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ENGINEERING GROUP PTY LTD

General Operating Instructions for Hydraulic Equipment

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1 General Safety Instructions

The hydraulic equipment was designed and manufactured considering the provisions of directives, standards and specifications relating to this technology. There is, however, still a risk of personal injury or damage to property if the following safety instructions and warnings contained in this document are not observed.

- You should read these instructions completely and thoroughly before working with the hydraulic equipment.
- When reading these instructions you should always have the product-specific documentation to hand.
- These instructions, together with the relevant product-specific documentation, should be kept so as to be readily accessible to all users.
- Always include the operating instructions and the product-specific documentation when passing the hydraulic equipment on to a third party.

Due to the interaction between the hydraulic equipment and the complete machine, the installation of the hydraulic equipment into the machinery will result in additional potential hazards. This applies in particular to the influence of hydraulic and electric controls on hydraulic drives generating mechanical movements. It is therefore essential for the manufacturer of the complete machine to have undertaken an independent risk assessment. Furthermore, the manufacturer must on this basis have prepared operating instructions for the complete machine.

These operating instructions are no substitute for the operating instructions for the complete machine.

1.1 Intended Use

As regards the specification of the intended use, explicit differentiation will be made in this document between hydraulic power units, hydraulic cylinders and hydraulic assemblies.

1.1.1 Hydraulic Power Units

The hydraulic power unit constitutes partly completed machinery in terms of EC Machinery Directive 2006/42/EC. In terms of the EC Machinery Directive the hydraulic power unit is not considered to be a ready-to-use machine. The hydraulic power unit is exclusively intended for integration into a machine or system or for assembly with other components to form a machine or a system. The product may be commissioned only if it has been integrated into the machine or system for which it is designed and if the machine or system fully complies with the requirements of the EC Machinery Directive.

The hydraulic power unit is not considered to be a safety component in terms of EC Machinery Directive 2006/42/EC.

- You should observe the operating conditions and performance limits specified in the technical data.

The hydraulic power unit is a work appliance and not designed for private use.

Intended use includes having fully read and understood these operating instructions, especially Chapter 1 "General Safety Instructions".

1.1.2 Hydraulic Cylinders

The product is a hydraulic system component.

According to directive "2006/42/EC" by the EU and EN 982, this hydraulic cylinder is a component that is not ready for use and exclusively intended for installation into machinery or systems.

You may only use the product for installation into machinery or systems! Hydraulic cylinders are thus not covered by the Machinery Directive.

According to the Pressure Equipment Directive, hydraulic cylinders are not to be classified as pressure vessel but as hydraulic controlling equipment as the pressure is not the decisive factor for the construction but rigidity, dimensional stability and stability against static and dynamic operating loads.

The product is only intended for industrial use and not for private use.

Intended use includes having read and understood this documentation completely, especially the chapter 1 "General Safety instructions".

The product may only be used within the data and specifications specified in the valid data sheets.

1.1.3 Hydraulic Assemblies

A hydraulic assembly is intended exclusively for integration into a machine or system or to be assembled with other components to form a machine or system. The product may only be commissioned if it has been integrated into the machine or system for which it is designed.

The hydraulic assembly is not considered to be a safety component or partly completed machine in terms of EC Machinery Directive 2006/42/EC.

- You should observe the operating conditions and performance limits specified in the technical data.

The hydraulic assembly is a work appliance and not designed for private use.

Intended use includes having fully read and understood these instructions, especially Chapter "1 General safety instructions".

1.2 Improper Use

Any use of the hydraulic power unit, hydraulic cylinder or the hydraulic assembly other than described in Chapter 1.1 "Intended use" is considered as being improper.

1.3 Safety Instruction in this Document

These operating instructions contain warning signs followed by an instruction where ever there is a risk of personal injury or damage to the equipment. The measures described for preventing these hazards must be observed.

Table 1: Meaning of warning signs

Symbol	Meaning
DANGER! 	Indicates an **imminently** hazardous situation which, if not avoided, will certainly result in serious injury or death.
WARNING! 	Indicates a **potentially** hazardous situation, which, if not avoided, could result in serious injury or even death.
CAUTION! 	Indicates a **potentially** hazardous situation, which, if not avoided, could result in minor or moderate injury or damage to machinery.

1.4 Adhere to the Following Instructions

1.4.1 General

- The regulations regarding accident prevention and environmental protection applicable in the country where the product is used and at the workplace must be observed.
- The McMillan Engineering Group warranty applies only to the configuration supplied. The warranty will not apply if the product is incorrectly assembled, not used as intended and/or handled improperly.
- You should keep the manufacturer's data sheet on oil safety to hand and observe the safety information contained therein.
- Only persons who have been authorized by the operator may be granted access to the immediate vicinity of operation. This also applies during machine standstill.
- Only authorized personnel are allowed to operate the adjusting mechanisms of the components or parts, under the proviso that the hydraulic power unit is used as intended.
- Persons who assemble, operate, dismantle or maintain products supplied by McMillan Engineering Group must not consume any alcohol, drugs or medication that may have a detrimental affect on their reactions.
- Please observe the specific information in the following chapters regarding the product life phases.

1.4.2 Avoidance of Hazards

- Before installation, check the hydraulic power unit for visible transport damage e.g. cracks, missing lead seals, screws, protective covers.
- McMillan Engineering Group hydraulic equipment should be used only if in a sound technical condition.
- Hydraulic equipment should be used only within the performance range specified in the technical data.
- Under no circumstances should the hydraulic equipment be subjected to inadmissible mechanical loads. Do not place any objects on top of the power unit.
- Never remove or damage lead seals that have been fitted by McMillan Engineering Group.
- Provide for sufficient stability of the hydraulic power unit.
    - In this context, observe the maximum load-bearing capacity of the foundations or ground as well as that of the attachment devices and vehicles used for transport.
    - You should use only the designated attachment points.
- Avoid damage of any kind on the pressurized or functional components of the hydraulic power unit.

1.4.3 Protective Measures

- Ensure that all associated safety devices pertaining to the hydraulic equipment are existent, have been correctly installed and are fully functional. Do not displace, bypass or disable the safety devices/equipment.
- If it does become necessary to temporarily disable any safety equipment, e.g. for commissioning or maintenance work, always take appropriate measures to ensure that no potential injury to persons or damage to property can occur. Also observe the superordinate operating instructions for the machine or system.
- If it does become necessary to work at height, entailing a fall hazard, suitable safety precautions must be taken (e.g. provision of gratings, handrails or harnesses).
- The hydraulic power unit may heat up during operation. The solenoids in the hydraulic power unit become so hot during operation that you may sustain burns. You should wear heat-proof gloves or protective clothing.

1.4.4 General Safety Instructions

- Suitable measures should be taken to prevent any slip hazard caused by oily surfaces that may e.g. result from maintenance work.
- In the event of leaks, you should never allow any part of your body to come into contact with the oil jet. Never try to stop or seal the leak or the oil jet using a cloth.
- Leaks may cause an oil mist. Take special care if there are potential ignition sources in the vicinity.

2 Product Description

The hydraulic power units or hydraulic assemblies, for which these operating instructions have been prepared, are exclusively intended for installation into machinery. As a general rule, these are products that have been developed and manufactured to customer specifications. For the specific description of your product, please refer to the relevant product-specific documentation consisting of:

- Technical specification: Description of the operating conditions and information on the installation into the machinery
- Hydraulic diagram: Function(s) and logic mode of operation of the product
- Component list to the hydraulic diagram
- Assembly drawing: Structural design, dimensions, information regarding the centre of gravity, connections, etc.

2.1 Hydraulic Power Unit

Hydraulic power units are drive system for hydraulic machines. In this sense, they are considered partly completed machinery according to EC Machinery Directive 2006/42/EC.

In accordance with these operating instructions hydraulic power units consist at least of:

- Electric motor and pump
- Pump pressure-limiting device
- Tanks, piping and hose assemblies, fittings, etc.
- Fluid level gauge

In addition, a hydraulic power unit may contain:

- Hydraulic control
- Accumulator, with separate N2 pressure tanks, if applicable
- Additional safety devices to prevent unintended pressures
- Additional equipment for recording defined operating conditions (pressure, temperature, filling level, filter contamination)

2.2 Hydraulic Cylinder

A hydraulic cylinder converts hydraulic energy into a linear movement. The drive power is determined by the hydraulic pressure in the cylinder chamber on the piston and/or annulus area.

In accordance with these operating instructions hydraulic cylinder consist at least of:

- Barrel
- Piston Rod
- Gland

In addition, a hydraulic cylinder may contain:

- Cushions, fittings, hoses, pipework, valving etc.
- Rod extensions / Load caps
- Bearings

2.3 Hydraulic Assemblies

Hydraulic assemblies include e.g. valve stands, accumulator stations, drive-motor hydraulic pump unit, circulation stations for filtration and/or cooling.

3 Transport and Storage

- Observe the transport instructions, e.g. on the packaging.
- When storing and transporting the product, always observe the ambient conditions specified in the Technical Data available in the product specific documentation.
- If the package has to be opened e.g. for inspection purposes, you should reseal the packaging to the condition in which it was supplied.
- Wherever possible, the packaging should not be removed until directly before assembling the unit.

3.1 Transporting Hydraulic Power Units

Danger to life due to tumbling, falling or uncontrolled movement of the hydraulic power unit!

If not transported appropriately, the hydraulic power unit may lose its stability and thus be knocked over, fall or move in an uncontrolled way.

