusting ring. See Figure 3-12.

The grease is forced into these fittings when the bowl is in crushing position and released.

Use a lithium-based grease, NLGI 1 or an equivalent type, preferable mixed with 5-10% of molybdenum bisulphite powder (by volume). For crushing hot products, slag, clinker, etc., a high-temperature grease, preferably mixed with 5 to 10% of molybdenum bisulphite powder, is recommended.

3.15 Bowl thread and adjusting ring wear

Whenever jaws are changed, check the wear of the bowl thread and the adjusting ring. To determine the degree of wear, check the difference between the vertical position of the bowl when locked and unlocked. Measure the distance between the top of the adjusting ring and the bottom of the adjustment cap. See dimension "A" in Figure 3-13.

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grease fitting</td>
</tr>
<tr>
<td>2</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>

Figure 3-12 Grease fitting

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>2</td>
<td>Adjustment cap liner</td>
</tr>
<tr>
<td>3</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>4</td>
<td>Wedges</td>
</tr>
<tr>
<td>5</td>
<td>Dimension &quot;A&quot;</td>
</tr>
<tr>
<td>6</td>
<td>Locking cylinder</td>
</tr>
</tbody>
</table>

Figure 3-13 Adjusting the ring with the head
For a new crushe, the gap between the threads is 3.57 mm. Any bigger gap is a sign of thread wear. If it attains 8 mm, thread wear equals 4.5 mm. This is the authorized maximum.

When the bowl's vertical displacement attains 8 mm, indicating 4.5 mm of wear, the locking cylinders and the locking ring must be wedged to make up the play and lock the bowl. Therefore the spacer sleeve must be lengthened by 4.5 mm. See Figure 3-14.

The cylinders can only be wedged once. If the vertical displacement between the threads after locking and unlocking attains 8 mm, the threads of the bowl or adjusting ring or both must be reconditioned.

### Table 3-14 Spacer sleeve

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flat washer</td>
</tr>
<tr>
<td>2</td>
<td>Locking screw</td>
</tr>
<tr>
<td>3</td>
<td>Spacer sleeve</td>
</tr>
<tr>
<td>4</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>5</td>
<td>Locking ring</td>
</tr>
</tbody>
</table>

**3.16 Difficulty turning the bowl**

Difficulties may be encountered turning the bowl, due to the poor condition of the bowl or adjusting ring threads or both. Often this occurs when first assembling the bowl assembly in the adjusting ring, when using a single cable on the adjustment cap to rotate the bowl. When turning the bowl this way, one generally uses a cable with a bullwheel anchored to a tractor or loader.

If a single cable is used to turn the bowl in the adjusting ring, the bowl tends to tilt in the threads of the adjusting ring. This swaying creates a point of contact between the outer diameter of the bowl's threads and the flat surface of the adjusting ring's threads in the direction of traction, above all if it is not horizontal. When the bowl is pushed to the centre of the apparatus, this causes swaying, which chips the threads. This damage is usually confined to the first thread of the bowl and the adjusting ring and appears on the flat surfaces of the threads. The resulting chips can damage the rest of the bowl's threads when turning in the adjusting ring. The same effects can occur when dismantling the bowl.
If stripping occurs on the thread, the methods below can minimize the damage when the bowl is being assembled or dismantled:

- Turn the bowl using a crane or another lifting system to maintain the adjusting ring in the floating position (see Figure 3-3). With the bowl in the floating position, two people can tighten or loosen the bowl to the desired setting. After each quarter turn, lower or raise the bowl so that it remains free in the adjusting ring. Rotate the bowl by at least 2 complete revolutions using this method.

- OR -

- Use a double cable and pull, to turn the bowl in one direction or the other.

- OR -

- Use the bowl's hydraulic adjustment system to complete at least two complete bowl revolutions.

After 2 complete revolutions, a single cable can be used to continue tightening or loosening it. Pull the bowl slowly (approximately 1 bowl revolution per minute); considerable force may be exerted to overcome the friction inside the adjusting ring. One or more of the following conditions can make it difficult for the bowl to rotate in the adjusting ring:

1. Crushing hot materials; using an unsuitable lubricant for the threads.
2. The threads of the bowl and the adjusting ring have not been regularly lubricated.
3. Wear or incorrect fitting of the dust seal. See Figure 3-15.
4. Crusher used with the same setting for too long a period.
5. Crusher exposed to bad weather, rain in particular, without adequate protection.

The following suggestions will eliminate any possibility of the bowl getting blocked in the adjusting ring:

1. Periodically, release the bowl from its crushing position and make it turn by moving it backwards and forwards.
2. Add grease in the grease fittings located all around the adjusting ring when bowl is engaged in it. Draw up a lubrication maintenance programme. Use a grease as recommend in paragraph 3.14 "Lubricating the threading".
3. On installation or when the bowl is removed, clean the threading and cover it with the lubricant recommended in paragraph 5.2 "Assembly instructions".
4. Check the seals of the protective apron occasionally for wear or damage.
When the bowl is blocked in the adjusting ring and cannot turn by the usual means, proceed as follows:

1. While the crusher is running, feed a certain amount of material into the crusher when the bowl is in the released position.

2. Pour penetrating oil or antifreeze all around the circumference of the bowl's threading and pour the same solution into the grease fittings through the adjusting ring. The penetrating oil or antifreeze will release any build-up of dust that may have infiltrated through the thread gap and will also remove any rust that may have formed.

3. Try and unscrew the bowl by applying as much force as possible.

If this procedure does not produce satisfactory results immediately, leave the crusher as is for a few hours, periodically applying penetrating oil or antifreeze around the threads, then repeat the previous steps.

3.17 Clearing the crusher

If the crusher stops while loaded, do not try and restart it without first completely emptying the crushing chamber. Trying to start it while loaded can seriously damage the crusher and the transmission.

The crusher may unexpectedly stop for any of the following reasons:

- The crusher’s motor lacks electricity or its engine runs out of fuel; too much feed enters the crushing chamber and jams the crusher. The discharge conveyor has stopped, causing the material to pile up under the crusher, resulting in jamming and blocking. or tramp iron is stuck in the cavity.

To clear the crusher, do as follows. The hydraulics cabinet must be powered up. See the hydraulic instructions for using the clearing system.

1. Turn the selector switch on the portable control box to MANUAL.

2. Press and hold down the UNRAMMING button until the cylinder rods are completely extended. In most cases, this will empty the crusher cavity. The red low pressure indicator should be on.

3. When it has been cleared, if the cavity is not empty, fit safety wedges between the adjusting ring and the frame to keep the adjusting ring and bowl in the raised position in case of a drop in pressure or a cylinder failure, see Figure 3-16.

**DANGER**

DO NOT TRY AND REMOVE MATERIAL BLOCKED IN THE CAVITY BY HAND WITHOUT FIRST INSTALLING SAFETY WEDGES. THIS IS TO PROTECT HANDS, ARMS OR TOOLS CAUGHT BETWEEN THE LINER AND MANTLE IN THE EVENT OF A HYDRAULIC FAILURE.

**DANGER**

NEVER PUT YOUR FEET OR HANDS BETWEEN THE ADJUSTING RING AND THE FRAME. ALWAYS PLACE SAFETY WEDGES BETWEEN THE FRAME AND ADJUSTING RING WHEN THE LATTER IS RAISED AND TRAMP IRON NEEDS REMOVING.
4. Pressing the PRESSURIZE button rests the bowl and ring assemblies on the safety wedges.

Before returning the adjusting ring to its normal position, make sure any personnel in the vicinity is out of harm's way.

Check whether the entire circumference of the adjusting ring is resting on the frame. If not, raise it again and lower it. If the adjusting ring does not rest properly on the frame span and the retaining jacks are pressurized, the latter could be seriously damaged.

IT IS IMPORTANT TO REMOVE ALL METAL PARTS FROM THE FEED. THE RETAINING JACKS ALLOW TRAMP IRON THROUGH. HOWEVER, EXCESS TRAMP IRON CAN DAMAGE THE FRAME SPAN. IF THE FEED CONTAINS A LOT OF FERROUS ITEMS, A MAGNETIC SEPARATOR SHOULD BE FITTED. A FRAME DAMAGED BY EXCESS TRAMP IRON WILL NO LONGER BE COVERED BY THE WARRANTY.

5. Remove the wedges or the tramp iron to big to pass through the cavity.

6. When the crushing chamber is completely empty, extend the maintaining cylinder rods. This will lift the adjusting ring and the bowl off the safety wedges. Remove the safety wedges.
3.18 Dismantling and installing the bowl

To dismantle the bowl assembly when replacing the bowl liner and mantle or to gain access to other parts, proceed as follows:

1. Unlock the bowl (see hydraulics manual).

DANGER (HP100 ONLY)

For reasons of safety and to avoid any damage to the machine, the locking pressure should be kept at 0 bars when the bowl assembly is not engaged in the locking and adjusting rings (while the bowl is unscrewed and until it is reassembled).

2. Turn the bowl in the adjusting ring anticlockwise or clockwise, using the hydraulic system or a crane or a cable as explained in this section.

3.19 Overhaul and repairs

Possibilities are offered to reconstruct cone crushers or recondition parts that have been used intensively or are worn after long periods of operation. It may be advisable and advantageous to return the crusher to the factory for this purpose. A thorough overhaul done in time is cheaper than the replacement of certain worn parts. We fully dismantle the crushers and examine all the parts to assess their value and remaining service life; we replace worn parts with new ones.

Consult the factory before re-tooling parts like the head, bowl, adjusting ring or frame. Other solutions can be found.

3.20 Regular inspections

The best way to keep a crusher in good working order after it has been installed and brought into service to carry out regular inspections. We recommend inspecting the crusher at regular intervals and maintenance work be carried out in good time. The requisite inspections and intervals at which they should be carried out are listed in Table 4-1. They are only given as a rough guide; only you can determine whether they need carrying out more or less often. The type of material being processed, the climate and operating conditions are key factors in determining inspection intervals.

Keep the crusher clean and painted. A clean machine is easier to service and depreciates more slowly than a neglected one.

Inspection intervals vary according to conditions of use and applications. Only experience can dictate them.
Section 4

REGULAR MAINTENANCE AND INSPECTION

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4.2 - Weekly inspection and maintenance. ............................... 3-4
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4.5 - Changing bowl liner and mantle, checks and maintenance .... 3-6
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Ambient temperature (°C)</th>
<th>Oil temperature (°C)</th>
<th>Oil pressure (bars) at countershaft</th>
<th>Absorb current (A)</th>
<th>Cavity outlet setting (mm)</th>
<th>Check alarms</th>
<th>Stoppage time (sec.) at countershaft</th>
<th>Check discharge</th>
<th>The low pressure indicator for locking and retaining must be off</th>
<th>Check breather is clean</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

**Remarks**

<table>
<thead>
<tr>
<th>Crusher size</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crusher no.</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 4.1 Daily inspection and maintenance

<table>
<thead>
<tr>
<th>Items</th>
<th>List</th>
<th>Normal conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Check the oil level in the tank.</td>
<td>Oil in the gauge</td>
<td></td>
</tr>
<tr>
<td>2 Check the temperature at the inlet and exit of the crusher.</td>
<td>Inlet 38°C - 54°C Return temperature: +0° to 5°C without cooling tower +0° to 8°C with cooling tower</td>
<td></td>
</tr>
<tr>
<td>3 Check pressure at the countershaft housing.</td>
<td>1.4 - 2.8 Bars (20-40 PSI)</td>
<td></td>
</tr>
<tr>
<td>4 Check input power or current requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Check setting at cavity outlet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Check support pressure.</td>
<td>See hydraulics supplement</td>
<td></td>
</tr>
<tr>
<td>7 Check locking pressure.</td>
<td>165 - 193 Bars (2,400 - 2,800 PSI)</td>
<td></td>
</tr>
<tr>
<td>8 Check feed, distribution and level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Check the crusher’s discharge area and accumulation on the arms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Check the imbalance liner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Check the time countershaft takes to stop.</td>
<td>30-60 seconds</td>
<td></td>
</tr>
<tr>
<td>12 Check connections and clamps.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Check for unusual sounds, signs of wear or excessive strain.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Liner and mantle worn out, check their condition at regular intervals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Check the adjustment ring for bounce.</td>
<td>correct operation when loaded, no bounce</td>
<td></td>
</tr>
<tr>
<td>16 Check return oil flow in the tank and the pump outlet filter.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4-1 Maintenance and inspection intervals
### 4.2 Weekly inspection and maintenance

<table>
<thead>
<tr>
<th>Ref.</th>
<th>List</th>
<th>Normal Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clean/replace the countershaft housing breathers and those of the tank.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check the oil circuits (for leaks).</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check the liner, mantle and cone feed plate for wear.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lubricate the adjustment ring threads with the bowl released then lock the bowl and lubricate them.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check the return filter in the tank.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check that there is no bouncing.</td>
<td>correct operation when loaded, no bounce</td>
</tr>
<tr>
<td>7</td>
<td>Check the tension and condition of the belts.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Make sure there are no oil leaks.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check the bullwheel (break, and tightness on shaft).</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Check that the feeder cone screws are tight.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Check the alarm indicators on the electrical cabinet are in good condition.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Check the guards of the arms, imbalance, head and the state of wear of the frame span plating.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Check the oil level in the tank.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Check the oil inlet and outlet oil temperatures.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Check the oil pressure at the countershaft</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Check the crusher’s adjustment and wear of the bowl liner and mantle.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Check the power or electric current requirement for the crusher.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Check that no suspicious noise is emitted, nor any unusual vibrations.</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4-2 Maintenance and inspection intervals (continued)**
4.3 Monthly inspection and maintenance/200h

<table>
<thead>
<tr>
<th>Ref.</th>
<th>List</th>
<th>Normal conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check the pre-load of the accumulators and top up with nitrogen if necessary.</td>
<td>See hydraulics supplement</td>
</tr>
<tr>
<td>2</td>
<td>Check that the adjustment mechanism pinion cog is properly engaged in the cogwheel.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Test all alarms, warning lights and lubricating and hydraulic devices (pressure switch, temperature, thermostats).</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Unlock the bowl and rotate it in one direction then in the other.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Change the lubricating oil. Change if necessary.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Analyse the lubricating oil if in doubt.</td>
<td>See the oil contamination table</td>
</tr>
<tr>
<td>7</td>
<td>Check the countershaft’s axial clearance.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check the guards of the arms, imbalance, head and the state of wear of the frame span.</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-3 Maintenance and inspection intervals (continued)

4.4 Annual inspection and maintenance/2000h

<table>
<thead>
<tr>
<th>Ref.</th>
<th>List</th>
<th>Normal conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dismantle the crusher completely to check the wear of all rings (head, eccentric, bearing and the surfaces of the pinion and crown).</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspect the frame, head and bowl (check for any fatigues cracks).</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check the state of couplings, supports, pipes.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check the state of wear of the head ball.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check the state of wear of the pinion and crown.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Change the gear motor oil.</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-4 Maintenance and inspection intervals (continued)
### 4.5 Changing bowl liner and mantle, checks and maintenance

<table>
<thead>
<tr>
<th>Ref.</th>
<th>List</th>
<th>Normal conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspect the bowl liner and mantle, the bowl's spans and the head. Grind down any defects on the spans (if necessary).</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspect the head bushing, head ball, bearing, eccentric ring and seals.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check the locking nut and the feeder cone (wear). Replace if necessary.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check the guards of the frame's arms, countershaft and frame span.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Inspect the threads of the bowl, adjusting and locking ring.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Inspect the hydraulics hoses (leaks).</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check the bowl liner's wedge locks and screws.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check the tightness of the imbalance bolts on the eccentric.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check the imbalance liner</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-5 Maintenance and inspection intervals (continued)
Feed

- The product must be correctly distributed all around the crusher cavity, both in terms of level and of grading.

Advantages: maximum throughput - better shape - uniform wear of the bowl liner and mantle.

Figure 4-1 Feed
The first setting determined by the desired size of the end product is not necessarily the best for maximum yield. That depends on the characteristics of the material to be crushed, the motor’s absorbed power and the ring’s bounce. We recommend you change settings gradually to find the best compromise between throughput and yield.

### Input power

- Run the crusher at 75 to 95% of total average power **WITHOUT RING BOUNCE**.

**Advantages:** Longer service life for the crusher - higher yield.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Input power</td>
</tr>
</tbody>
</table>

Figure 4-2 Input power
Section 5

BOWL, BOWL LINER AND HOPPER ASSEMBLIES

5.1 - Description ................................................................. 5-1
5.2 - Assembly instructions ..................................................... 5-1
5.3 - Maintenance ................................................................. 5-2
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  5.3.2 - Dismantling the bowl liner ......................................... 5-3
  5.3.3 - Installing the bowl liner ............................................. 5-5
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  5.4.1 - Bowl seating (liner) .................................................... 5-8
5.1 Description

This section describes the bowl, bowl liner and hopper assemblies. The bowl is screwed inside the adjusting ring, adjustments are made by rotating the bowl anticlockwise or clockwise, according to the desired setting. Bowl adjustment determines the gap between the bowl liner and mantle.

The adjustment cap is fixed to the top of the bowl and rubs against the joint of the protective apron fixed to the adjusting ring. This protects the bowl and the locking ring. A set of locking cylinders is located at the top of the adjusting ring and all round it. These cylinders push the locking ring and raise the bowl to the crushing position. The bowl turns with the adjustment cap with the aid of with the aid of a hydraulic motor mounted on the adjusting ring.

The hopper is placed on two pins on the upper edge of the bowl. The inside of the hopper directly feeds the crusher cavity. The shape of the bottom of the hopper has been designed so that the materials build up there, thereby forming a dead-bed that protects the hopper against the flow of feed material.

Under the hopper and on the bowl are several wedges and their screws, these wedges hold the liner firmly on the bowl.

5.2 Assembly instructions

If the bowl, liner and hopper assemblies have been dismantled from the crusher for reasons of transport, they should be cleaned, lubricated and assembled as follows:

1. To start with, the adjustment cap must be dismantled. Remove the screws and washers retaining the adjustment cap on the top of the bowl. Raise the adjustment with the aid of the lugs welded to it, see Figure 5-1.

2. Thoroughly clean the bowl, adjusting ring and locking ring threads, removing any dust and possibly the protective varnish.

3. Rub the threaded surfaces of the bowl, adjusting ring and locking ring with a rag soaked in molybdenum disulphide. This produces a lubricating film on the threaded surfaces, thereby improving bowl rotation. This is done in our workshops at the outset.

4. Cover the threads with grease containing 5 to 10% of molybdenum disulphide.

WHEN CRUSHING HOT MATERIALS SUCH AS CLINKER OR SLAG, A HIGH-TEMPERATURE GREASE MIXED WITH 5 TO 10% MOLYBDENUM BISULPHIDE POWDER SHOULD BE USED. WHEN MIXED WITH LUBRICATING OIL, IT IS PERFEKTLY SATISFACTORY.

5. Reassemble the adjustment cap and the other parts on the bowl.

6. Raise the assembly with slings secured to the lugs around the adjustment cap as shown Figure 5-1. Before reassembling the complete assembly, the locking cylinders must be depressurized as explained in paragraph 3.18 "Dismantling and installing the bowl".

7. Turn the bowl in the locking ring, then in the adjusting ring as explained in paragraph 3.9 "Bowl rotation".
**5.3 Maintenance**

**5.3.1 Dismantling the bowl**

1. Release the bowl by releasing the pressure in the locking cylinders as explained in paragraph 3.18 "Dismantling and installing the bowl".

---

**DANGER (HP100 ONLY)**

For reasons of safety and to avoid any damage to the machine, the locking pressure should be kept at 0 bars when the bowl assembly is not engaged in the locking and adjusting rings (while the bowl is unscrewed and until it is reassembled).

2. Turn the bowl clockwise for HP100 and anticlockwise for HP200, HP300, HP400 and HP500 outside the adjusting ring using the hydraulic adjusting system, see Figure 5.2, described in paragraph 3.9 "Bowl rotation".

---

**Figure 5-1 Handling the bowl assembly**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feed hopper</td>
</tr>
<tr>
<td>2</td>
<td>Sling</td>
</tr>
<tr>
<td>3</td>
<td>Shackle</td>
</tr>
<tr>
<td>4</td>
<td>Lifting lug</td>
</tr>
<tr>
<td>5</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>6</td>
<td>Bowl liner</td>
</tr>
<tr>
<td>7</td>
<td>Wedging</td>
</tr>
<tr>
<td>8</td>
<td>Bowl</td>
</tr>
</tbody>
</table>
SECTION 5 - BOWL, BOWL LINER AND HOPPER ASSEMBLIES

3. Raise the bowl with slings secured to the adjustment cap lugs and lay it on runners as shown in Figure 5-1.

5.3.2 Dismantling the bowl liner

Dismantle the bowl liner as shown below:

1. Dismantle the adjustment cap as described in paragraph 5.2 "Assembly instructions".

2. Make sure the bowl assembly rests on the bowl liner, not on the bowl. Insert wedges under the bowl liner if necessary.

3. Clean the threads of the adjusting ring, locking ring and bowl, removing all traces of dust and grease.

4. Dismantle the hopper from the bowl. You have access to the lugs that retain the bowl liner on the bowl. The lugs are located on the bowl's adaptor ring, which is fixed with pins.

5. Remove the pins retaining the nut locks. Remove the nut locks. Use a spanner to loosen the barrel nut that presses against the rear side of the locking wedge. The wedges are certainly caught between the edge of the liner and the adaptor ring. Place a chisel against the shoulder of the wedge and strike it with a hammer to release it. See Figure 5-3.

6. Use a special wrench to loosen the barrel nuts by 200 mm. These nuts retain the wedges against the bowl liner.
7. The wedges are wedged between the edge of the liner and the adaptor ring for HP200, HP300, HP400, HP500 and between the edge of the liner and the bowl for HP100.

Place a chisel against the shoulder of the wedge and strike it with a hammer to release it. Repeat for all the edges. See Figure 5-4.

8. Raise the bowl above the liner. Occasionally the resin may block the liner in the bowl. Hit the liner vertically to break up the resin. (no sealant resin for HP100)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stop</td>
</tr>
<tr>
<td>2</td>
<td>Loosen the nut by 20 mm</td>
</tr>
<tr>
<td>3</td>
<td>Chisel</td>
</tr>
<tr>
<td>4</td>
<td>Lug</td>
</tr>
<tr>
<td>5</td>
<td>Bowl liner</td>
</tr>
<tr>
<td>6</td>
<td>Sealant resin (no sealant resin for HP100)</td>
</tr>
<tr>
<td>7</td>
<td>Ball nut</td>
</tr>
<tr>
<td>8</td>
<td>Square head bolt</td>
</tr>
<tr>
<td>9</td>
<td>Bowl</td>
</tr>
</tbody>
</table>

Figure 5-4 Dismantling the wedge
9. Break up any remaining resin on the bowl, usually the resin hardly adhere at all to the liner.

10. Check the bowl seating. Grind down any scratches. If they are deep, refer to paragraph 5.4.1 "Bowl seating (liner)".

The bowl seating should be clean so that the bowl liner fits properly and does not bounce.

### DANGER

Remove the wedges as instructed in the procedures to avoid bodily injury.

### DANGER

Ventilate well and make sure all personnel wear respirator masks if they need to use a blowtorch to remove parts sealed with resin.

#### 5.3.3 Installing the bowl liner

Install the bowl liner as follows:

1. Place the liner on wooden wedges. Make sure the wedges allow the bowl to completely cover the liner (for HP200, HP300, HP400, HP500). Lightly coat the lower surface of the bowl with oil to prevent the resin sticking to it (no sealant resin on HP100).

2. Mark the position of the top of the bowl undulation with chalk, see Figure 5-5.

3. The bowl's adaptor ring now fixed, lower the bowl and the adjustment cap into position on the liner. To ensure it locks into place, position the bowl so that the lugs are aligned with the top of the bowl liner undulations as shown in Figure 5-5.

4. To be sure that the bowl liner is centred on the bowl, measure the distance between the outer diameter of the bowl liner and the inner diameter of the bowl at four different points 90° apart. See Figure 5-6. An incorrectly positioned bowl liner will damage its seating.

5. Pre-assemble each square head bolt, ball nut and wedge. Be sure that the spherical surface of the nut is placed against the wedge.

6. Place each wedge in contact with the bowl (for HP100) on the top of the bowl's adaptor ring (for HP200, HP300, HP400 and HP500). Push them until they come into contact with the liner.

7. Check each contact point between wedges lugs and the bowl liner as shown in Figure 5-6. Remove or add wedges underneath if necessary to achieve a correct point of contact. The wedges can be welded.

8. Place square head bolts and barrel nuts behind the wedges making the that the bolt heads are under the square stops welded to the bowl. See Figure 5-4.

9. Tighten each nut alternately and in opposition until each lug fits neatly against the jaw's helix. Use a gauge to check that the liner sits correctly all around the bowl span. The gap should not exceed 0.25 mm. Block up any gaps due to wear with clay, etc. to prevent the sealant resin from escaping. See Figure 5-7.

### Table: Figure 5-5 Position of the top of the undulation

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bowl liner</td>
</tr>
<tr>
<td>2</td>
<td>Mark the top of the undulation</td>
</tr>
<tr>
<td>3</td>
<td>Top of undulation</td>
</tr>
</tbody>
</table>

### Figure 5-5 Position of the top of the undulation
Figure 5-6 Mounting the bowl liner

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nut lock</td>
</tr>
<tr>
<td>2</td>
<td>View showing the nut lock</td>
</tr>
<tr>
<td>3</td>
<td>Bolt stop welded to the bowl</td>
</tr>
<tr>
<td>4</td>
<td>Nut lock</td>
</tr>
<tr>
<td>5</td>
<td>Lug</td>
</tr>
<tr>
<td>6</td>
<td>Contact surface</td>
</tr>
<tr>
<td>7</td>
<td>Bowl adaptor ring (HP200, HP300, HP400, HP500)</td>
</tr>
<tr>
<td>8</td>
<td>Gap imperative at this point</td>
</tr>
<tr>
<td>9</td>
<td>Bowl liner</td>
</tr>
<tr>
<td>10</td>
<td>Bowl</td>
</tr>
<tr>
<td>11</td>
<td>Wedges, if necessary</td>
</tr>
<tr>
<td>12</td>
<td>Wedge (HP200, HP300, HP400, HP500) or bowl (HP100) locking blocks</td>
</tr>
<tr>
<td>13</td>
<td>Wedge</td>
</tr>
<tr>
<td>14</td>
<td>View showing the locking blocks welded to the adaptor ring (HP200, HP300, HP400, HP500) or bowl (HP100)</td>
</tr>
<tr>
<td>15</td>
<td>Square head bolt</td>
</tr>
</tbody>
</table>
NOTE: If the nose of the wedge once in place touches the vertical wall of the liner, place a wedge under the locking wedge so that there is contact between its sloping side and the undulated surface of the liner. When the wedges are all place and tightly fixed, there should still be a small gap between the nose of the wedge and the outer vertical part of the liner, see Figure 5-6.

10. Refer to Table 6-2 for the approximate quantity of resin. Then pour in the resin, filling the cavity behind the bowl liner.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bowl</td>
</tr>
<tr>
<td>2</td>
<td>Foam seal</td>
</tr>
<tr>
<td>3</td>
<td>Bowl liner</td>
</tr>
<tr>
<td>4</td>
<td>Sealant resin (no resin on HP100)</td>
</tr>
<tr>
<td>5</td>
<td>Wedging</td>
</tr>
<tr>
<td>6</td>
<td>Set of wedges</td>
</tr>
<tr>
<td>7</td>
<td>Max acceptable play 0.25mm (0.01&quot;&quot;)</td>
</tr>
</tbody>
</table>

Figure 5-7 Checking the gap
11. Check again that all the wedges and ball nuts are tight when the resin has solidified.

12. Place the nut locks on the outer parts of the barrel nut. Insert the pins through the wedge and the nut lock. Spread the two half-ends of the pins so that they remain in place.

13. Weld a block measuring 12 mm x 12 mm x 40 mm (1/2" x 1/2" x 1 1/2") just above the square head of the locking screw, see Figure 5-6. The block will prevent the screw head from turning during crushing.

14. Cover the wedge assembly with foam joints to prevent ingress of dust and thereby facilitate subsequent dismantling of the liner.

15. Reinstall the hopper by positioning it on the pins fitted to the bowl.

16. Lubricate the threads of the bowl, locking ring and adjusting ring following the procedure indicated in paragraph 5.2 "Assembly instructions". It is very important that the bowl rotates freely in the adjusting ring.

17. Reassemble the rest of the parts.

5.4 Replacing the bowl's adaptor ring (HP200, HP300, HP400 and HP500)

To change equipment for a different production job, it may be necessary to change the adaptor ring.

The adaptor ring is simply centred in the bowl thanks to pins. To dismantle the adaptor ring, just lift it and install the new ring, positioning it with the pins. The new adaptor ring already has the wedge locking blocks. See Figure 5-8.

DANGER

Follow scrupulously the instructions on the resin boxes. Any contact with the skin can subsequently cause dermatosis. Avoid inhaling any emanated fumes, above all if the resin has been heated. If the skin comes into contact with the resin, wash straight away with water and soap.

5.4.1 Bowl seating (liner)

After a long period of use, the bowl seating must re-machined or reconditioned. In which case, contact Metso Minerals.
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  6.1.1 - HP100 ................................................................. 6-1
  6.1.2 - HP200 and HP300 .................................................. 6-1
  6.1.3 - HP400 and HP500 .................................................. 6-1

6.2 - Mounting the head assembly ......................................... 6-2

6.3 - Maintenance ............................................................ 6-5
  6.3.1 - Dismantling the head ............................................. 6-5
  6.3.2 - Replacing the mantle ............................................ 6-5
    6.3.2.1 - HP100 ......................................................... 6-5
    6.3.2.2 - HP200, HP300, HP400 & HP500 ........................... 6-9
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  6.3.6 - Another method for replacing the head bushing ............ 6-20
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  6.3.9 - Installing the lower head bushing - HP200 and HP300 ...... 6-24
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  6.3.12 - Mounting the upper head bushing - HP200, HP300, HP400 and HP500 .................................................. 6-27
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6.1 Description

6.1.1 HP100

This section describes the head, mantle and feeder cone assemblies. The head and mantle, as well as the bowl and bowl liner form the crusher cavity.

On the top of the mantle, there is the spacer ring, these two parts are firmly held on the head by a locking bolt screwed inside the head. A feeder cone is fixed onto the locking bolt. This plate rotates with the head, evenly spreading the material in the cavity (or compaction chamber).

Inside the head a bore is machined to receive the head ball. Two bores receive a head bushing which has a flange ring for fixing the bushing with screws to the lower part of the head.

The bronze ball inside the head is supported by the Sleeve. The head bushing is mounted with play on the eccentric. The head’s rotation is driven by being in contact with the ring and the eccentric.

When the machine is running idle, the head bushing comes into contact with the sleeve to retain the head ball on the sleeve.

Holes in the main shaft guide the oil towards the head bushing and into the sleeve.

A U-shaped seal machined over the imbalance matches the T-shaped seal mounted in a groove under the head, to prevent oil leaks and protect the crown, pinion and bushing surfaces from dust. A skirt acting as an oil deflector prevents leaks through the labyrinth seal.

6.1.2 HP200 and HP300

This paragraph describes the head, mantle and feeder cone assemblies. The head and mantle, as well as the bowl and bowl liner form the crusher cavity.

The mantle is firmly maintained against the head with the aid of the locking nut. The latter supports the feeder cone. The feeder cone rotates with the head and distributes the materials in the cavity.

Inside the head a bore is machined to receive the head ball. Two bores receive an upper head bushing, and one lower head bushing, the first fixed with keys, the second with screws slightly recessed.

The ball inside the head is supported by the spherical bearing. The lower head bushing is mounted with play on the eccentric making contact between the bushing and the eccentric.

When the machine is running idle, the upper head bushing comes into contact with the sleeve to maintain contact between the head ball and the sleeve.

Holes in the main shaft guide the oil towards the upper and lower head bushings and into the spherical bearing.

A U-shaped seal machined over the imbalance matches the T-shaped seal mounted in a groove under the head, to prevent oil leaks and protect the crown, pinion and bushing surfaces from dust. A skirt acting as an oil deflector prevents leaks through the labyrinth seal.

6.1.3 HP400 and HP500

This paragraph describes the head, mantle and feeder cone assemblies. The head and mantle, as well as the bowl and bowl liner form the crusher cavity.

The mantle is firmly maintained against the head with the aid of the locking nut. The latter supports the feeder cone. The feeder cone rotates with the head and distributes the materials in the cavity.

Inside the head a bore is machined to receive the head ball. This is mounted tight into the head. Two bores each receive a bushing (upper and lower) tightly mounted.

The head ball rests on the concave part of the spherical bearing at the top of the main shaft and the lower head bushing is mounted with play on the eccentric. The head’s rotation is driven by being in contact with the ring and the eccentric.

When the machine is running idle, the upper head bushing comes into contact with the sleeve to maintain contact between the head ball and the sleeve.
Holes in the main shaft guide the oil towards the upper and lower head bushings and into the spherical bearing.

A U-shaped seal machined over the imbalance matches the T-shaped seal mounted in a groove under the head, to prevent oil leaks and protect the crown, pinion and bushing surfaces from dust. A skirt acting as an oil deflector prevents leaks through the labyrinth seal.

6.2 Mounting the head assembly

(See Figure 6-1 for HP100)
(See Figure 6-2 for HP200 to HP500)

If the head, mantle and feeder cone assemblies are dismantled for shipping purposes, the various parts must be mounted as follows:

1. If the feeder cone was delivered already fitted on the head, it must be dismantled before the head assembly is handled (see paragraph 6.3.1 "Dismantling the head").

2. Carefully clean the eccentric, the inner walls of the head bushings, head ball and spherical ring. Make sure all surfaces are perfectly smooth. If there are any scratches or rough edges, they should be removed with a fine emery cloth. Check all oil passages.

3. Coat generously the outer diameter of the eccentric, the bores of the head bushings, the head ball and the bearing with lubricating oil. Use the crusher's oil.

4. The tools shipped with the crusher include a round plate with a tapped hole and a large matching handling ring.

Fit the lifting ring onto the locking bolt. Align the mounting holes and use the screws provided with the tools to fix the lifting ring onto the locking bolt.

5. With the aid of appropriate handling gear, raise the head assembly and centre it over the sleeve. The handling ring is off-centre in relation to the lifting ring so that the tilting angle of the assembly matches that of the eccentric's centreline. The highest point of the head assembly must be in line with the thick side of the eccentric. See Figure 6-1 and Figure 6-2.

6. Gently raise the head over the spherical bearing.

7. The top edge of the eccentric is chamfered, which helps to insert the head bushing. Gently lower the head assembly onto the eccentric shaking the head by hand to ease it into place.

8. When the head is resting on the spherical bearing, raise it by 6 mm to 10 mm and maintain it in this position. Then start the oil pump and let it run for 10 to 15 minutes to remove dust and pre-lubricate the bushings. Turn the pump off, lower the head onto the spherical bearing and remove the lifting ring.

9. Fix the feeder cone onto the locking nut. See Figure 6-2.
When the screw is tight, fill the hole with silicon plastic to cover the head of the screw, in order to protect the materials and for easy dismantling.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handling ring</td>
</tr>
<tr>
<td>2</td>
<td>Sling</td>
</tr>
<tr>
<td>3</td>
<td>Lifting ring</td>
</tr>
<tr>
<td>4</td>
<td>Head</td>
</tr>
<tr>
<td>5</td>
<td>Sleeve</td>
</tr>
<tr>
<td>6</td>
<td>Even gap</td>
</tr>
<tr>
<td>7</td>
<td>Thick side of the eccentric</td>
</tr>
<tr>
<td>8</td>
<td>Minimum play</td>
</tr>
<tr>
<td>9</td>
<td>Maximum play</td>
</tr>
<tr>
<td>10</td>
<td>Dismantling the head assembly:</td>
</tr>
<tr>
<td></td>
<td>1) Raise the assembly until the ring is no longer guided by the eccentric.</td>
</tr>
<tr>
<td></td>
<td>2) Centre the head in relation to the sleeve.</td>
</tr>
<tr>
<td>11</td>
<td>Mounting the head assembly:</td>
</tr>
<tr>
<td></td>
<td>1) Centre the head in relation to the sleeve.</td>
</tr>
<tr>
<td></td>
<td>2) Move the head so that the highest point of the assembly is aligned with</td>
</tr>
<tr>
<td></td>
<td>the thick side of the eccentric and continue lowering.</td>
</tr>
</tbody>
</table>

Figure 6-1 Installing or dismantling the head assembly (HP100)
### Installing or dismantling the head assembly (HP200 to HP500)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handling ring</td>
</tr>
<tr>
<td>2</td>
<td>Sling</td>
</tr>
<tr>
<td>3</td>
<td>Lifting ring</td>
</tr>
<tr>
<td>4</td>
<td>Head</td>
</tr>
<tr>
<td>5</td>
<td>Sleeve</td>
</tr>
<tr>
<td>6</td>
<td>Even clearance</td>
</tr>
<tr>
<td>7</td>
<td>Thick side of the eccentric</td>
</tr>
<tr>
<td>8</td>
<td>Minimum clearance</td>
</tr>
<tr>
<td>9</td>
<td>Maximum clearance</td>
</tr>
</tbody>
</table>

**Dismantling the head assembly:**
1. Raise the assembly until the ring is no longer guided by the eccentric.
2. Centre the head in relation to the sleeve.

**Mounting the head assembly:**
1. Centre the head in relation to the sleeve.
2. Move the head so that the highest point of the assembly is aligned with the thick side of the eccentric and continue lowering.

*Figure 6-2 Installing or dismantling the head assembly (HP200 to HP500)*
6.3 Maintenance

6.3.1 Dismantling the head

To remove the head for inspection or part replacement purposes, proceed as follows:

1. Remove the feeder cone.

Loosen the central bolt.

2. Screw the handling ring into the head's lifting plate (supplied with the tools). Position the lifting plate on the locking bolt with the aid of the holes on the head, in such a way that the handling ring is at the highest point of the head. Use appropriate bolts supplied with the tools.

3. With the aid of appropriate lifting gear, raise the head assembly until the ring is no longer guided by the eccentric, then centre the head assembly in relation to the sleeve. Raise vertically.

4. Place the head assembly on suitable wedges.

6.3.2 Replacing the mantle

6.3.2.1 HP100

To dismantle a worn mantle and replace it with a new one, proceed as instructed below:

1. Dismantle the lifting plate.

2. Grind the two weld seams between the locking bolt and the spacer ring and the mantle.

IF THIS OPERATION IS NOT CARRIED OUT WITH EXTREME CARE, THE HEAD COULD SWAY AND KNOCK AGAINST THE SLEEVE, WHICH COULD DAMAGE THE HEAD BUSHING OR OTHER PARTS.

3. Figure 6-3 Feeder cone assembly

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Silastic</td>
</tr>
<tr>
<td>2</td>
<td>Feeder cone</td>
</tr>
<tr>
<td>3</td>
<td>Central bolt</td>
</tr>
<tr>
<td>4</td>
<td>Locking bolt</td>
</tr>
</tbody>
</table>

Figure 6-3 Feeder cone assembly

4. Figure 6-4 Dismantling the locking bolt (HP100)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wrench fastening screw</td>
</tr>
<tr>
<td>2</td>
<td>Locking wrench</td>
</tr>
<tr>
<td>3</td>
<td>Sledgehammer</td>
</tr>
<tr>
<td>4</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>5</td>
<td>Loosen</td>
</tr>
<tr>
<td>6</td>
<td>Tighten</td>
</tr>
</tbody>
</table>

Figure 6-4 Dismantling the locking bolt (HP100)
Because the mantle tends to stretch during crushing, it may be difficult to remove the bolt. In that case the spacer between the mantle and the locking bolt can be oxygen-cut to eliminate the tension on the screws, (see Figure 6-5). To oxygen-cut the spacer ring, some precautions should be taken to avoid damaging the head. The blowtorch should be aimed at a tangential angle to the spacer ring, and it is preferable to burn a groove all the way round before actually cutting it off. The locking bolt is now free to turn and can be removed.

3. Fix the locking key (supplied with the tools) with the 2 screws into the matching holes on the locking bolt.

Hit the wrench with a sledgehammer to release the locking bolt by turning it CLOCKWISE. See Figure 6-4.

4. Dismantle the locking wrench with its screws.

5. Unscrew the locking bolt by hand.

6. Remove the spacer ring.

**DANGER**

Ventilate well and make sure all personnel wear respirator masks if they need to use a blowtorch to remove parts sealed with resin.

For the lifting lugs:

- **Ref.**
- **Description**
  
<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Section) Circular groove</td>
</tr>
<tr>
<td>2</td>
<td>Direction of the blowtorch flame</td>
</tr>
</tbody>
</table>

**Figure 6-5 Cutting a groove in the spacer ring (HP100)**

7. Make the lifting lugs according to the dimensions stated in Figure 6-6, welding as instructed below:

- **A** Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 18 8 Mn, AWS A 5-9 ER 307 Si (workshop).

- **B** DO NOT preheat the mantle.

- **C** Clean the eye bolt welding surfaces thoroughly.

- **D** A 6 mm weld seam is required on either side of the eye bolt.

- **E** THE WELDING SHOULD BE IMPECCABLE.

(See welding equipment in the "Safety Instructions" manual).
8. Raise the mantle with slings, placing suitable shackle in the lifting lugs. See Figure 6-7.

9. Inspect the mantle and the head before reassembling.
   a. Remove any rough edges, traces or blisters of paint from the bowl seating.
   b. Clean the seating of the liner on the head, this surface should be free of any defects.
   c. Check the head’s threads and the locking bolt. Remove any remaining burrs or rough edges and clean the threads thoroughly.
   d. Check the seating of the spacer ring on the locking bolt, which should be free of burrs and rough edges.
   e. If the locking bolt is not replaced, check that the screw rests properly on the spacer ring.

Otherwise (change the retaining locking bolt screw), the screw threads or head could be damaged and the mantle would no longer be firmly attached to the head.

f. Lightly coat the bowl seating with oil, to prevent corrosion.

10. Lift the mantle with a sling and suitable shackle inserted in the welded lifting rings (see step 7) or with slings attached directly to the moulded hooks on the mantle.

11. It is very important for the mantle to be properly fitted to the head. If the mantle were to bounce, extensive damage could be caused to the head at the level of the span. Install the mantle as follows:
   a. Before lowering the mantle onto the head, coat the bottom of the mantle seating with grease over a length of 25 mm.
   b. Lower the mantle over the head.
   c. Grease the head threads with lithium grease containing 5 to 10% of molybdenum disulphide (or anti-seize paste, subject to see agreement with Metso). Screw the locking bolt by hand anticlockwise without the spacer ring.
   d. Loosen the screw, fit the spacer ring onto the liner.
e. Bring the locking bolt close to the spacer ring. Position the mantle so that the gap between the spacer ring and the locking bolt is equal all around the edge. If the gap is uneven, the mantle can be adjusted by hitting it at the top or raising its bottom. Do not rely on the tightness of the bolt to align the mantle correctly.

![Diagram of mantle and assemblies](image)

### Figure 6-8 Correct position of the mantle (HP100)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mantle</td>
</tr>
<tr>
<td>2</td>
<td>Equal distance</td>
</tr>
<tr>
<td>3</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>4</td>
<td>Spacer ring</td>
</tr>
<tr>
<td>5</td>
<td>Head</td>
</tr>
</tbody>
</table>

12. Fix the locking wrench (supplied with the tools) onto the locking bolt with the aid of the 2 screws (supplied with the tools).

13. Bring the locking bolt into contact by hand with the spacer ring by turning it anticlockwise with the aid of the locking wrench mounted on the locking bolt.

14. Use a gauge to check that the mantle seating is in contact with the head set liner. The gap should not exceed 0.25 mm (0.010'). If the gap is wider due to wear, lift the mantle, cover the bottom of the head with clay or another material then refit the mantle.

15. Make a vertical mark on the mantle, the spacer ring and the locking bolt.

16. With a sledgehammer, strike the wrench to lock the locking bolt by making it turn ANTICLOCKWISE, to obtain a displacement of 80 to 100 mm.

17. After tightening the locking bolt onto the head:

- Apply 2 3-mm weld seams diametrically opposite over a length of 30 mm (1.2 inches) between the mantle and the spacer ring.
- Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 188 Mn, AWS A 5-9 ER 307 Si (workshop).
- Apply 2 3-mm weld seams diametrically opposite over a length of 30 mm (1.2 inches) between the spacer ring and the locking bolt. The weld should not interfere with the distribution cone on the locking bolt.
- Use rods compliant with standard ISO (2560), E515 B 120 29 (H), NF (EN 499) E 423 B 32 H 5, WAS (A 5.1) E 7018 or cored wire compliant with standard WAS A518 E70C-6MH4, EN 758: T 42 3 M M2 H5.
The weld seams between the mantle and the spacer ring and those between the spacer ring and the locking bolt should be in a quincunx and spaced 45° apart.

**DANGER**
The weld should not interfere with the feeder cone support on the mantle’s locking bolt.

18. Cut the lifting lugs or moulded hooks on the mantle.

19. Fit the head referring to the instructions given in paragraph 6.2 "Mounting the head assembly".

### 6.3.2.2 HP200, HP300, HP400 & HP500

To dismantle a worn mantle and replace it with a new one, proceed as instructed below:

1. Dismantle the lifting plate.

2. Grind the two weld seams between the locking bolt and the spacer ring and between the spacer ring and the mantle.

3. Screw the M10 lifting ring (supplied with toolkit) onto the locking wrench (supplied with the tools) (for HP200/400/500).

Lift the wrench with slings attached to the handle (HP300) or with suitable shackle attached to the lifting ring (HP200/400/500).

Lower the wrench into the imprint of the locking bolt and fit the L30 washer and M30 screw (for HP200/300) and the L42 washer and M42 screw (for HP400/500) supplied with the tools to lock the wrench onto the bolt. Hit the wrench with a sledgehammer to release the locking bolt by turning it CLOCKWISE. See Figure 6-9.

4. Dismantle the locking wrench with its screw.

Raise the locking wrench with a sling and suitable shackle inserted in the lifting eye bolt.

5. Screw the M30 (for HP200/300) or M42 (for HP400/500) handling ring (supplied with the tools) onto the locking bolt. Unscrew the locking bolt by hand.

Lift the locking bolt with a sling and place suitable shackle into the lifting ring.

6. Remove the spacer ring.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wrench fastening screw</td>
</tr>
<tr>
<td>2</td>
<td>Locking wrench</td>
</tr>
<tr>
<td>3</td>
<td>Sledgehammer</td>
</tr>
<tr>
<td>4</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>5</td>
<td>Loosen</td>
</tr>
<tr>
<td>6</td>
<td>Tighten</td>
</tr>
<tr>
<td>7</td>
<td>Pins</td>
</tr>
</tbody>
</table>

**Figure 6-9 Dismantling the locking bolt**

**Figure 6-10 Cutting a groove in the spacer ring**

3. Screw the M10 lifting ring (supplied with toolkit) onto the locking wrench (supplied with the tools) (for HP200/400/500).

Lift the wrench with slings attached to the handle (HP300) or with suitable shackle attached to the lifting ring (HP200/400/500).

Lower the wrench into the imprint of the locking bolt and fit the L30 washer and M30 screw (for HP200/300) and the L42 washer and M42 screw (for HP400/500) supplied with the tools to lock the wrench onto the bolt. Hit the wrench with a sledgehammer to release the locking bolt by turning it CLOCKWISE. See Figure 6-9.

4. Dismantle the locking wrench with its screw.

Raise the locking wrench with a sling and suitable shackle inserted in the lifting eye bolt.

5. Screw the M30 (for HP200/300) or M42 (for HP400/500) handling ring (supplied with the tools) onto the locking bolt.

Unscrew the locking bolt by hand.

Lift the locking bolt with a sling and place suitable shackle into the lifting ring.

6. Remove the spacer ring.
Figure 6-11 Handling the mantle

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mantle</td>
</tr>
<tr>
<td>2</td>
<td>Lifting with moulded hooks</td>
</tr>
<tr>
<td>3</td>
<td>Lifting with welded lugs</td>
</tr>
<tr>
<td>4</td>
<td>Lifting with the lifting accessory</td>
</tr>
<tr>
<td>5</td>
<td>Slings</td>
</tr>
</tbody>
</table>

INFORMATION:
If the production date of your crusher is earlier than April 2011, please contact Metso to procure this accessory and find out the technical alterations top make to the crusher.

DANGER
When the mantle is handled with welded eye bolts, make sure they are the right size and the welding is solid. Use welding rods that are suitable for manganese.

7. Since April 2011, each crusher comes with a mantle lifting accessory. This accessory is included in the toolbox and is designed to handle only new and worn Metso mantles for Metso HP cone crushers.

Please refer to the IM-308000000 instruction manual for instructions on setting up, using and maintaining the lifting accessory.

Figure 6-12 Lifting eye bolt

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 mm</td>
</tr>
<tr>
<td>2</td>
<td>50 mm</td>
</tr>
<tr>
<td>3</td>
<td>Diameter of hole: 50 mm</td>
</tr>
<tr>
<td>4</td>
<td>R: 50 mm</td>
</tr>
<tr>
<td>5</td>
<td>Thickness of the plate: 10 mm</td>
</tr>
</tbody>
</table>
If you do not have a lifting accessory, make the lifting lugs to the stated dimensions Figure 6-12 and use the welding procedure given below:

A. Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 18 8 Mn, AWS A 5-9 ER 307 Si (workshop).

B. DO NOT preheat the mantle.

C. Clean the eye bolt welding surfaces thoroughly.

D. A 6 mm weld seam is required on either side of the eye bolt.

E. THE WELDING SHOULD BE IMPECCABLE.

(See welding equipment in the "Safety Instructions" manual).

8. Raise the mantle with slings, placing suitable shackle in the lifting lugs. See Figure 6-11.

9. Inspect the mantle and the head before reassembling.

a. Remove any remaining sealant resin on the head.

b. Remove any rough edges, traces or blisters of paint from the bowl seating.

c. Clean the seating of the liner on the head, this surface should be free of any defects.

b. Grease the head threads and the locking bolt with lithium grease containing 5 to 10% of molybdenum disulphide (or anti-seize paste, see Metso agreement). Screw the locking bolt by hand anticlockwise without the spacer ring.

d. Loosen the screw, fit the spacer ring onto the liner.

e. Bring the locking bolt close to the spacer ring. Position the mantle so that the gap between the spacer ring and the locking bolt is equal all around the edge. If the gap is uneven, the mantle can be adjusted by hitting the top or raising the bottom of it. Do not rely on the tightness of the bolt to align the mantle correctly.

g. Lightly coat the bowl seating with oil, to prevent corrosion.

h. Check that the mantle has holes for pouring the resin as described in paragraph 14. Otherwise, cut out 25 x 40 mm 2 notches diametrically opposed in the top of the mantle for pouring the resin. See Figure 6-14 and Figure 6-15.

10.Lift the mantle with a sling and suitable shackle inserted in the lifting accessory's lugs, the welded lifting rings or with slings attached directly to the moulded hooks on the mantle (see step 7).

11. It is very important for the mantle to be properly fitted to the head. If the mantle were to bounce, extensive damage could be caused to the head at the level of the span. Install the mantle as follows:

a. Before lowering the mantle onto the head, coat the bottom of the mantle seating with grease over a length of 25 mm.

b. Lower the mantle over the head.

c. Grease the head threads and the locking bolt with lithium grease containing 5 to 10% of molybdenum disulphide (or anti-seize paste, see Metso agreement). Screw the locking bolt by hand anticlockwise without the spacer ring.

d. Loosen the screw, fit the spacer ring onto the liner.

e. Bring the locking bolt close to the spacer ring. Position the mantle so that the gap between the spacer ring and the locking bolt is equal all around the edge. If the gap is uneven, the mantle can be adjusted by hitting the top or raising the bottom of it. Do not rely on the tightness of the bolt to align the mantle correctly.
12. Fit the locking key (supplied with the tools) with the pins into the matching holes on the locking bolt.

Fit washer L30 and screw M30 (for HP200/300) and washer L42 and screw M42 (for HP400/500) supplied with the tools to lock the wrench onto the bolt.

13. Bring the locking bolt into contact by hand with the spacer ring by turning it anticlockwise with the aid of the locking wrench mounted on the locking bolt. Make a vertical marl on the mantle, the spacer ring and the locking bolt then strike the locking wrench with a sledgehammer to achieve the displacement stated in Table 6-1.

<table>
<thead>
<tr>
<th>Crusher</th>
<th>Displacement value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP200</td>
<td>60 mm</td>
</tr>
<tr>
<td>HP300</td>
<td>85 mm</td>
</tr>
<tr>
<td>HP400</td>
<td>130 mm</td>
</tr>
<tr>
<td>HP500</td>
<td>175 mm</td>
</tr>
</tbody>
</table>

Table 6-1 Displacement value before heating the mantle

14. Use a gauge to check that the mantle seating is in contact with the head set liner. The gap should not exceed 0.25 mm (0.010"). If the gap is wider due to wear, lift the mantle, cover the bottom of the head with clay or another material then refit the mantle to prevent any leaking of the sealant. See Figure 6-14.

15. Make a vertical mark on the liner, the spacer ring and the locking bolt.

16. Heat the lower part of the mantle with a flame at roughly 55°C above ambient temperature.

17. With a sledgehammer, strike the wrench to lock the locking bolt by making it turn ANTICLOCKWISE, to obtain a displacement of 20 to 30 mm.
18. After tightening the locking bolt onto the head:

- Apply 2 3-mm weld seams diametrically opposite over a length of 50 mm (2 inches) between the mantle and the spacer ring.

- Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 18 8 Mn, AWS A 5-9 ER 307 Si (workshop).

- Apply 2 3-mm weld seams diametrically opposite over a length of 50 mm (2 inches) between the spacer ring and the locking bolt. The weld should not interfere with the distribution cone on the locking bolt.

- Use rods compliant with standard ISO (2560), E515 B 120 29 (H), NF (EN 499) E 423 B 32 H 5, WAS (A 5.1) E 7018 or cored wire compliant with standard WAS A518 E70C-6MH4, EN 758: T 42 3 M M2 H5.

- The weld seams between the mantle and the spacer ring and those between the spacer ring and the locking bolt should be in a quincunx and spaced 45° apart.

DANGER

The weld should not interfere with the feeder cone support on the mantle’s locking bolt.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pouring channel</td>
</tr>
<tr>
<td>2</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>3</td>
<td>Mantle</td>
</tr>
<tr>
<td>4</td>
<td>Maximum admissible play 0.25mm (0.01&quot;)</td>
</tr>
<tr>
<td>5</td>
<td>Filling hole</td>
</tr>
<tr>
<td>6</td>
<td>Clean this surface with oil</td>
</tr>
<tr>
<td>7</td>
<td>Head</td>
</tr>
<tr>
<td>8</td>
<td>Set of wedges</td>
</tr>
</tbody>
</table>

Figure 6-14 Installing the mantle
19. Cut the lifting lugs or moulded hooks on the mantle.

20. When the mantle has cooled down, fill the cavity with sealant resin up to the top of the head.

The sealant resin is a hard-wearing, non-metallic and resilient material. It is available in various quantities.

Each packet contains a large box of resin and a small box of hardener for mixing.

No special handling, preparation or equipment is necessary to use it. The resin cannot be reused. It can be prepared at the place of use, without any prior training required for the personnel. Just follow the instructions on the packaging. When the resin has been mixed, it must be used without delay. If the prepared quantity is not enough, the operation can be repeated and liquid resin poured on the resin that has already solidified.

IF THE RESIN IS TOO COLD, IT WILL HARDEN SLOWLY AND WILL BE TOO VISCIOUS TO FILL THE SPACE BETWEEN THE TWO WALLS THAT ARE TOO CLOSE TOGETHER. IF IT IS TOO HOT, THE MIXTURE CAN HARDEN IN THE BOX BEFORE IT IS Poured. TO AVOID THIS, IMMERSE THE BOXES IN WATER BEFORE OPENING THEM TO BRING THEM TO A TEMPERATURE OF BETWEEN 16°C AND 32°. DO NOT USE THE RESIN WHEN THE CRUSHER FEED EXCEEDS 80°C. UNOPENED BOXES OF RESIN CAN BE KEPT FOR 12 MONTHS FROM THE DATE OF PRODUCTION.

Table 6-2 gives the approximate quantity of sealant resin required.

Use the filling holes moulded in the mantle or oxygen-cut two holes measuring 25 mm x 40 mm, diametrically opposed, at the top of the mantle, to pour the sealant resin.

Make a pouring channel in sheet metal or cardboard to pour the resin. To speed up the operation, it can be poured at several places at the same time. See Figure 6-14 and Figure 6-15.
If 25 x 40 mm notches are used to pour the resin, they must be blocked with a 3 mm (1/8") metal sheet welded to the mantel. This prevents dust penetrating the threads of the locking bolt and the head.

21. Install the head, following the instructions given in paragraph 6.2 "Assembling the head assembly".

---

**DANGER**

Follow scrupulously the instructions on the resin boxes. Any contact with the skin can subsequently cause dermatosis. Avoid inhaling any emanated fumes, above all if the resin has been heated. If the skin comes into contact with the resin, wash straight away with water and soap.

---

The sealant resin comes in kits of 10 kg and 5 kg after mixing.

### Table 6-2 Requisite quantity of sealant resin

<table>
<thead>
<tr>
<th>Type</th>
<th>Standard</th>
<th>Short head (HP200/300) Option (HP400/500)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HP 200</td>
<td>HP 300</td>
</tr>
<tr>
<td>Requisite quantity of resin for the mantle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Average weight (kg)</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Requisite quantity of resin for the bowl liner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Average weight (kg)</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

---

**Figure 6-16 Installing the head wear ring (HP400 and HP500)**
6.3.3 Replacing the head wear ring - HP400 and HP500

For a crusher equipped with an extra-thin short head, a wear ring must be placed behind the mantle to protect the head. This wear ring is in several parts. Align the bottom of the ring with the bottom of the head and weld only the upper part. See Figure 6-16.

6.3.4 Replacing the head ball

The head ball rests on the sleeve (HP100) or the spherical bearing (HP200 to HP500). Ball wear is therefore usually minimal. However, through a lack of oil or contaminated oil, the ball is worn so much that its spherical surface is uneven; it must be replaced, see Figure 6-17 and proceed as follows:

1. Remove the bolt fixing the head ball to the head.
   
   If the bolt was fitted with Loctite, it must be heated by flame to a temperature of approximately 205°C.

2. The ball is partially recessed in the head:
   
   a. Place a wooden wedge under the head in such a way that there is only a short distance between the ball and the wedge, to allow the ball to lower correctly.

   b. Use a 50 x 50 mm rafter, place it between the welded washer and the bore of the head, and strike until the head ball is released.

3. When the worn head ball has been dismantled, upturn the head and clean the head bore receiving the ball.

4. To reduce the diameter of the head ball, place it in a refrigerated bath for 4 to 6 hours. This will require approximately 23 kg of carbon dioxide snow. Measure the outer diameter of the ball and the inside of the head bore to determine whether the ball can be mounted.
Figure 6-17 Replacing the head ball

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bolt and flexible washer</td>
</tr>
<tr>
<td>2</td>
<td>Washer</td>
</tr>
<tr>
<td>3</td>
<td>Head</td>
</tr>
<tr>
<td>4</td>
<td>Pins</td>
</tr>
<tr>
<td>5</td>
<td>Head ball</td>
</tr>
<tr>
<td>6</td>
<td>Wooden wedges</td>
</tr>
<tr>
<td>7</td>
<td>Lower head bushing</td>
</tr>
<tr>
<td>8</td>
<td>Upper head bushing</td>
</tr>
<tr>
<td>9</td>
<td>Weld 6 mm</td>
</tr>
</tbody>
</table>

**DANGER**

Use well insulated gloves to handle carbon dioxide snow, which can cause serious burns.

5. Secure the head ball using a lifting ring placed in the central hole of the ball, and lower it into its housing. Ensure its bearing surface comes into contact with the head. Check 4 points with the aid of a gauge. Ensure the pin hole in the head ball is aligned with the pin in the head. See Figure 6-18.
6. Fit the screw into the washer welded in the head bore, then screw it into the ball.

7. Heat the ball to ambient temperature then remove the screw and clean all the threads and the hole with a solvent. Then apply Loctite 277 to the threads of the screw, and refit it with its washer.

6.3.5 Replacing the lower head bushing

(See Figure 6-19).

The lower head bushing mounted tightly in the head is kept in place by headless screws ref. 6 for HP200 and HP300. The bushing is kept in place by screws for HP100, HP400 and HP500.

If the lower head bushing needs to be dismantled, upturn the head and proceed as follows:

1. Use a saw with a suitable blade to cut the bronze ring in two places. Adjust the saw so that it follows and is guided by the head bushing bore hole, see Figure 6-20.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Head ball</td>
</tr>
<tr>
<td>2</td>
<td>Lifting ring</td>
</tr>
</tbody>
</table>

Figure 6-18 Assembling the head ball
2. Measure the distance between the blade and the head’s bore hole. Deduct a few tenths of millimetres from the resulting distance to be sure the saw does not damage the head.

3. Adjust the saw to the sawing depth determined in paragraph 2.

**DANGER**

Protective equipment must be worn. In particular, protect your head with a shock-resistant mask throughout the operation.
4. Saw a test cut to ensure the sawing depth is correct. Make any necessary adjustments.

5. Saw the head bushing along the cone distance.

6. Repeat at the diametrically opposed point. The bushing should be practically free after the second cut.

---

### Figure 6-20 Removing the bushing by sawing

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Circular saw</td>
</tr>
<tr>
<td>2</td>
<td>Lower head bushing</td>
</tr>
<tr>
<td>3</td>
<td>Base of the saw</td>
</tr>
<tr>
<td>4</td>
<td>Use a suitable saw blade</td>
</tr>
<tr>
<td>5</td>
<td>Sawing depth</td>
</tr>
</tbody>
</table>

---

### 6.3.6 Another method for replacing the head bushing

On HP200, HP300, HP400 and HP500, to replace the upper head bushing, the lower head bushing needs to be dismantled. To recover and reuse the lower head bushing, upturn the head and proceed as follows:

1. Remove the screws retaining the bushing on the head.

2. Make a centring plate as shown in Figure 6-21.

3. Slide the plate vertically through the bushing until it is behind the bushing. Turn the centring plate 90°. See Figure 6-22.

4. Holding the plate in position, screw a threaded rod 24 or 27 mm in diameter into the welded nut in the centre of the plate. The threaded rod should be longer than the height of the bushing.

5. Place a bar measuring 25 mm x 75 mm over the threaded rod and tighten firmly with a nut.

6. Place runners between the bar and head drum as shown in Figure 6-23.

7. Fill the bushing's bore with carbon dioxide snow to make it narrower. Cooling time: roughly 2 hours.
8. Use the threaded rod as a cylinder. Tighten the nut until the bushing comes out. Cylinders can also be used.
9. Unscrew the nut and place additional runners under the bar then tighten the nut until the bushing comes out.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dimension on lower flat metal strips inside the bushing</td>
</tr>
<tr>
<td>2</td>
<td>The diameter of the plate should be 3 mm less than the outer diameter of the bushing</td>
</tr>
<tr>
<td>3</td>
<td>Centring plate</td>
</tr>
<tr>
<td>4</td>
<td>25 mm</td>
</tr>
<tr>
<td>5</td>
<td>Weld a 24 or 27 mm nut</td>
</tr>
</tbody>
</table>

Figure 6-21 Centring plate

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slide the centring plate through the bushing and turn through 90°</td>
</tr>
<tr>
<td>2</td>
<td>Bushing</td>
</tr>
<tr>
<td>3</td>
<td>Centring plate</td>
</tr>
</tbody>
</table>

Figure 6-22 Centring plate
6.3.7 Checking the bore of the head and the two bushings

Before fitting the new head bushing, check that the head's bore hole is clean and smooth, free of scrapes etc. Also check that the bore has not been deformed after being heated. Measure the bore from the bottom upwards.
6.3.8 Installing the head bushing - HP100

(See Figure 6-24).
To install the bushing, proceed as follows:
1. Clean the bore of the head and outer circumference of the bushing.
2. Fill the new head bushing with carbon dioxide snow to make it narrower. 90 kg of carbon dioxide snow are required to reduce the outer diameter of the head bushing. Use a piece of wood measuring 100 mm x 100 mm to leave a large enough gap around it in the head bushing for the requisite quantity of carbon dioxide snow.
3. Measure the outer diameter of the ball and the inside of the head bore to determine whether the ball can be mounted.
4. Fit two lifting rings (supplied with the tools) into the bushing's handling holes.
5. Raise the bushing and centre it over the bore hole. Lower it rapidly into the head.
6. Push the bushing in until it rests on the underside of the head.

---

**DANGER**
Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

Wrap the outside of the head bushing with several layers of fibre glass to prevent frost forming, which could impede reassembly of the bushing into the head. This also helps cool the bushing right down.

The cooling process takes about two hours.

**DO NOT USE THIS METHOD FOR THE HEAD’S BORE HOLE; IT WOULD SHRINK.**

3. Measure the outer diameter of the ball and the inside of the head bore to determine whether the ball can be mounted.
4. Fit two lifting rings (supplied with the tools) into the bushing's handling holes.
5. Raise the bushing and centre it over the bore hole. Lower it rapidly into the head.
6. Push the bushing in until it rests on the underside of the head.

---

**DANGER**
Make sure the handling holes drilled on the head match up.

---

**Figure 6-24 Head assembly**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>Head bushing</td>
</tr>
<tr>
<td>3</td>
<td>Head bushing fixing screw</td>
</tr>
<tr>
<td>4</td>
<td>Washer</td>
</tr>
</tbody>
</table>
7. Clean the holes and screws with solvent then insert the screws with Loctite 277.
8. Lock the 8 M8 x 20 screws.
9. Install the bushing head as explained in paragraph 6.2 "Mounting the head assembly". When reassembling the feeder cone, cover the head of the screw retaining the cone with silastic.

AFTER FITTING A NEW HEAD BUSHING, REFER TO PARAGRAPH 3.6 "Initial start-up".

6.3.9 Installing the lower head bushing - HP200 and HP300
(See Figure 6-25).
To install the bushing, proceed as follows:
1. Clean the bore of the head and outer circumference of the bushing.
2. Fill the new head bushing with carbon dioxide snow to make it narrower. 90 kg of carbon dioxide snow are required to reduce the outer diameter of the bushing. Use a piece of wood measuring 100 mm x 100 mm to leave a large enough gap around it in the bushing for the requisite quantity of carbon dioxide snow.

---

**Figure 6-25 Fitting screws slightly recessed**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>Lower head bushing</td>
</tr>
<tr>
<td>3</td>
<td>Inner diameter of the head bushing</td>
</tr>
<tr>
<td>4</td>
<td>&quot;A&quot; See Table 6-3</td>
</tr>
<tr>
<td>5</td>
<td>Screw slightly recessed</td>
</tr>
</tbody>
</table>

---
Wrap the outside of the head bushing with several layers of fibre glass to prevent frost forming, which could impede reassembly of the bushing into the head. This also helps cool the bushing right down. The cooling process takes about two hours.

DO NOT USE THIS METHOD FOR THE HEAD'S BORE HOLE; IT WOULD SHRINK.

3. Measure the outer diameter of the bushing and the inside of the head bore to determine whether the bushing has cooled down enough.

4. Fit two lifting rings (supplied with the tools) into the bushing's handling holes.

5. Raise the bushing and centre it over the bore hole. Lower it rapidly into the head.

6. Push the bushing until the lower surfaces of the cylindrical bushing and the head are aligned.

7. After fitting the bushing, drill and tap the head and bushing to fix the slightly recessed screws as shown in Figure 6-25 and in Table 6-2.

8. Clean the holes and screws with solvent then insert the screws with Loctite 277. Check that the screws do not protrude beyond the head.

9. With a CHS-type wrench lock the screws.

10. Install the bushing head as explained in paragraph 6.2 "Mounting the head assembly". When reassembling the feeder cone, cover the heads of the screws retaining the cone with silastic.

AFTER FITTING A NEW LOWER HEAD BUSHING, REFER TO PARAGRAPH 3.6 "Initial start-up".

6.3.10 Installing the lower head bushing - HP400 and HP500

(See Figure 6-26).

Replace the head bushing as follows:

1. Clean the bore of the head and outer circumference of the bushing. Clean the holes fixing the bushing in the head.

2. Fill the new head bushing with carbon dioxide snow to make it narrower. 90 kg of carbon dioxide snow are required to reduce the outer diameter of the bushing. Use a piece of wood measuring 100 mm x 100 mm to leave a large enough gap around it in the bushing for the requisite quantity of carbon dioxide snow.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of screws</th>
<th>&quot;A&quot;</th>
<th>Dimension of the slightly recessed screws</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP200</td>
<td>3</td>
<td>16.5 mm</td>
<td>M16x40</td>
</tr>
<tr>
<td>HP300</td>
<td>4</td>
<td>18.5 mm</td>
<td>M16x40</td>
</tr>
</tbody>
</table>

Table 6-3 Information on slightly recessed screws

DANGER

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.
3. Measure the outer diameter of the bushing and the inside of the head bore to determine whether the bushing has cooled down enough.

4. Paint or draw a line outside the bushing at right angles to one of the mounting holes. Paint or draw a line at the top of the head at right angles to the tapped holes. These lines must serve to correctly align the holes for mounting the bushing and the head.

5. Fit two lifting rings (supplied with the tools) into the bushing's handling holes.

6. Raise the bushing and centre it over the bore hole. Lower it rapidly into the head.

7. Make sure immediately that the holes are well enough aligned to allow the tap screws to be screwed into the head. Otherwise, turn the bushing slightly until the tap screws are properly screwed in.

8. Temporarily tighten the tap screws at 50% of the torque stated in Table 6-3. Use a thickness gauge to check whether the bushing is tight against the head all around. Check at least four points.

9. WHEN THE bushing has been brought to ambient temperature, remove the previously inserted tap screws, clean the new tap screws and self-locking nuts and the holes tapped in the head with an oil-free solvent. The apply Loctite 277 to the threaded surfaces, fit the tapped screws and washers and tighten these screws to the FINAL torque as specified in Table 6-4. NEVER REUSE SELF-LOCKING TAP SCREWS.

10. Install the head as explained in paragraph 6.2 "Mounting the head assembly". When reassembling the feeder cone, the screw heads must be protected to ensure the seal.

---

**Ref.** | **Description**
--- | ---
1 | Head
2 | Lower head bushing
3 | Locking bolt
4 | Loctite 277
5 | Washer

**Figure 6-26 Lower head bushing**

---

**DANGER**

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

Wrap the outside of the head bushing with several layers of fibre glass to prevent frost forming, which could impede reassembly of the bushing into the head. This also helps cool the bushing right down.

The cooling process takes about two hours.

DO NOT USE THIS METHOD FOR THE HEAD'S BORE HOLE; IT WOULD SHRINK.
AFTER FITTING A NEW LOWER HEAD BUSHING, REFER TO PARAGRAPH 3.6 "Initial start-up".

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimension of the screws (Ref. 3 Figure 6-26)</th>
<th>Thread torque</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP400</td>
<td>M10 x 25</td>
<td>60 N.m</td>
<td>8</td>
</tr>
<tr>
<td>HP500</td>
<td>M10 x 25</td>
<td>60 N.m</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 6-4 Information on the screws

6.3.11 Dismantling the upper head bushing - HP200, HP300, HP400 and HP500

(See Figure 6-27).

The upper head bushing is mounted slightly tightened in the head and retained by retainer locks.

If upper head bushing needs to be dismantled, turn the head and proceed as follows:

On the HP200 and HP300, the lower head bushing must be dismantled before dismantling the upper head bushing. On the other hand, on the HP400, the lower head bushing does not need to be removed before the upper bushing.

1. Read the instructions in paragraph 6.3.5 "Replacing the lower head bushing" in this section, the "sawing" and "cooling" procedures are the same as for dismantling and installing the upper head bushing.

Remove the 4 rail stops by loosening the screws. If these screws were fitted with Loctite, they must be heated to around 205°C.

2. Remove the head bushing by sawing.

3. Check the head's bore, which must be clean. Check the dimensions of this bore.

6.3.12 Mounting the upper head bushing - HP200, HP300, HP400 and HP500

(See Figure 6-27).

To mount the head bushing, proceed as follows:

1. Clean the bore of the head and outer circumference of the bushing.

2. Cool the bushing with carbon dioxide snow for at least two hours.

3. Install the handling rings and bring the bushing into position over the bore hole.

4. Quickly lower the bushing until it fits into the bottom of the bore hole, aligning the grooves of the bushing's retainer lock with those of the rail stop supports.

5. Put the rail stops in place using locking plates and screws. Fit the screws with Loctite 277, after cleaning the holes and screws with solvent.

6. After tightening the retainer locks, pull the stop plates over the fastenings on HP200, HP300 and HP500, remount the lower head bushing as instructed in this section.

AFTER INSTALLING THE NEW HEAD BUSHINGS, SEE PARAGRAPH 3.6 "Initial start-up".
6.3.13 Checking the feeder cone screw - HP100, HP200 and HP300

Check the feeder cone and central bolt for wear; replace if necessary.

IF A FEEDER CONE FALLS INTO THE CAVITY, IT CAN CAUSE SERIOUS DAMAGE. Regularly check that the cone’s locking bolt is tight. If in doubt, change the bolt.

6.3.14 Fitting the feeder cone - HP100, HP200 and HP300

Set the one down on the screw, insert the screw (HM20 for HP100 and HM30 for HP200/300) and tighten it. The cone has a male part that fits into the female part of the screw, to prevent the cone rotating.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>Rail stop support</td>
</tr>
<tr>
<td>3</td>
<td>Retainer lock</td>
</tr>
<tr>
<td>4</td>
<td>Upper head bushing</td>
</tr>
<tr>
<td>5</td>
<td>Rail stop support welded on both sides</td>
</tr>
<tr>
<td>6</td>
<td>Screw and washer</td>
</tr>
</tbody>
</table>
6.3.15 Replacing the joints
(See Figure 6-28 and Figure 6-29)
The T-shaped polyurethane joint (I-shaped for HP100) glued into the machined groove under the head is not subject to wear. Should it be damaged for any reason whatsoever, it should be replaced straight away. This joint protects the pinion and crown assembly and bushings from airborne dust, which causes rapid wear, contaminates the oil and clogs up the oil filter.

1. Remove the worn seal and scrape off any remaining debris in the seal groove.
2. Clean the groove thoroughly with a quick-drying oil-free cleaner.

The diameter of the spare seals is the same or slightly larger than required. Insert the new seal into the groove without glue and mark out the required length. Remove the seal and make a clean cut at the desired length. The seal must be able to be mounted in its groove without forcing.

3. Apply the adhesive to the bottom of the head's throat. Use just enough adhesive to ensure the bond.
4. Put the joint in place in its groove as soon as the adhesive is applied. Press the joint in such a way that of is firmly fixed to the contact surface. The bonding is complete after more or less 3 minutes.

DANGER
Make sure the area is well ventilated when handling chemical products to avoid inhaling toxic fumes.
Section 7

SLEEVE ASSEMBLY

7.1 - Description ................................................................. 7-1

7.2 - Assembly instructions ..................................................... 7-1
   7.2.1 - Instructions for HP100. ........................................... 7-1
   7.2.2 - Instructions for HP200, HP300, HP400 and HP500 .......... 7-2

7.3 - Maintenance ................................................................. 7-5
   7.3.1 - Replacing the sleeve (HP100) .................................... 7-5
   7.3.2 - Replacing the spherical bearing (HP200, HP300, HP400 and HP500) . . . 7-6
7.1 Description
This section describes the sleeve assembly. The sleeve with its spherical bearing supports the head assembly and helps transmit the crushing force to the frame. The sleeve is mounted on the shaft and fixed with a series of 8-8 screws.