- Check the weight and also the location of the center of gravity of the hydraulic power unit.
- Place the product on a suitable foundation / on suitable ground.
- By means of additional suitable measures (e.g. by securing holding down points or with the use of cranes) provide for sufficient stability before removing any packing/transit materials or fixtures.
- Only the intended locations and attachment points should be used for securing or lifting the hydraulic power unit.
- Hydraulic power units must never be attached to or lifted at the mounted components (piping, hoses, manifolds, electric motors, accumulators, etc.).
- Observe the maximum load-bearing capacity of the attachment devices.
- Observe the maximum load-bearing capacity of the floor conveyors.
- Ensure that no unauthorized persons are within the hazard zone.

3.1.1 Transport Using Forklifts

Danger to life due to falling or uncontrolled movement of the hydraulic power unit!

If not transported appropriately, the hydraulic power unit may be knocked, fall or move in an uncontrolled way.

- When using floor conveyors as a means of transport, ensure a stable center of gravity position.
- The hydraulic power unit must not deviate from its intended orientation.
- Secure the hydraulic power unit against any resulting acceleration forces as required.

3.1.1 Transport Using Cranes

Danger to life due to falling or uncontrolled movement of the hydraulic power unit!

If not transported appropriately, the hydraulic power unit may be knocked, fall or move in an uncontrolled way.

- When using lifting tools, ensure a stable center of gravity position.
- The hydraulic power unit must not deviate from its intended orientation. If necessary, attach suitable safety and/or catch devices.

If using cranes as a means of transport, attachment device e.g. lifting straps, harnesses or chains should be used.

- Use only the intended locations and attachment points when lifting.

- Ensure that the built-on components of the hydraulic power unit do not come into contact with the attachment device or lifting tools during transport

The edges of the hydraulic power unit may cause damage to the fabric lifting straps or harnesses. An edge protector should therefore be used if necessary.

When using uncovered chains, scratches in the paintwork may result. If necessary, use suitable protection for these surfaces e.g. blankets.

- Lift and lower the hydraulic power unit slowly and carefully.
- Only lift the device as far off the floor as necessary.

3.2 Transporting Hydraulic Cylinders

Uncontrolled extension of the piston rod and lifting of the hydraulic cylinder at set-ups (subplates, piping, etc.)!

Risk of injury or damage to property!

- Hydraulic cylinders may only be transported as described in section 3.1 "Transporting Hydraulic Cylinders".
- During transport, leave the plastic/steel plugs in the line connections.

Depending on the size and the situation on site, hydraulic cylinders can be transported using a forklift, a crane or any other lifting gear.

When moving and lifting the hydraulic cylinder, please observe the following directives:

- Transport the hydraulic cylinder only in horizontal position, in its original packing, if possible, or on wooden blocks (prism-shaped squared timber) holding the hydraulic cylinder in a stable position.
- Make sure that when transporting the hydraulic cylinder on wooden blocks, there are no force effects on attachment parts (subplates, piping, threaded coupling, proximity switch, etc.).
- Use soft lifting slings in order to prevent damage in the preservation or coating.

Due to the tolerances, you must, during lifting, anticipate a weight of the hydraulic cylinder exceeding the one specified in the drawing or in the data sheets by 10 %.

For the weight of the hydraulic cylinder (without packaging), please refer to the shipping documents.

McMillan Engineering Group hydraulic cylinders are delivered without oil filling. Due to the final test in the McMillan Engineering Group company there may, however, still be oil residues in the hydraulic cylinder (for deviations see 3.4 "Storing hydraulic cylinders").

3.2.1 Transport Using Forklifts

To transport the hydraulic cylinder using forklifts proceed as follows:

1. Move the fork of the forklift under the packaging of the hydraulic cylinder or under the hydraulic cylinder secured for transport.
2. Carefully lift the load for checking the position of the centre of gravity. Ensure a stable position of the centre of gravity (S)!
3. Make sure that the hydraulic cylinder cannot move out of the intended position.
4. Secure the hydraulic cylinder against the resulting acceleration forces.
5. During transport, only lift the hydraulic cylinder as far off the floor as necessary for the transport.

3.2.2 Transport Using Lifting Gear

Action of forces caused by lifting slings on set-ups (subplates, piping, etc.) during lifting!

- Fasten the lifting gear (load chains, lifting slings) at the hydraulic cylinder so that during lifting, the lifting slings are free, i.e. do not rest against set-ups.

Lifting by means of Eyebolts at the Hydraulic Cylinder

Break of the eyebolt due to weight overload!

1. Attach suitable lifting gear at hydraulic cylinders using supplied and already attached eyebolts (load chains, lifting slings). The hydraulic cylinder may only be lifted and transported in the condition as supplied at the supplied eyebolts.
2. Carefully lift the hydraulic cylinder for checking the position of the center of gravity. Ensure a stable position of the center of gravity (S)!
3. Make sure that the hydraulic cylinder cannot move out of the intended position.
4. During transport, only lift the hydraulic cylinder as far off the floor as necessary for the transport.

Lifting by means of Lifting Slings

Fasten two lifting slings of equal length at both ends of the cylinder pipe of the hydraulic cylinder by forming loops.

1. Observe the admissible lifting capacity of the lifting slings!
2. Carefully lift the load for checking the position of the center of gravity. Ensure a stable position of the centre of gravity!
3. Make sure that the lifting slings do not slip during lifting.
4. During transport, only lift the hydraulic cylinder as far off the floor as necessary for the transport.

3.3 Storing Hydraulic Power Units

Observe the storage times specified in Table 2.

- If the storage time exceeds the values specified, flush the hydraulic power unit before commissioning using a suitable flushing fluid. The flushing procedure should be carried out as described in Chapter 5.6 "Flushing the hydraulic system".
- If necessary, replace the components for which a maximum storage time is specified e.g. hoses, compensators, accumulators.

Table 2: Storage Times

Storage Conditions	Packaging	Protective Agent	Storage Time (Months)	
			Test with the protective agent	Filling with the protective agent
Storage in dry rooms at constant temperature	For carriage overseas	A	12	24
		B	12	24
	Not for carriage overseas	A	9	24
		B	12	24
Outdoor storage (protect the product against damage and water ingress)	For carriage overseas	A	6	12
		B	9	24
	Not for carriage overseas	A	0	12
		B	6	24

A = Mineral oil
B = Corrosion protection oil

3.4 Storing Hydraulic Cylinders

3.4.1 Corrosion Protection Applied by the Factory

Primer Coat

By default, McMillan Engineering Group hydraulic cylinders are primed with a primer coat (colour matt black) of at least 40 µm.

With cylinders and attachment parts, the following surfaces are not primed or coated:

- All fit diameters and connection surfaces to the customer side
- Sealing faces for line connection
- Sealing faces for flange connection
- Connection surface for valve mounting
- Inductive proximity switches
- Position measurement system
- Minimess coupling
- Spherical/plain bearing
- Lubrication nipples

The surfaces that are not primed are protected by means of a corrosion protection oil.

With short storage times in dry rooms at constant temperature, the primer is sufficient as external preservation.

Internal Preservation

By default, McMillan Engineering Group hydraulic cylinders are tested with AW32 mineral oil. The oil film remaining inside after the test provides for short term internal corrosion protection.

The line connections are closed after the test by screw plugs or flange covers.

3.4.2 Storage Times According to Table 2

Storage of Oil Filled Cylinders

After the values specified in table 3, the internal preservation of the hydraulic cylinders is achieved by testing/flushing or filling with corrosion protection oil.

When storing hydraulic cylinders filled with oil, a pipeline from the line connection of the annulus area to the line connection of the piston chamber has to be attached on the customer side.

Hydraulic cylinders filled with oil must not be exposed to direct solar radiation or other sources of heat as due to the increase in the ambient temperature, the hydraulic pressure in the hydraulic cylinder increases.

Table 3: Storage Times

Storage Conditions	Packaging	Protective Agent	Storage Time (Months)	
			Test with the protective agent	Filling with the protective agent
Storage in dry rooms at constant temperature	For carriage overseas	A	12	24
		B	12	24
	Not for carriage overseas	A	9	24
		B	12	24
Outdoor storage (protect the product against damage and water ingress)	For carriage overseas	A	6	12
		B	9	24
	Not for carriage overseas	A	0	12
		B	6	24

A = Mineral oil
B = Corrosion protection oil

Storage of more than Six Months

In case of storage of more than six months, the surface of the hydraulic cylinder must be coated or treated with corrosion protection oil. Unprotected parts like fitting surfaces or mechanical interfaces must be protected with corrosion protection oil.

- Protect spherical bearings and fitting surfaces from humidity.
- In case of storage with corrosion protection oil, completely empty the hydraulic cylinders before the commissioning.
- As deformations at the seals cannot be excluded, renew the seals.

In case of improper storage, seals may embrittle and the corrosion protection oil may resinify.

3.4.3 Inspection During the Storage Period

In order for the hydraulic cylinder to remain in perfect condition during the storage period, the following conditions have to be met:

- Subject the hydraulic cylinder to a careful inspection once per year. While doing so, observe in particular the following:
    - External conservation; visual inspection for damage and rust formation
    - Hydraulic fluid; control with regard to oxidation or acidification
    - Inspection and lubrication of spherical bearings that are not maintenance-free
    - Inspection of the preservation of fitting surfaces or mechanical interfaces
- Extend and retract the hydraulic cylinder several centimeters per year in order to prevent the seals from bonding. Depending on the results, you may have to take corrective measures.