The spherical bearing pinned to the top of the sleeve protects the head ball bolted under the head. The upper surface of the bearing comprises a series of circular oil grooves. The bearing is lubricated by pressurized oil flowing through the passages between the main shaft and the sleeve.

7.2 Assembly instructions
7.2.1 Instructions for HP100

See Figure 7-1.

If the sleeve has been dismantled in order to dismantle the eccentric for shipping or repair purposes, reinstall the eccentric assembly then proceed as follows:

1. In the toolkit, take the 3 pilot studs (with threaded ends) and screw them into the 3 tapped holes on the upper part of the main shaft.
2. Screw 3 lifting rings onto the sleeve and sling it.
3. Heat the sleeve as specified in Table 7-1, over the ambient temperature and quickly fit the sleeve onto the main shaft.

NOTE: When the assembly has cooled down, check the tightening torque.

4. Rapidly lower the sleeve onto the main shaft, guiding it with the aid of the pilot studs. Make sure the seating of the sleeve is firm on the shaft.

Unscrew the 3 pilot studs at the top of the shaft. Fit the retaining screws and washers positioning the sleeve onto the main shaft. Tighten gradually up to the torque specified in Table 7-1.
SECTION 7 - SLEEVE ASSEMBLY

### 7.2.2 Instructions for HP200, HP300, HP400 and HP500

See Figure 7-2.

If the sleeve and spherical bearing have been dismantled in order to dismantle the eccentric for shipping or repair purposes, reinstall the eccentric then proceed as follows:

**a. Assembling the sleeve**

1. In the toolkit, take the 3 pilot studs (with threaded ends) and screw them into the 3 tapped holes on the upper part of the main shaft.
2. Screw 2 lifting rings onto the sleeve and sling it.
3. Heat the sleeve as specified in Table 7-2, over the ambient temperature and quickly fit the sleeve onto the main shaft.
4. Lower the sleeve onto the main shaft, guiding it with the pilot studs. Make sure the seating of the sleeve is firm on the shaft. Check with thickness gauges in the holes of the outer diameter of the sleeve that they are firmly in contact with the main shaft. See Figure 7-3.

**DANGER**

Use safety gloves when handling hot parts.

Unscrew the 3 pilot studs at the top of the shaft. Fit the retaining screws and washers positioning the sleeve onto the main shaft. Tighten gradually up to the torque specified in Table 7-2.

**b. Mounting the spherical bearing**

1. A new spherical bearing can be fitted in one of two ways:
   - **Pre-heating**: Pre-heat the sleeve to above ambient temperature, as specified in paragraph 7.3.2 "Replacing the spherical bearing (HP200, HP300, HP400 and HP500)". See Table 7-2.
   - **Cooling**: COOL the spherical bearing to above ambient temperature, as specified in paragraph 7.3.2 "Replacing the spherical bearing (HP200, HP300, HP400 and HP500)". See Table 7-4.
2. Fit the lifting rings to the outer diameter of the bearing. See Figure 7-4.
3. Sling the spherical bearing.
4. Position the spherical bearing, guiding it with the pilot studs. Then lower the bearing onto the sleeve.

**NOTE**: WHEN THE ASSEMBLY HAS COOLED DOWN, CHECK THE TIGHTENING TORQUE.

### Table 7-1 Temperatures for mounting the sleeve and screw tightening torque (HP100)

<table>
<thead>
<tr>
<th>Above ambient temperature</th>
<th>Sleeve screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centigrade (°C)</td>
<td>Fahrenheit (°F)</td>
</tr>
<tr>
<td>80°</td>
<td>145°</td>
</tr>
</tbody>
</table>

**NOTE**: WHEN THE ASSEMBLY HAS COOLED DOWN, CHECK THE TIGHTENING TORQUE.
SECTION 7 - SLEEVE ASSEMBLY

![Diagram of sleeve assembly]

**Table 7-2 Temperatures and screw tightening torque for mounting the sleeve**

<table>
<thead>
<tr>
<th>Type</th>
<th>Above ambient temperature</th>
<th>Sleeve screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP200</td>
<td>80° 145°</td>
<td>M16 x 80 mm</td>
</tr>
<tr>
<td>HP300</td>
<td>70° 125°</td>
<td>M16 x 90 mm</td>
</tr>
<tr>
<td>HP400</td>
<td>94° 168°</td>
<td>M20 x 100 mm</td>
</tr>
<tr>
<td>HP500</td>
<td>83° 150°</td>
<td>M20 x 80 mm</td>
</tr>
</tbody>
</table>

Figure 7-2 Assembling the sleeve
SECTION 7 - SLEEVE ASSEMBLY

Figure 7-3 Checking contact between sleeve and shaft

Table 7-3 Temperature for the 2nd heating of the sleeve

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
<th>Centigrade (°C)</th>
<th>Fahrenheit (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contact</td>
<td>45°</td>
<td>80°</td>
</tr>
<tr>
<td>2</td>
<td>Sleeve</td>
<td>45°</td>
<td>80°</td>
</tr>
<tr>
<td>3</td>
<td>Main shaft</td>
<td>45°</td>
<td>80°</td>
</tr>
<tr>
<td>4</td>
<td>Checking gauge</td>
<td>45°</td>
<td>80°</td>
</tr>
</tbody>
</table>

Table 7-4 Cooling the spherical bearing

<table>
<thead>
<tr>
<th>Type</th>
<th>Above ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centigrade (°C)</td>
</tr>
<tr>
<td>HP200</td>
<td>45°</td>
</tr>
<tr>
<td>HP300</td>
<td>45°</td>
</tr>
<tr>
<td>HP400</td>
<td>45°</td>
</tr>
<tr>
<td>HP500</td>
<td>45°</td>
</tr>
</tbody>
</table>

Figure 7-4 Mounting the spherical bearing

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spherical bearing</td>
</tr>
<tr>
<td>2</td>
<td>Main shaft</td>
</tr>
<tr>
<td>3</td>
<td>Screw and washer</td>
</tr>
<tr>
<td>4</td>
<td>Sleeve</td>
</tr>
<tr>
<td>5</td>
<td>Lifting ring</td>
</tr>
</tbody>
</table>
7.3 Maintenance

7.3.1 Replacing the sleeve (HP100)

The depth of the oil grooves should be used to determine the degree of wear of the sleeve and whether it needs replacing. When the spherical bearing surface is worn to such an extent that the depth of the lubrication grooves is reduced to 2.5 mm (0.098"), the sleeve should be replaced. Measure the depth of the grooves as shown in Figure 7-5.

1. Remove the three retaining screws from the sleeve on the shaft.

2. Insert the 3 dismantling screws (supplied with the tools) into the holes of the sleeve provided for the purpose, see Figure 7-6. Slowly and evenly heat the lower part of the sleeve while gradually also tightening the 3 dismantling screws. When the sleeve has reached the temperature specified in Table 7-1, it should have dilated enough to move freely on the shaft. Remove the dismantling bolts.

3. Fit the lifting rings into the top of the sleeve.

4. Sling and raise the sleeve.

NOTE: IF THE SLEEVE IS NOT PROPERLY TIGHT AGAINST THE SHAFT, REPLACE THE SLEEVE.

NOTE: IF THE DIAMETER OF THE SHAFT IS DAMAGED, A SLEEVE WITH AN APPROPRIATE BORE CAN BE MACHINED.

---

![Figure 7-5 Measuring the depth of the oil grooves](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gauge</td>
</tr>
<tr>
<td>2</td>
<td>New contour of the sleeve</td>
</tr>
<tr>
<td>3</td>
<td>Worn sleeve</td>
</tr>
<tr>
<td>4</td>
<td>Minimum depth of the oil grooves 2.5 mm (0.098&quot;)</td>
</tr>
<tr>
<td>5</td>
<td>Oil groove</td>
</tr>
</tbody>
</table>

---

![Figure 7-6 Dismantling the sleeve](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dismantling bolt</td>
</tr>
<tr>
<td>2</td>
<td>Sleeve</td>
</tr>
<tr>
<td>3</td>
<td>Main shaft</td>
</tr>
<tr>
<td>4</td>
<td>Heating part to help dismantle the sleeve</td>
</tr>
</tbody>
</table>

---
7.3.2 Replacing the spherical bearing (HP200, HP300, HP400 and HP500)

The depth of the oil grooves should be used to determine the degree of wear and whether it needs replacing. When the spherical bearing surface is worn to such an extent that the depth of the lubrication grooves is reduced to 2.5 mm (0.098"), the sleeve should be replaced. Measure the depth of the grooves as shown in Figure 7-7.

If the bearing starts moving slightly on the sleeve, this is not really a problem, because the pins prevent the bearing from turning.

Replace the spherical bearing as follows:

1. Fit the 3 dismantling screws (supplied with the tools) into the spherical bearing as shown in Figure 7-7.

2. Screw in the dismantling screws alternately, if necessary heating part of the sleeve.

3. Remove the dismantling screws and fit the lifting rings onto the outer diameter of the bearing.

4. Sling and raise the spherical bearing.

5. The new bearing is fitted by heating the sleeve. Heat the upper part of the sleeve to over ambient temperature, as specified in Table 7-4; this will widen the bore hole in the sleeve to allow the bearing to descend.

6. Align the bearing over the sleeve, guiding it with the pilot studs and lower the bearing into the bore hole of the sleeve.
NOTE: MAKE SURE THAT THE BEARING RESTS FIRMLY ON THE SLEEVE.

Figure 7-8 Dismantling the spherical bearing

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dismantling bolt</td>
</tr>
<tr>
<td>2</td>
<td>Spherical bearing</td>
</tr>
<tr>
<td>3</td>
<td>Sleeve</td>
</tr>
<tr>
<td>4</td>
<td>Heating part to help dismantling</td>
</tr>
<tr>
<td>5</td>
<td>Shaft</td>
</tr>
</tbody>
</table>

Figure 7-8 Dismantling the spherical bearing
Section 8

ECCENTRIC ASSEMBLY

8.1 - Description .............................................................. 8-1

8.2 - Mounting instructions .................................................. 8-2
  8.2.1 - Mounting the eccentric assembly .............................. 8-2
  8.2.2 - Checking and adjusting the play between and at the bottom of the teeth. 8-3

8.3 - Maintenance .............................................................. 8-4
  8.3.1 - Dismantling the eccentric assembly ............................ 8-4
  8.3.2 - Imbalance ............................................................ 8-4
  8.3.3 - Upper thrust washer .............................................. 8-5
  8.3.4 - Replacing the upper thrust washer ............................. 8-6
  8.3.5 - Eccentric bushing ............................................... 8-7
  8.3.6 - Dismantling the eccentric bushing ............................. 8-7
  8.3.7 - Checking the bore of the eccentric ............................ 8-8
  8.3.8 - Inspecting the main shaft ..................................... 8-9
  8.3.9 - Installing the eccentric bushing .............................. 8-9
  8.3.10 - Re-sealing the eccentric bushing ............................ 8-11
  8.3.11 - Adjusting play between the teeth ............................ 8-11
  8.3.12 - Replacing the toothed crown .................................. 8-11
  8.3.13 - Dismantling the imbalance and the toothed crown ......... 8-11
  8.3.14 - Installing the eccentric assembly ............................ 8-13
8.1 Description

This section describes the eccentric assembly, comprising the eccentric, the eccentric bushing, the crown and the imbalance. The outside of the eccentric is off-centre and slightly at an angle to the vertical axis of rotation, transmitting its movement to the head. A bronze ring is mounted inside the eccentric. A toothed crown bolted to the bottom of the eccentric is driven by the countershaft pinion. The eccentric rotates around the main shaft. The eccentric assembly rests on thrust bearings, the upper thrust washer in bronze is fixed to the bottom of the eccentric and the lower thrust washer in steel is fixed to the frame. These are there to reduce eccentric assembly wear through friction. The play between and at the bottom of the teeth between the crown and the pinion is maintained in this assembly by adding or removing adjusting wedges. The imbalance is dissymmetrical, in such a way that the greatest weight is directly opposite the centrifugal force generated by the swaying of the head. This imbalance forms an oil and dust seal between the rotating head and the fixed main frame, with a system of baffles with "U" and "T" joints.

Figure 8-1 Mounting the eccentric assembly
8.2 Mounting instructions

8.2.1 Mounting the eccentric assembly

See Figure 8-1.

If the eccentric assembly has been dismantled, proceed as follows to mount it:

1. Carefully clean the machined surfaces of the main shaft and the bore of the eccentric bushing. Sand all burrs or scrapes with emery cloth. Carefully clean the upper and lower thrust washers.

2. Make sure the retaining screws and lock washers of the thrust washers are tight.

3. Fix the lifting ring (supplied with the tools) to the top of the eccentric using the holes provided for the purpose. Screw the two handling rings (supplied with the tools) into the lifting ring. Coat the main shaft, the eccentric bushing and the two thrust washers with a thin layer of oil.

4. Anchor the two handling rings to appropriate lifting gear. The bevelled edge on the lower eccentric bushing lets you centre the assembly. Lower the assembly until the upper thrust washer rests on the lower thrust washer. You may need to turn the eccentric slightly to fully engage the toothed crown with the pinion. Make sure the eccentric rests firmly on the lower thrust washer.

5. Make sure the toothed crown is fully engaged with the pinion. See Figure 8-2. The play between and at the bottom of the teeth must match the values given in Table 8-1. After adjusting the play between and at the bottom of the teeth, remove the lifting ring.

<table>
<thead>
<tr>
<th>Type of crusher</th>
<th>Play between the teeth</th>
<th>Minimum play at the bottom on the teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>Inches</td>
</tr>
<tr>
<td>HP100</td>
<td>0.560 - 0.710</td>
<td>0.022 - 0.028</td>
</tr>
<tr>
<td>HP200</td>
<td>0.457 - 0.813</td>
<td>0.018 - 0.032</td>
</tr>
<tr>
<td>HP300</td>
<td>0.508 - 1.016</td>
<td>0.020 - 0.040</td>
</tr>
<tr>
<td>HP400</td>
<td>0.640 - 1.150</td>
<td>0.025 - 0.045</td>
</tr>
<tr>
<td>HP500</td>
<td>0.890 - 1.400</td>
<td>0.035 - 0.055</td>
</tr>
</tbody>
</table>

Table 8-1 Checking pinion/crown play

<table>
<thead>
<tr>
<th>Thickness of wedges</th>
<th>Adjusting the play</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HP100</td>
</tr>
<tr>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>3.0</td>
<td>1.90</td>
</tr>
<tr>
<td>1.7</td>
<td>1.03</td>
</tr>
<tr>
<td>0.4</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Table 8-2 Thickness of the wedges
8.2.2 Checking and adjusting the play between and at the bottom of the teeth

See Figure 8-2.

The check and adjust the play between and at the bottom of the teeth, proceed as follows:

1. Dismantle the imbalance.

2. Pull the countershaft outwards until there is no more play between the conical pinion and the inner countershaft bushing.

NOTE: IF NEED BE, SLACKEN THE TRANSMISSION BEFORE TAKING MEASUREMENTS.

3. Turn the countershaft until one of the crown's teeth is vertical. See Figure 8-2.

4. Eliminate any play between the inner eccentric bushing and the shaft by pushing the eccentric with the aid of a cylinder placed between the eccentric and the frame so as to bring the crown as close as possible to the pinion. Do not apply any more force than is strictly necessary to achieve this, and maintain the eccentric in this position while you take measurements.

5. To check the play between the teeth, rotate the countershaft until one of the pinion teeth touches the tooth and the crown. Measure the play between the teeth on the other side of the tooth with the aid of spacer rings. See Figure 8-2.

6. Then measure the play at the bottom of the teeth. See Figure 8-2.

7. The play between and at the bottom of the teeth may be less than the tolerance specified in Table 8-1. If that is the case, dismantle the eccentric and add spacer rings under the lower bushing as described in "Installing the lower thrust washer and spacer rings". This will raise the eccentric assembly and thus increase the play between and at the bottom of the teeth. If the play is more than it should be, remove some spacer rings.


<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gear</td>
</tr>
<tr>
<td>2</td>
<td>Pinion</td>
</tr>
<tr>
<td>3</td>
<td>Play between the teeth</td>
</tr>
<tr>
<td>4</td>
<td>Play at the bottom on the teeth</td>
</tr>
<tr>
<td>5</td>
<td>The tooth of the crown must be vertical for accurate measurements</td>
</tr>
</tbody>
</table>

Figure 8-2 Checking pinion/crown play
8.3 Maintenance

8.3.1 Dismantling the eccentric assembly

To dismantle the crusher's eccentric assembly, proceed as follows:

1. Fix the lifting ring (supplied with the tools) to the top of the eccentric using the holes provided for the purpose. Screw two handling rings and anchor them to appropriate lifting gear. See Figure 8-1.

2. Remove the eccentric from the shaft, maintaining it totally vertical.

3. Lift the assembly out of the crusher and set it down on wooden wedges prepared for the purpose.

8.3.2 Imbalance

The crushers have a shield around the imbalance to prevent any wear to it caused by friction of the materials. Check the wear of the shields and the build-up of materials on the imbalance, this could impair the balancing. See Figure 8-3. If the shields are very damaged, they must be replaced before the imbalance itself sustains damage. On the HP100/200/300/400, the shield is crewed to the imbalance. On the HP500, the shield is welded to the imbalance.

Replacing the imbalance shield for HP100/200 and HP300/400:

1. Slide the shield over the imbalance and fix it.

2. Chamfer the longitudinal joint up to the total thickness of the shield and position the joint in the centre on the reinforced side of the imbalance. Spot welding in place.

3. Weld the shield to the imbalance as shown in Figure 8-3.

4. Weld the cover to the shield and imbalance.

Material discharge in the frame must be checked every day to ensure there are no materials above all in the ballast. This is often caused by branches or roots that get caught on or between the arms of the frame. This can lead to rapid wear of the imbalance.

The useful life of the shield can be extended with a hard metal facing on the outer surface. The "U" and "T" joints at the top and bottom of the imbalance are not subject to contact or wear. These joints protect the crown and thrust washers from ingress of dust.

Replacing the imbalance shield for HP500:

1. Wrap the shield firmly to keep a minimum gap between the shield and the imbalance. Trim the circumference if necessary.
8.3.3 Upper thrust washer

When the eccentric has been removed from the crusher, examine the upper thrust washer. Excessive wear may cause 2 operating problems.

This causes the crown's teeth to descend deeper into the pinion's teeth and thus distorts the functional play. To make up for this wear, spacer rings need to be inserted under the lower thrust washer. See paragraph 8.2.2 "Checking and adjusting the play between and at the bottom of the teeth".

The second problem caused by thrust wear is a reduction of the oil grooves.

If the depth is less than the minimum specified in Table 8-3, the thrust washer must be replaced. If absolutely necessary, the groove can be deepened by machining.

**NOTE:** THE ABSOLUTE WEAR LIMIT OF THE THRUST WASHER IS ATTAINED WHEN ITS CONTACT SURFACE IS LEVEL WITH THE HEAD OF THE RETAINING SCREWS.
8.3.4 Replacing the upper thrust washer

See Figure 8-5.

To replace an upper thrust washer, proceed as follows:

1. Before you can access the thrust washer, the bowl, head, sleeve and eccentric assemblies must be dismantled. Refer to the corresponding sections for dismantling these assemblies.

2. Turn the eccentric over so that the thrust washer is facing upwards.

3. Unscrew the screws retaining the washer to the eccentric.

4. Screw the lifting rings into the holes provided for the purpose.

5. Lift the thrust washer. There is play between the outer diameter of the washer and the inner diameter of the eccentric.

6. The new thrust washer must be free of burrs.

7. Remove the lifting rings from the old washer and fix them to the new thrust washer. Fit the thrust washer by aligning its holes with those of the eccentric. Make sure the thrust washer's surface rests on that of the eccentric.

8. Fit new lock washers. Insert the screws then tighten the screws alternately and in staggered rows to the thread torque specified in Table 8-4.

---

### Table 8-3 Groove depth

<table>
<thead>
<tr>
<th>Type of crusher</th>
<th>Groove depth</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>8 mm (5/16&quot;)</td>
<td>6.7 mm (17/64&quot;)</td>
</tr>
<tr>
<td>HP200</td>
<td>8 mm (5/16&quot;)</td>
<td>6.7 mm (17/64&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>10 mm (25/64&quot;)</td>
<td>8.7 mm (11/32&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>11 mm (7/16&quot;)</td>
<td>9.7 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>11 mm (7/16&quot;)</td>
<td>9.7 mm (3/8&quot;)</td>
</tr>
</tbody>
</table>
8.3.5 Eccentric bushing

When dismantling the eccentric, check the fastening and wear of the eccentric bushing. When the bushing moves in the eccentric, follow the instructions in paragraph 8.3.10 "Re-sealing the eccentric bushing".

**NOTE:** WEAR ON THE ECCENTRIC BUSHING WILL BE MORE PRONOUNCED ON THE THICK SIDE OF THE ECCENTRIC, WHERE THE CRUSHING FORCE IS CONCENTRATED. THIS IS NORMAL AND THERE IS NO CAUSE FOR CONCERN. WHEN A CERTAIN DEGREE OF WEAR IS ATTAINED, THE BUSHING MUST BE REPLACED.

8.3.6 Dismantling the eccentric bushing

The bushing is kept in place by resin retainer locks cast in pockets in the bushing the eccentric; these pockets face one another. To replace the bushing, proceed as follows:

1. Drill a series of holes in each notch filled with resin on the bushing side. See Figure 8-6.

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
<th>Thread torque (N.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upper thrust washer</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Eccentric</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bolt</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lock washer</td>
<td></td>
</tr>
</tbody>
</table>

**Table 8-4 Thread torque for fixing the upper thrust washer**

<table>
<thead>
<tr>
<th>Type of crusher</th>
<th>Retaining screws for the upper thrust washer</th>
<th>Tightening torque (N.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>M8x20</td>
<td>45</td>
</tr>
<tr>
<td>HP200</td>
<td>M8x20</td>
<td>45</td>
</tr>
<tr>
<td>HP300</td>
<td>M10x25</td>
<td>90</td>
</tr>
<tr>
<td>HP400</td>
<td>M10x25</td>
<td>90</td>
</tr>
<tr>
<td>HP500</td>
<td>M14x35</td>
<td>250</td>
</tr>
</tbody>
</table>

**Figure 8-5 Upper thrust washer**

**Figure 8-6 Releasing the bushing**
2. Chisel the drilled hole and carefully remove any remnants of resin to facilitate dismantling.

3. Turn over the eccentric onto wooden wedges placed so as to clear a way for the bushing. See Figure 8-7.

4. Cut out a washer 25 mm thick with a diameter slightly smaller than the outer diameter of the bushing. The outer diameter of the washer must be free of burrs.

6. Use a wooden block measuring 100 x 100 mm and strike the plate until the bushing is completely freed from the eccentric.

If difficulties arise, there is another method for dismantling the eccentric bushing. This consists in sawing the entire height of the bushing at two diametrically opposed points. The sawed notches are over the entire thickness of the bushing without touching the bore of the eccentric. See paragraph 6.3.11 "Dismantling the upper head bushing - HP200, HP300, HP400 and HP500".

8.3.7 Checking the bore of the eccentric

Before installing the eccentric bushing, make sure that the bore is clean inside the eccentric and that all resin has been removed from the notches.

Check the bore, make sure its dimension is within limits. Measure the bore at the bottom and top of the eccentric.

Check roundness with micrometer callipers.

If the bore has tightened, it can be machined to its original dimension. If the bore is not concentric, it can be re-machined.

Contact the factory for the concentricity if the bore needs to be machined above its normal dimension.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wooden block</td>
</tr>
<tr>
<td>2</td>
<td>Plate</td>
</tr>
<tr>
<td>3</td>
<td>Wooden wedges</td>
</tr>
<tr>
<td>4</td>
<td>Eccentric bushing</td>
</tr>
<tr>
<td>5</td>
<td>Eccentric</td>
</tr>
</tbody>
</table>

**Figure 8-7 Dismantling the eccentric bushing**

5. Centre the plate on the bushing. Make sure the plate is not in contact with the inner diameter of the bushing.
SECTION 8 - ECCENTRIC ASSEMBLY

8.3.8 Inspecting the main shaft

When an eccentric bushing needs to be replaced, in particular if it has been jammed on the main shaft, the shaft must be checked. All traces of lead and bronze must be removed from the shaft with very fine emery cloth. Make sure to move only in a horizontal and peripheral direction.

Check with the factory to determine whether the condition of the shaft warrants its replacement.

If the eccentric bushing has jammed against the main shaft, it can be removed as follows:

1. There is a longitudinal groove on the inner diameter aligned with the large oil hole. Use a very hard-wearing circular saw fitted with an appropriate metal blade (the eccentric bushing is made of bronze and lead) to cut the side of the bushing. Set blade depth to between 20 mm (0.75") and 25 mm (1") maximum.
2. Saw the bushing at the location of the longitudinal groove.
3. With a lever, pry open the bushing at the point of cutting by placing a bar into the cut and levering outwards.
4. Be careful not to scratch the main shaft with the saw's blade because this could impair the performance of the new eccentric bushing.

1. Make sure all the resin has been removed from the notches and that the inner bore of the eccentric is clean.
2. Thoroughly clean all the surfaces of the new bushing.
3. Fill the bushing's bore with carbon dioxide snow to narrow its diameter. This operation requires 90 kg of carbon dioxide snow. A runner measuring 100 x 100 mm leaves enough room for the carbon dioxide snow to narrow the bushing.

8.3.9 Installing the eccentric bushing

The eccentric bushings are machined with a play of a few tens of millimetres in the bore. If there is a problem on installation due to stock shortages or shipping problems, the following procedure using carbon dioxide snow is recommended:

1. Make sure not to leave any traces on the shaft by removing all remnants of lead and bronze.

DANGER

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

4. Wrap the outer diameter with several layers of glass wool to prevent the formation of frost, which would delay putting the bushing in place. This envelope also serves to maintain the low temperature. Let the bushing cool down for roughly two hours.

NOTE: DO NOT USE THIS METHOD FOR THE ECCENTRIC'S BORE, THAT WOULD TIGHTEN IT UP.

5. Measure the outer diameter of the bushing and the eccentric's bore to determine whether the bushing has cooled down enough. Fit the two lifting rings (supplied with the tools) to the top of the eccentric bushing.

6. Draw or paint a line on the outer diameter of the bushing along both sides of the oil holes (one large hole and one small hole), see Figure 8-8. The draw or paint a line along the two faces of the oil holes in the eccentric up to its top. These lines are used to properly align the bushing's oil holes with the eccentric.
7. Use the lifting rings and washers (supplied with the tools) to lift the bushing. See Figure 8-9. Centre the bushing with the top of the eccentric's bore. Quickly lower the cooled bushing into the bore while aligning the notches with the oil holes.

![Figure 8-8 Aligning the bushing and the eccentric](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mark along the oil holes</td>
</tr>
<tr>
<td>2</td>
<td>Minimum hole</td>
</tr>
<tr>
<td>3</td>
<td>Eccentric bushing</td>
</tr>
<tr>
<td>4</td>
<td>Maximum hole</td>
</tr>
</tbody>
</table>

![Figure 8-9 Position of the bushing in the eccentric](image)

**NOTE:** THE OIL HOLES IN THE BUSHING MUST BE ALIGNED WITH THOSE OF THE ECCENTRIC. THE NOTCHES AT THE TOP OF THE BUSHING MUST BE ALIGNED WITH THOSE OF THE ECCENTRIC. THESE NOTCHES CAN BE SLIGHTLY OFFSET, BUT ON NO ACCOUNT MUST THE OIL HOLES BE MISALIGNED.

8. When the bushing is in place, its top must be aligned with the top of the eccentric.

9. Prepare the sealant resin and fill the notches up to the top.
10. The eccentric, bushing and resin must be at a temperature of between 16°C and 32°C.

11. When the resin has solidified, remove any excess resin to adjust the alignment between the bushing and the eccentric.

**NOTE:** AFTER MOUNTING THE ECCENTRIC BUSHING, SEE 3.6 "Initial start-up".

### 8.3.10 Re-sealing the eccentric bushing

If the bushing frees itself and starts turning in the eccentric due to wear of the resin retainer locks, it must be re-cast. Drill, clean and remove the resin in the notches and cast an adequate amount of resin, taking care to align the oil holes. See Figure 8-8 and Figure 8-6.

**NOTE:** BEFORE RE-CASTING AND MAKING RESIN RETAINER LOCKS, CHECK THAT THE BUSHING IS PROPERLY INSTALLED. SEE PARAGRAPH 8.3.9 "Installing the eccentric bushing".

### 8.3.11 Adjusting play between the teeth

When the thrust washer and teeth are so worn that play can no longer be maintained, this must be adjusted by adding or removing spacer rings until the play matches the values specified in Table 8-1. Adding spacer rings increases play while removing them reduces it. An adequate mounting is necessary.

**NOTE:** ONE SHOULD AVOID MESHING THE BOTTOM OF THE TEETH AS MUCH AS POSSIBLE, SOME PLAY MUST BE LEFT AT THE BOTTOM OF THE TEETH, HOWEVER WORN THEY ARE. SEE Table 8-1.

### 8.3.12 Replacing the toothed crown

The crown is mounted at the bottom of the eccentric. When inspecting the eccentric, check the crown for wear.

Marks or flaking on the face of the teeth are signs of heavy wear. These marks may be due to incorrect contact between the teeth further to incorrect spacing under the lower thrust washer, to crusher overload or to a contaminated oil supply. Worn crowns are more liable to broken teeth, which can cause heavy damage inside the crusher. One should therefore not leave it too long before changing worn crowns.

### 8.3.13 Dismantling the imbalance and the toothed crown

See Figure 8-12.

After dismantling the crusher's eccentric assembly as instructed in paragraph 8.3.9 "Installing the eccentric bushing", the assembly can be dismantled as described below:

1. Place the eccentric assembly on wooden wedges. Separate the imbalance and the eccentric by unscrewing the retaining screws traversing the imbalance and fixed to the edge of the eccentric. If the screws were fitted with Loctite, heat with flame up to around 205°C.

2. Fit the 4 lifting rings (supplied with the tools) to the edge of the imbalance.

3. Lift the imbalance vertically to release the locating pin.

4. Remove the eccentric's retaining screw on the crown located on the edge of the eccentric. If the screws were fitted with Loctite, heat to around 205°C.

5. The crown is tight on the outer diameter of the eccentric. Fit the eccentric's lifting ring as well as the handling rings (supplied with the tools).
6. Raise the assembly to roughly 40 mm above appropriate wooden wedges. Heat the crown gradually around its outer diameter. The crown's outer diameter will expand and the crown will fall of its own accord.

7. Set the eccentric down on wooden wedges, maintaining access to the thrust washer.

8. Unlock then remove the retaining screws of the thrust washer on the eccentric. Remove the thrust washer.

9. On HP100, HP200 and HP300 Remove the screws fixing the imbalance shield, as well as the 2 screws blocking the handling holes. Fix 2 lifting rings into these holes and raise the imbalance shield. Fit the new shield. Do not forget to replace the 2 screws blocking the handling holes after removing the lifting rings.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sling</td>
</tr>
<tr>
<td>2</td>
<td>Shield retaining screws</td>
</tr>
<tr>
<td>3</td>
<td>Imbalance liner</td>
</tr>
<tr>
<td>4</td>
<td>Imbalance</td>
</tr>
<tr>
<td>5</td>
<td>Lifting ring</td>
</tr>
</tbody>
</table>

Figure 8-10 Dismantling the imbalance shield (HP100)
8.3.14 Installing the eccentric assembly

1. Turn over the eccentric to gain easy access to the thrust washer and place it on wooden wedges.

2. Put in place the thrust washer, checking hole alignment. Insert and tighten the screws mounted with new lock washers.

3. Set the crown down on wooden wedges, its teeth against the wedges, see Figure 8-12.

4. Turn the eccentric the right way up. Fit the handling rings into the lifting ring, then fix it to the top of the eccentric.

5. With an appropriate lifting device, raise the eccentric above the crown. Adjust centring and perpendicularity between the eccentric and the crown.
6. Heat the crown regularly to roughly 45°C above ambient temperature.

7. Measure the outer diameter of the eccentric and the bore of the crown, and make sure that the bore is slightly larger than the eccentric. Quickly lower the eccentric onto the crown, lining up the holes. Since the holes are equidistant, no special alignment is necessary. Make sure the eccentric fits smoothly at the bottom of the crown's bore.

8. Clean the screws and holes then apply Loctite 271 to the threads of the screws fixing the crown to the eccentric.

**NOTE:** IT IS VERY IMPORTANT TO HEAT THE GEAR ASSEMBLY UNIFORMLY AND THAT THE HEAT IS NOT CONCENTRATED ON ONE SURFACE THEREBY CREATING A HOT SPOT THAT COULD DESTROY TREATMENT OF THE GEARING. A CHEMICAL MARKING METHOD ACTING AT A PREDEFINED TEMPERATURE MUST BE USED FOR ENSURE UNIFORM HEATING.

---

**Figure 8-12 Raising the imbalance and eccentric**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Imbalance/eccentric fastening</td>
</tr>
<tr>
<td>2</td>
<td>Imbalance</td>
</tr>
<tr>
<td>3</td>
<td>Eccentric</td>
</tr>
<tr>
<td>4</td>
<td>Eccentric bushing</td>
</tr>
<tr>
<td>5</td>
<td>Eccentric/crown fastening</td>
</tr>
<tr>
<td>6</td>
<td>Wooden wedges</td>
</tr>
<tr>
<td>7</td>
<td>Upper thrust washer</td>
</tr>
<tr>
<td>8</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>9</td>
<td>Pin</td>
</tr>
<tr>
<td>10</td>
<td>Lifting ring</td>
</tr>
</tbody>
</table>

---
9. Lock these screws by tightening them alternately to the torque specified in Table 8-5.

10. If the crown has been replaced, the eccentric is fitted without the imbalance assembly. This lets one check the play between the crown's teeth and the pinion. See the instructions in paragraph 8.2.2 "Checking and adjusting the play between and at the bottom of the teeth".

11. Fit the 4 lifting rings (supplied with the tools) to the inner edge of the imbalance.

12. Carefully lower the imbalance onto the eccentric as shown in Figure 8-12. Align the pin hole in the imbalance with the eccentric's pin.

13. Insert the largest screws fixing the imbalance, the eccentric and the crown.

14. Alternately tighten the screws in staggered rows to the thread torque specified in Table 8-5.

15. Before installing the eccentric assembly in the crusher, check the pinion teeth for wear or damage by turning the countershaft.

16. Install the eccentric assembly as described in paragraph 8.3.14 "Installing the eccentric assembly".

**NOTE:** CHECK THE THREAD TORQUE OF THE SCREWS RETAINING THE ECCENTRIC AND THE IMBALANCE TO THE CROWN EACH TIME THE LINER IS CHANGED AND WHEN THE HEAD IS DISMANTLED.

<table>
<thead>
<tr>
<th>Type of crusher</th>
<th>Eccentric/crown retaining screw</th>
<th>Imbalance/crown retaining screw</th>
<th>Tightening torque (N.m)</th>
<th>Above ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M12 x 70</td>
<td>M12 x 70</td>
<td>135</td>
<td>45° 80°</td>
</tr>
<tr>
<td>HP100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP200</td>
<td>M14 x 70</td>
<td>M14 x 70</td>
<td>167</td>
<td>45° 80°</td>
</tr>
<tr>
<td>HP300</td>
<td>M16 x 70</td>
<td>M16 x 70</td>
<td>260</td>
<td>45° 80°</td>
</tr>
<tr>
<td>HP400</td>
<td>M20 x 100</td>
<td>M20 x 120</td>
<td>470</td>
<td>34° 61°</td>
</tr>
<tr>
<td>HP500</td>
<td>M24 x 110</td>
<td>M24 x 140</td>
<td>810</td>
<td>32° 57°</td>
</tr>
</tbody>
</table>

**Table 8-5 Information on the toothed crown's retaining screws**
Section 9

COUNTERSHAFT, COUNTERSHAFT HOUSING AND BULLWHEEL ASSEMBLIES

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  9.1.2 - Assembling the countershaft housing - HP300, HP400 and HP500 ........................................ 9-2
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9.1 Description

This section describes the countershaft housing, countershaft and bullwheel assemblies.

Power is transmitted to the crusher's countershaft motor by a V-belt transmission or a coupling sleeve. At one end of the countershaft is mounted a pinion the rotation of which is transmitted to the eccentric by the toothed crown. The countershaft is supported by two bronze bushings. These two bushings are prevented from rotating by pins inserted in the countershaft housing. The bushings have a flange at their end that receives the axial load both from the pinion and the oil deflector. The latter is inserted tight on the countershaft control side.

The deflector's role is to centrifuge on the cover the oil coming from the lubrication of the housing's bushings. The countershaft housing returns the oil to the tank. This countershaft housing is solidly fixed with large screws.

The oil seal is formed between the frame and the countershaft housing by an O-ring seal or a lip seal. A shield protects the part of the countershaft housing exposed to wear caused by the falling crushed materials.

NOTE: ON HP100 ST HP200, THE COUNTERSHAFT HOUSING IS BUILT INTO THE FRAME.

9.1.1 Countershaf t housing - HP100 and HP200

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pinion</td>
</tr>
<tr>
<td>2</td>
<td>Inner countershaft bushing</td>
</tr>
<tr>
<td>3</td>
<td>Outer countershaft bushing</td>
</tr>
<tr>
<td>4</td>
<td>Lock washer</td>
</tr>
<tr>
<td>5</td>
<td>Spacer</td>
</tr>
<tr>
<td>6</td>
<td>Hub</td>
</tr>
<tr>
<td>7</td>
<td>Crusher bullwheel</td>
</tr>
</tbody>
</table>

Figure 9-1 Countershaf t housing HP100
9.1.2 Assembling the countershaft housing - HP300, HP400 and HP500

To assemble the various components of the countershaft assembly, see paragraph 9.2 "Maintenance" in this chapter. If the countershaft housing was dismantled for shipment, it must be reassembled as follows:

1. Lubricate and correctly position the O-ring seal in the appropriate groove on the flange on the pinion side of the countershaft housing. This forms a seal between the drum of the main frame and the countershaft housing. See Figure 9-2.

![Figure 9-2 Countershaft housing seal](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame</td>
</tr>
<tr>
<td>2</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>3</td>
<td>Bearing seal</td>
</tr>
<tr>
<td>4</td>
<td>O-ring seal</td>
</tr>
</tbody>
</table>

2. A bearing seal must be fitted in the groove of the countershaft housing, on the pinion side. This seal suppresses any vibrations between the countershaft housing and the frame. This seal is split. Fit the seal into the groove of the countershaft housing, on the pinion side, and glue the two ends together. There should be no gap between the two ends of the seal.

If there is no glue, maintain the bearing seal with the aid of metal wire twisted at the ends. Cover the seal with grease and proceed as explained in paragraph 3. If metal wire is used, remove it when the seal is in place in the bore of the frame, see Figure 9-4 (Step 1).
3. Fill the bore of the frame at the locations of the O-ring seals with a strip of silicone seal. See Figure 9-3.

4. Slide a long tube at the bullwheel side end of the countershaft to balance the weight of the other end. See Figure 9-3.

**NOTE:** IF THERE IS NOT ENOUGH SPACE TO USE A TUBE FOR COUNTERBALANCING PURPOSES, PUSH THE COUNTERSHAFT HOUSING INTO THE BORE OF THE FRAME AS FAR AS POSSIBLE. REST THE INTERIOR FLANGE OF THE HOUSING (PINION SIDE) TEMPORARILY ON THE FRAME'S GUIDE LOBE. RAISE THE COUNTERSHAFT HOUSING WITH A SLING THREADED INSIDE THE CRUSHER THEN CONTINUE FITTING THE HOUSING IN AS FAR AS POSSIBLE.

5. With the aid of hoisting gear (overhead travelling crane or other gear), place the guide lobe of the countershaft housing on the guide lobe of the frame.

6. Screw the 3 tension bolts into the outer housing flange matching the 3 holes at 120° angles on the frame, see step 1 in Figure 9-4.

7. Because the countershaft housing is mounted tight in the frame, gradually tighten each of the 3 bolts in turn to keep the housing aligned, until contact is made between the housing’s flanges and the frame.

8. Remove the bolts and fit shim washers under the screw heads and repeat the previous operation. Tighten each of the bolts again alternately until they reach the bottom of the threaded holes. See step 2 in Figure 9-4.

9. Replace the tension bolts with normal bolts that will fix the countershaft housing for good.

---

**Figure 9-3 Mounting the countershaft assembly**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bearing seal</td>
</tr>
<tr>
<td>2</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>3</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>4</td>
<td>Sling</td>
</tr>
<tr>
<td>5</td>
<td>Tube</td>
</tr>
<tr>
<td>6</td>
<td>Centring lobe on housing</td>
</tr>
<tr>
<td>7</td>
<td>Guide lobe on frame</td>
</tr>
<tr>
<td>8</td>
<td>Frame bore</td>
</tr>
<tr>
<td>9</td>
<td>Pinion</td>
</tr>
<tr>
<td>10</td>
<td>Frame</td>
</tr>
</tbody>
</table>

---

**Figure 9-4**

**Ref. Description**

1. Bearing seal
2. O-ring seal
3. Countershaft housing
4. Sling
5. Tube
6. Centring lobe on housing
7. Guide lobe on frame
8. Frame bore
9. Pinion
10. Frame
10. Continue pushing the countershaft housing in by successive turns on the bolts until the flanges of the frame and the countershaft housing come into contact. See step 3 in Figure 9-4.

11. Place the sleeve onto the countershaft housing, engaging the notches on the sleeve with the bosses of the housing. On HP500 the sleeve is in two parts. See Figure 9-5.

**Figure 9-4 Installing the countershaft housing**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame</td>
</tr>
<tr>
<td>2</td>
<td>Shim washers</td>
</tr>
<tr>
<td>3</td>
<td>Tension bolts</td>
</tr>
<tr>
<td>4</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>5</td>
<td>Washer</td>
</tr>
<tr>
<td>6</td>
<td>Final bolts</td>
</tr>
<tr>
<td>7</td>
<td>Contact</td>
</tr>
</tbody>
</table>

**9.1.3 Checking axial play**

See Figure 6-5.

If the crusher was shipped completely assembled, the axial play was correctly adjusted in the workshop; but we recommend you check this on arrival. The countershaft must be able to move axially by the value specified in Table 9-1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Axial play (tolerances)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>1.3 mm (0.050&quot;) - 1.8 mm (0.070&quot;)</td>
</tr>
<tr>
<td>HP200</td>
<td>1.3 mm (0.050&quot;) - 1.8 mm (0.070&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>0.8 mm (0.031&quot;) - 1.6 mm (0.062&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>0.8 mm (0.031&quot;) - 1.6 mm (0.062&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>0.8 mm (0.031&quot;) - 1.6 mm (0.062&quot;)</td>
</tr>
</tbody>
</table>

**Table 9-1 Axial play**
### SECTION 9 - COUNTERSHAFT, COUNTERSHAFT HOUSING AND BULLWHEEL ASSEMBLIES

#### Figure 9-5 Mounting the housing sleeve

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Countershaft housing sleeve</td>
</tr>
<tr>
<td>2</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>3</td>
<td>Bosses</td>
</tr>
</tbody>
</table>

#### Figure 9-6 Axial play

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pinion</td>
</tr>
<tr>
<td>2</td>
<td>Inner housing bushing</td>
</tr>
<tr>
<td>3</td>
<td>Outer housing bushing</td>
</tr>
<tr>
<td>4</td>
<td>Axial play</td>
</tr>
<tr>
<td>5</td>
<td>See Table 9-1</td>
</tr>
<tr>
<td>6</td>
<td>Contact</td>
</tr>
</tbody>
</table>
9.2 Maintenance

9.2.1 Dismantling the countershaft assembly and replacing the pinion - HP100 and HP200

See Figure 9-7.

When dismantling the eccentric assembly, it is advisable to check the condition of the pinion (wear or broken teeth). Extensive metal pitting or erosion on the sides of the teeth are signs of excessive wear. This may be due to poor contact of the pinion teeth with the crown resulting from incorrect spacing or crusher overload or even poor quality oil. A worn pinion is more vulnerable to tooth breakage that a pinion in good condition.

What is more, running the crusher with a worn pinion can cause serious damage to other crusher parts. An excessively worn must therefore be replaced. To get the best out of the drive gear and pinion, it is advisable to change the crown at the same time.
If a new pinion is mounted with a worn crown, the profile of the crown's worn teeth can rapidly damage the new pinion. If a new pinion or crown are mounted, check the play of the teeth as explained in paragraph 8.2.2 "Checking and adjusting the play between and at the bottom of the teeth".

To dismantle the countershaft assembly, replace the bushings, pinion or other parts, proceed as follows:

1. Remove the bowl, head, sleeve, and eccentric assemblies.

2. Dismantle the crusher's bullwheel. To dismantle the crusher's bullwheel, proceed as follows:
   a. First remove the hub's retaining screws.
   b. Insert the screws into the hub's tapped holes.

   DANGER
   If the bullwheel is hard to separate form its removable hub, tap it with a hammer, maintaining pressure on the thrust screws.

3. Dismantle the cover of the oil ring as well as the seals.

4. Heat the oil ring to roughly 27°above ambient temperature.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bullwheel</td>
</tr>
<tr>
<td>2</td>
<td>Spacer</td>
</tr>
<tr>
<td>3</td>
<td>Hub</td>
</tr>
<tr>
<td>4</td>
<td>Screw in mounting position</td>
</tr>
<tr>
<td>5</td>
<td>Retainer lock</td>
</tr>
</tbody>
</table>

Figure 9-8 Bullwheel assembly
5. Place a lever between the oil ring and the frame, applying moderate force. As soon as the ring starts to slide, pull it horizontally to extract it from the countershaft.

**NOTICE:**

**WARNING**

Use safety gloves when handling hot parts.

**NOTE:** on the HP100, to dismantle the pinion, you need to dismantle the thrust washer.

6. Loosen the lock washer screws. Since the screws were mounted with Loctite, heat to roughly 205°C in order to unscrew them.

7. Place the pinion key (supplied with the tools) as shown in Figure 9-9.

8. Place the countershaft key (supplied with the tools) at the end of it. Tap the key with a hammer to turn the countershaft anticlockwise.

9. Fit a lifting ring (supplied with the tools) into the hole between the teeth of the pinion. Then unscrew the countershaft completely and lift the pinion.

10. Remove the thrust washer.

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pinion</td>
</tr>
<tr>
<td>2</td>
<td>Pinion locking wrench</td>
</tr>
<tr>
<td>3</td>
<td>Retainer lock</td>
</tr>
<tr>
<td>4</td>
<td>Countershaft key</td>
</tr>
<tr>
<td>5</td>
<td>Countershaft</td>
</tr>
<tr>
<td>6</td>
<td>Countershaft bushing</td>
</tr>
<tr>
<td>7</td>
<td>Headless screw</td>
</tr>
<tr>
<td>8</td>
<td>Lock washer</td>
</tr>
</tbody>
</table>

**Figure 9-9 Dismantling the pinion**
9.2.2 Dismantling the countershaft housing HP300, HP400 and HP500

See Figure 9-10.

To dismantle the countershaft assembly housing and countershaft in order to replace the housing's bushings, the pinion or other parts, proceed as follows:

1. Remove all oil pipes that could impede the dismantling of the countershaft housing.
2. Dismantle the crusher's bullwheel. The bullwheel must be removed before the countershaft housing, because it could sustain damage.
3. Remove the screws retaining the housing on the frame.
4. Screw the extraction screws (supplied in the crusher's tools) in the 3 tapped holes evenly spaced out in the housing cover.
5. Gradually and alternately tighten each extraction screw to remove the countershaft housing without it jamming.

**NOTE:** IF DIFFICULTIES ARE OCCASIONALLY ENCOUNTERED IN REMOVING THE COUNTERSHAFT HOUSING AS EXPLAINED ABOVE, YOU CAN HEAT THE FRAME TO ABOUT 55°C (100°F) ABOVE AMBIENT TEMPERATURE.

6. Continue tightening the extraction screws until the countershaft housing works free.
7. Slide a long tube at the countershaft end in place of the bullwheel to balance the weight. Remove the countershaft housing with the aid of appropriate lifting gear. (See Figure 9-3).
8. Remove the countershaft housing cover.
9. Heat the oil deflector to roughly 27°C (50°F) above ambient temperature.

**DANGER**

Use safety gloves when handling hot parts.

10. Place a lever between the oil ring and the countershaft, applying moderate force. As soon as the ring starts to slide, pull it horizontally to extract it from the countershaft.
11. Remove the countershaft pinion assembly from the countershaft housing.

9.2.3 Replacing the pinion - HP300, HP400 and HP500

When dismantling the countershaft housing, it is advisable to check the condition of the pinion (tooth wear or breakage). Extensive metal pitting or erosion on the sides of the teeth are signs of excessive wear. This may be due to poor contact of the pinion teeth with the crown resulting from incorrect spacing or crusher overload or even poor quality oil.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame</td>
</tr>
<tr>
<td>2</td>
<td>Tension bolts</td>
</tr>
<tr>
<td>3</td>
<td>Housing cover</td>
</tr>
<tr>
<td>4</td>
<td>Countershaft</td>
</tr>
<tr>
<td>5</td>
<td>Countershaft housing</td>
</tr>
</tbody>
</table>

**Figure 9-10 Dismantling the countershaft housing**

3. Remove the screws retaining the housing on the frame.
4. Screw the extraction screws (supplied in the crusher's tools) in the 3 tapped holes evenly spaced out in the housing cover.
A worn pinion is more vulnerable to tooth breakage than a pinion in good condition. What is more, running the crusher with a worn pinion can cause serious damage to other crusher parts. An excessively worn must therefore be replaced. To get the best out of the drive gear and pinion, it is advisable to change the crown at the same time. If a new pinion is mounted with a worn crown, the profile of the crown's worn teeth can rapidly damage the new pinion. If a new pinion or crown are mounted, check the play of the teeth as explained in paragraph 8.2.2 "Checking and adjusting the play between and at the bottom of the teeth". To replace the pinion do as follows:

1. Remove the countershaft pinion assembly from the countershaft housing. Place the countershaft on appropriate wedges.

2. Slowly heat the pinion with a blowtorch to roughly 100°C. With the aid of a rafter, strike the pinion while continuing to heat it. As soon as the pinion starts to slide, grab it with both hands and take it off the shaft.

3. Heat the replacement pinion in an oil bath (see temperatures in Table 9-2). With the aid of insulating gloves, slide the pinion on the countershaft, matching up the retainer lock grooves. Push the pinion on the shaft in such a way that the shaft protrudes from the pinion by the distance specified in Table 9-2.

NOTE: IF THE COOLING PINION STARTS TO GRIP THE SHAFT, HEAT IT WHILE CONTINUING TO STRIKE IT WITH THE AID OF A RAFTER. REMEMBER THAT THE BLOWTORCH FLAME MUST BE DIRECTED ALL AROUND THE PINION TO PREVENT ANY LOCAL OVERHEATING.

9.2.4 Dismantling the countershaft bushings

Generally, when the bushings are worn and need changing, they have play in the countershaft housing. In which case, the bushings can easily be removed from the housing. However, due to machining tolerances or crusher overload or insufficient lubrication, a bushing can be gripped or even jammed in the housing. If that is the case, it is harder to dismantle.

Proceed as follows:

1. Remove the countershaft housing from the frame and the countershaft from its housing as explained in paragraph 9.2.2 "Dismantling the countershaft housing HP300, HP400 and HP500".

<table>
<thead>
<tr>
<th>Type</th>
<th>Position of pinion&quot;A&quot;</th>
<th>Above ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP300</td>
<td>4 mm (5/32&quot;)</td>
<td>100° 180°</td>
</tr>
<tr>
<td>HP400</td>
<td>5 mm (3/16&quot;)</td>
<td>147° 261°</td>
</tr>
<tr>
<td>HP500</td>
<td>FLUSH</td>
<td>133° 240°</td>
</tr>
</tbody>
</table>

Table 9-2 Position of the pinion and requisite heating temperatures
NOTE: Since the countershaft housings of the HP100 and HP200 are an integral part of the frame, dismantle the countershaft as explained in paragraph 9.2.1 "Dismantling the countershaft assembly and replacing the pinion - HP100 and HP200".

2. Make an extractor as shown in Figure 9-2.

3. Insert this extractor horizontally into the bushing and place it behind the bushing. Turn it 90°C to apply it against the bushing.

4. Hold this extractor with an rod M24 threaded at both ends and longer than the bushing by a hundred millimetres. Screw this rod into the nut welded on the extractor.

5. Place a flat piece (25 x 75 x 305 mm) across the other end of the rod and fix the assembly with a nut.

6. Push the bushing out of the countershaft housing with the aid of a rafter or a tube, tapping the centring plate. See Figure 9-13. If this method still fails to extract the bushing, we suggest the following method (see Figure 9-14):

- Use the extractor described earlier, but the threaded rod and the transverse flat piece must be longer. Place tow wooden wedges between the flat piece and the countershaft housing flange.

For HP100 and HP200, the inner countershaft bushing is kept in place by a headless screw traversing the frame and placed at 12h. This screw must be removed before the bushing. Since this screw is glued with Loctite, heat to around 205°C (400°F) before loosening it.

- Work simultaneously on the centring device nut and the rafter or thrust tube.

- When the bushing reaches the cross-wide flat piece, unscrew the nut from the threaded rod, increase the thickness of the wedging and repeat the operation (b).

- Repeat operations (b) and (c) until the bushing comes completely out of the housing.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extractor</td>
</tr>
<tr>
<td>2</td>
<td>Countershaft bushing</td>
</tr>
<tr>
<td>3</td>
<td>Slightly under the outer diameter of the bushing</td>
</tr>
<tr>
<td>4</td>
<td>M24 nut welded onto the plate</td>
</tr>
<tr>
<td>5</td>
<td>Slightly under the inner diameter of the bushing</td>
</tr>
<tr>
<td>6</td>
<td>Insert this plate horizontally and place it behind and against the bushing</td>
</tr>
</tbody>
</table>

**Figure 9-12 Centring plate**

For HP100 and HP200, the inner countershaft bushing is kept in place by a headless screw traversing the frame and placed at 12h. This screw must be removed before the bushing. Since this screw is glued with Loctite, heat to around 205°C (400°F) before loosening it.
### Ref. | Description
--- | ---
1 | Countershaft housing
2 | Extractor
3 | Rafter
4 | Threaded rod
5 | Countershaft bushing
6 | Cross-wide flat piece
7 | Pin

*Figure 9-13 Dismantling a bushing with thrust*
### Figure 9-14 Dismantling a Countershaft Bushing with Traction and Thrust

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Countershaft bushing</td>
</tr>
<tr>
<td>2</td>
<td>Wooden wedge</td>
</tr>
<tr>
<td>3</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>4</td>
<td>Extractor</td>
</tr>
<tr>
<td>5</td>
<td>Threaded rod</td>
</tr>
<tr>
<td>6</td>
<td>Cross-wide flat piece</td>
</tr>
</tbody>
</table>

The table above lists the components and their descriptions for dismantling a countershaft bushing using traction and thrust.
9.2.5 Dismantling the countershaft bushings - HP100 and HP200

Generally, when the bushings are worn and need changing, they are no longer tight in the frame. In that case, the bushings can be removed from the frame without any difficulty. However, due to machining tolerances or crusher overload or insufficient lubrication, a bushing can be gripped or even jammed in the housing. If that is the case, it is harder to dismantle.

Proceed as follows:

**Bushing on bullwheel side:**

1. Since the countershaft housing on the **HP100 and HP200** is an integral part of the frame, remove the crusher's countershaft as described in paragraph 9.2.1 "Dismantling the countershaft assembly and replacing the pinion - HP100 and HP200".

2. Make an extractor as shown in **Figure 9-15**.

3. Insert this extractor horizontally into the bushing and place it behind the bushing. Turn it 90°C to apply it against the bushing.

4. Holding the plate in position, screw a threaded rod into the nut welded onto the extractor; the rod must be slightly longer than the bushing and threaded at both ends.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extractor</td>
</tr>
<tr>
<td>2</td>
<td>Countershaft bushing</td>
</tr>
<tr>
<td>3</td>
<td>Slightly under the outer diameter of the bushing</td>
</tr>
<tr>
<td>4</td>
<td>M24 nut welded onto the plate</td>
</tr>
<tr>
<td>5</td>
<td>Slightly under the inner diameter of the bushing</td>
</tr>
<tr>
<td>6</td>
<td>Slide the extractor in the bushing and turn it 90°.</td>
</tr>
</tbody>
</table>

**Figure 9-15 Extractor**
5. Place a flat piece (25 x 75 x 250 mm) across the other end of the rod and fix the assembly with a nut. (See Figure 9-16).

![Figure 9-16 Dismantling the countershaft bushing (bullwheel side)](image)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Countershaft bushing</td>
</tr>
<tr>
<td>2</td>
<td>Extractor</td>
</tr>
<tr>
<td>3</td>
<td>Threaded rod</td>
</tr>
<tr>
<td>4</td>
<td>Cross-wide flat piece</td>
</tr>
<tr>
<td>5</td>
<td>Wedging</td>
</tr>
<tr>
<td>6</td>
<td>Nut</td>
</tr>
</tbody>
</table>

6. Use the threaded rod as a cylinder. When the bushing rests against the transverse flat piece, unscrew the nut and wedge.

7. Repeat step 6 until the bushing has come completely out of the housing.

**Bushing pinion side:**

1. The inner countershaft bushing is maintained in the bore of the housing (an integral part of the frame) by a headless screw positioned at 12h. See Figure 9-17. This screw must be removed before the bushing is dismantled. Since this screw is glued with Loctite, heat to around 200°C (°F) before unscrewing it.

2. Place the extractor at the end of the rod. Press the extractor against the bushing to release the latter from its housing.
9.2.6 Assembling the countershaft bushings - HP100 and HP200

After examining the frame, the new bushings can be mounted. If the bushing-frame assembly is slippery, mount the bushings, making sure that the oil grooves are in the position stated in step 4. If the bushings are mounted slightly tight, cool them down to mount them as explained in step 5.

Proceed as follows:

1. Remove the locating pins (bushing on bullwheel side).
2. Replace the pins with rods of the same diameter and slightly longer than the bushings. These rods will serve as a guide. See Figure 9-18.
3. To fit the inner countershaft bushing, align the hole in the bushing with the hole in the frame, receiving the headless screw.
4. The inner and outer bushings are identical. However the position of their oil groove differs. Determine this position as follows:
   a. The longitudinal oil groove of the inner bushing should be situated at 12h. See Figure 9-19.
   b. The longitudinal oil groove of the outer bushing is usually situated at 6h. See Figure 9-19. However this position must be changed it the motor is situated above the crusher in a region 45° either side of the vertical axis. See Figure 9-20.

NOTE: The bushing must then be turned so that the longitudinal groove is situated at 12h. This position lets the transmission exert its tractive force outside the groove and therefore does not impede the oil supply.

---

**Ref.** | **Description**
--- | ---
1 | Countershaft bushing
2 | Extractor
3 | Bar
4 | Headless screw

**Ref.** | **Description**
--- | ---
1 | Countershaft bushing
2 | Guide rod
3 | Frame

---

**Figure 9-17 Dismantling the bushing pinion side**

**Figure 9-18 Mounting a countershaft bushing**
### Figure 9-19 Position of the countershaft bushing lubrication grooves

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inner countershaft bushing</td>
</tr>
<tr>
<td>2</td>
<td>Oil groove positioned at 12h</td>
</tr>
<tr>
<td>3</td>
<td>Frame</td>
</tr>
<tr>
<td>4</td>
<td>Outer countershaft bushing</td>
</tr>
<tr>
<td>5</td>
<td>Oil groove positioned at 6h</td>
</tr>
<tr>
<td>6</td>
<td>Oil groove positioned at 12h for vertical transmission, with the motor under the crusher bullwheel.</td>
</tr>
<tr>
<td>7</td>
<td>Oil groove positioned at 6h for horizontal transmission, with the motor over the crusher bullwheel.</td>
</tr>
</tbody>
</table>

Figure 9-19 Position of the countershaft bushing lubrication grooves
5. Line the bores of the new bushings with carbon dioxide snow for 2 to 3 hours to facilitate assembly. Approximately 22 kg of carbon dioxide snow are needed to replace both bushings.

**NOTE:** COVER THE OUTSIDE OF THE COOLED BUSHING TO PREVENT FORMATION OF CONDENSATION, WHICH COULD IMPEDE ASSEMBLY OF THE BUSHING IN THE HOUSING. THIS ALSO HELPS TO ACHIEVE MORE UNIFORM COOLING.

**NOTE:** If the frame temperature exceeds 24°C (75°F), you can use ice instead of carbon dioxide snow. Measure the outer diameter of the bushing and the housing bore to determine when the bushing has cooled down enough.

6. Quickly slide the bushing into the housing using the guide rods.

**NOTE:** align the hole of the inner bushing with the hole in the frame of the headless screw. See Figure 9-15.

**NOTE:** Check that the oil groove is properly positioned at 12h and that the hole in the outer diameter of the bushing is properly aligned with the hole in the frame receiving the headless screw. DO NOT USE THE GUIDE ROD TO MOUNT THE INNER BUSHING IN HP100.

**NOTE:** Clean the threads of the headless screws and the tapping of the hole in the frame with a solvent. The apply Loctite 277 to the threaded surfaces and fit the headless screws. Screw in until the screw comes into contact with the bushing. DO NOT TIGHTEN EXCESSIVELY: TOO MUCH PRESSURE MAY DEFORM THE BUSHING'S BORE.

7. If the assembly was not completed soon enough and the bushing works loose during assembly, or if you have no means of cooling, you can insert the bushings by hitting them if you protect them with a piece of wood. The guide rods particularly are useful in that case.

**NOTE:** EXERT MODERATE PRESSURE TO PREVENT THE BUSHING JAMMING.

8. Remove the guide rods and replace them with the two pins you previously removed.

---

**DANGER**

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crusher bullwheel</td>
</tr>
<tr>
<td>2</td>
<td>With crusher vertical</td>
</tr>
<tr>
<td>3</td>
<td>Drive bullwheel</td>
</tr>
</tbody>
</table>

---

**Figure 9-20 Vertical control - motor under crusher**

---

**Ref. Description**

1. Crusher bullwheel
2. With crusher vertical
3. Drive bullwheel

---

**DANGER**

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.
9.2.7 Examining prior to mounting a countershaft bushing - HP100

Check the bore of the countershaft housing built into the frame. Check the straightness of the countershaft. Since the countershaft is mounted between points, the out-of-roundness should not exceed 0.1 mm. If the out-of-roundness is greater, the shaft must be replaced. If the bore of a countershaft bushing has contracted due to excessive tightening in the housing, the latter may jam in the bushing. Finally a bent shaft (which can be detected by examining the alignment of the retainer lock grooves) must be replaced with a new shaft.

9.2.8 Examining prior to mounting a countershaft bushing - HP200, HP300, HP400 and HP500

When mounting new bushings it is advisable to check the housing/bushing adjustment.

The housing bore and the outer diameter of the bushing must be checked to ascertain this adjustment. If it is too tight, the bore of the housing must be altered to bring it within tolerance. Excessive tightness can cause the inner diameter of the bushing to contract, and therefore reduce the play between it and the countershaft. If the diameter of the countershaft housing bore is smaller than it should be, contraction can therefore be put down to overheating.

NOTE: On the HP200, check the bore of the countershaft housing, which is built into the frame. Check the straightness of the countershaft. Since the countershaft is mounted between spikes, out-of-roundness should not exceed 0.1 mm. If out-of-roundness is greater, the shaft must be replaced. If the bore of a countershaft bushing has contracted due to excessive tightening in the housing or if a curved countershaft is used, this may jam in the bushing. Finally a bent shaft (which can be detected by examining the alignment of the retainer lock grooves) must be replaced with a new shaft.

9.2.9 Mounting the countershaft - HP100 and HP200

See Figure 9-7.

Assembly is the reverse of the dismantling procedure, subject to the following remarks:

1. Fix the locking plate on the pinion. Clean the threads of the screws and the holes in the pinion with solvent. Apply Loctite 242 to the threads and screw the screws into the pinion. Tighten firmly.
   - HP100 thread torque: 140 N.m.
   - HP200 thread torque: 180 N.m.

2. Install the lifting ring in the hole of the pinion between the teeth. Lower the pinion into the frame, this is horizontal and aligned with the bushing bore.

3. Screw the countershaft into the pinion by turning clockwise. Hold the pinion with the special wrench and turn the countershaft with the appropriate wrench. See Figure 9-9.

4. Screw until the end of the countershaft comes into contact with the locking plate fixed to the pinion. Usually the countershaft can be mounted without resorting to using a hammer to hit the wrench.

5. Once the end of the countershaft is in contact with the locking plate, strike the wrench with a hammer to make sure the contact is effective.

6. Heat the oil deflector to roughly 27°C above ambient temperature and mount it as quickly as possible on the countershaft.

7. If difficulties arise, push the oil ring with a rafter. The ring is correctly mounted when:
   - For HP100 there is 1.3 mm to 1.8 mm of play between the oil deflector and the countershaft bushing. Check with a gauge.
8. When the oil ring has cooled down, remove the gauge and fit the compression ring.

9. Apply silicone sealant to the face of the countershaft housing before fixing its housing cover onto it. Fit the cover by matching up the bolt holes. Gradually and alternately tighten the retaining screws.

If the bushings are mounted slightly tight, cool them down to mount them as explained in step 4. Proceed as follows:

1. Remove the locating pins from the housing flange.

Replace the pins with rods of the same diameter and slightly longer than the bushings. These rods will serve as a guide. See Figure 9-22.

### 9.2.10 Mounting countershaft bushings - HP300, HP400 and HP500

When the countershaft and its housing have been fully examined, the new bushings can be mounted. If the bushing-frame assembly is slippery, mount the bushings, making sure that the oil grooves are in the position stated in step 3.
NOTE: In **HP100** and **HP200**: To fit the inner countershaft bushing, align the hole in the bushing with the hole in the frame, receiving the headless screw.

2. The inner and outer bushings are identical. However the position of their oil groove may differ. Determine this position as follows:
   a. The longitudinal oil groove of the countershaft bushing on the pinion side should be situated at 12h. See *Figure 9-24*.

   b. The longitudinal oil groove of the countershaft bushing on the bullwheel side should be situated at 6h. See *Figure 9-24*. However this position must be changed if the motor is situated above the crusher in a region 45° either side of the vertical axis. See *Figure 9-23*. The bushing must then be turned so that the longitudinal groove is situated on the upper part. This position lets the transmission exert its tractive force outside the groove and therefore does not impede the oil supply.
TECHNICAL MANUAL NORDBERG CONE CRUSHERS HP100/200/300/400/500

SECTION 9 - COUNTERSHAFT, COUNTERSHAFT HOUSING AND BULLWHEEL ASSEMBLIES

Figure 9-23 Vertical control - motor under crusher

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>With crusher vertical</td>
</tr>
<tr>
<td>2</td>
<td>Drive bullwheel</td>
</tr>
<tr>
<td>3</td>
<td>Crusher bullwheel</td>
</tr>
</tbody>
</table>

Figure 9-23 Vertical control - motor under crusher
3. Line the bores of the new bushings with carbon dioxide snow for 2 to 3 hours to facilitate assembly. Approximately 22 kg of carbon dioxide snow are needed to replace both bushings.

**NOTE:** COVER THE OUTSIDE OF THE COOLED BUSHING TO PREVENT FORMATION OF CONDENSATION, WHICH COULD IMPEDE ASSEMBLY OF THE BUSHING IN THE HOUSING. THIS ALSO HELPS TO ACHIEVE MORE UNIFORM COOLING.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>2</td>
<td>Outer countershaft bushing</td>
</tr>
<tr>
<td>3</td>
<td>Oil groove positioned at 6h for horizontal or vertical transmission, with the motor over the crusher bullwheel.</td>
</tr>
<tr>
<td>4</td>
<td>Oil groove</td>
</tr>
<tr>
<td>5</td>
<td>Oil groove positioned at 12h for vertical transmission, with the motor under the crusher bullwheel.</td>
</tr>
<tr>
<td>6</td>
<td>Oil groove positioned at 12h</td>
</tr>
<tr>
<td>7</td>
<td>Inner countershaft bushing</td>
</tr>
</tbody>
</table>

**Figure 9-24 Position of the countershaf bushing lubrication grooves**
NOTE: If the temperature of the countershaft housing exceeds 24°C, you can use ice instead of carbon dioxide snow. Measure the outer diameter of the bushing and the housing bore to determine when the bushing has cooled down enough.

4. Quickly slide the bushing into the housing using the guide rods.

NOTE: On HP100 and HP200, align the hole in the countershaft bushing with the hole in the frame. See Figure 9-7. Check that the oil groove is properly positioned at 12h and that the hole in the outer diameter of the bushing is properly aligned with the hole in the frame receiving the headless screw. DO NOT USE THE GUIDE ROD TO MOUNT THE INNER BUSHING OF THE HP200.

5. Clean the threads of the headless screws and the tapping of the hole in the frame with a solvent. The apply Loctite 277 to the threaded surfaces and fit the headless screws. Screw in until the screw comes into contact with the bushing. DO NOT TIGHTEN EXCESSIVELY: TOO MUCH PRESSURE MAY DEFORM THE BUSHING’S BORE.

6. If the assembly was not completed soon enough and the bushing works loose during assembly, or if you have no means of cooling, you can insert the bushings by hitting them if you protect them with a piece of wood. The guide rods particularly are useful in that case.

NOTE: EXERT MODERATE PRESSURE TO PREVENT THE BUSHING JAMMING.

7. Remove the guide rods and replace them with the two pins you previously removed.

9.2.11 Mounting the countershaft housing - HP300, HP400 and HP500

See Figure 9-2.

Whether the countershaft is dismantled for inspection purposes or to replace parts, it is advisable to replace the seals: O-ring seal or lip seal between the housing and the frame, flat or silicone seal between the housing cover and the countershaft housing or frame, compression ring between the oil ring and housing cover.

These seals can "age" and lose their quality over time. They are not expensive and it is better to replace them than to run the risk of dismantling in order to fix an oil leak.

To mount the countershaft assembly housing, proceed as follows:

1. Mount the countershaft assembly in the countershaft housing.

2. To hold the countershaft in place, use a C-clamp as shown in Figure 9-25. You can also place the pinion against a wall or on solid wooden wedges.
SECTION 9 - COUNTERSHAFT, COUNTERSHAFT HOUSING AND BULLWHEEL ASSEMBLIES

9. Gradually and alternately tighten the retaining screws.

9.2.12 Oil leak at the countershaft on the control side

If an oil leak occurs at the countershaft housing cover, this may be due to the compression ring positioned on the oil ring. Faulty parts must be replaced. See Figure 9-21.

Check the breather. A clogged breather may be the cause of an oil leak.

Return piping with an insufficient gradient, or excessively viscous oil may be the cause of an oil leak. Minimum oil return gradient: 25 mm for 305 mm. (8% or 5°)

Check the inside of the return piping, and their condition.

All such defects can cause an oil leak behind the cover of the deflector.

9.2.13 Mounting the crusher bullwheel

See Figure 9-26.

To fit the crusher bullwheel into its hub, proceed as follows:

1. Refer to the piping plan and install.
2. Remove the removable hub of the bullwheel by removing the locking screws.
3. Clean the shaft, retainer lock, faces and outer cone of the hub as well as the tapered bore of the bullwheel on which it is to be mounted. Remove shavings, traces of varnish or paint.
4. Place the spacer and the removable hub in the tapered bore of the bullwheel, taking care to place the smooth half-holes opposite the tapped half-holes.
5. Oil the thread and the rounded end of the screws (or the underside of the head for screws with heads).
6. Fit the screws in the tapped holes on the bullwheel without tightening them, the hub remaining free on the rim.

---

Figure 9-25 Mounting the countershaft

3. Heat the oil ring to roughly 27°C above ambient temperature and mount it as quickly as possible on the countershaft.
4. If difficulties arise, push the oil ring with a rafter. The ring is correctly mounted when the axial play matches the values specified in Table 9-1, check with a gauge. See Figure 9-21.
5. When the oil ring has cooled down, remove the gauge and fit the compression ring.
6. The oil ring is equipped with a ring seal to form a seal between the oil ring and its housing. Check that this ring can turn freely in the groove machined in the ring. Remove all burrs or dirt that may have gathered on the ring. Replace it if necessary.
7. Check the ring bore before mounting the ring on the countershaft housing. The bore should be smooth.
8. Apply silicone sealant to the face of the countershaft housing before fixing its housing cover onto it. Fit the cover by matching up the bolt holes.
7. Slide the assembly onto the shaft up to the desired position, not forgetting the retainer lock (pinned bullwheel version).
8. Tighten the screws uniformly and alternately. The screws must be tightened to the necessary torque.

<table>
<thead>
<tr>
<th>Bullwheel</th>
<th>Torque N.m. Magic lock hub</th>
<th>Torque N.m. Veco bloc hub</th>
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<tr>
<td>500-6 SPC</td>
<td>195</td>
<td>275</td>
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<tr>
<td>630-4/8V</td>
<td>270</td>
<td>360</td>
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</table>

Table 9-3 Thread torque - HP100

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<thead>
<tr>
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<th>Torque N.m.</th>
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<tr>
<td>560-8 SPC</td>
<td>360</td>
</tr>
<tr>
<td>630-6/8V</td>
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</table>

Table 9-4 Thread torque - HP200

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<td>630-10 SPC</td>
<td>360</td>
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<tr>
<td>630-8/8V</td>
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Table 9-5 Thread torque - HP300

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<td>800-12 SPC</td>
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<tr>
<td>762-12/8V</td>
<td>406.7</td>
</tr>
<tr>
<td>902-10/8V</td>
<td>610</td>
</tr>
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</table>

Table 9-6 Thread torque - HP400

<table>
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<th>Torque N.m.</th>
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</thead>
<tbody>
<tr>
<td>800-12 SPC</td>
<td>560</td>
</tr>
<tr>
<td>762-12/8V</td>
<td>610</td>
</tr>
<tr>
<td>902-12/8V</td>
<td>610</td>
</tr>
<tr>
<td>1016-12/8V</td>
<td>610</td>
</tr>
</tbody>
</table>

Table 9-7 Thread torque - HP500

9. If there is a risk of oxidization, fill the other holes with grease.

9.2.14 Dismantling the crusher bullwheel

See Figure 9-26.
To dismantle the crusher's bullwheel, proceed as follows:
1. First remove the hub's retaining screws.
2. Insert the screws into the hub's tapped holes.

DANGER
If the bullwheel is hard to separate form its removable hub, tap it with a hammer, maintaining pressure on the thrust screws.
### Figure 9-26 Bullwheel assembly

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>Bolt</td>
</tr>
<tr>
<td>3</td>
<td>Retainer lock</td>
</tr>
<tr>
<td>4</td>
<td>Spacer</td>
</tr>
<tr>
<td>5</td>
<td>Hub</td>
</tr>
<tr>
<td>6</td>
<td>For dismantling</td>
</tr>
<tr>
<td>7</td>
<td>For mounting</td>
</tr>
</tbody>
</table>

Figure 9-26 Bullwheel assembly
9.2.15 Replacement of the HP100 and HP200 counter-shaft casing shield

1. To replace the counter-shaft casing shield, remove the bowl assembly as indicated in paragraph 5.3.1 "Dismantling the bowl".
2. Remove the head assembly as indicated in paragraph 6.3.1 "Dismantling the head".
3. Withdraw the worn shield and replace it with a new shield.
4. Refit the head assembly as indicated in paragraph 6.2 "Mounting the head assembly".
5. Refit the bowl assembly as indicated in paragraph 5.2 "Assembly instructions".