In order to prevent damage at the seals, we recommend rotating the hydraulic cylinders by 90 °C every six weeks unless they are stored vertically.

4 Assembly and Installation

This chapter describes the assembly of the product at its place of use as well as the connection of the product to the hydraulic system, the electrical systems and the water supply of the machine.

For information regarding the installation into the complete machine, particularly regarding its overall function and logic mode of operation, please refer to the instructions and/or the documentation for the complete machine.

Risk of personal injury and damage to property!

A basic knowledge of hydraulics is required for assembling the hydraulic equipment.

- Only qualified personnel are permitted to assemble the hydraulic equipment.

4.1 Assembling Hydraulic Power Units

Risk of injury due to tumbling, falling or uncontrolled movement of the hydraulic power unit!

You should ensure that the product is sufficiently stable.

- Observe the information on handling the product in Chapter 3 "Transport and Storage".
- Any packing/transit materials, straps, props or fixtures should only be removed if stability has been ensured by other means.
- Place the hydraulic power unit on a suitable foundation. Observe the specifications of the overall weight.

To assemble the hydraulic power unit you should proceed as follows:

- Position the hydraulic power unit or the assembly as specified in the product specific documentation.
- Ensure that the footprint contact associated with mounting is consistent.
- Level the hydraulic power unit so that its longitudinal and transverse axes are horizontal.
- Prevent possible bouncing by suitable means (e.g. height adjustment of the feet, insertion of shims, packers).
- Securely fix the product at the mounting positions specified in the product specific documentation.

4.2 Assembling Hydraulic Cylinders

4.2.1 Installation Conditions

Mounting surfaces at machines and systems must be designed so that any torsion of the hydraulic cylinder in the installed condition is avoided. The hydraulic cylinder must be installed so that unwanted lateral loads during operation are avoided. Stroke length, load and cylinder mounting must be observed in order to avoid bending and kinking in every stroke position (extract from: E DIN ISO 4413: 1990-10/6.2.2.3).

- Fasten the hydraulic cylinder so that the load acts axially on the center line of the hydraulic cylinder.
- Make sure that the hydraulic cylinder and particularly the piston rod are not damaged during installation. The counter bearings for spherical bearing, trunnion, foot and flange mounting must be able to absorb the occurring forces.
- When installing hydraulic cylinders and assemblies with spherical or plain bearings it has to be ensured that when installing the bolt, the bolt and/or the spherical or plain bearing is not damaged (if necessary, cool the bolt when installing it).
- Design the bolts for cylinder mounting according to the forces to be expected. Only use the genuine bolts when using accessories like clevis brackets etc.

We recommend limiting the swivel angles / tilting angles at the spherical bearings on the customer side in order to prevent the undesired action of forces on mounting elements.

In the fastening of the hydraulic cylinder at the system, the following enumeration must be kept to a minimum (extract from: E DIN ISO 4413: 1990-10/6.2.2):

- Excessive deformation of the hydraulic cylinders due to pushing or pulling load
- Introduction of lateral or bending loads
- Swivelling velocities in the trunnion assembly requiring continuous external lubrication

Make sure that the "A - piston chamber" and "B - annulus area" line connections are not interchanged when connecting the hydraulic cylinders.

4.2.2 Assembling Hydraulic Cylinders

Uncontrolled and dangerous machine movements!

- Depressurize the corresponding part of the system before mounting the hydraulic cylinder. Make sure that the system is mechanically unloaded, if necessary.

- When assembling swivel heads or other customer connection elements at the hydraulic elements, screw the swivel head to the stop.
- The connection elements must not be used to set installation differences.
- Remove the protective device like e.g. screw plugs only when establishing the corresponding connection.

4.3 Installing the Hydraulic System

4.3.1 Installing the Hydraulic Power Unit

Risk of injury when assembling under pressure!

If you fail to depressurize the product before starting the installation, you may suffer injury and also damage the unit or system components.

- Always depressurize the relevant part of the system before assembling the hydraulic power unit.

Damaging the hydraulic power unit!

When assembling hydraulic lines and hoses under mechanical stress, they are exposed to additional mechanical forces during operation, which reduces the service life of the hydraulic power unit and the complete machine or system.

- Assemble the piping and hose assemblies without mechanical stress.

Wear, tear and malfunctions!

The cleanliness of the hydraulic fluid has a considerable impact on the cleanliness and service life of the hydraulic system as a whole. Any pollution/contamination of the hydraulic fluid will result in wear and malfunctions. In particular, foreign bodies e.g. welding beads or metal swarf in the hydraulic lines may damage the hydraulic power unit.

- Always ensure absolute cleanliness
- Assemble the hydraulic power unit free from any pollution/contamination.
- Ensure that all connections, hydraulic lines and add-on units (e.g. measuring instruments) are clean.

- Ensure that no pollutants are able to penetrate when sealing the connections.
- Ensure that no detergents are able to penetrate the hydraulic system.
- Do not use cleaning rags/cotton waste or linty cloth for cleaning.
- Do not under any circumstances use hemp as a sealant.

Risk of injury from ejection of high-pressure oil!

If the nominal pressure is exceeded, the component may burst.

- The connection lines should be dimensioned in accordance with the performance data in the circuit diagram.
- You should only use components that are designed for the required pressures.

Risk of injury from ejection of high-pressure oil!

Fittings with metric or Whitworth threads may, for certain sizes, be mis-matched without this being immediately evident. Fittings with threads that are mis-matched will not withstand the specified nominal pressure.

- You should therefore ensure that there is no risk of confusion with respect to the correct screw fittings.

Preparation

Remove the blanking plugs and flange covers (colored plastic) and replace them with pressure-resistant fittings or flanges.

- You should observe the manufacturer's installation instructions for the screw fittings to ensure there is no external leakage. We recommend the use of fittings with elastic seals.

Cleaning the Lines

- Before installing, clean the connection lines to the hydraulic system, ensuring they are free from dirt, scales, chippings, etc. Welded pipes must be blank on the inside and flushed.
- Do not use cleaning rags/cotton waste for cleaning.

Hose Assemblies

The hose assemblies should be installed such that

- Kinking and tensile load of the hose is avoided during operation,
- The hose is not twisted or turned,
- The outer layer of the hose does not rub off through abrasion or impact,
- The weight of the hose assembly does not cause inadmissible loading.

If a hose assembly becomes detached and there is a risk of whipping, it is advisable to fit a hose safety catch. If the hose assemblies are equipped with loosening-resistant fittings, no safety catch is required.

4.3.2 Connecting the Water Supply

- The fittings must be tightened according to manufacturer specifications!
- Lay the lines to the water connections provided and connect them according to the circuit diagram.

4.3.3 Installing the Hydraulic Cylinder

To the lifting and moving during installation of the hydraulic cylinder into the system / machine, the same rules apply as already described under chapter 3.2.2 "Transport using lifting gear".

- During installation into the machine / system remember that damage to the hydraulic cylinder particularly at piston rods and mounting areas may reduce the functionality / standstill period.
- When installing hydraulic cylinders and assemblies with spherical or plain bearings, you must moreover ensure that when installing the bolt, the bolt and/ or the spherical or plain bearing is not damaged (if necessary, cool the bolt when installing it).

4.3.4 Hydraulically Connecting the Hydraulic Cylinder

The hydraulic connection has to be established according to the specifications of the hydraulic diagram.

4.3.5 Electrical Connection

Any electrical work, including isolation, should be completed by a qualified electrician.

- Disconnect power supply before removing electrical box cover.
- Motor to be wired for clockwise rotation when viewed from the top of the motor.
- The electrical motor is a 3 phase, 50 Hz, 415V motor which is wired direct to contactors and an overload in the electrical control box.
- Should the armature of the motor rotate in a counter clockwise direction after wiring, reverse the location of any two of the three power supply leads.

5 Commissioning

According to EC Machinery Directive 2006/42/EC, commissioning must not be undertaken until it has been determined that the machinery into which the hydraulic equipment is to be installed complies with the provisions of all relevant guidelines/directives.

The combination of components may give rise to other types of hazard. It is therefore essential that the information in the operating instructions for the complete machine be observed.

This applies in particular to "Mechanical hazards" that may result from mechanical movements of the machine initiated by the hydraulic power units and drives (cylinders, motors).

Risk of personal injury and damage to property!

If the hydraulic equipment is not assembled correctly, persons could be injured and the equipment or system damaged while commissioning the hydraulic equipment.

- Ensure that the hydraulic equipment has been assembled correctly by qualified personnel before commissioning.

Damaging the hydraulic equipment!

Polluted oil can result in wear and malfunctions. In particular, foreign bodies e.g. welding beads or metal swarf in the suction line may damage the hydraulic equipment.

- When commissioning you should ensure absolute cleanliness.
- Ensure that no pollutants are able to penetrate when sealing the measuring connections.

Risk of personal injury and damage to property from leaking oil!

Hydraulic fluid may leak out if the blanking plugs have not been removed and there is oil at the blanking plugs.

- Before commissioning, remove all plastic plugs and replace them with pressure-resistant fittings/flanges.

Damaging the hydraulic power unit!

If you commission the hydraulic equipment either without oil or with insufficient oil, the unit will be damaged.

- When commissioning or re-commissioning a machine or system, you should ensure that the tank, as well as the suction and work lines of the hydraulic power unit and the components are filled with oil according to the manufacturer's specifications and that they remain filled with oil during operation.

5.1 First Commissioning of the Power Unit

5.1.1 Before Commissioning

- Ensure that the line system is in good, work-safe condition.
- Open the taps in the cooling water line (if present).
- Open the taps in the suction line (if present).
- Open the pressure gauge air relief to prevent measuring errors (change from "Closed" position to "Open").
- Adjust the electrical level monitoring and/or temperature-measuring device (if present) as required for operation of the machine.

5.1.2 Valve Settings

- Set operating pressure valves and flow control valves to the lowest settings possible.
- Bring directional valves into the basic position.
- Do not energize proportional valves to the command value.

Do not make any changes on sealed valves.

Do not change the factory settings. Do not set or adjust valves that, according to the technical specifications (circuit diagram or parts list), have been provided with a fixed factory setting.

5.1.3 Safe Handling of Pressure Tapping Points

When setting pressure valves the respective pressures must be displayed. This can be done by using fixed installed pressure gauges, digital pressure displays or by connecting external measuring equipment. To this purpose, measuring couplings have been installed within the hydraulic power unit. As the measuring points can be operated while under pressure, extreme caution is required!

WARNING!

Risk of injury from inappropriate installation with system under pressure!

Measuring hoses have no blocking or closing function.

- Before connecting the measuring hose to the measuring coupling ensure that the other end of the hose has been connected to the measuring equipment (pressure gauge, pressure transducer) and that it is pressure-tight.

If the scope of delivery includes a measuring device that is connected to both measuring hose and coupling, the connection may only be opened on the coupling side.

The following diagram (see Fig. 1) shows the position for safe separation of the measuring equipment from the pressurized measuring coupling of the hydraulic power unit.

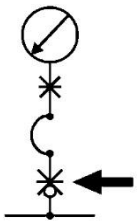

Figure 1: Position for safe separation of the measuring equipment (arrow)

WARNING!

Risk of injury from inappropriate installation with system under pressure!

Measuring connections may also be assembled with a hexagon bolt fitting in the hydraulic power unit. These are not designed for assembly under pressure.

- They should not be dismantled until the connected hydraulic circuit has been depressurized.

5.1.4 Accumulator

If the hydraulic power unit includes accumulators, the instructions applicable at the place of installation are to be complied with before commissioning as well as during operation. "Product-specific Operating Instructions" are supplied with each accumulator.

- You should ensure that these documents are kept together with the accumulator. Experts will need these for subsequent inspections.
- On the oil side, the hydraulic power unit must be sealed tightly, bled (see Chapter 5.1.7 "Bleeding the complete hydraulic system of the machine) and depressurized.

- Fill the accumulator according to the information in the circuit diagram to the prescribed pre-set gas pressure.
- The filling and measuring procedures are undertaken using a testing and filling device (in this connection see "Product-specific operating instructions" for this device).

Affix a label to the accumulator specifying the accumulator filling pressure and note this value in the circuit diagram. This will enable you to perform a comparative control at a later date.

Filling with gas

Only nitrogen should be used as gas! (Nitrogen Class 4.0 purest; N2 99.99 vol. -%).

- The operator will have sole responsibility for complying with the inspection to be carried out before commissioning as well as for subsequent inspections.

5.1.5 Filling the Hydraulic System

Fill the hydraulic system with suitable oil as specified, proceeding as follows:

- When filling the hydraulic system you should ensure absolute cleanliness.
- If, after transport or storage, the hydraulic power unit is seen to be contaminated, you should clean the filter inlets on the tank before opening.
- Under no circumstances should you remove filter screens at the filler neck and/or the filter insert while filling.
- With longer transport or storage times, check the tank for any water present and remove via the drain cock.

Recommendation: Experience has shown that the cleanliness class required for operation of the machine is already exceeded in the case of new oils in the original container.

If you wish to ensure that the cleanliness class is acceptable, use a special filter unit for filling the hydraulic power unit if necessary, or use a filter station with fine filter.

When filling the pump housing you should proceed as follows:

- For pumps with drain line, fill the housing with oil (see also "Product-specific operating instructions").
- Observe the maximum/minimum fluid levels, taking into consideration tank volumes, line system, drives, etc.

5.1.6 Activating the Electrical Supply

See machine manufacturer's operating instructions.

5.1.7 Bleeding the Complete Hydraulic System of the Machine

See machine manufacturer's operating instructions.

The hydraulic system should be bled at the hydraulic components at the highest point.

5.2 First Commissioning of the Hydraulic Cylinder

- Before the installation, clean the lines and all connection surfaces from dirt, scales, chips, etc. For that purpose, use industrial residue-free wipes. Particularly welded pipes must be blank on the inside and flushed.
- Observe the installation instructions of the fitting manufacturer.

- Fittings with a soft seal at the screw-in stud are recommended (pipe thread ISO 228-1, metric thread ISO 261).
- Sealants like hemp and kit are not admissible as they may cause pollution and thus malfunctions.
- Hose lines must satisfy all applicable European and/or international standards.

- Check the system for tightness.
- The connection lines should be dimensioned in accordance with the performance data in the circuit diagram.

5.2.1 Filling Hydraulic Cylinders with Fluid and Bleeding Them

Uncontrolled and dangerous machine movements!

Danger to life, risk of injury or damage to property!

- Do not screw out the complete bleed valve.
- Only set the ventilation by adjusting the bleeding bolt.
- The bleeding bolt may only be adjusted, however not removed.

Contact with hydraulic fluid!

Health hazard / impairment of health, e.g. eye injuries, skin lesions, intoxication upon inhalation!

- Avoid contact with hydraulic fluids.
- When dealing with hydraulic fluids, you must imperatively observe the safety instructions of the lubricant manufacturer.
- Use your personal protective equipment (like e.g. safety goggles, protective gloves, suitable working clothes, safety boots).
- If nevertheless, hydraulic fluid comes into contact with the eyes or gets into the bloodstream or is swallowed, please consult a doctor immediately.

The basic pollution of the hydraulic fluid filled in must not exceed the maximum admissible cleanliness class according to ISO 4406 (c) class 20/18/15. The cleanliness classes specified for the components (like valves) must be adhered to in hydraulic systems.

If you are not sure how your hydraulic cylinder is to be filled and bled, please contact the McMillan Engineering Group service department.

For filling and bleeding the hydraulic cylinder proceed as follows (the starting point is a retracted hydraulic cylinder in horizontal position):

1. Provide for an easily readable circuit diagram of the entire system.
2. The oil leaking during the bleeding process must be collected in a corresponding container.
3. Open the bleed screw on the piston rod side (at the cylinder head) of the depressurized hydraulic cylinder.
4. If there is a threaded coupling, you can bleed the hydraulic cylinder by connecting a corresponding hose to the coupling (the threaded coupling has an internal check valve).
5. Set the hydraulic system so that the pressure at the hydraulic cylinder does not exceed approx. 5 bar.
6. Switch the hydraulic system on.
7. Switch the control valves so that the hydraulic cylinder wants to retract at very low velocities (pressure at the piston rod side). The annulus on the piston rod side of the hydraulic cylinder is now filled with oil and the existing air exits via the bleed port or the threaded coupling.

8. As soon as the oil does not contain air any more, i.e. it exits free from bubbles, the hydraulic accumulator has been sufficiently bled. This is, however, only true if the bleeding point is at the highest point.
9. Then, switch off the hydraulic system and close the bleed screw.
10. After bleeding the hydraulic fluid on the piston rod side of the hydraulic cylinder, bleed the bottom side in the same way.
11. Afterwards, the hydraulic cylinder is ready for operation.
    a. Now only operate the hydraulic cylinder with low pressure until the hydraulic system is completely bled.
    b. Observe the fluid level in the container and top up, if necessary.

Filling and Bleeding Hydraulic Cylinders with Safety Bleeding

1. Opening: Screw out the bleeding bolt maximally to the stop, to the safety plug screw using a hexagon wrench.
2. Filling: Fill the hydraulic cylinder with oil; air and oil exit.
3. Bleeding: The air has been completely removed from the hydraulic cylinder if the oil exits without bubbles.
4. Closing: Tighten the bleeding bolt to the internal stop using a hexagon wrench until no more oil leaks.

Filling and Bleeding Hydraulic Cylinders with Internal Hexagon Bleed Screw

1. Opening: Screw out the internal hexagon bleed screw half a rotation using a hexagon wrench.
2. Filling: Fill the hydraulic cylinder with oil; air and oil exit.
3. Bleeding: The air has been completely removed from the hydraulic cylinder if the oil exits without bubbles.
4. Closing: Screw in the internal hexagon bleed screw using a hexagon wrench. Close it in an oil-tight form. Observe the torque!

Filling and Bleeding Hydraulic Cylinders with a Check Valve

1. Opening: Screw out the internal hexagon bleed screw at the check valve half a rotation using a hexagon wrench.
2. Filling: Fill the hydraulic cylinder with oil; air and oil exit.
3. Bleeding: The air has been completely removed from the hydraulic cylinder if the oil exits without bubbles.
4. Closing: Close the internal hexagon bleed screw at the check valve in an oil tight form using a hexagon wrench. Observe the torque!