9.2.16 Replacement of the HP300 counter-shaft casing shield

1. To replace the counter-shaft casing shield, remove the bowl assembly as indicated in paragraph 5.3.1 "Dismantling the bowl".
2. Remove the head assembly as indicated in paragraph 6.3.1 "Dismantling the head".
3. Remove the bush assembly as indicated in paragraphs 7.2 "Assembly instructions" to 7.3.2 "Replacing the spherical bearing (HP200, HP300, HP400 and HP500)".
4. Remove the crank assembly as indicated in paragraph 8.3.1 "Dismantling the eccentric assembly".
5. Replace the worn shield with a new shield.
6. Refit the crank assembly as indicated in paragraph 8.3.14 "Installing the eccentric assembly".
7. Refit the bush assembly as indicated in paragraphs 7.2 "Assembly instructions" and 7.3.2 "Replacing the spherical bearing (HP200, HP300, HP400 and HP500)".
8. Refit the head assembly as indicated in paragraph 6.2 "Mounting the head assembly".
9. Refit the bowl assembly as indicated in paragraph 5.2 "Assembly instructions".

9.2.17 Replacement of the HP400 counter-shaft casing shield

1. To replace the counter-shaft casing shield, remove the casing assembly as indicated in paragraph 9.2.2 "Dismantling the countershaft housing HP300, HP400 and HP500", then replace the worn shield with a new shield.
2. Refit the counter-shaft casing assembly as indicated in paragraph 9.1.2 "Assembling the countershaft housing - HP300, HP400 and HP500".

9.2.18 Replacement of the HP400 counter-shaft casing shield

1. Withdraw the worn half-shield located at the central side of the frame and then withdraw the worn half-shield on the external side of the frame.
2. Fit the new half-shield in place on the external side of the frame, then the new half-shield on the central side of the frame.
Section 10

FRAME, ADJUSTING RING AND RETAINING CYLINDER ASSEMBLIES

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10.1 Description

This section deals with the frame, the adjusting ring and the protective mechanism.

The frame bolted to its foundations or a metal chassis equipped with vibration dampers forms a rigid support for the other components.

A liner welded to the inside of the frame and the arm liners protect the inside of the frame against wear; these liners must be replaced.

An adjusting ring resting on a conical seating machined in the upper part of the frame has a female thread for adjusting the bowl. A locking ring over the adjusting ring presses against the inner face of the bowl threads thanks to cylinders placed between the locking ring and the adjusting ring, thereby preventing the bowl from turning during crushing.

A protective apron fixed to the adjusting ring protects the locking cylinders and the bowl's threads against airborne dust.

Hydraulic cylinders pinned to the frame and traversing the adjusting ring keep the latter pressed firmly against the conical part of the frame. Abnormal operating conditions or tramp iron in the crusher can strain the bowl and the adjusting ring and lift them by pulling on the cylinder's rods. This movement pushes the oil in the cylinders into the accumulators, where the pressure of the nitrogen increases. When the excess load has passed, the compressed nitrogen returns the oil to the cylinders, the cylinder rods retract and the adjusting ring returns to rest on the frame.

Vertical pins fixed to the frame guide the adjusting ring when it lifts off the frame.

A thrust washer bolted to the drum of the frame supports the eccentric. Wedges inserted under the washer adjust play between and at the bottom of the teeth of the crown and pinion.

On HP100 and HP200, a labyrinth seal in two parts: one on the frame, the other on the eccentric, prevent any oil leaking and protect the crown, pinion and bearing surfaces against ingress of dust. The seal is made of special plastic and is glued in a groove of the frame around the crown.

The countershaft is supported by two bronze bushings.

On HP300, HP400 and HP500, a U seal glued into a groove of the frame around the crown forms a seal with the T seal behind the imbalance.

The main shaft, mounted in the central drum of the frame, supports the sleeve and serves as a spindle around which the eccentric rotates.

10.2 Mounting instructions

10.2.1 General

In most cases, the components of the frame, adjusting ring and protective mechanism are shipped assembled. However, the assembly may be shipped as separate parts if there are space restrictions. In that case, the mounting procedure is provided in the part dealing with maintenance.

10.2.2 Setting up the crusher

Whether the crusher is shipped fully assembled or in separate parts, the frame must be made level on its foundations. Two materials are used to do this: concrete and resin. Formerly, concrete would be used almost exclusively for embedding purposes. However, resin has tended to be used instead of concrete for some years.

In most cases, resin is preferable since it is easy to prepare and use.

Epoxy resin stands up well to static and dynamic loads and vibrations and is very resilient. It is available in packs of different quantities. Each pack includes two products, the resin itself and a hardener, which you mix in just before using it. The kit includes full instructions. No particular equipment, preparation or handling is required to use resin.
To install the frame assembly or the complete crusher, see Figure 10-1 and proceed as follows:

1. Flame-cut 4 holes in a 10-mm metal plate and place it around the bonding holes. Thread one or more suitable slings through the lifting lugs on the lower section of the frame. See Figure 10-2.

---

**DANGER**

Do not use lifting hooks on the adjustment cap to lift the entire machine because such hooks are not strong enough; this could lead to a serious accident or damage.
SECTION 10 - FRAME, ADJUSTING RING AND RETAINING CYLINDER ASSEMBLIES

NOTE: THE SURFACE OF THE BLOCK RECEIVING THE CONCRETE SHOULD BE ROUGH AND THOROUGHLY CLEANED BEFORE BONDING THIS SURFACE SHOULD ALSO BE THOROUGHLY SOAKED WITH WATER AND REMAIN DAMP TO AVOID THE BLOCK RAPIDLY ABSORBING WATER FROM THE BONDING CONCRETE. HOWEVER, REMOVE ANY EXCESS WATER JUST BEFORE POURING THE CONCRETE. ADD A RUST PREVENTIVE AGENT TO THE BONDING CONCRETE.

4. Set the level of the crusher by sliding the C-shaped washers around the foundation bolts so that there is a gap of between 12 and 20 mm between the frame and the block (optimal thickness for the resin).

5. Then build the form work on either side of the frame, which is where the resin will be poured. Use battens measuring 25 mm x 50 mm to build the form work. Place and fasten the form work about 12 mm from the base of the frame outside the crusher in line with the vertical sides inside the crusher. See Figure 10-1. The form work should be coated with 3 layers of ordinary wax on either side. This prevents the wood from sticking to the resin. All seals should be caulked to prevent leaks when you pour in the resin.

6. Mix and pour the resin as per the instructions. In cold weather, heat the resin to 18°/27°C. For better results, store the resin in a warm room before use. To avoid air bubbles forming under the crusher, pour the resin in one place at a time, covering an area of about 600 mm on either side. Then return to the point where the resin stopped previously and pour more in. Continue until the form work is full.

NOTE: DO NOT FILL MORE THAN ONE SURFACE WITH RESIN AT THE SAME TIME.

### Figure 10-2 Handling the crusher

2. Lift the frame and coat the footing of the frame with a thin layer of oil to prevent the resin from adhering to the crusher.

3. Place the crusher on the block over the 10-mm washers.

NOTE: WHEN USING CONCRETE, PLACE THE FRAME ON WOODEN WEDGES PLACED AT THE FOUR CORNERS OF THE FRAME RATHER THAN ON METAL WASHERS BECAUSE THE WOOD WILL RETRACT WITH THE CONCRETE.

NOTE: THE WEDGES SHOULD RAISE THE FRAME ABOUT 50 TO 60 CM ABOVE THE BLOCK’S BEARING FACE TO HAVE AN ADEQUATE THICKNESS OF BONDING CONCRETE.
Pour have the necessary average number of kg for bonding the crusher with a layer of mortar 12 to 20 mm thick, see Table 10-1.

7. The resin usually dries in roughly 6 hours if the seating, crusher and resin are at an ambient temperature of 21°C at the time of casting.

8. When the seating is dry, clamp the crusher firmly to its foundations.

*All these quantities include enough mortar for one adequate bonding layer. If the surface is uneven, increase the quantities by 10%.

Table 10-1 Requisite quantity for bonding

<table>
<thead>
<tr>
<th>Type of crusher</th>
<th>Requisite quantity of resin*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 mm mortar</td>
</tr>
<tr>
<td>HP100</td>
<td>35 kg</td>
</tr>
<tr>
<td>HP200</td>
<td>45 kg</td>
</tr>
<tr>
<td>HP300</td>
<td>45 kg</td>
</tr>
<tr>
<td>HP400</td>
<td>45 kg</td>
</tr>
<tr>
<td>HP500</td>
<td>85 kg</td>
</tr>
</tbody>
</table>

Do not use lifting hooks on the adjustment cap to lift the entire machine because such hooks are not strong enough; this could lead to a serious accident or damage.

3. Flame-cut 4 washers 305 mm x 305 mm 6 mm thick with a hole in the middle, matching the fixing bolt, and place them over it.

4. Raise the frame and place is on the steel construction.

5. Level the crusher by sliding U-shaped washers around the foundation bolts on the top of the cross-piece. The 4 U-shaped washers may vary in thickness. Use the top of the main shaft to level the crusher in both directions.

6. When the crusher has been set in place, measure the gap between the frame's footing and the metal structure at 3 different points as shown in Figure 10-3. These surfaces must be wedged to form a support between the frame's footing and the structure. The wedges, which may vary in thickness, must be roughly the same width of the frame's footing; 610 mm to 915 mm long, depending on the size of the crusher. Generally, 915 mm wedges are used for the HP400 and HP500.

7. When the wedges are in place under the frame's footing, spot weld them to the structure to dampen vibrations.

8. When the crusher is securely bolted to the structure, check whether you can lift the crusher.

9. Check the fastenings periodically: after one week, one month, six months, one year.
10.3 Maintenance

10.3.1 Frame and arm liners

See Figure 10-4.

When the machine is stopped to change the bowl liner and mantle, check the frame and arm liners for wear.

When the head has been dismantled, lower the arm liners. These can be placed from underneath the crusher, when the head is not dismantled, but this is fairly difficult.

The frame liner is generally shipped in pieces, which makes it easier to fit. If the liner is shipped as one piece, its ends must overlap so that its diameter is smaller than that of the adjusting ring threads. The height at which the liner must be welded inside the frame is easy to see with the aid of the remaining welds of the old liner.
10.3.2 Replacing the shaft
One very seldom needs to dismantle the shaft from the frame. Achieving perfect alignment between the frame's shaft and the hub is a major and difficult task; we therefore recommend you have this done by a specialized workshop that has the necessary resources.

10.3.3 Replacing the lower thrust washer and the spacer rings
See Figure 10-5.
To replace a damaged or worn lower thrust washer, or add spacer rings to restore the normal play the teeth, proceed as follows:

1. To gain access to the washer, the bowl, head, sleeve and eccentric assemblies need to be removed. Refer to the chapter dealing with these assemblies.
2. Remove the thrust washer's retaining screw.
3. Screw a lifting ring into each of the 2 holes drilled in the thrust washer.
4. Using appropriate lifting gear, remove the thrust washer.

5. Check that the contact surfaces of the new thrust washer and spacers are free of scratches, burrs and other rough edges.

6. Refer to the eccentric assembly section, 8.2.2 "Checking and adjusting the play between and at the bottom of the teeth" for how to check the play between and at the bottom of the teeth. If supplementary spacers need to be added, place them on the upper face of the existing stack. If a new washer needs to be mounted, use the two previous lifting rings, make sure the thrust washer rests properly on the spacers and the holes are correctly aligned.

7. Put the washers and the retaining screws back in place. Make sure the washer is correctly mounted (streaks under the head of the screws). Tighten the screws energetically.

10.3.4 Replacing a sealing joint - HP100

See Figure 10-6.

Generally the joints are not affected by wear. If in spite of everything they should be damaged they would need replacing. The joints prevent oil leaks and protect the machined surfaces of the gear assembly and the thrust washers against ingress of dust. Replace the joint as shown below:

1. Remove the worn seal and scrape off any remaining debris in the seal groove.

2. Clean the groove thoroughly with a quick-drying oil-free cleaner.

3. The diameter of the spare seals is the same or slightly larger than required. Insert the new seal into the groove without glue and mark out the required length. Remove the seal and make a clean cut at the desired length. The seal must be able to be mounted in its groove without forcing. For U seals, draw a line with a crayon at the point where the joint sticks out of the groove.

4. Joint gluing instructions:
   a. Apply a very thin layer of activator in the bottom of the groove. Leave to dry (partial sticking may be caused by excess activator).
   b. Apply the adhesive at 12 points (see figure) along the bottom of the groove approximately 5 to 10 mm apart.
   c. Place the joint and press down so that the two surfaces remain in contact for more or less 3 minutes.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower thrust washer</td>
</tr>
<tr>
<td>2</td>
<td>Retaining screw</td>
</tr>
<tr>
<td>3</td>
<td>Lock washer</td>
</tr>
<tr>
<td>4</td>
<td>Spacer ring</td>
</tr>
</tbody>
</table>

Figure 10-5 Mounting the thrust washer
10.3.5 Replacing the sealing joint for HP200, HP300, HP400 and HP500

See Figure 10-6.

Generally the U seal is not affected by wear. If in spite of everything it should be damaged it would need replacing. The joints prevent oil leaks and protect the machined surfaces of the gear assembly and the thrust washers against ingress of dust. To replace it, proceed as follows:

1. Remove the worn seal and scrape off any remaining debris in the seal groove.
2. Clean the groove thoroughly with a quick-drying oil-free cleaner.
3. After removing the new "made-to-measure" sealing joint from its shipping box, thoroughly clean the bottom of the sealing joint with coarse sandpaper to remove the surface "gloss" before cementing the joint. These joints are coated with a parting agent to allow the joint to be released from its mould during production. For the joint to adhere correctly to the adhesive, this parting agent must be totally removed.

**NOTE:** IF THE PARTING AGENT IS NOT TOTALLY REMOVED, THE JOINT COULD MOVE DURING THE OPERATION!

4. APPLY A VERY THIN LAYER OF ACTIVATOR TO THE OUTER BOTTOM EDGE OF THE JOINT. If too much activator is applied, this could bring about partial vulcanization of the joint.
5. apply a small amount of ADHESIVE TO THE BOTTOM OF THE GROOVE RECEIVING THE JOINT of the main frame. Apply only the amount of adhesive required to guarantee minimal pressure.
6. Position the joint in the groove as soon as possible after applying the adhesive. Apply enough pressure to the bottom of the joint to ensure contact between the joint and the bottom of the groove.
10.3.6 Replacing the frame pins - HP100

See Figure 10-8.

The frame pins prevent the adjusting ring from turning. They reposition the ring when tramp iron passing through the crushing chamber lifts it. Repeated lifting of the adjusting ring is not normal and can be averted through appropriately graded feed. Incorrect operation with excessive bounce of the ring will lead to wear on the pins and damage the pin rings in the frame.

The pins should be replaced as follows:

1. Remove the screw from the frame pin above the adjusting ring.
2. Depressurize the protective cylinders and the accumulators. Take out the worn pins by hitting the top of the adjusting ring. The pin support may need to be heated.
3. Push the new pins from underneath the frame by hitting or heating the pin support or cooling the pin to make fitting easier.
4. The pin must be in contact with the bottom of its bore hole.
5. Fix each pin with the aid of screws fitted with normal thread brake.
6. Repressurize the protective cylinders.

10.3.7 Replacing the frame pins - HP200 and HP300

See Figure 10-9.

The frame pins prevent adjusting ring from turning and reposition it when tramp iron passing through the crushing chamber lifts it. Repeated lifting of the adjusting ring is not normal and can be averted through appropriately graded feed. Incorrect operation with excessive bounce of the ring will lead to wear on the pins and expand the bore holes in the adjusting ring.

The wear is visible under the adjusting ring in the frame pins region. The rotating head transmits force to the bowl and the adjusting ring that makes it turn in the same direction as the head, thereby causing wear to the pins and rings only on one side. The pins should be replaced as follows:

1. Depressurize the protective cylinders. Make sure the pressure in the hydraulic protective system equals 0.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame</td>
</tr>
<tr>
<td>2</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>3</td>
<td>Frame pin</td>
</tr>
<tr>
<td>4</td>
<td>Pin retaining screw</td>
</tr>
</tbody>
</table>

Figure 10-8 Replacing a frame pin (HP100)
2. Raise the adjusting ring with a crane or other lifting gear. Turn it to centre the pins in the frame’s holes and the ring.

3. Remove the screw under the frame pin, the washer and the retaining plate under each pin.

4. Take out the worn pins from underneath the frame using a hydraulic cylinder. The pin support may need to be heated or the pin cooled. Dismantle the protective cylinders and the accumulators during this procedure.

5. Push the new pins by hitting or heating the pin support to make fitting easier.

6. Fix each pin with the aid of a retaining plate, lock washer and screw.

7. Repressurize the protective cylinders.

8. After fitting the new pins, put the covers back on the pins.

### 10.3.8 Replacing the frame pins - HP400 and HP500

See Figure 10-10.

The frame pins prevent adjusting ring from turning and reposition it when tramp iron passing through the crushing chamber lifts it. Repeated lifting of the adjusting ring is not normal and can be averted through appropriately graded feed. Incorrect operation with excessive bounce of the ring will lead to wear on the pins and expand the bore holes in the adjusting ring.

The wear is visible under the adjusting ring in the frame pins region. The rotating head transmits force to the bowl and the adjusting ring that makes it turn in the same direction as the head, thereby causing wear to the pins and rings only on one side. The pins should be replaced as follows.

1. Depressurize the protective cylinders. Make sure the pressure in the hydraulic protective system equals 0.

2. Unscrew the ball nut on the protective cylinder's piston rod. Since this nut was fitted with Loctite, it must be heated to roughly 205°C (400°F) before it can be unscrewed.

3. Fix all the protective cylinders to the outer diameter of the main frame.

4. With a crane or other suitable hoisting equipment, lift the adjusting ring assembly, including the lock ring and the locking cylinders to take them out of the main frame.

5. Remove the snap rings from the top of each pin to be replaced.

6. Heat the boss of the adjusting ring while guiding the worn pin through the bottom of the adjusting ring hitting it with a sledgehammer. You can also drill the centre of the pin before heating the boss.
7. Before fitting the new pins on the main frame, they must be immersed in carbon dioxide snow for roughly 2 hours.

**DANGER**
Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

8. Just before fitting the pin, heat the adjusting ring for roughly 10 minutes. Then quickly insert the cooled pin into the adjusting ring and hit it with a sledgehammer until it is tight. Refit the snap ring.

9. Install the adjusting ring assembly on the main frame. The base of the adjusting ring must be coated with grease, lithium NLGI No.1 with 3% molybdenum disulphide powder.

10. Refit the cylinders' domed nuts as described later.

11. Repressurize the protective cylinders.

---

**Ref.** | **Description**
--- | ---
1 | Frame pins
2 | Adjusting ring
3 | Pin ring
4 | Snap ring
5 | Lock ring, screw and lock washer

**Figure 10-10 Replacing a frame pin (HP400 and HP500)**

**10.3.9 Replacing the frame pins - HP100**

See **Figure 10-11**

To replace the pin ring, proceed as follows:

1. Place a U ring 15 mm thick around the retaining cylinder rods, between the underside of the adjusting ring and the cylinder nut.
2. Raise the adjusting ring until the retaining cylinders are completely extended, as described in paragraph 3.17 "Clearing the crusher". As soon as the ring is fully raised, place the 3 safety wedges, supplied with the crusher, at an equal distance from the pins, between the frame and the ring. Then lower the ring so that it rests on the safety wedges.

---

**DANGER**

Do not try and remove the pin rings without first fitting the safety wedges, even though the protective cylinders have been depressurized; there may still be residual pressure that could lower the adjusting ring and cause serious damage.

---

3. The frame pins must first be removed (see removing the frame pins in this section).

4. To remove the pin rings, use a flat washer and an extractor support. See Figure 10-11.

5. Place the support between the frame and the adjusting ring.

6. Place the flat washer against the lower face of the frame ring.
7. Engage an M20 screw in the flat washer and screw it onto the extractor support until the pin ring is completely extracted.

8. Before fitting the new pin rings, these must be cooled for more or less 2 hours in carbon dioxide snow.

**DANGER**

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

9. Use the backed-up washer as specified in *Figure 10-11*. 

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flat washer</td>
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<tr>
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</tr>
<tr>
<td>3</td>
<td>Extractor support</td>
</tr>
<tr>
<td>4</td>
<td>M20 screw</td>
</tr>
<tr>
<td>5</td>
<td>Pin ring</td>
</tr>
<tr>
<td>6</td>
<td>Frame</td>
</tr>
<tr>
<td>7</td>
<td>Backed-up washer</td>
</tr>
<tr>
<td>8</td>
<td>Safety wedge</td>
</tr>
<tr>
<td>9</td>
<td>Welded M20 nut</td>
</tr>
<tr>
<td>10</td>
<td>Removal</td>
</tr>
<tr>
<td>11</td>
<td>Mounting</td>
</tr>
</tbody>
</table>

*Figure 10-11 Replacing the pin rings*
10. Use a flat washer 80 in diameter and place it against the frame, on the opposite side from the backed-up washer (See Figure 10-11).

11. Engage an M20 screw in the flat washer and screw it onto the backed-up washer.

12. Screw until the flange ring rests on the bottom of its seating.

13. You can also use the hydraulic holding system. In that case, push the ring on by about 10 mm (proceed in series of 2 opposed rings).

14. Put a plate 20 mm thick onto the rings and lower the bushing to complete the fitting process.

15. Mount the pins again (see mounting pins in this chapter).

16. Raise the adjusting ring, remove the safety wedges.

17. Lower the adjusting ring onto the frame. Restore normal pressure in the protective cylinders.

18. Remove the U rings that were put around the retaining cylinder rods.

It is advisable to change the pin rings and the pins at the same time. In that case, it is preferable to dismantle the adjusting ring.

1. Depressurize the protective cylinders. Make sure the pressure in the hydraulic protective system equals 0.

2. Separate the protective cylinders from the adjusting ring.

3. Raise the adjusting ring with a crane or other lifting gear.

4. Mount the pins again (see mounting pins in this chapter).

5. Replace the pin rings (see replacing the pin rings in this chapter).

6. Increase the adjusting ring and lower it onto the frame, aligning the pins with the frame's ringed holes.

7. Remount the protective cylinders (see chapter on mounting a protective cylinder).

8. Restore normal pressure in the protective cylinders.

10.3.10 Replacing the pin rings - HP200 and HP300

See Figure 10-12.

To replace the pin rings, proceed as follows:

1. Raise the adjusting ring until the retaining cylinders are completely extended, as described in paragraph 3.17 "Clearing the crusher". As soon as the adjusting ring is fully raised, place the 3 safety wedges, supplied with the crusher, at an equal distance from the pins, between the frame and the adjusting ring. Then lower the adjusting ring so that it rests on the safety wedges.

---

**DANGER**

Do not try and remove the pin rings without first fitting the safety wedges, even though the protective cylinders have been depressurized; there may still be residual pressure that could lower the adjusting ring and cause serious damage.
2. Remove the 6 screws retaining the pin rings in the adjusting ring and remove the pin covers.

3. Measure the distance between the bottom of the pin ring and the top of the frame boss. See Figure 10-13.

4. Cut 3 pieces of 76 x 6 mm tubing to the measured length (see step 3). Cut each tube in the middle lengthwise, as specified in Figure 10-13.

5. Place each tube section around the frame pin as shown Figure 10-13. Hold the half-tubes in place with electric conduits.

6. Raise the adjusting ring then remove the safety wedges.

7. Pressure up the retaining cylinders to lower the adjusting ring under the 3 split tubes. Maintain pressure in the cylinders until the tubes force on the rings, enabling you to remove them.

8. When the adjusting ring rests on the frame, raise the adjusting ring again and place the safety wedges at the points where the rings were removed, to allow you to remove the 3 other rings.

9. Remove the 3 remaining rings as specified in steps 5, 6 and 7.

10. Raise the adjusting ring and insert the safety wedges.

11. Before replacing the new pin rings, they must be cooled for roughly 2 hours in carbon dioxide snow.

---

**Figure 10-12 Safety wedge**

**Ref.** | **Description**
---|---
1 | Adjusting ring
2 | Pin ring
3 | Frame pin
4 | Teat screw
5 | Safety wedge
6 | Retaining plate
7 | Screw and lock washer
8 | Frame

**Ref.** | **Description**
---|---
1 | Necessary space
2 | Measure this distance
3 | Tube split in two parts

**Figure 10-13 Dismantling the pin rings**
12. Just before fitting the pin rings, heat the bosses on the adjusting ring for 10 minutes. Then rapidly mount the rings in the bosses until the ring is aligned with the bottom of the adjusting ring, tighten the screw retaining the ring to the adjusting ring.

13. Raise the adjusting ring, then move the 3 safety wedges, to let you insert the 3 other rings. Rest the adjusting ring on the safety wedges.

14. Insert the 3 pin rings (see step 12).

15. After fitting the new frame pins, cover the holes in the adjusting ring with new plugs.

16. Raise the adjusting ring and remove the safety wedges. Lower the adjusting ring onto the frame and restore normal pressure in the protective cylinders.

### 10.3.11 Replacing the pin rings - HP400 and HP500

See Figure 10-8.

To replace the pin rings, proceed as follows:

1. Depressurize the protective cylinders. Make sure the pressure in the hydraulic protective system equals 0.

2. Unscrew the ball nut over the adjusting ring from the protective cylinders' piston rod. Since this nut was fitted with Loctite, it must be heated to roughly 205°C (400°F) before it can be removed.

3. Fix all the protective cylinders to the outer diameter of the main frame.

4. With a crane or other suitable hoisting equipment, lift the adjusting ring assembly, including the lock ring and the locking cylinders to take them out of the main frame.

5. Remove the snap rings from the grooves in the pin rings.

6. Heat the bosses on the frame while easing out the worn pins with a sledgehammer.

7. Before fitting the new pins on the main frame, they must be immersed in carbon dioxide snow for roughly 2 hours.

### DANGER

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

8. Just before fitting the pin rings, heat the frame boss for roughly 10 minutes. Then quickly insert the cooled ring into the hole of the boss.

9. Fit the snap ring to the bottom of the ring.

10. Install the adjusting ring assembly on the main frame. The base of the adjusting ring must be coated with grease, lithium NLG1 No.1 with 3% molybdenum disulphide powder.

11. Refit the nuts of the cylinder domed nuts as described later.

### 10.3.12 Frame contact surfaces

#### 10.3.12.1 General information

The contact surface of the frame must be periodically checked for wear. Irregular feed and the friction between the adjusting ring and the frame's contact surface cause wear on the contact surface. Excessive bounce of the adjusting ring will accelerate and aggravate the wear on the span.

As standard on all cone crushers, a bronze liner is welded on the frame, see Figure 10-14.

Using a liner made of bronze alloy gives contact surfaces that are easy to replace. Using a soft alloy avoids rapid wear of the adjusting ring and the frame.

In addition to the bronze liner on the frame, a second liner in steel can be added.
This steel liner is very important because it lets the adjusting ring tilt and straighten up correctly when it rises as tramp iron passes through.

To determine the precise degree of wear of the bronze and steel liners, proceed as follows:

1. Starting with the first pin on the left of the countershaft and moving clockwise, paint or mark the numbers 1, 2, 3, 4, 5 and 6 on the outer side of the adjusting ring or on the frame's boss.

2. Measure the distance from the bottom of the adjusting ring to the top of the frame's boss, as specified in Figure 10-16 and note down the dimensions.

3. Measure these points at regular intervals and compare them with the original dimensions. By comparing the 2 sets of dimensions, one can determine the degree of wear of the liners or the contact surfaces and see whether the wear is localized or uniformly distributed around the crusher. This is the only method for determining wear on the liners.

4. When any of the dimensions are smaller than the initial dimension given in Table 10-2, the bronze liner and the steel liner must be replaced. This vertical dimension means there is only 1.5 mm (1/16") of wear on the liner.

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Steel liner</td>
</tr>
<tr>
<td>2</td>
<td>Bronze liner</td>
</tr>
<tr>
<td>3</td>
<td>Contact surface</td>
</tr>
<tr>
<td>4</td>
<td>Frame</td>
</tr>
</tbody>
</table>

Figure 10-14 Liners on the frame's bearing surfaces
This difference of 8 mm (5/16") between the two measurements indicates that the surfaces are worn. On the basis of the table, the liners must be replaced.

When you check for wear using the above method, and you find a difference of 6 mm (1/4") or more between two points, the liner must be partially worn on one side, causing the adjusting ring to tilt on the frame. This tilt is caused by uneven distribution of the materials in the crusher cavity. Uneven distribution causes the adjusting ring to work mainly on this face, which causes excessive wear to this surface. If the difference between the 2 points varies by between 6 and 10 mm, the bronze liner and the steel liner must be replaced.

To remedy this problem, the crusher's feed and its distribution in the crusher cavity should be reviewed, see paragraph 2.3 "Feed".

When replacing the bronze liner, the steel liner must be replaced too. The welding and mounting procedures are given further on in this section.

The described method can also be used to determine the degree of wear between the adjusting ring and the frame, when the crusher is not fitted with liners.

If you notice that the span is worn when inspecting the wear surfaces of the adjusting ring and frame, installation and re-machining plans can be provided, as can the welding procedures.
NOTE: BEFORE A LINER CAN BE MOUNTED ON AN OLD CRUSHER, THE FRAME AND THE ADJUSTING RING MUST BE RECONDITIONED AS NEW.

10.3.12.2 Wear on the adjusting ring

There is play between the steel liner and the lower face of the adjusting ring; this play must be maintained when replacing the liner. After a long period of activity, remember to change the liner if there is no more play between the lower face of the adjusting ring and the steel liner.

NOTE: IT IS VERY IMPORTANT THAT THE PLAY BE MAINTAINED BETWEEN THE LOWER PART OF THE RING AND THE LINER.

IF THE ADJUSTING RING WERE TO REMAIN SUPPORTED ON THE UPPER LINER, IT COULD SUFFER SERIOUS DAMAGE.

To determine if the play between the top of the steel liner and the bottom of the adjusting ring is correct, proceed as follows:

1. Place balls of clay or mastic on the top of the steel liner or on the frame.
2. Then lower the adjusting ring onto the frame. When the adjusting ring rests on the span, the clay or mastic will be compressed, showing the exact amount of play between the adjusting ring and the steel liner.
3. Raise the adjusting ring and measure the thickness of the compressed clay or mastic.
   a. If the thickness of the clay or mastic is less than 1 mm (0.04") the minimum specified in Figure 10-16, the lower surface of the adjusting ring must be hard-surfaced and machined to obtain the minimum play, see Figure 10-17.
   b. If the thickness of the clay or mastic is greater than 4 mm (5/32") the minimum specified in Figure 10-16, the lower surface of the adjusting ring must be hard-surfaced and machined to obtain the maximum play.
Example

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Lower surface of the ring</td>
</tr>
</tbody>
</table>

**Figure 10-17 Adjusting ring span**

4. If there is a difference of 6 mm (1/4") or more between the various measured points, this means that the adjusting ring has been knocked on one side. This causes the adjusting ring to tilt on the frame. Fitting a bronze and steel liner will not resolve the problem. The adjusting ring tilts due to uneven distribution of the materials in the crusher cavity. Uneven distribution causes the adjusting ring to work mainly on this face, which causes excessive wear to this surface. To remedy this problem, the adjusting ring's span must be hard-surfaced and re-machined. Contact the factory for the span reconditioning procedure (welding and re-machining).

To remedy this problem, the crusher's feed and its distribution in the crusher cavity should be reviewed.

**10.3.12.3 Installing the bronze and steel liners**

Proceed as follows:

1. Depressurize the protective cylinders as described in the paragraph on depressurizing in the hydraulics supplement.

2. Unscrew the ball nut over the adjusting ring from the protective cylinders' piston rod. Since this nut was fitted with Loctite, it must be heated to roughly 205°C (400°F) before it can be removed.

3. Fix all the protective cylinders to the outer diameter of the main frame.

4. With a crane or other suitable hoisting equipment, lift the adjusting ring assembly, including the lock ring and the locking cylinders to take them out of the main frame.

5. Remove the old liners.

6. Weld the bronze sectors (see Figure 10-18), preheat the inside of the frame to around 50°C (122°F). Place the bronze liners in position and spot weld them to the frame. Preheat the inside of the frame again to a temperature of between 80°C (176°F) and 100°C (212°F), and finish welding the bronze liners. Preheating is necessary for proper penetration and resistance of the welding material.

7. Weld the protective liner on top of the main frame in individual segments (see Figure 10-18).

8. After checking the gap between the support bar and the underneath of the adjusting ring, as described earlier in this part on the wear of the adjusting rings, install the adjusting ring assembly on the main frame. The adjusting rings must be coated with grease, lithium NLG1 No.1 with 5-10% of molybdenum disulphide powder.
9. Refit the cylinders' domed nuts as described later.

10.3.13 Dismantling the protective cylinders - HP100

See Figure 10-19.
A cylinder leak requires immediate attention. Any external leak around a piston rod or internal leak of the piston will cause the adjusting ring to bounce. There is an external leak if oil oozes between the cylinder's piston rod and nose. If the protective mechanism often needs hard-surfacing, this may point to an oil leak inside the cylinders. To change or repair a leaky cylinder, proceed as follows:
1. Shut of the power supply to lower the pressure. Make sure the pressure has fallen to 0.
2. Disconnect the protection circuit coupling (the circuit feeding the upper chamber of the cylinder) and the unramming circuit coupling (the circuit feeding the lower chamber of the cylinder).
3. Attach a sling around the body of the cylinder and use suitable lifting equipment.
4. Remove the barrel nut on the cylinder rod; if the nut was fitted with Loctite, heat to around 200°C (400°F) before removing the nut.
5. Remove the pins split at both ends on the lower spindle of the cylinder.
6. The lower spindles are mounted to slide in the holes of the frame's ribs. Remove the spindles with a hammer.
7. Extricate the cylinder rod from the adjusting ring taking care not to damage pipes or couplings.
8. See the hydraulics manual for how to reassemble the circuit.

DANGER
On no account disconnect the hydraulic couplings without first ascertaining that the pressure has dropped to zero. Disconnecting a pressurized hose is dangerous because the energy accumulated by the fluid will eject the hose with such force that this could seriously injure the user.
10.3.14 Mounting the protective cylinders - HP100

See Figure 10-19.

To mount a new or repaired cylinder, proceed as follows:

1. Push the cylinder rods down, piston against the bottom of the cylinder on the clevis side.
2. Screw a nut onto the lower end of the thread.
3. Support the cylinder with suitable lifting equipment, the cylinder rod pointing upwards. Slide the cylinder rods through the holes of the ring and install the smooth spindle and the pin.
4. Put wedges under the cylinder to make up the play in the clevis: mark the rod where it comes out of the cylinder.
5. Screw the ball nut until the end of the rod is flush with the upper face of the nut; measure the rod extension using the mark you made earlier. This should be at least 10 mm, otherwise turn the nut more.
6. Remove the ball nut, refit it with Loctite.
7. Apply the Loctite to the thread of the rod, over an area of between 15 and 55 mm under the lower face of the ring.
8. Screw the nut until the top of the nut is 15 mm from the adjusting ring.
9. Reconnect the hydraulic circuits and hoses connecting it to the accumulator.
10. All the components of the protective mechanism assembly are designed for 207 bars.
11. Before operating the protective mechanism or after maintenance work, purge all the air from its circuit: loosen the drain plugs of the cylinders and accumulators (purging pressure of roughly 20 bars).
12. After assembling and purging the circuit, test it at a pressure of 207 bars.
13. Before assembly, check the accumulators' inflating pressure, which should be 83 bars.

![Diagram of Protective Cylinders Assembly - HP100](image-url)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Retaining cylinder circuit</td>
</tr>
<tr>
<td>3</td>
<td>Unramming circuit</td>
</tr>
<tr>
<td>4</td>
<td>Spindle</td>
</tr>
<tr>
<td>5</td>
<td>Ball nut</td>
</tr>
<tr>
<td>6</td>
<td>Nut</td>
</tr>
<tr>
<td>7</td>
<td>Protective cylinder</td>
</tr>
<tr>
<td>8</td>
<td>Frame rib</td>
</tr>
<tr>
<td>9</td>
<td>Accumulator</td>
</tr>
<tr>
<td>10</td>
<td>Piston rod</td>
</tr>
</tbody>
</table>

Figure 10-19 Protective cylinders assembly - HP100
10.3.15 Dismantling the protective cylinders- HP200, HP300, HP400 and HP500

See Figure 10-20 and Figure 10-21.

A cylinder leaks requires immediate attention. Any external leak around a piston rod or internal leak of the piston will cause the adjusting ring to bounce. There is an external leak if oil oozes between the cylinder's piston rod and nose. If the protective mechanism often needs hard-surfacing, this may point to an oil leak inside the cylinders. To change or repair a leaky cylinder, proceed as follows:

1. Shut of the power supply to lower the pressure. Make sure the pressure has fallen to 0.
2. Disconnect the protection circuit coupling (the circuit feeding the upper chamber of the cylinder) and the unramming circuit coupling (the circuit feeding the lower chamber of the cylinder).
3. Attach a sling around the body of the cylinder and use suitable lifting equipment.
4. Remove the barrel nut on the cylinder rod; if the nut was fitted with Loctite, heat to around 200°C (°F) before removing the nut.
5. Remove the pins split at both ends on the lower spindle of the cylinder.
6. The lower spindles are mounted to slide in the holes of the frame's ribs. Remove the spindles with a hammer.
7. Lift the cylinder and accumulator out of the crusher while sliding the piston rod through the hole in the adjusting ring. Make sure not to damage any of the hoses.
8. Loosen the tap screw on the accumulator flange.
9. Dismantle the accumulator by unscrewing the couplings and sliding the accumulator out of its lock ring. See replacing the accumulator in this section.
10. See the hydraulics manual for how to reassemble the circuit.

DANGER
On no account disconnect the hydraulic couplings without first ascertaining that the pressure has dropped to zero. Disconnecting a pressurized hose is dangerous because the energy accumulated by the fluid will eject the hose with such force that this could seriously injure the user.
SECTION 10 - FRAME, ADJUSTING RING AND RETAINING CYLINDER ASSEMBLIES

Figure 10-20 Protective cylinder assembly - HP200, HP300, HP400 and HP500

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Ball nut</td>
</tr>
<tr>
<td>3</td>
<td>Nut</td>
</tr>
<tr>
<td>4</td>
<td>Protective cylinder</td>
</tr>
<tr>
<td>5</td>
<td>Union</td>
</tr>
<tr>
<td>6</td>
<td>Accumulator</td>
</tr>
<tr>
<td>7</td>
<td>Frame rib</td>
</tr>
<tr>
<td>8</td>
<td>Spindle</td>
</tr>
<tr>
<td>9</td>
<td>Unramming circuit</td>
</tr>
<tr>
<td>10</td>
<td>Retaining cylinder circuit</td>
</tr>
</tbody>
</table>
10.3.16 Mounting a protective cylinder - HP200, HP300, HP400 and HP500

See Figure 10-20 and Figure 10-21.

To mount a new or repaired cylinder, proceed as follows:

1. Remount the accumulator on the body of the cylinder.

2. Push the cylinder rods down, piston against the bottom of the cylinder on the clevis side.

3. Screw a nut onto the lower end of the thread.
4. Support the cylinder with suitable lifting equipment, the cylinder rod pointing upwards and the largest tapped orifice on the accumulator side. Raise the cylinder by sliding the rod through the holes of the adjusting ring and pass the clevis at the base of the cylinder on the frame's rib.

5. Make sure the spindle is in good condition and is free of burrs.

6. Align the bore holes of the cylinder clevis with the hole in the frame. Coat the spindle with oil and slide it into the lug, if need be tap it lightly with a hammer. Refit the two cotter pins on the ends of the spindle.

7. Make sure the piston rod is completely lowered and rests on the bottom of the cylinder. Measure the distance between the top of the adjusting ring and the top of the piston rod.

8. Turn the special ball nut several times on the piston rod and put the rod out of the cylinder by the length specified in Table 10-3. When the piston rod protrudes from the cylinder by the requisite length, remove the ball nut from the rod.

9. Clean the piston rod threads over a distance of 100 mm with alcohol or acetone, then apply Loctite 242 to the threads.

11. Check the distance again between the top of the adjusting ring and the top of the rod. It should match the distance you found in steps 7 and 8.

12. Clean the thread of the piston rod underneath the adjusting ring with oil-free solvent. After cleaning the thread, apply Loctite 242 to the four threads of the rods, starting 20 mm (0.79") from the bottom of the adjusting ring. Then turn the hexagonal nut on the rod until there is a gap of 20 mm (3/4") between the top of the hexagonal nut and the bottom of the adjusting ring.

13. Reconnect the hydraulic circuits and hoses connecting it to the accumulator.

14. When the cylinder is installed and the hydraulic circuits reconnected, the mechanism must be purged to remove any trapped air. Check that there are no leaks by pressurizing the circuit. See the hydraulics section of the manual for more information on purging and tests.

15. When the protective circuit is pressurized, check the distance between the top of the lower nut and the bottom of the adjusting ring; this should have been adjusted in step 7. If it is incorrect, depressurize and correct by adjusting the barrel nut.

### Table 10-3 Maximum rod distance

<table>
<thead>
<tr>
<th>Type</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP200</td>
<td>12 mm (1/2&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>23 mm (1&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>25 mm (1&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>25 mm (1&quot;)</td>
</tr>
</tbody>
</table>

10.3.17 Replacing an accumulator - HP100, HP200, HP300, HP400 and HP500

See Figure 10-22.

A faulty accumulator, nitrogen escaping into the atmosphere or internal leak in the vessel is dangerous and requires immediate action. In any of these cases, the accumulator will fill up with oil and will thus no longer have elasticity and powerful thrust will develop if the crusher is overloaded or tramp iron passes through it. The accumulator's preload must be checked every 200 hours (1 month).
Before reloading the accumulator, check the gas pressure. If the preload pressure is too low: reload the accumulator. If normal pressure cannot be maintained in service, the accumulator must be replaced. For the HP100 see paragraph 12.1.8 "Checking accumulator preload" and for the HP200-300-400-500 see paragraph 12.2.1.6 "Checking accumulator preload". To replace a faulty accumulator, proceed as follows:

1. Power down the hydraulic unit, lower the pressure as explained in the hydraulics manual by opening the valve provided for the purpose in the hydraulic unit. Make sure the pressure gauge on the hydraulic circuit reads 0.

DANGER
On no account disconnect the hydraulic couplings without first ascertaining that the pressure has dropped to zero. Disconnecting a pressurized hose is dangerous because the energy accumulated by the fluid will eject the hose with such force that this could seriously injure the user.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protective cylinder</td>
</tr>
<tr>
<td>2</td>
<td>Bolts fixing the accumulator to the cylinder</td>
</tr>
<tr>
<td>3</td>
<td>Accumulator</td>
</tr>
<tr>
<td>4</td>
<td>U-bolt for accumulator</td>
</tr>
</tbody>
</table>

Figure 10-22 Replacing an accumulator

2. Remove the valve protection on top of the accumulator (HP100) and underneath the accumulator (HP200, HP300, HP400 and HP500) and the plug on the valve rod. Remove the washer that was under the plug. With the inflation checking equipment supplied as an optional extra, make sure the coupling screwed to the base is compatible with the accumulator valve. Fully unscrew the upper knurled button of the inflation checking equipment on the accumulator with the lower knurled button on the inflation checking equipment.
Open the purge screw until all the nitrogen has been released. When the pressure gauge reads 0, the accumulator is considered empty. Dismantle the inflation checking equipment.

3. Remove the screw and the washers of the U-bolt holding the accumulator on the cylinder, attach a sling around the accumulator and use suitable handling equipment.

4. With a wrench, lock the union on the top of the accumulator and turn it clockwise until it can be removed.

5. Coat the thread of the coupling and the inner thread of the accumulator. Then screw the coupling into the accumulator.

6. Carefully place the new accumulator and its union near the retaining cylinder and screw the union into the part provided for the purpose in the cylinder's barrel, the accumulator must be as straight as possible. Tighten firmly.

7. Fit the flange with screws and washers.

8. Preload the new accumulator as explained in paragraph 12.1.8 "Checking accumulator preload" for the HP100 and paragraph 12.2.1.6 "Checking accumulator preload" for the HP200-300-400-500. The accumulator could be damaged by incorrect preloading before pressurizing the oil.

9. When the accumulator is in place and all the connections have been made, purge the various circuits then pressurize the circuit and check for leaks. See the hydraulics manual for instructions on purging and testing pressure in the hydraulic circuit.

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower screw of the blow head</td>
</tr>
<tr>
<td>2</td>
<td>Protective plug</td>
</tr>
<tr>
<td>3</td>
<td>Knurled screw</td>
</tr>
<tr>
<td>4</td>
<td>Accumulator</td>
</tr>
<tr>
<td>5</td>
<td>Protective plug</td>
</tr>
<tr>
<td>6</td>
<td>Purge screw</td>
</tr>
</tbody>
</table>

Figure 10-23 Depressurizing the accumulator
10.3.18 Dismantling the locking ring

To check or replace parts, dismantle the locking ring as instructed below:

1. Dismantle the bowl assembly as explained in paragraph 5.3.1 ”Dismantling the bowl” of this section.

2. Remove the screw traversing the locking ring. These screws prevent the locking ring from turning while you are dismantling the bowl and protect the locking cylinders if they are pressurized when the bowl is not in place.

3. Make sure that the circuit is at zero pressure then disconnect the hose linking the first locking cylinder to the elbow on the adjusting ring.

4. Screw the lifting ring to the locking ring and carefully lift the locking ring and the locking cylinders.

5. One or more cylinders can now be dismantled for repair or replacement. Disconnect the hoses on each side of the cylinder and unscrew the headless screw retaining the cylinder in its housing.

10.3.19 Installing the locking ring - HP100

To install the locking ring on the adjusting ring, proceed as follows:

1. Thoroughly clean the thread of the clamping ring and the thread of the bowl and the adjusting ring. The holes in the rings fixing the oil chamber must also be cleaned and all trimmings must be removed. With a brush, coat the casing of the clamping ring chamber with ISO-XM2 grease.

2. When the clamping ring is turned over, pass the two valves through the clamping ring. Put the oil chamber flat in the casing.

3. Position the valves:
   a. Push the valve through the clamping ring to keep it in position, fit the spring and tighten the flat screw by hand.
   b. Repeat this operation on the second valve.

4. Position of the polyurethane wedge:
   a. Coat the oil chamber with grease.
   b. Place the polyurethane wedge on the chamber.
   c. Do not place the bevelled edge of the polyurethane wedge opposite a valve.

5. Place the mechanism between strips of plastic (Colson collars) and return the clamping ring assembly to the right position.

6. Tightening the valves:
   a. Screw the flat nut onto the valve and compress the spring to 21 mm (0.83”).
   b. Lock the locknut.
   c. Repeat this operation on the second valve. See Figure 10-24.

7. Lower the locking ring and screw the lifting rings. Install the slings between the bolts of the ring and suitable lifting gear then raise the locking ring onto the adjusting ring as shown in Figure 10-24.

8. Turn the locking ring until the locating hole is aligned with the matching mounting marks on the adjusting ring.
NOTE: IF THE MOUNTING MARKS ARE NOT ALIGNED WITH ONE ANOTHER, THE LOCKING RING THREADING WILL BE OUT OF PHASE WITH THE ADJUSTING RING THREADING, SLOWING DOWN THE BOWL AND SOMETIMES PREVENTING IT FROM TURNING IN THE ADJUSTING RING. THE CORRECT POSITION OF THE LOCKING RING ON THE ADJUSTING RING IS EXTREMELY IMPORTANT.

9. Lower the locking ring onto the adjusting ring, watching the tube fixed to the adjusting ring.
10. Remove the retaining device. (Colson collar)
11. Remount the nuts and locknuts with normal thread brake on the dowels traversing the locking ring.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking ring</td>
</tr>
<tr>
<td>2</td>
<td>Slings</td>
</tr>
<tr>
<td>3</td>
<td>Locating hole in the locking ring</td>
</tr>
<tr>
<td>4</td>
<td>Clamp</td>
</tr>
<tr>
<td>5</td>
<td>Polyurethane wedge</td>
</tr>
<tr>
<td>6</td>
<td>Oil chamber</td>
</tr>
<tr>
<td>7</td>
<td>Tube</td>
</tr>
<tr>
<td>8</td>
<td>Locating hole in the adjusting ring</td>
</tr>
</tbody>
</table>

Figure 10-24 Aligning the locating holes and fitting the oil chamber
NOTE: Respect dimension A = 9 mm (0.35") +/- 0.5 mm (see Figure 10-25) between the nuts and the locking ring with the six dowels.

12. Reconnect the hose between the oil chamber and the threaded tube traversing the locking ring, positioned on the adjusting ring. This hose connects the oil chamber with the hydraulic unit through a hole in the adjusting ring. See Figure 10-24.

---

**Table: Reference Numbers and Descriptions**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Oil chamber</td>
</tr>
<tr>
<td>3</td>
<td>Polyurethane wedge</td>
</tr>
<tr>
<td>4</td>
<td>Locking ring</td>
</tr>
<tr>
<td>5</td>
<td>Hose</td>
</tr>
<tr>
<td>6</td>
<td>Tube</td>
</tr>
<tr>
<td>7</td>
<td>Nut and locknut</td>
</tr>
<tr>
<td>8</td>
<td>Hose connecting the oil chamber to the hydraulic unit</td>
</tr>
<tr>
<td>9</td>
<td>Dowel</td>
</tr>
<tr>
<td>10</td>
<td>Dimension &quot;A&quot;</td>
</tr>
<tr>
<td>11</td>
<td>Purge plug</td>
</tr>
<tr>
<td>12</td>
<td>Purge valve</td>
</tr>
</tbody>
</table>

*Figure 10-25 Connecting hoses to the oil chamber*
Fill and purge the oil chamber with the hydraulic unit. To do so, carry out a locking operation with the locking circuit valve open, when the oil flows clear and without bubbles from the bleed valve, close the circuit with the bleed plug.

Install the dust ring.

13. Cover the locking ring, bowl and adjusting ring threads with molybdenum disulphide powder. This process makes for better bowl rotation. A layer of molybdenum bisulphide is already applied in the factory.

**NOTE:** WHEN THE EQUIPMENT CRUSHES MATERIALS AT HIGH TEMPERATURES SUCH AS CLINKER, USE A SPECIAL HIGH-TEMPERATURE GREASE MIXED WITH 5 TO 10% OF MOLYBDENUM BISULPHIDE.

14. Install the bowl. The oil chamber must be at zero pressure (unlocked) as described in the hydraulics manual.

15. Close the locking circuit valve inside the hydraulic unit and restore the circuit's service pressure. Check the circuit for leaks.

### 10.3.20 Installing the locking ring - HP200, HP300, HP400 and HP500

To install the locking ring on the adjusting ring, proceed as follows:

1. Carefully clean the threads the bowl's locking ring and the adjusting ring. The bores of the locking cylinders must be clean and free of burrs.

2. Mount the locking cylinders in the bores of the adjusting ring, see Figure 10-26 and secure them with the aid of headless screws.

### Figure 10-26 Installing the locking cylinders

3. Screw the lifting ring to the locking ring, sling and position the locking ring over the adjusting ring. See Figure 10-27.

4. Turn the locking ring in such a way that the hole traversing it is aligned with the one in the adjusting ring. See Table 10-4.
NOTE: IF THE LOCATING HOLE IN THE LOCKING RING IS NOT IN LINE WITH THAT OF THE ADJUSTING RING, THE THREADS OF THE TWO RINGS WILL NO LONGER BE IN PHASE, WHICH WILL IMPEDE OR EVEN PREVENT THE BOWL FROM BEING SCREWED INTO THE ADJUSTING RING. IT IS VERY IMPORTANT TO CORRECTLY ALIGN THESE TWO HOLES.

5. Lower the locking ring onto the adjusting ring. Make sure the locking cylinders are at zero pressure.

6. Refit the screws and spacer sleeves traversing the locking ring and screwed into the adjusting ring.
Screw each screw in the adjusting ring, observing the distance from the bottom of the locking ring. See Figure 10-28.

This distance lets the locking ring move vertically when the locking cylinders are pressurized.

After all the cylinders have been connected to the hoses, and before installing the bowl, raise the pressure in the hydraulic system to its maximum (172 bars, 2500 PSI) for **HP200, HP300** and 193 Bars (2,800 PSI) for **HP400** and **HP500**. Maintain the pressure for 10 minutes to check for any leaks in the cylinders and at the hose couplings.

8. Cover the locking ring, bowl and adjusting ring threads with molybdenum disulphide powder. This process makes for better bowl rotation. A layer of molybdenum bisulphide is already applied in the factory.

**NOTE:** WHEN THE EQUIPMENT CRUSHES MATERIALS AT HIGH TEMPERATURES SUCH AS CLINKER, USE A SPECIAL HIGH-TEMPERATURE GREASE MIXED WITH 5 TO 10% OF MOLYBDENUM BISULPHIDE.

9. Install the bowl. The locking cylinders must be at zero pressure (unlocked).

---

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>2</td>
<td>Bolt</td>
</tr>
<tr>
<td>3</td>
<td>10 mm (before locking - HP200/ HP300)</td>
</tr>
<tr>
<td>4</td>
<td>Spacer sleeve</td>
</tr>
<tr>
<td>5</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>

**Figure 10-28 Fixing the screws**

7. Reconnect the hose to the elbow, on the adjusting ring. This hose connects all the cylinders to the hydraulic unit through a hole in the adjusting ring. See **Figure 10-29**.
### Table 10-4 Position and diameter of the locating holes

<table>
<thead>
<tr>
<th>Type</th>
<th>Position of the locating hole</th>
<th>Diameter of the locating holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP200</td>
<td>Over the countershaft housing</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP300</td>
<td>15° to the right of the countershaft housing</td>
<td>12 mm (1/2&quot;)</td>
</tr>
<tr>
<td>HP400</td>
<td>15° to the right of the countershaft housing</td>
<td>10 mm (3/8&quot;)</td>
</tr>
<tr>
<td>HP500</td>
<td>15° to the right of the countershaft housing</td>
<td>10 mm (3/8&quot;)</td>
</tr>
</tbody>
</table>

### Figure 10-29 Connecting the hoses of the locking cylinders

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking rings</td>
</tr>
<tr>
<td>2</td>
<td>Plug</td>
</tr>
<tr>
<td>3</td>
<td>90° elbow</td>
</tr>
<tr>
<td>4</td>
<td>Hole in the adjusting ring for connection between the cylinders and the</td>
</tr>
<tr>
<td></td>
<td>hydraulics cabinet</td>
</tr>
<tr>
<td>5</td>
<td>Locking cylinder no. 1</td>
</tr>
<tr>
<td>6</td>
<td>Hose</td>
</tr>
<tr>
<td>7</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>
10.3.21 Replacing the frame - HP300, HP400 and HP500

See Figure 10-30.

These crushers are equipped with a removable hoop placed in the frame's bore on the pinion side. This ring absorbs the minimal movement between the countershaft housing and the frame's bore. Such movements in the frame's bore could damage it.

The ring very rarely needs to be replaced. Given the importance of the adjustment between the ring and the frame's bore, it would be preferable to entrust the dismantling and reassembly of this ring to a workshop having the necessary tooling.

1. Remove the countershaft housing assembly.
2. Since the frame ring was fitted with Loctite, it must be heated to roughly 205°C (400°F) before it can be lifted.
3. Remove the frame's ring frame from its bore.
4. Remove all traces of Loctite and clean the frame's bore and the outer diameter of the new frame ring with oil-free solvent then dry.
5. Apply Loctite to the outer diameter of the ring and leave to dry for 3 to 5 minutes.
6. Cool the ring so that the temperature difference at least 10°C (18°F) between the ring and the frame.
7. Apply Loctite 680 to the frame's bore.
8. Fit the ring in the frame. Let the Loctite harden for 6 hours before installing the countershaft housing in the frame.
9. Install the countershaft housing as described in the countershaft section.
Section 11

LUBRICATION SYSTEM

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Section 11

11.1 Description

The oil the pump sucks into the oil tank is discharged towards the filter. A bypass discharge valve is installed to protect the filter parts from any excess pressure that could build up if the filters are too dirty or the oil too cold. There is a clogging indicator on top of the filter. It indicates excessive pressure drop in the filter. If the indicator is constantly in the red zone, the filter cartridge must be changed. This pressure gauge indicates when the filter cartridges fitted in the filter box need replacing.

![Figure 11-1 Internal oil flow](image)

The oil is cooled by a cooling tower or water cooler. A check valve bypasses the cooler when the oil is too cold.

A check valve on the crusher prevents pressure building up on the countershaft. It also protects the pump and the other parts.

The pressurized oil is introduced towards the spherical part, at the main shaft, towards the parts in contact with the eccentric bushing, the eccentric bushings and the head then through the sleeve towards the sleeve's contact surface.

The oil spills over the sleeve and the top of the head and eccentric bushings. It falls through the holes of the head and goes down through wide slits in the imbalance and is then recovered in the frame under the eccentric's 'gear assembly. The oil also flows under the head bushing and the eccentric bushing then through wide slits in the imbalance before being recovered in the main frame under the eccentric crown.
The oil flowing from the bottom of the eccentric bushing traverses the thrust bearings under the eccentric before being recovered in the frame. The oil recovered in the frame flows and is projected onto the teeth of the crown and pinion. A separate line bypassing the main shaft's supply line injects the oil in the countershaft housing rings. All the oil is finally recovered in a pan under the pinion and is returned by gravity to the oil tank.

11.2 Installation, operation and maintenance

Before trying to install or operate a new crusher, please read the following instructions carefully. See the Lubrication Supplement in the HP manual for detailed information on the requisite components.

11.3 Oil specifications

Use a paraffin-rich lubricating oil: It must have: a highly resistant film, high adhesive capacity for metal surfaces, and stable physical and chemical properties. It should have the EP (Extreme Pressure) properties of sulphur phosphide agents, lead naphtenate or other anti-galling agents compatible with the metals used in the construction of crushers (bronze, antifriction metal, cast iron and steel). Furthermore, the oil should have a high viscosity index, good water separation ability, good antifoaming properties, have good corrosion protection, resist oxidation and have wear-resistant agents.

The viscosity of the oil used should be:

- 135 to 165 cSt at 40°C,
- 13 cSt or more at 100°C

Moreover, the oil’s viscosity index should be 90 or more.

Various classification systems are used to describe viscosity characteristics. Our oil specifications are as follows:

- ISO Grade 150
- AGMA Grade 4 EP

Consult the factory for specific advice (information and full specifications) when used in particular conditions, for instance when handling burning products or in extreme climates and weather conditions when the heating or cooling systems are unsuitable. Unsuitable lubricants can damage the crusher and their use will invalidate all warranties covering our crushers.

All the major oil companies make a product meeting these specifications. If your local supplier cannot recommend a product having the aforesaid properties, please do not hesitate to consult Metso Minerals.

**NOTE:** Some degree of oil consumption is normal. If this exceeds 30 cl per hour, see section 13 "Frequently asked questions".

<table>
<thead>
<tr>
<th>Type</th>
<th>Oil flow Litres per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100</td>
<td>72 / 83</td>
</tr>
<tr>
<td>HP200</td>
<td>103 / 114</td>
</tr>
<tr>
<td>HP300</td>
<td>121 / 132</td>
</tr>
<tr>
<td>HP400</td>
<td>190 - 210</td>
</tr>
<tr>
<td>HP500</td>
<td>227 - 246</td>
</tr>
</tbody>
</table>

Table 11-1 Oil flow
NOTE: IF A VERTICAL SCAVENGE CANNOT BE AVOIDED, A TRAP SHOULD BE FITTED FOR VERTICAL DROPS OF OVER 1220 MM. THE TOP OF THE TRAP SHOULD BE AT LEAST 305 MM UNDER THE CRUSHER’S SCAVENGE FOR PROPER RUN-OFF, BUT AVOID AN ADDITIONAL VERTICAL DROP ABOVE THE TRAP.

NOTE: THE DUST PENETRATING THE CRUSHER’S SEALS CONTAMINATES THE LUBRICATING OIL, CAUSES EXCESSIVE INTERNAL WEAR AND COULD CAUSE THE BUSHINGS TO FAIL. SEE Figure 11-3 FOR INSTALLING THE TRAP.
11.4 Winter mode operation

This operating mode heats the pipes in periods of cold weather. This must be fitted from 0°C. This system maintains a temperature of between 20°C and 25°C in the tank, pumping the oil intermittently in the pipework when the crusher is stationary. (See the lubrication unit manual).

If "Winter" mode cannot be implemented before the lubrication pump unit motor is started, the pipework and the cooler must be heated to bring the entire to a temperature of roughly 20°C.
11.5 Oil contamination

Change the oil as and when necessary. If no abnormal contamination is detected, it is recommended to renew the lubricant every 2000 hours. Metso Minerals recommends regular analysis of oil samples. This analysis should at least indicate the amounts of the following chemicals in PPM:
- Copper (Cu), Aluminium (Al), Iron (Fe), Silica (Si), Chromium (Cr), Lead (Pb).
- And also the percentage of solid particles, the percentage of water and the viscosity at 40°C.
The sample must be taken on the return line in the unit.

Lubricant pollution is normal. What is abnormal is an increase in the degree of pollution between two sample analyses. During the first weeks of operation, rapid contamination of the oil is possible. This is caused by the running-in of the mechanical parts. In due course the degree of pollution measured at regular intervals should stabilize. A rapid rise in the degree of pollution may be indicative of an operating malfunction. The distribution of chemical components will help locate the possible source of wear (ferrous, metallic, non-metallic). Contact Metso Minerals for further information if the analysis values exceed those given in the table below.

<table>
<thead>
<tr>
<th>Contamination</th>
<th>If the analysis gives results lower than the following values, no further investigation is necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (Cu)</td>
<td>210 PPM</td>
</tr>
<tr>
<td>Aluminium (Al)</td>
<td>10 PPM</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>50 PPM</td>
</tr>
<tr>
<td>Silica (Si)</td>
<td>65 PPM</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>1.5 PPM</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>190 PPM</td>
</tr>
<tr>
<td>Total solid particles</td>
<td>0.2%</td>
</tr>
<tr>
<td>Water</td>
<td>1%</td>
</tr>
<tr>
<td>Viscosity at 40°C</td>
<td>140 mm²/s</td>
</tr>
</tbody>
</table>

1 PPM = 1mg/kg

Table 11-2 Lubricating oil pollution factors

11.6 Crusher breather HP400 and HP500 short head

A breather must be connected to the countershaft housing next to the bullwheel as specified in Figure 11-4. This breather maintains the atmospheric pressure in the crusher to ensure the oil drains freely. Install the air inlet far away from the crusher bullwheel, in a dust-free area, the breather and the bullwheel must be connected to a flexible pipe. This arrangement is suggested because the swirls of dust thrown up by the bullwheel will clog up the filter and impair its efficiency.

To check whether the crusher's breather is working properly, remove the filter completely and place a thin sheet of paper on the elbow onto which the filter was screwed.

The paper should be sucked slightly inwards. This means that the crusher is properly ventilated. If the paper is pushed fully outwards, this means that there is a ventilation problem inside the crusher, since the paper should be sucked inwards.
If the breather is not working, one possible cause is that the pipe inside the crusher is blocked. If that is the case, remove the breather and its pipes and clean the hole with compressed air. Usually the countershaft does not need to be removed to clean any dust that has gathered in this pipe.

11.7 Breather and fan - HP500 Standard

The breather and fan are used to inject air into the crusher to prevent the oil from being polluted by dust. The breather, fan and all the parts required to connect it to the crusher (hoses, clamp connections and packing) are shipped loose. These parts must be connected to the right of the countershaft housing when looking at the crusher bullwheel. See Figure 11-5.

**NOTE:** The breather motor should be turned on at the same time as the pump unit.

11.7.1 Prolonged storage

Machines shipped to the customer and kept in storage for as long as two years need special storage conditions to keep them in good working order. These devices should be packed in cases wrapped in polythene sheeting. Moreover, the rotors should be turned by hand once a month.

For best results, keep the devices in a cool, dry and sheltered place.

---

### Figure 11-4 Vent installation

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crusher pulley</td>
</tr>
<tr>
<td>2</td>
<td>Countershaft housing</td>
</tr>
<tr>
<td>3</td>
<td>Hose</td>
</tr>
<tr>
<td>4</td>
<td>Vent</td>
</tr>
</tbody>
</table>

---

**Ref. Description**
11.7.2 Handling
Small devices should be handled with care and lifted only by the base, never by the shaft, backbone or casing. Larger devices should also be lifted by the base or by the lifting ring where appropriate. Be careful not to drop or shake the equipment because this could cause damage to the shaft or bullwheel invisible to the naked eye but liable to lead to vibration problems.

11.7.3 Fitting the fan
The fan should be placed no more than 3.6 m from the crusher. The breather can be fitted directly on the fan, as Figure 11-5 shows, in a dust-free area. If the fan is fitted in a dusty area, the breather should be installed in a relatively dust-free environment where it is easy to service. The breather and fan must be connected with a wide diameter hose pipe (100-150 mm).

The fans and motors must be mounted on structurally sound foundations, like concrete for instance. The equipment should be set level and wedged on the foundations or bonded on the spot. This prevents the mechanism from seizing up by fixing it on an even surface. As a general rule, if vibration absorbers are used, fans should first be fixed to a steel base plate; the vibrations are then absorbed between the steel base plate and the foundations, thereby making it more stable.

11.7.4 Fan layout and fitting procedure
1. Assemble the motor, the coupling and the fan before fixing the latter.
2. When the fan is in its final location, the warping of the support plate must be compensated with wedges the thickness of which must be measured with the aid of gauges. Incorrect wedging can cause seizing up or bending of the shaft or coupling, incorrect alignment of the motor and/or bearings generating high levels of vibration and premature failure of the transmission parts.
3. After wedging, each fixing bolt must be gradually tightened with a torque wrench until the torque value matching the dimension of the bolt used for the foundations is reached.
4. When the device is completely fixed to the foundations, check the alignment of the coupling again. If this is out of line, loosen the foundation bolts and check the alignment again.
5. When the device is secured to the foundations and the coupling is aligned, replace the liners and check the pipework, etc. The device is now ready for operation.
6. Make sure the device rotates in the right direction. In that case, increase the speed and check motor intensity to ascertain that the static pressure of the system is sufficient to bother overload of the motor.
7. Check for vibrations. If they exceed 1.0 MIL at 3600 rpm or 1.5 MILS at 1800 rpm, an engineer specialized in balancing should adjust the device to attain these levels.
11.7.5 Before start-up

1. Fastenings - all the fixing bolts, the hub mounting screw, the bullwheel locking bolts and the bearing locking rings must be tightened.

2. Bearings - Make sure they are well lubricated.

3. Pull the fan turbine by hand to see whether it works unimpeded, does not seize up or knock against the fan housing. Otherwise, you may need to move it on the shaft or readjust the bearings if they move.

4. Motor - check the electric circuit of the motor. The power line’s normal characteristics should match those on the motor’s nameplate. The motor should be wired and fitted with fuses in compliance with the national electrical Code and local codes.

5. The V-type belt transmission should be lined up with the belts with the right tension.

6. The couplings between the fan and countershaft should not be distorted. The ducts should never rest on the fan. The expansion joints between the duct couplings should only be used should the need arise (vibrations, expansion). All duct joints should be airtight to prevent air leakage. All debris should be removed from ducts and the fan.
11.7.6 Start-up

1. Run the motor for a short time to check that the turbine is rotating in the right direction. The motor should be started according to the manufacturer’s instructions. There are arrows on the fan indicating the correct direction of rotation and airflow.

2. Fan speed can now be increased. Watch out for anything unusual like vibrations, overheating bearings and motor etc. Check fan speed on devices equipped with a V-type belt transmission and adjust the drive bullwheel (on adjustable transmissions) to achieve the desired rotation speed.

3. Check the current absorbed by the motor in relation to the ampere rating to be sure that the motor is not overloaded.

11.7.7 Routine servicing

1. An inspection schedule should be drawn up for all parts and pivoting accessories. Inspection frequency depends on the degree of risk of the operation and the location. Inspections can be weekly in the initial stages until the schedule is instituted.

2. Alignment- Misalignment can cause overheating, wear out the dust-proof seals, cause the bearings to fail or cause an imbalance.

3. Equipment - check that all bolts and adjusting screws are tight.

4. Airflow - make sure that no obstacles block ingress or egress of air in the ducts.

5. On high-speed fans, the bearings tend to heat up. Consequently, there is no point replacing a bearing because it is hot to the touch. Place a contact thermometer against the bearing and check the temperature.

6. Turbine - check for accumulated dust and dirt on the turbine's vanes. Clean carefully with a jet of water, compressed air or a metal brush. This helps to prevent imbalance. If the blades are aluminium, make sure not to damage them. Cover the bearings so that water cannot enter the bearing. The turbine should be centred to prevent the blades from striking the device's housing. Make sure the turbine rotates in the right direction. Never run a fan faster than its rated speed without first checking with the factory.

11.7.8 Servicing the bearings

In most applications lithium grease should be used. This type of grease retards corrosion, is water-resistant and supports temperature of between -34°C (-30°F) and 93°C (200°F) with intermittent peaks of up to 121°C (250°F). When greasing the bearings, it is important not to apply too much grease. This is particularly true if the bearings have longer lubrication channels and if the bearings are not visible. In that case, more bearing failures are due to excessive lubrication rather than to a lack of grease. It is preferable to apply only a squirt of grease regularly when they are not visible. When the bearings are visible, pump the grease until a small band of grease forms around the bearing joints. It is very important to grease the fan bearings while it is running.

DANGER

be extremely careful when working on or near rotating equipment to avoid injury.
11.7.9 Motor maintenance

Lubricate the motor’s bearings according to the manufacturer’s instructions. Refer to the lubricating instructions on labels on the motor. If there is no label, follow these recommendations:

- Motors fitted with threaded plugs or grease connections should be lubricated when hot and stationary.
- On each cover replace a threaded plug with a grease connection.
- Remove the other plug for the grease overflow.
- At low pressure, lubricate, run and lubricate again until the grease again reaches the overspill.
- Leave the motor running for ten minutes to remove excess grease.
- Replace the threaded plugs.

Motors not fitted with threaded plugs or grease connections may be lubricated by removing the flanges, cleaning the grease chamber and filling the circumference of the chamber to three quarters full. See Table 11-3 for recommended lubricating intervals.

11.7.10 Servicing the transmission

If the belts slip on start-up, they are too slack and must be tensioned. Check regularly for wear, alignment and belt and bullwheel tension. When the belts show signs of wear, replace all the belts at the same time with new ones. The new belts do not work properly with used belts due to the length difference. The belts and bullwheels must be clean and free of grease. After fitting the new belts, check the tension halfway between the bullwheels. Leave the device running for 4 to 6 hours, then you will need to re-tension the belts because new belts tend to stretch in the first hours of operation.

<table>
<thead>
<tr>
<th>HP range</th>
<th>Standard operation 8 hours a day</th>
<th>Intensive operation 24 hours a day</th>
<th>Very intensive operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dirty/dusty</td>
<td></td>
<td>Very dirty</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Extreme temperatures</td>
</tr>
<tr>
<td>1.5 - 7.5</td>
<td>5 years</td>
<td>3 years</td>
<td>9 months</td>
</tr>
<tr>
<td>10-40</td>
<td>3 years</td>
<td>1 year</td>
<td>4 months</td>
</tr>
<tr>
<td>50-150</td>
<td>1 year</td>
<td>9 months</td>
<td>4 months</td>
</tr>
</tbody>
</table>

Table 11-3 Recommended lubricating intervals

11.7.11 Trouble-shooting

Here follows a list of the most common problems encountered on fans. These points should be checked to avoid unnecessary delays and the cost of factory repairs.

1. Weak or inefficient backflow:
   a. Total system resistance greater than expected.
   b. Too slow.
   c. Poor fan suction or exhaust.
   d. Air leaks in the system.
   e. Damaged turbine.
   f. Wrong direction of rotation.
   g. Turbine mounted at the rear of the shaft.
2. Problems of vibration and noise:
   a. Bearings, couplings or turbine or V-type belt transmission misaligned.
   b. Unstable foundations. The fan is fixed on uneven foundations, not wedged or bonded.
   c. Presence of foreign matter in the fan, causing an imbalance.
   d. Worn bearings.
   e. Damaged turbine or motor.
   f. Adjusting bolts and screws broken or loose.
   g. Bent shaft.
   h. Worn coupling.
   i. Imbalance in the turbine or fan drive motor.
   j. Too fast or incorrect direction of rotation.
   k. Vibration problems.

3. Overheated bearings:
   a. Too much lubricant.
   b. Misaligned.
   c. Damaged turbine.
   d. Bent shaft.
   e. Dirty bearings.
   f. Belts too tight.

11.7.12 Breather

The breather, which is connected to the fan, has a replaceable filter cartridge. It is important to replace this cartridge when it is dirty, to prevent the overheating or premature wear of the bearings.
Section 12

HYDRAULIC SYSTEM

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   12.1.2 - Using the hydraulic unit
   12.1.3 - Oil specifications
   12.1.4 - Locking oil chamber
   12.1.5 - Holding cylinder assembly
   12.1.6 - Hydraulic adjustments assembly
      12.1.6.1 - General
      12.1.6.2 - Hydraulic adjustments assembly
   12.1.7 - Connecting the hydraulic hoses to the crusher
   12.1.8 - Checking accumulator preload
   12.1.9 - Purging and testing the pressure of the hydraulic system
      12.1.9.1 - Starting up the hydraulic unit
      12.1.9.2 - Locking circuit
      12.1.9.3 - Unramming circuit
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   12.1.11 - Maintenance
      12.1.11.1 - Depressurizing
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   12.2.1 - Description
   12.2.1.1 - Using the hydraulic unit
   12.2.1.2 - Oil specifications
   12.2.1.3 - Locking cylinders assembly
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      12.2.1.4.1 - General
      12.2.1.4.2 - Assembly with a welded gear motor bracket
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      12.2.1.4.4 - Hydraulic adjustments assembly
   12.2.1.5 - Connecting the hydraulic hoses to the crusher
   12.2.1.6 - Checking accumulator preload
   12.2.1.7 - Purging and testing the pressure of the hydraulic system
      12.2.1.7.1 - Locking circuit
      12.2.1.7.2 - Unramming circuit
      12.2.1.7.3 - Holding circuit
      12.2.1.7.4 - Braking circuit
   12.2.1.8 - Pressurizing the holding circuit
   12.2.2 - Maintenance
      12.2.2.1 - Depressurizing
      12.2.2.2 - Replacing a holding cylinder
      12.2.2.3 - Replacing an accumulator
      12.2.2.4 - Repairing a locking cylinder
12.1 Hydraulic system HP100

12.1.1 Description
Hydraulic holding cylinders pinned to the frame and traversing the adjusting ring keep the latter pressed firmly against the conical part of the frame. Abnormal operating conditions or tramp iron in the crusher can strain the bowl and the adjusting ring and lift them by pulling on the cylinder's rods. This movement pushes the oil in the cylinders into the accumulators, where the pressure of the nitrogen increases. When the excess load has passed, the compressed nitrogen returns the oil to the cylinders, the cylinder rods retract and the adjusting ring returns to rest on the frame.

The lower chambers of each cylinder (unramming or clearing circuit) are interconnected.

The two circuits are fed by the hydraulic unit via two hoses.