Filling and Bleeding Hydraulic Cylinders with a Threaded Coupling

1. Connect the pressure tapping hose: Screw off the end cap of the threaded coupling and screw the pressure tapping hose with fitting onto the threaded coupling to the stop.
2. Filling: Fill the hydraulic cylinder with oil. Air and oil exit and are discharged via the pressure tapping hose.
3. Bleeding: The air has been completely removed from the hydraulic cylinder if the oil exits without bubbles.
4. Closing: When you screw off the pressure tapping hose, the spring presses the valve poppet back onto its seat. Screw the end cap of the threaded coupling on again in order to protect the device from dirt and damage.

5.3 Commissioning of the Hydraulic Power Unit

The following steps are to be performed unless superordinate commissioning instructions applicable at machine level are to be observed.

Risk of personal injury and damage to property!

Commissioning will activate machine functions.

- Ensure that the existing safety devices are activated.

- Start the electric motor in inching mode. Check the direction of rotation.
- Flush the hydraulic system as described in Chapter 7.1.9.
- Operate the directional valves and extend and retract the actuators several times. Repeat the bleeding processes. (Bleeding is ensured if there is no oil foam in the tank, no jerky movements at the actuator and no abnormal noises).
- Operate the system at low pressure until the hydraulic power unit is completely bled. Increase the load in steps.
- Observe the fluid level in the tank and refill if necessary.
- Monitor the operating temperature as it sets itself, if the machine has been in full operation for several hours.
- Check the connection points for tightness, seal any leakage points; check the connection points again for tightness after a few hours.

5.4 Commissioning of the Hydraulic Cylinder

After the hydraulic cylinder has been installed into the system, the system has been filled with the correct hydraulic fluid and the hydraulic cylinder has been bled correctly, you can commission the hydraulic cylinder.

Observe the product-specific and system-specific operating instructions.

Identical hydraulic cylinders may show different functions or malfunctions after the installation into a machine due to machine-specific conditions (weights, velocities, friction, electrical control, command value specification, etc.).

5.5 Setting the End Position Cushioning

Uncontrolled and dangerous machine movements!

- Do not screw out the complete throttle valve.
- Only set the throttle valve by adjusting the throttling pin.

Regarding the adjustable end position cushioning it has to be noted that the full cushioning capacity can only be achieved when the throttle valve is closed.

In this connection, you must always observe the information of the valid data sheets. The information of the data sheet is specified on the hydraulic cylinder's name plate.

Hydraulic cylinders are supplied with greatest effect of the end position cushioning, i.e. the throttling pin of the throttle valves is screwed to the stop and closes the oil channel of the adjustable end position cushioning. By unscrewing the throttling pin, the velocity in the area of the end position cushioning is increased.

Observe the higher end stop velocity!

Adjustable End Position Cushioning with Secured Throttling Pin

- In order to change the factory setting of the end position cushioning, screw out the throttling pin using a hexagon wrench until the desired cushioning behaviour is achieved. Due to the securization, the throttling pin cannot be screwed out of the throttle valve completely.

Adjustable End Position Cushioning with Locked Throttling Pin

- Loosen the throttle valve lock nut using a suitable tool (ring or open-end wrench) and screw the throttling pin out using a hexagon wrench until the desired cushioning behavior is achieved.
- Then tighten the throttle valve lock nut. The throttling pin is positioned by tightening the lock nut.

5.6 Flushing the System

Flushing the hydraulic system to attain a specified oil cleanliness class prevents faults and simultaneously increases the service life of the components. After installing the hydraulic power unit into the machine and/or after installing with the hydraulic system, it must be ensured that the minimum requirements are met with respect to the cleanliness class of the components. Hydraulic systems in general industrial applications require a cleanliness class of 20/18/15 according to ISO 4406, whereas hydraulic systems with servo valves or control valves of higher quality demand a higher cleanliness class e.g. 19/16/13.

You must take into consideration the cleanliness requirement for the components as specified on the manufacturers' data sheets, when determining the flushing target.

Materials Required

- Supply of replacement or flushing filter elements
- If required: Supply of additional material for piping and hose assemblies for establishing flushing and/or shorting links
- Supply of flushing plates or directional valves
- On a case-by-case basis: Flushing fluid (see following note)

Information on Flushing Fluid

You can use the same medium as the one that is also to be used later when operating the hydraulic system. When using another oil, this must be compatible with the operating medium intended for use with the hydraulic system, as well as with the materials, particularly seals, used in the hydraulic system. A maximum admissible residual amount of flushing liquid in the operating medium (e.g. 0.5 volume %) may be specified in certain circumstances (see manufacturer's specification); in this case, this has to be assured by carefully draining the flushing liquid before filling with the operating medium.

For more complex hydraulic systems with ring and branch lines, the flushing process must be planned in detail and undertaken with care.

This is imperative if piping within the system have been welded and maybe also pickled.

The following statements assume that the flushing process is undertaken using the hydraulic power unit described in these operating instructions. When using a separate flushing unit, it is imperative to observe the operating instructions pertaining to this unit!

Flushing Temperature

For the flushing operation the hydraulic power unit must be brought to operating temperature, if possible, and is to be operated with reduced pressure settings. Remember either to deactivate any existing pressure monitoring circuits for the flushing phase or to adjust them to the lower flushing pressures.

Flushing Duration

As far as the duration of flushing is concerned, no generalization can be made. It is recommended that oil samples be taken at periodic intervals during the flushing process and then analysed for cleanliness. Suitable sampling points include e.g. the return line downstream from any existing return line filter. Depending on these results the decision then has to be made as to whether the flushing operation should be stopped (once the target cleanliness level has been attained) or continued.

The operating pressure must only be set at the pressure valves intended for that purpose.

Never change the setting of sealed valves or valves with a fixed factory setting.

After Flushing

After completing the flushing process care should be taken to ensure that the operating settings of the hydraulic power unit have been restored, that any flushing connections have been dismantled and connection lines sealed so as to be pressure-tight. When replacing the flushing plates with original valves, these are to be assembled according to manufacturer specification.

5.7 The Most Frequent Errors During Commissioning

- The fluid tank is not being checked.
- The system is being filled with unfiltered oil.
- Pressure relief valves are being set too close to the working pressure (closing pressure difference is not being observed).
- Pressure controllers of hydraulic pumps are being set higher than or equal to that of the pressure relief valve.
- Abnormal pump noises are not being observed (cavitation, leaky suction line, too much air in the oil)
- The switching hysteresis of pressure switches is not being considered in the setting
- Before commissioning, the hydraulic pump and hydraulic motor housings are not being filled with oil
- The settings are not being documented
- During commissioning, uninvolved personnel are staying in the vicinity of the machine

5.8 Re-commissioning the Power Unit After an Extended Standstill

When re-commissioning the system after an extended standstill period, you should proceed as follows:

- Check:
  - the oil level
  - the accumulator pressure on the gas side
  - the tightness of the hydraulic components and the line system
- Perform switch-on procedures with increased caution.
- Bleed the hydraulic system.
- Observe the information in the operating instructions of the machine manufacturer.

5.9 Re-commissioning Hydraulic Cylinders After an Extended Standstill

- In the re-commissioning, observe the commissioning instructions (see section 5.4 "Commissioning of the Hydraulic Cylinder").

6 Operation

As partly completed machinery, the hydraulic power unit is intended for installation into machinery.

Information on operating the hydraulic power unit can only be provided in connection with the [complete] machine. For this information, please refer to the operating instructions of the machine manufacturer.

Information on the functional operation and logic of the hydraulic power unit can be obtained either from hydraulic experts or from the product-specific documentation.

7 Maintenance and Repair

McMillan Engineering Group offers a wide range of repair services for maintenance of the hydraulic equipment unit. Please send any enquiry to McMillan Engineering Group, for contact details refer to www.mcmillaneng.com.au.

Maintenance tasks (inspection, service, repair) must be defined in terms of component-specific requirements, operating conditions (pressures, temperatures, ambient conditions) and use (duty cycle, cycle times, shift operation. Please refer to the operating instructions of the machine manufacturer.

Within this framework, a visual inspection is to be undertaken to detect obvious faults:

- Incomprehensible notes or warning signs
- Leaks
- Loose and/or missing components
- Indication of the application of external force

McMillan Engineering Group hydraulic systems and hydraulic cylinders have the structural prerequisites for high functionality (operational safety, service life). They only require little maintenance work. The latter is, however, indispensable in order to ensure functionality.

Experience has shown that 70 % of the malfunctions and damage in hydraulic systems and hydraulic cylinders are indirectly caused by the hydraulic fluids. Consequently, the primary inspection and maintenance task is the examination and completion of measures to maintain the functionality (condition, cleanliness class) of the hydraulic fluid.

7.1 Maintenance Documentation

It is recommended that the results of the inspections and the derived measures required be documented,

- so that considering functionality and economy, the service intervals can be adjusted to the actual operating conditions,
- as they offer the possibility of early fault recognition thanks to comparative evaluation (preventive maintenance).

Any negative trend of the test parameters e.g. oil temperature, replacement intervals of the filter elements or noise may be an indication of changes. The troubleshooting matrix (see Chapter 8) may provide help in minimizing this problem.

Gradual temperature increases and/or shorter filter replacement intervals may be an indication of possible wear at pumps, control edges, seals and aging of the oil and means that an inspection should be undertaken of all components under consideration.

An immediate high temperature increase is an alarm signal and requires an immediate inspection of the machine.

7.2 Hydraulic Power Unit Inspection, Maintenance & Repair

Recommendations are based on the following: A Central European climate and an environmental load as is usual in metal-processing companies.

Before commencing the inspection, cleaning should be undertaken if necessary. Always ensure cleanliness when working on the hydraulic power unit.