In addition to the hydraulic support and unramming functions, the crusher features a locking and adjusting device. The locking ring is on the adjusting ring. An oil chamber located between these two rings provides the holding force. The locking ring holds the bowl in place in the adjusting ring when the oil chamber is pressurized. When the pressure in the oil chamber drops, the pinion of the gear motor can be turned. The pinion drives the toothed crown; the latter with its slides pushes the adjustment cap and rotates the bowl assembly. The gap between the bowl liner and mantle (adjustments) widens or narrows according to the direction of rotation.

The HP100 crusher is equipped with a hydraulic cabinet performing support, clearing, locking and adjusting functions.

12.1.2 Using the hydraulic unit
The hydraulic unit should always be powered up when the crusher is running to ensure adequate locking and holding pressure. It is also on for adjusting and clearing operations.

Refer to the hydraulics manual, INSTRUCTIONS FOR USING THE CRUSHER'S ADJUSTING, UNRAMMING FUNCTIONS AND DISMANTLING AND INSTALLING THE BOWL.

12.1.3 Oil specifications
For the hydraulics, use a paraffin-rich oil (without naphthalene) having a protective film, strong adhesiveness to metallic surfaces, and stable physical and chemical properties. Each lubricant should have a high viscosity level, have rapid water separation properties against rust and corrosion, resist emulsion and oxidation and have good wear resistance properties.

Recommended oil (ISO 3448) ISO VG32.

Its viscosity should be:
- 28.8 to 35.2 cSt at 40°C kinematic viscosity
- 4.9 cSt or more at 100°C

In addition, its viscosity index should be at least 95.

Appropriate lubricants are essential to protecting the parts of your crusher. They are available from most major oil companies. Using the wrong oil can damage the crusher and invalidate its terms of warranty.

NOTE: DO NOT USE NON-FLAMMABLE HYDRAULIC FLUIDS BECAUSE THE HYDRAULIC CIRCUIT HAVE NOT BEEN DESIGNED FOR SUCH FLUIDS.


Approximately 100 litres are needed to fill the tank of the hydraulic system, the holding cylinders, accumulators, locking cylinders and hydraulic hoses.
12.1.4 Locking oil chamber

To install the oil chamber, refer to paragraph 10.3.19 "Installing the locking ring - HP100" in section 10 "Frame, adjusting ring and retaining cylinder assemblies" and Figure 12-1.

12.1.5 Holding cylinder assembly

To install the holding cylinders, refer to paragraph 10.3.20 "Installing the locking ring - HP100" in section 10 "Frame, adjusting ring and retaining cylinder assemblies" and Figure 10-19.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>2</td>
<td>Oil chamber</td>
</tr>
<tr>
<td>3</td>
<td>Locking ring</td>
</tr>
<tr>
<td>4</td>
<td>Hose</td>
</tr>
<tr>
<td>5</td>
<td>Tube</td>
</tr>
<tr>
<td>6</td>
<td>Connection of the oil chamber to the hydraulics cabinet</td>
</tr>
</tbody>
</table>

Figure 12-1 Connecting the oil chamber hoses
12.1.6 Hydraulic adjustments assembly

See Figure 12-2.

12.1.6.1 General

The hydraulic adjustments system (which rotates the bowl) is always delivered already mounted on the adjusting ring. However, in rare cases (delivery, etc.) the adjusting assembly may be dismantled.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>2</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>3</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>4</td>
<td>Hydraulic motor assembly</td>
</tr>
<tr>
<td>5</td>
<td>Pinion</td>
</tr>
</tbody>
</table>

Figure 12-2 Hydraulic adjusting mechanism
If the assembly is dismantled, proceed as follows:

1. Position the motor mounting bracket over the pins on the adjusting ring as shown in Figure 12-3. Screw the bracket onto the adjusting ring.

2. Install the gear motor under the bearing plate as shown in Figure 12-3. Its position is important, the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

Then place the bearing plate assembled with the gear motor on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

3. If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

Then install the gear motor under the bearing plate as shown in Figure 12-3. Its position is important. The gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

4. Mount the pinion on the shaft of the gear motor and fix the washer with the screw.

5. Assemble the roller on its support, this is welded to the outer diameter of the adjusting ring.

6. Place the toothed crown in such a way that it rests on the top of the roller.

7. Fix the slides on the top of the toothed crown as shown in Figure 12-3, using the screws and washers.

8. Centre the toothed crown on the adjustment cap.

9. Use the horizontal adjusting screw on the bearing plate to position the pinion so that the teeth of the crown are three-quarters engaged in the teeth of the pinion. Then tighten the locking bolts.
Figure 12-3 Assembling the hydraulic adjusting mechanism on the adjusting ring

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Guard plate</td>
</tr>
<tr>
<td>2</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>3</td>
<td>Washer</td>
</tr>
<tr>
<td>4</td>
<td>Bearing plate</td>
</tr>
<tr>
<td>5</td>
<td>Pin</td>
</tr>
<tr>
<td>6</td>
<td>Bolt</td>
</tr>
<tr>
<td>7</td>
<td>Slide</td>
</tr>
<tr>
<td>8</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>9</td>
<td>Self-locking nut and washer</td>
</tr>
<tr>
<td>10</td>
<td>Roller support</td>
</tr>
<tr>
<td>11</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>12</td>
<td>Roller</td>
</tr>
<tr>
<td>13</td>
<td>Motor mounting bracket</td>
</tr>
<tr>
<td>14</td>
<td>Adjusting screw</td>
</tr>
<tr>
<td>15</td>
<td>Locking nut</td>
</tr>
<tr>
<td>16</td>
<td>Washer and 3 screws</td>
</tr>
<tr>
<td>17</td>
<td>Pin</td>
</tr>
<tr>
<td>18</td>
<td>Hydraulic motor</td>
</tr>
<tr>
<td>19</td>
<td>Reduction gear</td>
</tr>
<tr>
<td>20</td>
<td>Lubrication tap</td>
</tr>
</tbody>
</table>

**Figure 12-3 Assembling the hydraulic adjusting mechanism on the adjusting ring**
SECTION 12 - HYDRAULIC SYSTEM

Figure 12-4 Hydraulic hose connections HP100

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Holding cylinders</td>
</tr>
<tr>
<td>2</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>3</td>
<td>Hydraulic adjustments assembly</td>
</tr>
<tr>
<td>4</td>
<td>Accumulator</td>
</tr>
<tr>
<td>5</td>
<td>Unramming circuit</td>
</tr>
<tr>
<td>6</td>
<td>Holding circuit</td>
</tr>
<tr>
<td>7</td>
<td>Loosening circuit</td>
</tr>
<tr>
<td>8</td>
<td>Tightening circuit</td>
</tr>
<tr>
<td>9</td>
<td>Locking circuit</td>
</tr>
</tbody>
</table>

Figure 12-4 Hydraulic hose connections HP100
### Section 12 - Hydraulic System

**Figure 12-5 Taps and connections on the gear motor**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Breather tap</td>
</tr>
<tr>
<td>2</td>
<td>Levelling tap</td>
</tr>
<tr>
<td>3</td>
<td>Tightening and loosening connection</td>
</tr>
</tbody>
</table>

---

**Ref. Description**

- Ref. 1: Breather tap
- Ref. 2: Levelling tap
- Ref. 3: Tightening and loosening connection
10. Connect the unit's hydraulic hoses to the hydraulic adjustments system on the crusher. See paragraph 12.1.7 "Connecting the hydraulic hoses to the crusher".

11. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation. To do so, proceed as follows:
   a. With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.

<table>
<thead>
<tr>
<th>Reduction gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of oil</td>
</tr>
<tr>
<td>Quantity</td>
</tr>
</tbody>
</table>

Table 12-1 Oil specification for the hydraulic adjusting system

b. If necessary, fill as specified in Table 12-1. Filling takes place via the breather tap on the upper part of the gear motor.

12. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the toothed crown engage properly. Adjust play with the bearing plate adjusting screw.
   When the control is positioned correctly, tighten the locking bolt.

13. Fit the protective hood on the bearing plate to prevent materials jamming the teeth of the crown and pinion.

12.1.6.2 Hydraulic adjustments assembly

Hydraulic motor maintenance should seldom be necessary. Given the complexity of the internal components, only the supplier of the equipment is fully equipped to dismantle and replace parts and reassemble the assembly.

12.1.7 Connecting the hydraulic hoses to the crusher

See Figure 12-4.

When the hydraulic unit has been installed and the hydraulic adjusting mechanism mounted on the ring, connect the hoses linking the unit to the hydraulic motor to the oil chamber and holding cylinders, make the connections to the crusher as follows.

The five hoses linking the unit to the crusher are the same.

All orifices and hoses are clearly indicated, to facilitate connection of the hoses between the unit, crusher and hydraulic motor, the numbers (1, 2, 3, 4 et 5) are marked on the various inlets and outlets.

**NOTE:** This connection is not valid for the HP200, HP300, HP400 and HP500.

1. Connect the loosening hose to the connection on the right of the hydraulic motor.

**NOTE:** IT IS VERY IMPORTANT THAT THE HOSES AND CONNECTION REMAIN CLEAN THROUGHOUT THE ASSEMBLY PROCEDURE.

2. Connect the tightening hose on the connection on the left of the hydraulic motor.

3. CHECK THE MOTOR AND BRAKE HYDRAULIC CONNECTION.

4. Connect the locking circuit hose to the connection on the side of the adjusting ring.

5. Connect the unramming hose to the T connection on the unramming circuit, located on the crusher and connecting all the lower chambers of the protective cylinders. See Figure 12-6.

6. Connect the holding circuit hose to the T connection on the holding circuit, located on the crusher and linking all the upper chambers of the protective cylinders. See Figure 12-6.
SECTION 12 - HYDRAULIC SYSTEM

Figure 12-6 Connecting the holding and unramming cylinders

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Holding circuit</td>
</tr>
<tr>
<td>2</td>
<td>Unramming circuit</td>
</tr>
<tr>
<td>3</td>
<td>Distributor</td>
</tr>
<tr>
<td>4</td>
<td>Holding cylinder</td>
</tr>
<tr>
<td>5</td>
<td>Accumulator</td>
</tr>
</tbody>
</table>

Figure 12-6 Connecting the holding and unramming cylinders
12.1.8 Checking accumulator preload

(Holding circuit)

After prolonged use or after dismantling the protective mechanism, the preload pressure in the accumulators must be checked. The accumulators are preloaded with nitrogen and before carrying out any checks, the pressure in the holding circuit must be zero; to achieve this, open the corresponding valve in the hydraulic unit. When carrying out a check, make sure the accumulators are not in direct sunlight and the outdoor temperature is roughly 20°C. To connect the checking device and check the preload pressure of the accumulators, proceed as follows:

1. The holding circuit and the accumulators must be empty of oil, see the hydraulics manual.
2. See Figure 12-7, remove the valve guard on top of the accumulator and the plug on the valve stem. Remove the washer that was under the plug.
3. Use the inflation checking equipment (optional extra).

The inflation checking equipment is required to connect an accumulator to a nitrogen cylinder to increase the preload in the accumulator. The inflation checking equipment comprises a 3-metre hose equipped with a rotating coupling at one end and a gland bolt nut (left-hand thread) at the other end a unit equipped with a purge screw and a charging valve and a pressure gauge.

The checking equipment checks accumulator preload. It is used to inflate or deflate the accumulator.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Valve system</td>
</tr>
<tr>
<td>2</td>
<td>Accumulator</td>
</tr>
<tr>
<td>3</td>
<td>Valve plug</td>
</tr>
<tr>
<td>4</td>
<td>Valve guard</td>
</tr>
<tr>
<td>5</td>
<td>Washer</td>
</tr>
</tbody>
</table>

Figure 12-7 Accumulator valve

CAUTION

The coupling of the nitrogen cylinder (delivered as an optional extra) varies according to country.

4. Fully remove the upper knurled knob of the inflation checking equipment, make sure the purge screw is closed.
5. Screw the inflation checking equipment onto the accumulator with the lower knurled knob of the inflation checking equipment.
6. Connect the inflation checking equipment to the nitrogen cylinder inflator with the hose.

The relief valve should limit pressure to the maximum value equal to the maximum pressure of the accumulator (this value is cold-stamped on the accumulator).

7. Screw in the upper knurled knob, the pressure value appears on the pressure gauge.
8. If the pressure is higher than the required pressure, slowly unscrew the purge screw until the requisite pressure of 83 bars is attained.
9. If the pressure is lower than the required pressure, slowly open the nitrogen cylinder valve until the requisite pressure is attained.
10. Close and disconnect the nitrogen cylinder.
11. Unscrew the upper knurled knob on the inflation checking equipment and unscrew the purge screw.

12. Dismantle the inflation checking equipment from the accumulator.

13. Check the valve's airtightness with soapy water; if the valve leaks, repeat the pressure-checking operation. If the valve still leaks, change it.

14. Put the valve plug back on.

15. Perform the same operation on the other accumulators.

16. Close the hydraulic unit valve.

17. Pressurize the holding circuit.

12.1.9 Purging and testing the pressure of the hydraulic system

After making the initial connection, or whenever any circuit has been opened to replace or repair a component, you must purge it to remove the air in the circuit. You do not need to remove all the air because a small pocket of air will not impair the working of the crusher if it is started up for the first time, each circuit must be purged before being pressurized.

**NOTE:** While filling and purging the hydraulic circuits, check the level in the tank frequently and top up if necessary.

12.1.9.1 Starting up the hydraulic unit

Before purging the system or any of the circuits, oil needs to be circulated in all the circuits of the hydraulic unit. Starting up the unit for purging or pressure testing purposes, see the hydraulics manual.

**NOTE:** Do not pump the oil in the holding circuit before preloading the accumulators with nitrogen. This could damage the bladder and the accumulator would need to be replaced.

12.1.9.2 Locking circuit

To purge and test the locking circuit, proceed as follows:

1. Start up the hydraulic unit, see the hydraulics manual.

2. Lower the locking pressure, see the hydraulics manual.

3. Unscrew the plug of the oil chamber valve that is not being used. When the oil is clear and therefore free of air, plug the valve and tighten the connection.

4. Raise the locking pressure, see the hydraulics manual.

**DANGER**

NEVER INFLATE ACCUMULATORS WITH ANY GAS OTHER THAN NITROGEN, EVEN PARTIALLY.

ANOTHER GAS COULD CAUSE THE CIRCUIT TO EXPLODE.

DO NOT USE OXYGEN.

ON NO ACCOUNT SHOULD YOU PURGE A CIRCUIT WHEN IT IS PRESSURIZED.

A CONNECTION THAT BREAKS OR PRESSURIZED OIL ESCAPING COULD CAUSE BODILY INJURY.

WEAR SUITABLE SAFETY GLASSES WHEN PURGING CIRCUITS.
12.1.9.3 Unramming circuit

The six cylinders are connected by pipework all around the frame.

The cylinder chambers (unramming side) will be purged independently.

On each cylinder, proceed as follows:

1. Start up the hydraulic unit (see the hydraulics manual).
2. The pressure should be 14 bars. (See the hydraulics manual)
3. Loosen the unramming hose couplings connected to the bottom of the holding cylinder by roughly 1 and a half turns. When the oil flows clear, without any bubbles or spluttering, tighten the couplings again. Do likewise for the other cylinders.
4. Lock the cylinders at the end of the upper stroke by lifting the ring to its maximum, activate unramming and check the seals of the couplings. Tighten them if necessary.
5. Lower the adjusting ring onto the frame.

12.1.9.4 Holding circuit

This circuit comprises six cylinders and accumulators connected by pipework surrounding the frame hoop.

The cylinders and accumulators of each group will be purged simultaneously, as follows:

1. Start up the hydraulic unit, see the hydraulics manual.
2. Bring the pressure in the holding circuit to 14 Bars, see the hydraulics manual.
3. Loosen the purge screw at the bottom of the accumulator until the oil escapes. Tighten the screw again as soon as the oil flows without bubbles.
   On each cylinder, loosen the couplings to let the oil flow. When the oil flows clear and free of bubbles, tighten the couplings.
4. Do likewise for the other cylinders and accumulators.
5. Pressurize the holding circuit as explained later in the paragraph PRESSURIZING THE HOLDING CIRCUIT. Check all couplings for leaks, tighten if need be.
6. Run two complete pressurizing and depressurizing cycles alternately on the holding circuit, to expel any air still trapped in it and return it to the tank.

12.1.10 Pressurizing the holding circuit

After having made all the connections, purged the circuits and fixed any leaks, pressurize the holding circuit before starting up the crusher. Maintain the holding circuit at the recommended pressure to ensure adequate protection in case of overload. The holding pressure should be maintained between the minimum and the maximum specified in the hydraulics manual table.

If the pressure exceeds the recommended pressure, relieve the pressure as described in paragraph 12.1.11.1 "Depressurizing" in the Maintenance part of this chapter. If the pressure is too low, proceed as follows:

---

**DANGER**

WHILE THE ADJUSTING RING IS IN ITS UPPERMOST POSITION, THE AREA AROUND THE RING SHOULD BE CLEAR, TO AVOID ANY ACCIDENTS CAUSED BY THE RING ACCIDENTALLY DESCENDING. PUT SAFETY WEDGES IN PLACE. KEEP THE UNRAMMING BUTTON DEPRESSED TO CHECK FOR AND REPAIR ANY LEAKS.

THE RING WILL DESCEND IF THE UNRAMMING BUTTON IS RELEASED.

5. Lower the adjusting ring onto the frame.
1. Check that the oil used is the recommended one.

**NOTE:** DO NOT PUMP THE OIL IN THE HOLDING CIRCUIT BEFORE PRELOADING THE ACCUMULATORS WITH NITROGEN. THIS COULD DAMAGE THE BLADDER AND THE ACCUMULATOR WOULD NEED TO BE REPLACED.

2. Check the preload pressure of the accumulators and adjust if necessary. See the instructions in paragraph 12.1.8 "Checking accumulator preload".

3. Pressurize the holding circuit. (see the hydraulics manual)

The crusher cannot function with too low a holding pressure, otherwise the ring could bounce and damage the frame span. To restore correct pressure, see the hydraulics manual.

### 12.1.11 Maintenance

#### 12.1.11.1 Depressurizing

Before carrying out any maintenance work on a hydraulic device, the relevant oil circuits must be depressurized, this is extremely important for the personnel carrying out repairs. Several circuits are usually depressurized while the crusher is running and are only pressurized for specific operations. As a general rule, check the pressure gauges before doing any maintenance. The holding circuit however remains pressurized thanks to the accumulators, even after a prolonged stoppage of the pump, proceed as instructed in the hydraulics manual.

#### 12.1.11.2 Replacing a holding cylinder

(See Figure 12-8).

See section 10 "Frame, adjusting ring and retaining cylinder assemblies" for the method to follow for dismantling and installing a holding cylinder. See paragraph 10.3.13 "Dismantling the protective cylinders - HP100".

The parts of the cylinder that can be replaced include:

- Wiper seal
- Blower
- Rod seals
- Piston seals
- Anti-extrusion ring

We recommend changing the O-ring seals whenever components are dismantled. There is a leak if oil oozes between the cylinder's piston rod and nose or if holding pressure cannot be maintained. When a cylinder leaks, it must be replaced straight away.

A leaking cylinder is harmful because it causes the adjusting ring to bounce.

If the cylinder needs to be repaired, we recommend changing all the seals at the same time. These seals are available in a kit.

Be sure to have the necessary quantities or parts to be able to repair the damaged cylinders. During repairs, it is very important that the working surface be clean and free of dust. To dismantle, check, reassemble or repair a holding cylinder, proceed as follows:

1. Unscrew the 7 hexagonal socket head cap screws retaining the head of the cylinder on the body. (HP100) Or unscrew the head.
2. Gently pull the piston to take the piston, rod and head assembly completely out of the cylinder.
3. To dismantle the piston and rod, unscrew the piston and pull the rod through the bore of the cylinder head.
4. Remove all the seals (wiper seal, piston and rod seals, O-ring seal and anti-extrusion rings) from the head and piston.
5. Clean the rod, piston, cylinder head and cylinder. All the cylinder's surfaces and parts in contact with the cylinder must be thoroughly cleaned and free of dust. If the cylinder is pitted with rust or if burrs appear, replace the cylinder.

6. Use the cylinder plan to fit the seals on the head and piston. Then slide the rod through the head, turning slowly (the head is fixed).

7. Lightly oil the surfaces of the cylinder rod, piston, head, seals and bore. Gently insert the assembled piston, rod and head in the cylinder, while turning the rod and the piston (fixed cylinder).

8. Lower the head onto the cylinder and lock the 7 hexagonal socket head cap screws.

9. The holding cylinder is ready to be reassembled on the crusher.

---

**Figure 12-8 Holding cylinder (HP100)**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Piston</td>
</tr>
<tr>
<td>2</td>
<td>Set of seals</td>
</tr>
<tr>
<td>3</td>
<td>Cylinder head</td>
</tr>
<tr>
<td>4</td>
<td>Wiper seal</td>
</tr>
<tr>
<td>5</td>
<td>Cylinder rod</td>
</tr>
<tr>
<td>6</td>
<td>Cylinder head retaining screw</td>
</tr>
<tr>
<td>7</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>8</td>
<td>Retaining ring</td>
</tr>
<tr>
<td>9</td>
<td>Cylinder assembly</td>
</tr>
</tbody>
</table>
12.1.12 Replacing an accumulator

See Figure 12-9.

See section 10 "Frame, adjusting ring and retaining cylinder assemblies" for more information on dismantling and reassembling an accumulator. If it was necessary to dismantle the accumulator to change the bladder or to inspect other parts, contact the factory for instructions on reassembling the accumulator.

12.1.13 Replacing the oil chamber (HP 100)

See section 10 "Frame, adjusting ring and retaining cylinder assemblies" for information on dismantling and fitting the oil chamber. See paragraph 10.3.19 "Installing the locking ring - HP100".

There is a leak if oil oozes under the protective apron or if locking pressure cannot be maintained. When the oil chamber leaks, it must be replaced immediately.

A leak in the oil chamber is harmful because it will destroy the threads of the bowl and the adjusting ring.

12.2 Hydraulic system HP200, HP300, HP400 and HP500

12.2.1 Description

Hydraulic holding cylinders pinned to the frame and traversing the adjusting ring keep the latter pressed firmly against the conical part of the frame. Abnormal operating conditions or tramp iron in the crusher can strain the bowl and the adjusting ring and lift them by pulling on the cylinder's rods. This movement pushes the oil in the cylinders into the accumulators, where the pressure of the nitrogen increases. When the excess load has passed, the compressed nitrogen returns the oil to the cylinders, the cylinder rods retract and the adjusting ring returns to rest on the frame.

The lower chambers of each cylinder (unramming or clearing circuit) are interconnected.

The two circuits are fed by the hydraulic unit via two hoses.

In addition to the hydraulic support and unramming functions, the crusher features a locking and adjusting device. The locking ring is on the adjusting ring. A series of cylinders located between the two rings performs the locking function. The locking ring holds the bowl in position in the adjusting ring.
When the pressure in the locking cylinders drops, the pinion of the gear motor can be turned. The pinion drives the toothed crown; the latter with its slides pushes the adjustment cap and rotates the bowl assembly. The gap between the bowl liner and mantle (adjustments) widens or narrows according to the direction of rotation.

All HP crushers are equipped with a hydraulic unit performing holding, unramming, locking and adjusting functions.

### 12.2.1.1 Using the hydraulic unit

The hydraulic unit should always be powered up when the crusher is running to ensure adequate locking and holding pressure. It is also on for adjustment and clearing operations.

Refer to the hydraulics manual, INSTRUCTIONS FOR USING THE CRUSHER'S ADJUSTING, UNRAMMING FUNCTIONS AND DISMANTLING AND INSTALLING THE BOWL.

### 12.2.1.2 Oil specifications

For the hydraulics, use a paraffin-rich oil (without naphthalene) having a protective film, strong adhesiveness to metallic surfaces, and stable physical and chemical properties. Each lubricant should have a high viscosity level, have rapid water separation properties, protect against rust and corrosion, resist emulsion and oxidation and have good wear resistance properties.


Its viscosity should be:
- 28.8 to 35.2 cSt at 40°C kinematic viscosity
- 4.9 cSt or more at 100°C

In addition, its viscosity index should be at least 95.

Appropriate lubricants are essential to protecting the parts of your crusher. They are available from most major oil companies. Using the wrong oil can damage the crusher and invalidate its terms of warranty.

**NOTE:** DO NOT USE NON-FLAMMABLE HYDRAULIC FLUIDS BECAUSE THE HYDRAULIC CIRCUITS HAVE NOT BEEN DESIGNED FOR SUCH FLUIDS.

### 12.2.1.3 Locking cylinders assembly

To install a locking cylinder refer to paragraph 10.3.21 "Installing the locking ring - HP200, HP300, HP400 and HP500" of section 10 "Frame, adjusting ring and retaining cylinder assemblies", Figure 12-10 and Figure 12-11.
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Figure 12-10 Installing a locking cylinder

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>2</td>
<td>Locking cylinder</td>
</tr>
<tr>
<td>3</td>
<td>Locking ring</td>
</tr>
<tr>
<td>4</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>

Figure 12-11 Connecting the hoses of the locking cylinders

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking rings</td>
</tr>
<tr>
<td>2</td>
<td>Plug</td>
</tr>
<tr>
<td>3</td>
<td>90° elbow</td>
</tr>
<tr>
<td>4</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>5</td>
<td>Hose</td>
</tr>
<tr>
<td>6</td>
<td>Cylinder no. 1</td>
</tr>
<tr>
<td>7</td>
<td>Hole in the adjusting ring for connection between the cylinders and the hydraulics cabinet</td>
</tr>
</tbody>
</table>

1 Locking bolt 2 Locking cylinder 3 Locking ring 4 Adjusting ring 5 Hose 6 Cylinder no. 1 7 Hole in the adjusting ring for connection between the cylinders and the hydraulics cabinet.
12.2.1.4 Hydraulic adjustments assembly

See Figure 12-12.

12.2.1.4.1 General

Generally, the hydraulic adjusting system (which turns the bowl) is delivered already mounted on the ring. However, in rare cases, for delivery reasons, the adjusting assembly may be dismantled.

12.2.1.4.2 Assembly with a welded gear motor bracket

1. Position the bracket over the pins on the adjusting ring as shown in Figure 12-13. Weld the mounting bracket to the adjusting ring. Make sure the motor mounting bracket is level and straight on the adjusting ring before welding.

2. Install the gear motor under the bearing plate as shown in Figure 12-14. Its position is important; the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

Then place the bearing plate assembled with the gear motor on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

3. If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

Then install the gear motor under the bearing plate. Its position is important; the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

4. Mount the pinion on the shaft of the gear motor. Fix the washer with the screw.

5. Assemble the roller on its support then fit; this is welded to the outer diameter of the adjusting ring, see Figure 12-12. See Table 12-2 for the correct position.

6. Place the toothed crown in such a way that it rests on the top of the roller.
Figure 12-12 Hydraulic adjusting mechanism

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjustment cap</td>
</tr>
<tr>
<td>2</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>3</td>
<td>Pinion</td>
</tr>
<tr>
<td>4</td>
<td>Hydraulic motor assembly</td>
</tr>
<tr>
<td>5</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>6</td>
<td>Roller support</td>
</tr>
<tr>
<td>7</td>
<td>Roller</td>
</tr>
</tbody>
</table>

Table 12-2 Position of the cam

<table>
<thead>
<tr>
<th>Type</th>
<th>Position of the top of the roller at the top of the adjusting ring</th>
</tr>
</thead>
</table>
| HP200 | 200 mm (7-7/8"
| HP300 | 152 mm (6"
| HP400 | 231 mm (9-1/8"
| HP500 | 240 mm (9-1/2"

7. Fix the slides on the top of the toothed crown as specified in Figure 12-14, using the screws and washers.

8. Centre the toothed crown on the adjustment cap. See Figure 12-12.

9. Use the adjusting screw (Ref. 16 and 17) on the bearing plate to position the pinion so that the teeth of the crown are three-quarters engaged in the teeth of the pinion. Then tighten the screws, washers and nuts (Ref. 15).
10. Connect the hydraulic hoses of the unit to the hydraulic adjustments system. See HYDRAULIC CONNECTIONS in the lubrication/hydraulics manual.

11. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation.

To do so, proceed as follows:

a. With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.

b. If necessary, fill as specified in Table 12-3. Filling takes place via the breather tap (Ref. 13 in Figure 12-13) on the upper plate of the gear motor.

<table>
<thead>
<tr>
<th>Type of oil</th>
<th>ISO-L-CKC-150 (as per standard ISO 12925-1)</th>
</tr>
</thead>
</table>

Table 12-3 Oil specification for the hydraulic adjusting system

12. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the toothed crown engage properly. Adjust play with the bearing plate adjusting screw.

When the plate is positioned correctly, tighten the locking bolt.

13. Fit the protective hood on the bearing plate to prevent materials jamming between the teeth of the crown and pinion.

12.2.1.4.3 Assembly with a bolted gear motor bracket

1. Position the bracket over the pins on the adjusting ring as shown in Figure 12-14. Fix the motor mounting bracket on the adjusting ring with the screws, see Figure 12-14 for HP200 and HP300 and Figure 12-15 for HP400 and HP500.

2. Install the gear motor under the bearing plate as shown in Figure 12-15. Its position is important; the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

Then place the bearing plate assembled with the gear motor on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

3. If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers. DO NOT TIGHTEN.

Then install the gear motor under the bearing plate. Its position is important; the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.

4. For the HP200 and HP300 mount the pinion on the gear motor shaft. Fix the washer with the screw, see Figure 12-14. And for the HP400 and HP500, mount the pinion, ring and seal on gear motor shaft, then fix the washer with the screw, see figure 12-17.

5. Assemble the roller on its support then set and weld it on the outer diameter of the adjusting ring. See Table 12-2 for the correct position.

6. Place the toothed crown in such a way that it rests on the top of the roller.
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Figure 12-14 Assembling the hydraulic adjusting mechanism on the adjusting ring - HP200 and HP300

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Guard plate</td>
</tr>
<tr>
<td>2</td>
<td>Locking bolt</td>
</tr>
<tr>
<td>3</td>
<td>Washer</td>
</tr>
<tr>
<td>4</td>
<td>Bearing plate</td>
</tr>
<tr>
<td>5</td>
<td>Motor mounting bracket</td>
</tr>
<tr>
<td>6</td>
<td>Pins</td>
</tr>
<tr>
<td>7</td>
<td>Screw + washer + nut for fixing the motor mounting bracket</td>
</tr>
<tr>
<td>8</td>
<td>Bolt</td>
</tr>
<tr>
<td>9</td>
<td>Washer</td>
</tr>
<tr>
<td>10</td>
<td>Slide</td>
</tr>
<tr>
<td>11</td>
<td>Toothed crown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>13</td>
<td>Roller</td>
</tr>
<tr>
<td>14</td>
<td>Self-locking nut and washer</td>
</tr>
<tr>
<td>15</td>
<td>Roller support</td>
</tr>
<tr>
<td>16</td>
<td>Reduction gear</td>
</tr>
<tr>
<td>17</td>
<td>Hydraulic motor</td>
</tr>
<tr>
<td>18</td>
<td>Pinion</td>
</tr>
<tr>
<td>19</td>
<td>3 screws and washers for fixing the pinion</td>
</tr>
<tr>
<td>20</td>
<td>Locking nut</td>
</tr>
<tr>
<td>21</td>
<td>Locking screw</td>
</tr>
<tr>
<td>22</td>
<td>Lubrication tap</td>
</tr>
</tbody>
</table>

Figure 12-14 Assembling the hydraulic adjusting mechanism on the adjusting ring - HP200 and HP300
Figure 12-15 Assembling the hydraulic adjusting mechanism on the adjusting ring - HP400 and HP500

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Guard plate</td>
</tr>
<tr>
<td>2</td>
<td>Screws and lock washers</td>
</tr>
<tr>
<td>3</td>
<td>Bearing plate</td>
</tr>
<tr>
<td>4</td>
<td>Screw and washers for adjusting the plate</td>
</tr>
<tr>
<td>5</td>
<td>Motor mounting bracket</td>
</tr>
<tr>
<td>6</td>
<td>Screws, washers and nuts for fixing the motor mounting bracket</td>
</tr>
<tr>
<td>7</td>
<td>Reduction gear</td>
</tr>
<tr>
<td>8</td>
<td>Hydraulic motor</td>
</tr>
<tr>
<td>9</td>
<td>Adjusting ring</td>
</tr>
<tr>
<td>10</td>
<td>Toothed crown</td>
</tr>
<tr>
<td>11</td>
<td>Pin</td>
</tr>
<tr>
<td>12</td>
<td>Screws, washers and nuts for fixing the reduction gear</td>
</tr>
</tbody>
</table>

SECTION 12 - HYDRAULIC SYSTEM
SECTION 12 - HYDRAULIC SYSTEM

Figure 12-16 Hydraulic connections - HP200, HP300, HP400 and HP500

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hydraulic motor assembly</td>
</tr>
<tr>
<td>2</td>
<td>Brake</td>
</tr>
<tr>
<td>3</td>
<td>Hydraulic motor</td>
</tr>
<tr>
<td>4</td>
<td>Holding cylinders</td>
</tr>
<tr>
<td>5</td>
<td>Braking circuit</td>
</tr>
<tr>
<td>6</td>
<td>Locking circuit</td>
</tr>
<tr>
<td>7</td>
<td>Loosening circuit</td>
</tr>
<tr>
<td>8</td>
<td>Tightening circuit</td>
</tr>
<tr>
<td>9</td>
<td>Unramming circuit</td>
</tr>
<tr>
<td>10</td>
<td>Holding circuit</td>
</tr>
<tr>
<td>11</td>
<td>Accumulator</td>
</tr>
<tr>
<td>12</td>
<td>Adjusting ring</td>
</tr>
</tbody>
</table>

Figure 12-16 Hydraulic connections - HP200, HP300, HP400 and HP500
7. Fix the slides on the top of the toothed crown as specified in Figure 12-14, using the screws and washers.
8. Centre the toothed crown on the adjustment cap.

9. Use the adjusting screw on the bearing plate to position the pinion so that the teeth of the crown are three-quarters engaged in the teeth of the pinion. Then tighten the locking bolts.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Breather tap</td>
</tr>
<tr>
<td>2</td>
<td>Levelling tap</td>
</tr>
<tr>
<td>3</td>
<td>Tightening/loosening connection</td>
</tr>
<tr>
<td>4</td>
<td>Brake connection</td>
</tr>
<tr>
<td>5</td>
<td>Seal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Bushing</td>
</tr>
<tr>
<td>7</td>
<td>Pinion</td>
</tr>
<tr>
<td>8</td>
<td>Tightening washer</td>
</tr>
<tr>
<td>9</td>
<td>Bolt</td>
</tr>
</tbody>
</table>

Figure 12-17 Taps and connections on the gear motor
10. Connect the hydraulic hoses of the unit to the hydraulic adjustments system. See chapter 12.1.7 "Connecting the hydraulic hoses to the crusher".

11. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation. To do so, proceed as follows:
   a. With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.
   b. If necessary, fill with oil as specified in Table 12-4. Filling takes place via the breather tap or the levelling tap, see Figure 12-17 and Figure 12-5.

<table>
<thead>
<tr>
<th>Type of oil</th>
<th>ISO-L-CKC-150 (as per standard ISO 12925-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction gear</td>
<td></td>
</tr>
<tr>
<td>Brake</td>
<td></td>
</tr>
</tbody>
</table>

Table 12-4 Oil specification for the hydraulic adjusting system

12. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the toothed crown engage properly.

If necessary adjust play by loosening the locking bolt, then turn the adjusting screw of the bearing plate. When the plate is positioned correctly, tighten the locking bolt.

12.2.1.5 Connecting the hydraulic hoses to the crusher

See Figure 12-16.

When the hydraulic unit has been installed and the hydraulic adjusting mechanism mounted on the ring, connect the hoses linking the unit to the hydraulic motor, the locking and holding cylinders, make the connections to the crusher as follows.

- The six hoses linking the unit to the crusher are the same.
- All orifices and hoses are clearly marked at the factor, to facilitate connection of the hoses to the cabinet, crusher and hydraulic motor, the numbers (1, 2, 3, 4, 5 and 6) are marked on the various inlets and outlets. Beware, this connection is not compatible with the HP100.

1. Connect the loosening circuit hose to the connection on the left of the hydraulic motor.

**NOTE:** IT IS VERY IMPORTANT THAT THE HOSES AND CONNECTION REMAIN CLEAN THROUGHOUT THE ASSEMBLY PROCEDURE.

2. Connect the tightening circuit hose to the connection on the right of the hydraulic motor.

3. Connect the brake's hose to the brake coupling just above the hydraulic motor; see Figure 12-17.

**NOTE:** CHECK THE MOTOR AND BRAKE HYDRAULIC CONNECTION.

4. Connect the locking circuit hose to the connection on the side of the adjusting ring.

5. Connect the unramming hose to the T connection on the unramming circuit located on the crusher and connecting all the lower chambers of the protective cylinders. See Figure 12-18.

6. Connect the holding circuit hose to the T connection on the holding circuit, located on the crusher and linking all the upper chambers of the protective cylinders. See Figure 12-18.
12.2.1.6 Checking accumulator preload
(Holding circuit)

After prolonged use or after dismantling the protective mechanism, the preload pressure in the accumulators must be checked. The accumulators are preloaded with nitrogen. Before carrying out any checks, the pressure in the holding circuit must be zero; to achieve this, open the corresponding valve in the hydraulic unit. When carrying out a check, make sure the accumulators are not in direct sunlight and the outdoor temperature is roughly 20°C. To connect the checking device and check the preload pressure of the accumulators, proceed as follows:

1. The holding circuit and the accumulators must be empty of oil, see the hydraulics manual.

2. See Figure 12-19. Remove the valve guard at the bottom of the accumulator; as well as the plug on the valve stem. Remove the washer that was under the plug.

3. Use the inflation checking equipment (optional extra).

The inflation checking equipment is required to connect an accumulator to a nitrogen cylinder to increase the preload in the accumulator. The inflation checking equipment comprises a 3-metre hose equipped with a rotating coupling at one end and a gland bolt nut (left-hand thread) at the other end a unit equipped with a purge screw and a charging valve and a pressure gauge.