7.2.1 Filling Level

Oil Level

The filling level should be checked at intervals of 8 operating hours.

While the hydraulic power unit is in operation, the oil level will not remain constant.

Level changes result from the different volume requirements of plunger and differential cylinder and/or the absorption/delivery of oil in hydraulic accumulators during a working cycle.

Due to the variable conditions mentioned above a complete working cycle of the machine must be observed when undertaking the visual inspection of the oil level. This will enable you to determine whether the oil needs to be refilled or topped up, and if so, by how much.

During operation, the oil level must neither exceed the upper mark nor fall below the lower mark. If the minimum filling level is undershot, there is a risk of pump failure due to cavitation.

If the maximum filling level is exceeded, this may have been caused by the thermal expansion of the oil or by fluid entry (e.g. water in the case of internal leaks of the oil/water heat exchanger.

Fluid Level Indicator

The hydraulic power unit can also be equipped with an electrical fluid level indicator. The switching points can be seen from the technical specification and the circuit diagram.

Measures to be taken if the maximum filling level is exceeded

- Expansion due to temperature increase (Approximate determination: Δ V = Thermal expansion coefficient x Δ T)
    - Correcting the filling level
- Exceeding the maximum filling level due to suspected water ingress
    - Close the water valves (shut-off the cooling water supply)
    - Draw an oil sample at the lowest point of the tank and check for water content
    - If the suspected water ingress is confirmed, you should complete the machine working cycle and then shut down safely.
    - Repair the oil/water heat exchanger according to the manufacturer's specifications or replace if necessary
    - Perform more extensive control measures and implement the following measures depending on these results:
- Clean or drain and change the oil
- Undertake a flushing process, if necessary
- Check the oil for admissible water content

Measures to be taken if the minimum filling level is undershot

Risk of personal injury and damage to property from oil loss!

An oil loss is always associated with leakage.

- First identify and remedy the actual cause of the leakage.
- Only then should you top up the oil to the correct level.

7.2.2 Oil Temperature (Optional)

The oil temperature should be checked at intervals of 8 operating hours.

The hydraulic power unit may be equipped with an optical thermometer or electrical temperature-measuring device, depending on the order specification. The switching points can be seen from the technical specification and the circuit diagram.

Possible causes of a temperature increase include:

- Malfunctioning of the heat exchangers
- A change in the cooling water conditions
- Malfunctioning or incorrect setting of the pressure valves (e.g. maximum pressure limitation, pump controller, pressure relief valve)
- Malfunctioning of the heating system
- Fault at the pump (wear, increased leakage)
- A change in ambient conditions (e.g. increased ambient temperature)
- A change in load conditions at the drives

In the case of an inadmissible temperature increase, the causes are to be determined and rectified.

7.2.3 Filter Clogging Indicator (Optional)

The contamination level of the filters should be checked at intervals of 8 operating hours.

McMillan Engineering Group specified filters will be used as standard.

With these filters, if the admissible back/differential pressure is exceeded, an optical signal is output, i.e. a red pin becomes visible.

Cold Start

After a cold start, the red pin on the filter clogging indicator is to be pushed in after the operating temperature has been reached (check function). With this control, if the pin jumps out again immediately, the filter element must be replaced at the end of the shift at the latest.

In addition, the monitoring equipment may be electrical for evaluation at control level. The switching points can be seen from the technical specification and the circuit diagram.

When using filters from other manufactures, different optical or electrical filter clogging indicators may be installed. In individual cases and depending on the order specification, this control may have been dispensed with.

You should be wary if the filter clogging indicator still does not indicate that a replacement is necessary after several inspection intervals. Of course, this may be an indication that the oil is clean. It may, however, also be due to the following reasons:

- The filter clogging indicator is defective.
- The filter element is defective.
- A bypass valve, if present, does not close properly (e.g. due to penetration of dirt particles).

Maintenance / Repair

Measures: Plan and carry out a filter replacement at the end of the shift.

If the intervals between necessary replacement of the filter elements become shorter, the reason for the increased deposition of dirt is to be identified and remedied.

WARNING!

Risk of injury from falling parts!

Depending on filter size, the filter housings may be quite heavy.

- If necessary, ask a second person for help.

Before commencing the work, prepare receptacles for oil, as well as for filter housing and filter element.

When dismantling and assembling the filter element, please refer to the operating instructions of the filter manufacturer.

You should dispose of the filter elements according to the national or operator specific regulations.

7.2.4 Pressure Valves

The pressure values must be checked if the behaviour of the drives changes (e.g. cycle time extension, end product quality, etc). Otherwise, one control at least every six months is recommended.

We recommend recording the pressure values within the scope of the maintenance documentation.

Lead Seals

Lead seals, e.g. on the accumulator safety valves provide information that the original pressure setting has not been changed. Without attaining the set pressure, the sealed valves cannot be checked within the scope of a normal inspection. The inspection here comprises a check to ensure the lead seals are intact.

If the lead seals defective, contact the manufacturer.

6.2.5 Oil Maintenance

An oil analysis should be performed at least once per year.

An oil analysis entails drawing a sample of oil in a professional manner. The oil sample must be checked in a suitable laboratory in accordance with the oil manufacturer's specifications.

Maintenance / Repair

Depending on the result, it may be necessary to implement more measures, e.g.:

- Filtration (measures)
- Dehydrogenation
- Changing the oil

The use of recycled oil (recovered oil) is to be avoided.

- If the oil is changed, it must be drained completely.

You must also ensure that the lines and actuators have been completely drained. You may also have to carry out bleeding measures, if necessary.

As with the initial filling, the hydraulic system must be bled after each subsequent refill.

7.2.6 Hydraulic Accumulators

Risk of personal injury and damage to property!

Accumulators are a potential source of hazards. Leaking pressurized gas may result in serious injury or even death.

Particular care must be taken when working on hydraulic systems with accumulators, as inappropriate behaviour may result in serious injury.

- Never perform welding or soldering work or any mechanical processing on accumulators!

WARNING!

Risk of personal injury and damage to property!

If air or oxygen is used as an accumulator medium, there is a high risk of explosion!

If uncleaned gases are used, the contaminating substances contained therein or the water content may lead to unforeseeable and uncontrollable behaviour of the device.

- Only use nitrogen as gas in the accumulator (Nitrogen Class 4.0 purest; N2: 99.99 Vol-%)!

WARNING!

Risk of personal injury and damage to property!

When draining the nitrogen from the accumulator, the atmospheric oxygen will be displaced. In very small rooms, this may result in fainting or even suffocation.

- Before discharging the nitrogen accumulator pressure, the doors and windows of the room in which the accumulator is located must be opened.

WARNING!

Risk of personal injury and damage to property!

The draining of the nitrogen from the accumulator may result in an excessive increase in pressure.

- Before discharging the nitrogen accumulator pressure, the doors and windows of the room in which the accumulator is located must be opened.

There are legally prescribed inspections for accumulators, which have to be undertaken at defined intervals. This is the responsibility of the operator.

In order for the accumulator to function as intended, the gas pre-charge is to be checked periodically according to the information in the circuit diagram.

CAUTION!

Risk of injury!

Due to the fast discharge of the gas pressure, the components and component parts affected will be subjected to extreme cooling. In extreme cases, contact with unprotected skin may even result in supercooling in the form of burns!

- You should wear thermal gloves and avoid contact with the supercooled components. Wait for a reasonable period of time until the supercooled components have reached ambient temperature once more!

Regarding the maintenance of hydraulic accumulators, you should observe the relevant stipulations of ISO 4413 (Chapter 7.3.2.2) in its current version, as well as those in the operating instructions of the accumulator manufacturer.

Gas Filling Pressure

The essential maintenance required for hydraulic accumulators entails the verification and setting of the gas filling pressure.

To this purpose, only those testing and filling devices and procedures may be used, which are recommended by the manufacturer for filling accumulators.

Please note that the gas filling pressure must be selected according to the gas temperature.

In this connection, it must be ensured that the admissible accumulator pressure is not exceeded. Ensure that the gas valve is securely closed after each inspection or adjustment.

Dismantling from the System

Before dismantling hydraulic accumulators, the liquid pressure in the accumulator must be reduced to ambient pressure (i.e. be in a depressurized condition).

Service, maintenance and/or replacement of hydraulic accumulator components may only be carried out by sufficiently trained personnel on the basis of written instructions and by using parts and materials, the manufacture of which has been certified as being in accordance with current specifications.

Before dismantling an accumulator, it must be completely depressurized on both the liquid and the gas side.

7.2.7 Hose Assemblies and Compensators

Hose assemblies and compensators consist of an elastic part (hose/diaphragm) and fittings mounted on both sides.

Optional Components

- Hose assemblies are optionally available with:
- Abrasion protection (only apply at the places where there really is abrasion)
- Hose safety catch
- Splash guard (also possible with hose safety catch)
- Fire protection (only possible with hose safety catch)

Hose assemblies and compensators are components requiring constant monitoring.

Maintenance / Repair

They should be replaced if one of the following conditions is determined during inspection:

- Damage of the outer layer down to the core (e.g. abrasion points, cuts or cracks).
- Visible traces of overheating, fire: Carbonization, blistering or fouling due to partial heat impact (hot spots).
- Embrittlement of the outer layer (formation of cracks in the elastic part).
- Deformation not corresponding to the original shape of the components in both depressurized and pressurized condition.
- Leaks.
- Damage or deformation of the fitting (sealing function impaired).
- Corrosion of the fitting reducing function and stability.
- Hose working loose from the fitting.
- Storage time and service life exceeded.