The checking equipment checks accumulator preload; it is used to solely inflate or deflate the accumulator.

CAUTION
The coupling of the nitrogen cylinder (delivered as an optional extra) varies according to country.
4. Fully remove the upper knurled knob of the inflation checking equipment, make sure the purge screw is closed.

5. Screw in the inflation checking equipment onto the accumulator with the lower knurled knob of the inflation checking equipment.

6. Connect the inflation checking equipment to the nitrogen cylinder relief valve with the hose. The relief valve should limit pressure to the accumulator's maximum pressure. This value is cold-stamped on the accumulator.

7. Screw in the upper knurled knob on the inflation checking equipment. The pressure value appears on the pressure gauge.

8. The pressure is higher than 83 bars for the HP200/HP300 and 105 bars for the HP400/HP500. Unscrew the purge screw until the necessary pressure is attained.

9. If the pressure is lower than the required pressure of 83 bars for the HP200/HP300 and 105 bars for the HP400/HP500, open the nitrogen cylinder valve until the requisite pressure is attained.

10. Close and disconnect the nitrogen cylinder.

11. Unscrew the upper knurled knob on the inflation checking equipment and unscrew the purge screw.

12. Dismantle the inflation checking equipment from the accumulator.

13. Check the valve's airtightness with soapy water; if the valve leaks, repeat the pressure-checking operation. If the valve still leaks, change it.

14. Put the valve plug back on.

15. Perform the same operation on the other accumulators.

16. Close the hydraulic unit valve.

17. Pressurize the holding circuit.

**Reminder of preload pressures:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP100 to 400</td>
<td>83 bars (1200 PSI)</td>
</tr>
<tr>
<td>HP500</td>
<td>105 bars (1500 PSI)</td>
</tr>
</tbody>
</table>

**DANGER**

NEVER INFLATE ACCUMULATORS WITH ANY GAS OTHER THAN NITROGEN, EVEN PARTIALLY. ANOTHER GAS COULD CAUSE THE CIRCUIT TO EXPLODE. DO NOT USE OXYGEN.

### 12.2.1.7 Purging and testing the pressure of the hydraulic system

After making the initial connection, or whenever any circuit has been opened to replace or repair a component, you must purge it to remove the air in the circuit. You must purge it to remove the air in the circuit. You do not need to remove all the air because a small pocket of air will not impair the working of the crusher. If it is started up for the first time, each circuit must be purged before being pressurized.

**NOTE:** WHILE FILLING AND PURGING THE HYDRAULIC CIRCUITS, CHECK THE LEVEL IN THE TANK FREQUENTLY AND TOP UP IF NECESSARY.

STARTING UP THE HYDRAULIC UNIT

Before purging the system or any of the circuits, oil needs to be circulated in all the circuits of the hydraulic unit. (For starting up the unit for purging or pressure testing purposes, see the hydraulics manual).

**NOTE:** DO NOT PUMP THE OIL IN THE HOLDING CIRCUIT BEFORE PRELOADING THE ACCUMULATORS WITH NITROGEN. THIS COULD DAMAGE THE BLADDER AND THE ACCUMULATOR WOULD NEED TO BE REPLACED.
12.2.1.7.1 Locking circuit

To purge and test the locking circuit, proceed as follows:

1. Start up the hydraulic unit, see the hydraulics manual.
2. Lower the locking pressure, see the hydraulics manual.

3. Follow the locking circuit hose up to the threaded coupling on the side of the adjusting ring. Loosen the coupling to allow the oil to escape. When the oil flows clean without bubbles or spluttering, tighten the coupling.
4. Raise the locking pressure, see the hydraulics manual.

12.2.1.7.2 Unramming circuit

This circuit comprises six cylinders and accumulators connected by pipework surrounding the frame hoop. The cylinder chambers (unramming side) will be purged independently of each cylinder, proceed as follows:

1. Start up the hydraulic unit, see the hydraulics manual.
2. Bring the pressure up to 14 Bars. (See the hydraulics manual)
3. Loosen the unramming hose couplings connected to the bottom of the holding cylinder by roughly 1 and a half turns. When the oil flows clear, without any bubbles or spluttering, tighten the couplings. Do likewise for the other cylinders.
4. Lock the cylinders at the end of the upper stroke by lifting the ring to its maximum, activate unramming, check the seals of the couplings, tighten them if necessary.

DANGER

ON NO ACCOUNT SHOULD YOU PURGE A CIRCUIT WHEN IT IS PRESSURIZED. A CONNECTION THAT BREAKS OR PRESSURIZED OIL ESCAPING COULD CAUSE BODILY INJURY. WEAR SUITABLE SAFETY GLASSES WHEN PURGING CIRCUITS.

5. Lower the adjusting ring onto the frame.

12.2.1.7.3 Holding circuit

This circuit comprises six cylinders and accumulators connected by pipework surrounding the frame hoop. The cylinders and accumulators of each group will be purged simultaneously, as follows:

1. Start up the hydraulic unit, see the hydraulics manual.
2. Bring the pressure in the holding circuit to 14 Bars (200 PSI), see the hydraulics manual.
3. Loosen the purge screw at the bottom of the accumulator until the oil escapes. Tighten the screw again as soon as the oil flows clear without bubbles. Loosen the couplings on each cylinder to let the oil flow. When the oil flows clear and free of bubbles, tighten the couplings.
4. Do likewise for the other groups of cylinders and accumulators.
5. Pressurize the holding circuit as explained later in paragraph Pressurizing the holding circuit. Check all couplings for leaks, tighten if needed.
6. Run two complete pressurizing and depressurizing cycles alternately on the holding circuit, to expel any air still trapped in it and return it to the tank.
12.2.1.7.4 Braking circuit

THE BRAKING CIRCUIT IS INTERCONNECTED WITH THE LOOSENING AND TIGHTENING OPERATIONS. Therefore, purge the braking circuit as explained below:

1. Follow the unit's hose up to the hole on the side of the brake, forming an integral part of the gear motor mounted on the adjusting ring. Loosen the coupling to let the oil flow. Tighten the coupling as soon as the oil flows clear without bubbles or spluttering.

12.2.1.8 Pressurizing the holding circuit

After having made all the connections, purged the circuits and fixed any leaks, pressurize the holding circuit before first starting up the crusher. Maintain the holding circuit at the recommended pressure to ensure adequate protection in case of overload. The holding pressure should be maintained between the minimum and the maximum specified in the hydraulics manual table.

If the pressure exceeds the recommended pressure, relieve the pressure as described in paragraph 12.2.2.1 "Depressurizing" in the Maintenance part of this chapter. If the pressure is too low after initial installation or repairs, proceed as follows:

1. Check that the oil used is the recommended one.

NOTE: DO NOT PUMP THE OIL IN THE HOLDING CIRCUIT BEFORE PRELOADING THE ACCUMULATORS WITH NITROGEN. THIS COULD DAMAGE THE BLADDER AND THE ACCUMULATOR WOULD NEED TO BE REPLACED.

2. Check the preload pressure of the accumulators and adjust if necessary. See the instructions in paragraph 12.2.1.6 "Checking accumulator preload".

3. Pressurize the holding circuit. (see the hydraulics manual)

The crusher cannot function with too low a holding pressure, otherwise the ring could bounce and damage the frame span. To restore correct pressure, see the hydraulics manual.

12.2.2 Maintenance

12.2.2.1 Depressurizing

Before carrying out any maintenance work on a hydraulic device, the relevant oil circuits must be depressurized, this is of vital importance for the personnel carrying out repairs on the crusher. Several circuits are usually depressurized while the crusher is running and are only pressurized for specific operations. As a general rule, check the pressure gauges before doing any maintenance. The holding circuit however remains pressurized thanks to the accumulators, even after a prolonged stoppage of the pump. Proceed as instructed in the hydraulics manual.

12.2.2.2 Replacing a holding cylinder

See Figure 12-20 and Figure 12-21.

Refer to section 10, "Frame, adjusting ring and retaining cylinder assemblies" for the method to follow for dismantling and installing a holding cylinder. See paragraph 10.3.15 "Dismantling the protective cylinders-HP200, HP300, HP400 and HP500".

The parts of the cylinder that can be replaced include:

- the cylinder head or the protective seals
- the rod seals
- the piston seals
- the bearing segments.

We recommend changing the O-ring seals whenever components are dismantled. There is a leak if oil oozes between the cylinder's piston rod and nose or if holding pressure cannot be maintained. When a cylinder leaks, it must be replaced straight away.

A leaking cylinder is harmful because it causes the adjusting ring to bounce.

If the cylinder needs to be repaired, we recommend changing all the seals at the same time. These seals are available in a kit.
### SECTION 12 - HYDRAULIC SYSTEM

#### Figure 12-20 Holding cylinder (HP200-HP300)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rod assembly</td>
</tr>
<tr>
<td>2</td>
<td>Wiper seals</td>
</tr>
<tr>
<td>3</td>
<td>Cylinder head</td>
</tr>
<tr>
<td>4</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>5</td>
<td>Piston seal</td>
</tr>
<tr>
<td>6</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>7</td>
<td>Cylinder assembly</td>
</tr>
<tr>
<td>8</td>
<td>Piston bearing segment</td>
</tr>
<tr>
<td>9</td>
<td>Retaining ring</td>
</tr>
<tr>
<td>10</td>
<td>Rod bearing segment</td>
</tr>
<tr>
<td>11</td>
<td>Rod seal</td>
</tr>
<tr>
<td>12</td>
<td>Anti-extrusion ring</td>
</tr>
</tbody>
</table>
### SECTION 12 - HYDRAULIC SYSTEM

**Figure 12-21 Holding cylinder (HP400-HP500)**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rod assembly</td>
</tr>
<tr>
<td>2</td>
<td>Rod bearing segments</td>
</tr>
<tr>
<td>3</td>
<td>Piston bearing segments</td>
</tr>
<tr>
<td>4</td>
<td>Cylinder assembly</td>
</tr>
<tr>
<td>5</td>
<td>Seal</td>
</tr>
<tr>
<td>6</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>7</td>
<td>Wiper seal</td>
</tr>
<tr>
<td>8</td>
<td>Retaining ring</td>
</tr>
<tr>
<td>9</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>10</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>11</td>
<td>Seal</td>
</tr>
<tr>
<td>12</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>13</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>14</td>
<td>Cylinder head</td>
</tr>
</tbody>
</table>
Be sure to have the necessary quantities or parts to be able to repair the damaged cylinders. During repairs, it is very important that the working surface be clean and free of dust. To dismantle, check, reassemble or repair a holding cylinder, proceed as follows:

1. Unscrew the cylinder head from the cylinder. (Use a socket key fixed in the notches of the outer diameter of the cylinder head.)

2. Gently pull the piston to take the piston, rod and head assembly completely out of the cylinder.

3. To dismantle the piston and rod, unscrew the piston and pull the rod through the bore of the cylinder.

4. Remove all the seals (wiper seal, piston and rod seals, O-ring seal and anti-extrusion rings) from the head and piston.

5. Clean the rod, piston, cylinder head and cylinder. All the cylinder's surfaces and parts in contact with the cylinder must be thoroughly cleaned and free of dust. If the cylinder is pitted with rust or if burrs appear, replace the cylinder.

6. Use the cylinder sketch to fit the seals on the head and piston. Then slide the rod through the head while turning it and reassemble the piston on the rod.

7. Lightly oil the surfaces of the cylinder rod, piston, head, seals and bore. Gently insert the assembled piston, rod and head in the cylinder, while turning the rod and the piston in the fixed cylinder.

8. Screw the head onto the cylinder and tighten firmly.

9. The holding cylinder is ready to be reassembled on the crusher.

12.2.2.3 Replacing an accumulator

See Figure 12-22.

See section 10 "Frame, adjusting ring and retaining cylinder assemblies" for more information on dismantling and reassembling an accumulator. See paragraphs 10.3.17 "Replacing an accumulator - HP100, HP200, HP300, HP400 and HP500" and 10.3.18 "Dismantling the locking ring". If it was necessary to dismantle the accumulator to change the bladder or to inspect other parts, contact the factory for instructions on reassembling the accumulator.
### SECTION 12 - HYDRAULIC SYSTEM

**Figure 12-22 Accumulator assembly**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protective valve</td>
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<tr>
<td>2</td>
<td>Filling valve</td>
</tr>
<tr>
<td>3</td>
<td>Seal</td>
</tr>
<tr>
<td>4</td>
<td>Bladder and valve assembly</td>
</tr>
<tr>
<td>5</td>
<td>Valve</td>
</tr>
<tr>
<td>6</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>7</td>
<td>Spacer</td>
</tr>
<tr>
<td>8</td>
<td>Locking nut</td>
</tr>
<tr>
<td>9</td>
<td>Purge screw</td>
</tr>
<tr>
<td>10</td>
<td>Machined plug</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Locking nut</td>
</tr>
<tr>
<td>12</td>
<td>Piston</td>
</tr>
<tr>
<td>13</td>
<td>Anti-extrusion ring</td>
</tr>
<tr>
<td>14</td>
<td>O-ring seal</td>
</tr>
<tr>
<td>15</td>
<td>Washer</td>
</tr>
<tr>
<td>16</td>
<td>Spring</td>
</tr>
<tr>
<td>17</td>
<td>Accumulator</td>
</tr>
<tr>
<td>18</td>
<td>Valve nut</td>
</tr>
</tbody>
</table>

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**TECHNICAL INSTRUCTIONS NORDBERG CONE CRUSHERS HP100/200/300/400/500** 12-34
12.2.2.4 Repairing a locking cylinder

See Figure 12-23.

See section 10 "Frame, adjusting ring and retaining cylinder assemblies" for more information on dismantling and fitting the locking cylinders. See paragraph 10.3.21 "Replacing the frame - HP300, HP400 and HP500".

A leak in the locking cylinder is harmful because it will destroy the threads of the bowl and the adjusting ring. If the cylinder needs to be repaired, we recommend changing all the seals at the same time. These seals are available in a kit. Proceed as follows:

1. Disconnect the couplings on the faulty cylinder. Loosen the pressure screw retaining the cylinder in the locking ring. The cylinder is now free and can be removed.

Be sure to have the necessary quantities or parts to be able to repair the damaged cylinders. During repairs, it is very important that the working surface be clean and free of dust. To dismantle, check, reassemble or repair a locking cylinder, proceed as follows:

2. Dismantle the thrust washer on the cylinder nose and the plug on the bottom of the cylinder.

3. Extract the piston by pushing it from underneath with a wooden pole inserted through the hole at the bottom of the cylinder, and if need be gently tapping it with a hammer.

4. Remove the seal, anti-extrusion ring and wearing rings of the piston.

5. Thoroughly clean the piston and the cylinder barrel. All surfaces must be clean and dust-free. If the cylinder is pitted with rust or if burrs appear, replace the cylinder.

6. Reassemble the new wearing rings on the piston and position them in their groove. Fit the seal and anti-extrusion ring on the piston.

7. Lubricate the surfaces of the piston, seals and cylinder with hydraulic oil. Put the piston back in place in the cylinder while turning it and pushing it at the same time to the bottom of the cylinder.

8. When the piston is installed, reassemble the thrust washer on the cylinder nose and the plug on the bottom of the cylinder.

9. Fit the locking cylinder as specified in section 10.

Ref. | Description
--- | ---
1 | Piston
2 | Thrust washer
3 | Cylinder
4 | Plug
5 | Wearing ring
6 | Coupling
7 | Wearing ring
8 | Piston seal
10 | Machined screw

**Figure 12-23 Locking cylinder**

There is a leak if oil oozes under the protective apron or if locking pressure cannot be maintained. When a cylinder leaks, it must be replaced straight away.
Section 13

FREQUENTLY ASKED QUESTIONS
<table>
<thead>
<tr>
<th>Crusher problems</th>
<th>Possible causes</th>
<th>Comments/Solutions</th>
<th>Section ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crusher overheating</td>
<td></td>
<td>1. Check the backflow of oil returned by the pump (l/min).</td>
<td>5 Lubrication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Too much fine materials fins in the crusher cavity, entailing excessive input power.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. An oil cooler must be fitted.</td>
<td>Lubrication</td>
</tr>
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<td></td>
<td></td>
<td>4. Check the pressure relief valve, which may be faulty due to wear. It may be bypassing the crusher. Check the quality of the oil used.</td>
<td>Lubrication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Adjust belt tension.</td>
<td></td>
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<td></td>
<td></td>
<td>6. Replace the lubricant as per the specification.</td>
<td>5 Lubrication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Axial play of the countershaft: 0.8 to 1.2 mm for the HP100; 1.3 to 1.8 mm for the HP 200 and 0.8 to 1.6 mm for the other crushers.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. The lubricating grooves are worn, preventing proper lubrication of the surface and causing the temperature to rise. Replace the washer.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Poor feed conditions, too much fine product or crusher working too hard. Tramp iron causes overloads.</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td>11. Do not adjust the crusher below its minimum gradation setting. Check bounce on the adjusting ring.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1. Damaged pump</td>
<td>2. Bowl liner and mantle unsuited to the application.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inadequate throughput</td>
<td>3. A special feed generates too much heat in the crusher.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4. Insufficient lubrication of the crusher.</td>
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<td></td>
<td></td>
<td>5. V-type drive belts are too taut</td>
<td></td>
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<td></td>
<td></td>
<td>6. Lubrication too contaminated</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>7. No axial play on the countershaft.</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>8. Upper thrust washer worn out.</td>
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<td></td>
<td></td>
<td>10. The crusher absorbs to much power.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>11. Crusher adjustments too narrow.</td>
<td></td>
</tr>
<tr>
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<td>Possible causes</td>
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<td>--------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Crusher overheating (continued)</td>
<td>12. The lubrication holes in the shaft are clogged with mud or rubble.</td>
<td>12. Clean the vertical and horizontal holes in the shaft with compressed air.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13. The unit heater is clogged up with mud or rubble or block on the outside (curtains).</td>
<td>13. Clean the unit heater.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. The lower head bushing is warped.</td>
<td>14. Crushing with insufficient mechanical force, power under 40%.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>The crusher remains without feed for too long, too many fines in the feed.</td>
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<tr>
<td></td>
<td></td>
<td>Oil pressure too low, high temperature, wrong oil viscosity (too low)</td>
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<tr>
<td></td>
<td></td>
<td>Oil contaminated due to the presence of foreign particles upstream of the filter, or filter obstructed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15. Eccentric bushing surface warped.</td>
<td>15. Lubricating failure due to too high a temperature of the oil, incorrect oil viscosity (too low).</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect feed, excessive quantity of fines in the feed or crusher gradation set too fine.</td>
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<tr>
<td></td>
<td></td>
<td>Large amount of impurities in the feed, causing overload.</td>
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<tr>
<td></td>
<td></td>
<td>Insufficient film of oil. The surface of the main shaft was damaged earlier.</td>
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<tr>
<td></td>
<td></td>
<td>Play between the main shaft and the eccentric bushing.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Incorrect adjustment between the shaft and the frame. Check it with a thickness gauge.</td>
<td></td>
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Lubrication
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<tr>
<td>Sleeve unlocked</td>
<td>1. Sleeve screws broken. Play between the sleeve and the shaft due to wear.</td>
<td>1. Check the gap between the shaft and the sleeve. If necessary recondition the sleeve by hard-surfacing and machining, to achieve maximum screw adjustment or if the shaft is damaged, mount a sleeve with a smaller bore. Replace the screws using the correct thread torque, tighten after cooling the assembly.</td>
<td>5</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>The crusher uses too much oil</td>
<td>1. The T and/or U seals are worn or damaged.</td>
<td>1. Replace the seals. 5</td>
<td>Lubrication</td>
</tr>
<tr>
<td></td>
<td>2. Faulty pressure relief valve.</td>
<td>2. The relief valve is incorrectly set or the spring remains in the closed position. Replace the relief valve. Too much oil flow in the crusher.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Oil is too cold.</td>
<td>3. Fit an immersion heater to heat the oil to 27°C.</td>
<td>Lubrication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The oil in the crusher is too viscous.</td>
<td>Lubrication</td>
</tr>
<tr>
<td></td>
<td>5. The crusher is not properly ventilated.</td>
<td>5. Clean the breathers at the countershaft housing or on the cover.</td>
<td>Lubrication</td>
</tr>
<tr>
<td></td>
<td>6. Oil return blocked with mud or rubble.</td>
<td>6. Inspect the oil return and clean if necessary.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>7. Oil return unsuitable.</td>
<td>7. Check the oil return gradient (minimum 25 mm for 300 mm) or if the diameter of the oil return tube is too small. Replace the return tube with a suitable one.</td>
<td>None</td>
</tr>
<tr>
<td>Production is reduced</td>
<td>1. Too fine a feed causes irregular wear on the bowl liner and mantle that when corrected reduces grip.</td>
<td>1. Replace the bowl liner and mantle or adjust the bowl for a bigger opening.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2. Too low or high an operating speed.</td>
<td>2. Check countershaft speed.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3. Much too much debris in the feed (wood, roots, etc.).</td>
<td>3. Remove the debris.</td>
<td>2</td>
</tr>
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<td>Crusher problems</td>
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</tr>
<tr>
<td>Production is reduced (continued)</td>
<td>4. Materials are too large at the feed, preventing correct feed.</td>
<td>4. Reduce the dimensions of the materials at the feed.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5. Too much sticky material in the feed, blocking the bowl liner and mantle inlet.</td>
<td>5. Remove sticky products.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>6. Incorrect feed distribution.</td>
<td>6. Correct feed distribution.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7. The bottom of the mantle have a “duckbill” shape.</td>
<td>7. Contact the factory. Replace the bowl liner and mantle.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>8. The bowl liner and mantle in the parallel zone area have worn too quickly.</td>
<td>8. Contact the factory. Replace the bowl liner and mantle, use another type of profile.</td>
<td>1</td>
</tr>
<tr>
<td>The crusher is blocked</td>
<td>1. V-type drive belts are too slack</td>
<td>1. Tauten the V-type belts.</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>2. Electric problems on the motor.</td>
<td>2. Check the crusher’s off-load power rating and power absorbed by only the motor (without the belts). If both readings are similar, have the motor tested by an electrician.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>3. Clogging under the crusher.</td>
<td>3. Check the passage of materials in the sheet metal work under the crusher. Fit a rotation checker on the discharge conveyor and have it driven by the crusher feed.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4. Countershaft speed too slow.</td>
<td>4. Check countershaft speed. (rpm).</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>5. Oil pressure too low.</td>
<td>5. Check to have a correct pressure.</td>
<td>5 Lubrication</td>
</tr>
<tr>
<td>Crusher problems</td>
<td>Possible causes</td>
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</tr>
<tr>
<td>The crusher is blocked (continued)</td>
<td>6. Feed opening problem. Since crushing only occurs at the bottom of the chamber, motor power take-off.</td>
<td>6. Check the profile of the bowl liner and mantle...</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7. The bowl liner and mantle look like a &quot;duckbill&quot;.</td>
<td>7. Cut the &quot;duckbill&quot;. Replace the bowl liner and mantle.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>8. The bowl liner and mantle wear out quickly in the parallel zone.</td>
<td>8. Replace the bowl liner and mantle with suitable profiles. Contact the factory.</td>
<td>1</td>
</tr>
<tr>
<td>Oil leak</td>
<td>1. The T and/or U seals are worn or damaged.</td>
<td>1. Replace the seals.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. The O-ring or lip seals are damaged or worn (countershaft housing).</td>
<td>2. Replace the joints and thoroughly clean the pinion side interlocking, lag with silicone.</td>
<td>5</td>
</tr>
<tr>
<td>Countershaft jammed or broken</td>
<td>1. Belts too tight.</td>
<td>1. Check the tension of the belts and the alignment of the bullwheels.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>2. No lubrication or not enough oil on the countershaft bushings.</td>
<td>2. Check the connection between the main oil pipe and the oil inlet in the countershaft box. Remove any valve or other device restricting the countershaft oil supply pipe.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. The lubrication grooves in the bushing are incorrectly positioned.</td>
<td>3. The belt drive should not pull the countershaft against the lubrication groove.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4. No play at the end of the countershaft.</td>
<td>4. Adjust axial play to 0.8 to 1.2 mm for HP100, 1.3 to 1.8 mm for HP 200 and 0.8 to 1.6 mm for other crushers.</td>
<td>5</td>
</tr>
</tbody>
</table>
## SECTION 13 - FREQUENTLY ASKED QUESTIONS

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</thead>
<tbody>
<tr>
<td>Countershaft jammed or broken (continued)</td>
<td>5. Countershaft bent, generally due to excessive vibrations at the end of the countershaft.</td>
<td>5. Replace the countershaft.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6. The oil grooves in the outer countershaft bushing are clogged up with mud or debris.</td>
<td>6. Clean the oil grooves.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>7. Crown or pinion teeth broken.</td>
<td>7. Replace the crown or pinion.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>8. Incorrect play between teeth or at the bottom of the teeth between the crown and the pinion.</td>
<td>8. Adjust the play between and at the bottom of the teeth.</td>
<td>5</td>
</tr>
<tr>
<td>Water is mixed with oil</td>
<td>1. Accumulation of water coming through the imbalance cover.</td>
<td>1. Drill holes and weld return tubes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Breather blocked on the oil tank.</td>
<td>2. Replace the breather.</td>
<td></td>
</tr>
<tr>
<td>Bowl blocked</td>
<td>1. Accumulation of dust or rust in the thread of the bowl adjusting ring du bowl due to:</td>
<td>1. Try any of the following solutions:</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>- Too hot a feed.</td>
<td>- Put penetrating oil in the threads.</td>
<td></td>
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<tr>
<td></td>
<td>- Insufficient lubrication of the threading.</td>
<td>- Relieve the pressure in the holding and locking cylinders and let the products pass through the crusher.</td>
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<tr>
<td></td>
<td>- The adjustment cap cover is worn or the dust prevention collar is damaged.</td>
<td>- Feed small pieces of wood through the crusher.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No weather protection.</td>
<td>- Throw small pieces of soft steel into the crusher.</td>
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<td></td>
<td>- The crusher has run too long for the given settings.</td>
<td>- Heat the adjusting ring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Bowl or adjusting ring threads damaged.</td>
<td>- Heat the adjusting ring and cool down the bowl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The threads are broken.</td>
<td>- DO NOT REMOVE THE FRAME'S ADJUSTING RING.</td>
<td></td>
</tr>
<tr>
<td>Crusher problems</td>
<td>Possible causes</td>
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</tr>
<tr>
<td><strong>The bowl mantle or liner are detached</strong></td>
<td>1. The thread torque of the nut's locking bolt is not correct, nor is the play between the head of the screw and the locking nut.</td>
<td>1. Apply the correct thread torque.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. Wrong position of the locking nut on the spacer ring.</td>
<td>2. Change the locking nut.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3. The locking nut knocks against the top of the head.</td>
<td>3. Insufficient play between the bottom of the locking nut and the top of the head. This should be about 10 mm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Liner/mantle or head spans damaged.</td>
<td>4. Remake the spans.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5. Insufficient play for the seal between the mantle and the head.</td>
<td>5. The play should be between 6 mm and 10 mm.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6. Cylindricality defect.</td>
<td>6. This should not exceed 3 mm.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>7. Mantle not secured to the head.</td>
<td>7. Check at the bottom of the mantle with a gauge. The gap should not exceed 0.1 mm.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>8. Mantle not centred on the head.</td>
<td>8. Dismantle the mantle and reinstall correctly.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9. Mantle-The crusher rotates too long without feed.</td>
<td>9. The maximum time without feed should not exceed 30 minutes.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>10. Mantle too thin.</td>
<td>10. Wear should not exceed 2/3 of the mantle.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>11. The old sealant resin was not completely removed before the new mantle was installed.</td>
<td>11. Remove all the old sealant resin.</td>
<td>5</td>
</tr>
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<td></td>
<td>12. The tightening lugs of the bowl liner touch the outer diameter of the liner or the screws have worked loose.</td>
<td>12. Wedge the lug or tighten the screw.</td>
<td>5</td>
</tr>
<tr>
<td>The bowl mantle or liner are detached (continued)</td>
<td>13. Bowl liner too thin.</td>
<td>13. Wear should not exceed 2/3 of the bowl liner.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>14. Too much tramp iron passes through the crusher.</td>
<td>14. Too much tramp iron will loosen the bowl liner.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>15. The span on the bowl liner or bowl is damaged.</td>
<td>15. Remake the spans to the original dimensions.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>16. The old sealant resin was not completely removed before the new bowl liner was installed.</td>
<td>16. Remove all the old sealant resin.</td>
<td>5</td>
</tr>
<tr>
<td>Oil leak at the end of the countershaft housing, bullwheel side</td>
<td>1. The crusher is not at atmospheric pressure.</td>
<td>1. Clean the breather of the countershaft housing.</td>
<td>5 Lubrication</td>
</tr>
<tr>
<td></td>
<td>2. Not enough oil returns from the countershaft housing or oil deflector, above all when the oil is cold.</td>
<td>2. Clean the oil inlet hole in the countershaft housing.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>3. Defective lip seals.</td>
<td>3. Replace the lip seals.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4. The crusher is not level.</td>
<td>4. Level the crusher.</td>
<td></td>
</tr>
<tr>
<td>Excessive vibrations</td>
<td>1. Imbalance or imbalance liner worn.</td>
<td>1. Remake the imbalance, consult the factory. Replace the imbalance line.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. Play incorrectly adjusted at the bottom of the teeth.</td>
<td>2. Reassemble the eccentric and wedge it.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3. Bent countershaft.</td>
<td>3. Replace the countershaft.</td>
<td>5</td>
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</tr>
<tr>
<td>Excessive vibrations (continued)</td>
<td>4. The crusher's bullwheel turns with difficulty.</td>
<td>4. Remove the accumulated dust on the spokes of the bullwheel.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5. If the crusher is mounted as a mobile unit, the ground should be correctly prepared.</td>
<td>5. Check the seating.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6. Unsuitable foundations.</td>
<td>6. Check the foundations.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7. Bowl liner loose or worn.</td>
<td>7. Dismantle the bowl liner and replace or change it.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>8. Countershaft speed too high (rpm).</td>
<td>8. Use the correct speed.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9. Imbalance liner missing.</td>
<td>9. Replace the liner; consult the factory.</td>
<td>5</td>
</tr>
<tr>
<td>Wear on the head span and bowl</td>
<td>1. The crusher runs with the bowl liner and mantle loose.</td>
<td>1. Make sure the bowl liner and mantle are properly mounted and that the locking nut is tight enough.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. The crusher runs with damaged bowl liner and mantle.</td>
<td>2. Excessive wear on the bowl liner and mantle accelerates wear on the bowl and head spans.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>3. The crusher runs with worn bowl liner and mantle.</td>
<td>3. Excessive wear on the bowl liner and mantle accelerates wear on the bowl and head spans.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>4. Mantle and bowl liner broken.</td>
<td>4. Running with broken bowl liner and mantle accelerates wear on the bowl and head spans.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5. Intermittent feed while the new bowl liner and mantle are being run in.</td>
<td>5. For crushers without freewheeling clutch, starting the feed loosens torque when the feed slows down head rotation. Avoid intermittent feed when new bowl liner and mantle are mounted.</td>
<td>None</td>
</tr>
<tr>
<td>Crusher problems</td>
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<td></td>
</tr>
<tr>
<td>Dust enters the lubrication system</td>
<td>1. No breather on the crusher.</td>
<td>1. Fit a breather on the top of the countershaft housing.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. The breathers on the crusher or the oil tank do not work properly.</td>
<td>2. Clean the breathers on the countershaft and the oil tank. To check, with the crusher running, a sheet of paper placed on the breather pipe should be sucked slightly inwards.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. The crusher bullwheel sends dust towards the breather.</td>
<td>3. Position the breather further away from the bullwheel.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4. Dust penetrated the crusher when parts were being dismantled.</td>
<td>4. Cover the sleeve and the eccentric with a plastic sheet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. The oil return between the crusher and the tank is too vertical.</td>
<td>5. Dust may have been sucked towards the sleeve; add another breather on the oil return pipe. Consult the factory.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. No seal between the oil tank and its cover.</td>
<td>6. Fit a seal or apply silicone.</td>
<td></td>
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<tr>
<td></td>
<td>7. The hose between the fan and the countershaft housing is damaged or disconnected.</td>
<td>7. Check the hose and the couplings.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. The breather hose or couplings are damaged or disconnected.</td>
<td>8. Check the hose and the couplings.</td>
<td></td>
</tr>
<tr>
<td>Wear on the crown and pinion teeth</td>
<td>1. The oil is dirty.</td>
<td>1. Replace the oil and clean the tank.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Tooth wear too low.</td>
<td>2. Defective eccentric thrust washers, adjust the eccentric assembly with spacer rings.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3. Tooth wear too high.</td>
<td>3. Lower the eccentric assembly by removing spacer rings.</td>
<td>5</td>
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</tbody>
</table>
### SECTION 13 - FREQUENTLY ASKED QUESTIONS

<table>
<thead>
<tr>
<th>Crusher problems</th>
<th>Possible causes</th>
<th>Comments/Solutions</th>
<th>Section ref.</th>
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<tbody>
<tr>
<td></td>
<td>Wear on the crown and pinion teeth (continued)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>4. Crusher overworking.</td>
<td>4. Generally revealed by adjusting ring bounce. Reduce the amount of feed.</td>
<td>1.5</td>
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<tr>
<td></td>
<td>5. Too much play at the end of the countershaft.</td>
<td>5. Adjust play to 0.8 to 1.2 mm for <strong>HP100</strong>; 1.3 to 1.8 mm for <strong>HP 200</strong> and 0.8 to 1.6 mm other crushers.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Noise on the drive gear and pinion</td>
<td>1. Incorrect play between the teeth and at the bottom of the teeth.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1. The crusher runs with a new crown and an old pinion, or vice versa.</td>
<td>2. Too frequent overload or unsuitable bowl liner and mantle profiles, causing the adjusting ring to bounce.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>The adjusting ring is tilted</td>
<td>1. Contact surfaces damaged between frame and adjusting ring, due to ring bounce.</td>
<td>2 Hydraulics</td>
</tr>
<tr>
<td></td>
<td>2. Too frequent overload or unsuitable bowl liner and mantle profiles, causing the adjusting ring to bounce.</td>
<td>2. Too much fine product in the feed, refer to paragraph &quot;bowl liner and mantle selection&quot;. Increase the feed in the crusher. Increase the gap between bowl liner and mantle. Materials clogged, water the feed.</td>
<td>5 3</td>
</tr>
<tr>
<td></td>
<td>Bowl bounce</td>
<td>1. Wear on the adjusting ring and bowl threads.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>2. Lack of pressure in the locking cylinders.</td>
<td>2. Re-machine the surface of the threads at 45° to achieve a uniform slope, provided the threads are not irreparably damaged.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>3. Crusher adjustments too narrow.</td>
<td>3. Increase the gap until the bowl no longer jumps.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4. Bowl liner and mantle too thick.</td>
<td>4. Not enough threads engaged. Mount thinner bowl liner and mantle.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5. Gap adjustment too wide.</td>
<td>5. Not enough threads engaged. Reduce the gap.</td>
<td>3</td>
</tr>
<tr>
<td>Crusher problems</td>
<td>Possible causes</td>
<td>Comments/Solutions</td>
<td>Section ref.</td>
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</tr>
<tr>
<td>Bowl bounce (continued)</td>
<td>6. Check that the hydraulic hoses and locking cylinders are correctly connected.</td>
<td>6. When the hydraulic unit is running, the hose between the cabinet and the locking cylinders must be “taut”.</td>
<td></td>
</tr>
<tr>
<td>Light signal indicating low pressure in the tightening circuit</td>
<td>1. Possible leak on the unit or tightening circuit.</td>
<td>1. If the signal comes on more than once in the space of 10 minutes, look for leaks on the unit and the tightening circuit.</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>Light signal indicating low pressure in the unramming circuit</td>
<td>1. Possible leak on the unit or unramming circuit.</td>
<td>1. If the signal comes on more than once in the space of 3 hours, look for leak on the unit and the unramming circuit.</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>Locking bolts on the feeder cone are broken</td>
<td>1. Too much feed in the crushing chamber.</td>
<td>1. Reduce the amount of feed.</td>
<td>1</td>
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<tr>
<td></td>
<td>2. Feed contains large pieces of product.</td>
<td>2. Reduce the size of the input products or increase the admission opening by changing the bowl liner and mantle.</td>
<td>1</td>
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<tr>
<td></td>
<td>3. The contact surfaces between the feeder cone and the locking nut are worn.</td>
<td>3. Hard-surface and re-machine the locking nut. Replace the feeder cone.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4. The feeder cone bolts are loose.</td>
<td>4. Tighten the bolts to their thread torque.</td>
<td>None</td>
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<tr>
<td></td>
<td>5. Drop too high.</td>
<td>5. Reduce the drop between the feed box/belt and the feeder cone.</td>
<td>None</td>
</tr>
<tr>
<td>Crusher problems</td>
<td>Possible causes</td>
<td>Comments/Solutions</td>
<td>Section ref.</td>
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</tr>
<tr>
<td>Bounce on the adjusting ring</td>
<td>1. Overload or incorrect profile of the bowl liner and mantle.</td>
<td>1. Excessive quantity of fines in the feed.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2. Operation with too little cylinder pressure.</td>
<td>Too much feed.</td>
<td>3</td>
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<td></td>
<td></td>
<td>Opening too narrow.</td>
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<td></td>
<td></td>
<td>Sticky materials.</td>
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<td>2. Cylinder seal defect.</td>
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<td>The unit does not repressurize the cylinders automatically (faulty pressure switch).</td>
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<td></td>
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<td>Leak in the cylinder circuit valve inside the unit.</td>
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<td></td>
<td></td>
<td>Leak in the cylinder pressure relief valve or valve left open.</td>
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<tr>
<td></td>
<td></td>
<td>Leak or defect on the hose or coupling...</td>
<td>Hydraulics</td>
</tr>
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