7.2.8 Piping

The piping consists of the pipes and the connection elements.

Connection types:

- Form-type fitting
- Flare-type fitting
- Welded conical fitting
- Compression joint
- Flange connection

The piping must be checked at least once every six months (or more frequently depending on operating conditions and use).

In order to allow for a visual inspection, prior cleaning may be required.

There is an inspection for:

- Corrosion
- Crack formation
- Leaks
- Indication of the application of external force

Maintenance / Repair

In the case of leaks at fittings, the latter are to be re-tightened once and this then recorded. If there are still leaks at these fittings, these must be carefully checked for the cause of the leakage. Depending on the findings, the seals may need to be renewed and/or the fitting replaced with a pipe section. In the case of leaks at flanges, you should proceed in a similar manner.

In the case of crack formation or leaks at welded seams, the cause has to be determined and remedied. Afterwards, the components concerned are to be replaced or repaired in a professional manner.

If there are signs of an application of external force the cause must be determined and remedied. Afterwards, the component and also adjacent pressurized components are to be checked for damage and assessed with respect to further reliable use. If necessary, these components are to be replaced or repaired in a professional manner.

If there are signs of corrosion the component is to be checked for damage and assessed with respect to further reliable use. If necessary, this component is to be replaced or repaired in a professional manner. You must in all cases provide for corrosion protection.

7.2.9 Heat Exchanger

The following may be installed, depending on the order:

- Oil-vacuum heat exchangers
- Oil-water heat exchangers

In Case of Reduced Cooling Power

If the cooling power of the heat exchanger is reduced, you should follow the manufacturer's operating instructions.

When using water filters in the cooling water circuit, the water filter elements are to be checked at least once every six months and cleaned if necessary.

When using oil-vacuum heat exchangers, the lamellae must be checked regularly for contamination and cleaned if necessary.

7.2.10 External Inspection of Tanks and Steel Components

The external inspection is a visual one and must be undertaken at least once every six months (or more frequently depending on operating conditions and use).

In order to allow for a visual inspection, prior cleaning may be required.

Visual Inspection

There is a visual inspection for:

- Leaks
- Crack formation

- Corrosion
- Dents due to the application of external force

Maintenance / Repair

In the case of leaks at components screwed into the tank the latter are to be re-tightened once and this then recorded. If there are still leaks at this point, the contact point must be carefully checked for the cause of the leakage. Depending on the result, seals are to be renewed and/or the component replaced. In the case of leaks at flange-mounted components, you should proceed in a similar manner.

In the case of crack formation or leaks at welded seams, the cause must be determined and remedied. Afterwards, the components concerned are to be replaced or repaired in a professional manner.

If there are signs of an application of external force the cause must be determined and remedied. Afterwards, the component and also adjacent components are to be checked for damage and assessed with respect to further reliable use. If necessary, these components are to be replaced or repaired in a professional manner.

If there are signs of an application of external force on the tank, an internal inspection of the tank should be undertaken.

If there are signs of corrosion the component is to be checked for damage and assessed with respect to further reliable use. If necessary, this component is to be replaced or repaired in a professional manner. You must in all cases provide for corrosion protection.

7.2.11 Internal Inspection of Tanks

The internal inspection is a visual inspection of the tank on the inside and is generally performed when the oil is changed. Oil change will depend on the result of oil samples taken.

In order to perform the visual inspection, you must first of all completely drain the oil (in this connection see also Chapter 10.1 "Preparing for decommissioning"). If there is any contamination, internal cleaning must also be carried out.

There is a visual inspection/inspection for:

- Corrosion
- Crack formation
- Foreign bodies
- In the case of screw connections, you must ensure that they are sitting correctly

Particular Characteristics with Walk-in Tanks

Prerequisite: The inspector must not suffer from claustrophobia and must be physically fit enough to move around in a confined space!

Recommendation: Before commencing the work inside a tank, you should inform the fire department and/or a first aider/paramedic or ensure that they are on standby.

If the inspector has to move his whole body completely into the oil tank, he must be suitably harnessed and secured by at least a second person outside the oil tank.

Preparation

For his own safety, the inspector must:

- Prepare a means of rescue before entering the tank,
- Take off watch and jewelry,
- Wear a cap or a hair net,
- Wear protective clothing (tight-fitting overall with zips and no outside pockets),

- A lamp suitable for explosive atmospheres must be used

Risk of personal injury and damage to property!

There is a risk of suffocation inside tanks.

The breathable air in a tank must contain sufficient oxygen for it to remain breathable for the relevant personnel without posing any risks.

- Before entering the tank, open all manholes and access openings.
- Ensure sufficient ventilation with breathable air, if necessary by means of forced ventilation.

Maintenance / Repair

In the case of crack formation at welded seams, the cause must be determined and remedied. Afterwards, the welded seams concerned are to be repaired in a professional manner.

If foreign bodies are detected they are to be removed from the tank. Their origin and the cause of their presence must be established. Depending on the cause established, suitable measures must be introduced to ensure safe operation of the hydraulic power unit.

If there are signs of corrosion the location concerned is to be checked for damage and assessed with respect to further reliable use. If necessary, the tank must be replaced or repaired professionally. You must in all cases provide for medium-resistant corrosion protection.

If piping and hose fittings are loose the former must be tightened professionally.

If screw connections are loose the parts to be secured must sit correctly and the screw connection tightened professionally.

7.3 Hydraulic Cylinder Inspection, Maintenance & Repair

Normally, hydraulic cylinders are almost maintenance-free after the commissioning. After a new system has been commissioned, regular checks are necessary in order to determine whether the hydraulic cylinder functions perfectly. During these checks, you must particularly watch out for the following:

- Possible oil leaks at the oil ports
- Check with regard to "rubbing marks" or mechanical damage at the surface of the stroke-related piston rod running surfaces. Rubbing marks may be an indication of a polluted hydraulic system or of inadmissible traverse loads on the hydraulic cylinder.
- Damage to the coatings
- Possible leakage at the cylinder head or cylinder bottom
- Extreme temperatures and pollution shorten the hydraulic cylinder's service life. You should therefore provide for regular maintenance of the entire hydraulic system. For reference to the specific requirements of the hydraulic cylinder on the operating and ambient temperatures as well as the oil cleanliness please refer to the corresponding data sheet. For possible additional requirements, please refer to the installation and maintenance instructions of the hydraulic system and the data sheets of the hydraulic fluids used.
- The replacement intervals for wear parts like e.g. seals, guide sleeves and guide rings depend on the relevant application, the operating conditions, temperatures, etc. and on the medium quality. No fixed time has been determined for the exchange of these wear parts.
- Leakage in the area of the piston rod and the cylinder head is an indication of the necessity to exchange the wear parts.
- According to the operating requirements, the lubrication intervals for self-aligning clevis, trunnion, etc. must already be determined in the project planning of the hydraulic cylinder. The lubrication intervals are contained in the system manufacturer's maintenance schedule.

7.3.1 Piston Rod Maintenance

In order to prevent corrosion at the piston rod, the piston rod should always be retracted during standstill times.

When using hydraulic fluids in hydraulic cylinders like e.g. HFD-R (phosphoric acid ester), HFA (oil-water emulsion) or HFC (water glycol), the following works have to be completed within the scope of the maintenance:

General

- The piston rod must always be covered by a protective oil film. Ensure compatibility of the medium used.
- In areas with high humidity or strongly fluctuating conditions (e.g. temperature fluctuations or outdoor installation), check the protective oil film every week. In areas with moderate conditions, the protective oil film can be checked every month.

The protective oil film is necessary in order to guarantee corrosion protection of the exposed piston rod. In this connection, the following preventative maintenance is to be completed:

Preventative Piston Rod Maintenance

1. If possible, the preventative maintenance work should be completed in a dry environment.
    a. Using fresh water loosen and remove all salt, sand and machining residues as well other pollution from the piston rod.
    b. Do not use steam cleaners or high-pressure water jets.
2. The preventative maintenance can only be completed with a clean and dry piston rod. If there is not sufficient time in order to let the piston rod dry completely, let it dry as long as possible before the maintenance. Repeat the maintenance as long as you have sufficient time.
3. Soak an industrial residue-free wipe with protection oil of low viscosity. Using the cloth, apply the protection oil to the entire piston rod.

Immediate Maintenance for Hydraulic Cylinders and Piston Rods After Contact with Chemicals

After contact with chemicals, an immediate maintenance cycle has to be completed as fast as possible. The immediate maintenance comprises the following works:

1. Loosen and remove all chemical residues using a suitable cleaning agent.
2. Perform the work steps of the preventative maintenance.

The preventative maintenance described here should be completed before the first commissioning of the hydraulic cylinder or after standstill times.

7.4 Spare and Wear Parts

7.4.1 Hydraulic Power Unit Spare and Wear Parts

Risk of personal injury and damage to property due to the use of incorrect spare parts!

Spare parts not complying with the ones listed in the product-specific documentation may cause mechanical hazards or malfunctioning of the machine.

- Only use components listed in the product-specific documentation (parts list).
- Only use new seals with the required resistance to media.
- As the sealing material may differ despite being of identical appearance, the material number should be checked.

Please send your spare part orders to McMillan Engineering Group. For the contact details, please refer to www.mcmillaneng.com.au.

Ordering Spare Parts

- Spare parts should be ordered in writing. In urgent cases you can also order by phone, but you are kindly requested to confirm your order in writing e.g. by fax.
- Please provide the following information when ordering spare parts:
  - Material number and order number of the hydraulic power unit (nameplate)
  - Material number of the respective component
  - Required quantity
- The required type of dispatch (e.g. as parcel, freight, air freight, by courier etc.).

7.4.2 Hydraulic Cylinder Spare and Wear Parts

In case of questions or doubt, please contact McMillan Engineering Group in any case.

Opening the hydraulic cylinder will invalidate the warranty claim.

7.5 Repair

McMillan Engineering Group offers a wide range of repair services for your hydraulic cylinder.

Please send any enquiry to McMillan Engineering Group. For the contact details, please refer to www.mcmillaneng.com.au.

8 Troubleshooting

Risk of personal injury and damage to property!

Depending on the system, troubleshooting may give rise to a wide range of potential hazards.

- Troubleshooting must only be undertaken when the safety equipment is active!
- You must proceed with extreme caution if you have to deactivate this safety equipment in order to search for errors/faults. If possible, you should operate the machine in set-up mode with reduced performance data when identifying faults!

Successful troubleshooting within a hydraulic power unit requires precise knowledge of the set-up and the mode of operation of the individual components. The combination of hydraulic and electrical systems and electronics makes the troubleshooting even more complex.

For effective troubleshooting, the circuit diagrams (hydraulic and electrical, if applicable), parts lists, any functional diagrams and other documents must be available.

8.1 How to Proceed with Troubleshooting a Hydraulic Power Unit

- Always work systematically and focused, even when under time pressure. Random and imprudent disassembly and readjustment of settings can, in the worst-case scenario, result in the inability to determine the original cause of the fault.
- You should first get a general idea of how the hydraulic power unit works in conjunction with the entire system.
- Try to establish whether the hydraulic power unit was working properly in conjunction with the entire system before the problem first occurred.
- Try to determine any changes within the entire system into which the hydraulic power unit is integrated:

Control Questions

- Were any changes made to the operating conditions or operating range of the hydraulic power unit?
- Were any changes or repair work undertaken on the entire system (machine/ system, electrics, control) or on the hydraulic power unit?
- If so: What were they?
- Was the hydraulic power unit or machine used as intended ?
- How did the malfunction become apparent?

Try to get a clear idea of the cause of the fault. If necessary, ask the actual (machine) operator

8.2 Overview of the Impact of Defects on a Hydraulic Power Unit

The following tables contain errors/faults and their consequences, the causes of which are not exclusively attributable to the hydraulic power unit. The listed error sources, possible causes and remedies refer exclusively to the hydraulic power unit. You will also frequently have to look at the control system or connection technology when seeking the causes of faults.

The following list is meant as an aid, but does not claim to be comprehensive.

Tabular classification of the impact of defects:

"A" Excessive / abnormal noises

"B" Insufficient power / torque / pressure in the drives

"C" Irregular drive movements (pressure and volume fluctuations)

"D" Operating or oil temperature too high

"E" Contaminated oil

Table 4: Impact of Defect "A" – Excessive / Abnormal Noises

	Malfunction	Possible Causes	Remedy
1	Mechanical Drive Section	Coupling: Incorrectly aligned, loose, defective	Align, tighten, exchange coupling
		Pump and/or motor fastening loose	Tighten the fastening according to manufacturer specifications
		Pump or motor defective	Replace pump / motor
		Wrong direction of rotation	Change around the electrical connections of the energy supply
2	Suction Conditions	Oil level in the tank is too low	Check and remedy the cause of the oil loss, top up the oil (see also A5)
		Breather filter contaminated or too small	Clean or replace breather filter
		Tap in the suction line is only partially open	Fully open the tap Note: Check the electrical spool position monitoring
		Suction line plugged, not tight	Clean, seal the suction line
		Suction filter plugged or too small	Clean or replace suction filter Note: In compliance with E DIN EN ISO 4413:2008-07, the use of suction filters is not recommended.
		Location over 1000 m above sea level	Provide for structural changes after consultation with McMillan Engineering Group
3	Pump	Pump seals or pump defective	Replace pump seals or pump according to the manufacturer specifications
		Vibrating controller system, e.g. pressure controller	Check for sufficient bleeding and correct basic setting of the controller according to the manufacturer specifications
4	Pressure Valves	Flow noises and vibrations due to wrong setting	Check and, if necessary, correct the settings according to the specifications in the circuit diagram
5	Oil	Viscosity too high (temperature too low)	Before starting the machine function, temper the hydraulic power unit; if necessary, use oil of a lower viscosity class.
		Oil foams (proportion of air too great)	Check and remedy the cause of the ingress of air

Table 5: Impact of Defect "B" – Insufficient Power, Torque or Pressure at the Drives

	Malfunction	Possible Causes	Remedy
1	Pressure Valves	Operating pressure setting too low	Control of the setting according to the specifications in the circuit diagram
2	Directional Valves	Incorrect spool position (e.g. pressureless circulation; valve does not switch)	Check for jammed plug-in connection and correct current feed of the solenoid
3	Piping and Hose Assemblies to the Drive	Pressure loss too high due to incorrect dimensioning	Replace the piping and hose assemblies with larger nominal widths
4	Other	Total values for flow and load resistance and/or leaks too large	Check the hydraulic design after consulting with McMillan Engineering Group

Table 6: Impact of Defect "C" – The Pump is Switched On or Off Too Frequently

	Malfunction	Possible Causes	Remedy
1	Pump	For machines with accumulators, the pump delivery volume is too low	Check the design of the pump/accumulator circuit; enlarge the pump or accumulator, if necessary
2	Accumulator	• Tap to the accumulator is closed • The preset gas pressure is not correct • The operating and set pressures (e.g. pressure switches) do not comply with the requirements	Check the spool position at the accumulator control block, the gas pre-load and the settings according to the circuit diagram

Table 7: Impact of Defect "D" – Oil Temperature Too High

	Malfunction	Possible Causes	Remedy
1	Pump	Partial load operation of the machine, pump delivery volume cannot be adjusted in the case of fixed displacement pumps	Check the hydraulic design after consulting with McMillan Engineering Group
2	Pressure Valve	Incorrect setting of pressure valves - usually too low. One part of the pump delivery volume flows back to the tank via the pressure relief valves	Check and, if necessary, correct the settings according to the circuit diagram
3	Heat Radiation	Too little oil in the tank	Check the oil level in the tank
		Insufficient heat radiation due to encapsulation / lack of ventilation	Provide for forced ventilation, if necessary
4	Heat Exchanger	For oil/water heat exchangers: Too little flow of cooling water, temperature of cooling water too high, too little cooling water in the system, inlet pressure too low or deposits in the heat exchanger For oil-vacuum heat exchangers: The air flow is impaired, ambient temperature too high	Check whether the coolants (water, air) comply with the requirements of the technical specification
5	Other	Increased reduction in efficiency due to changed conditions, also wear, if applicable	Perform maintenance work, replace components, if necessary

Table 8: Impact of Defect "E" – Contaminated Oil

	Malfunction	Possible Causes	Remedy
1	Particulate contamination	Deposition of dirt due to insufficiently cleaned components (e.g. piping) during installation	Determination of the causes, rectification of the causes & flushing of the system
		Deposition of dirt during the filling of oil	
		Deposition of dirt due to improperly undertaken maintenance and repair work	
		Ingress from the environment, e.g. via piston rods, breather filters	
		Abrasion of components	
2	Water in the oil	Corrosion of the oil/water heat exchanger due to water quality deviating from the material specification of the heat exchanger	Examination of the water quality, replacement of the heat exchanger if necessary
		Pressure surges on the cooling water side	Solenoid water lock valves must only be arranged in the the supply line

8.3 How to Proceed with Troubleshooting a Hydraulic Cylinder

Troubleshooting is primarily the exchange of the defective components.

Only replace the components mentioned in the parts list (spare parts list) by new, interchangeable and tested components in original equipment quality.

Regarding the repair of the defective hydraulic cylinder, please contact McMillan Engineering Group. For the contact details, please refer to www.mcmillaneng.com.au.

After remedy of the actual damage, you should imperatively remove the causes and/or consequential damage as well. After a component failure caused by wear, you must for example flush the system and clean and/or change the oil.

Table 9: Hydraulic Cylinder Troubleshooting

	Malfunction	Possible Causes	Remedy
1	Stick-slip effect	Air in the hydraulic cylinder	Bleed the hydraulic cylinder, see section 5.2.1 "Filling hydraulic cylinders with hydraulic oil and bleeding them".
		Seals are worn	Initiate the exchange of the seals, see section 7.4.2 "Hydraulic Cylinder Wear and Spare Parts"
		Introduced radial forces on piston rod and hydraulic cylinder	In this connection, observe section 4.2.1 "Installation conditions".
2	Leakage at the piston rod side	Traces of wear at the piston rod surface	Initiate the exchange of the piston rod.
		Piston rod seals are worn	Initiate the exchange of the seals..
3	Leakage at the line connections	Fittings are loose	Tighten the fittings firmly
		Defective sealing element	Exchange the sealing element at the fitting
4	Hydraulic cylinder has no cushioning effect/moves hard into the end position	The end position cushioning setting does not comply with the requirements	Set the adjustable end position cushioning, see section 8.1.3 "Setting the end position cushioning"

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