

Service Manual

Hydraulic excavator

A 309 - R 317 Litronic TCD

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Manual no.

User:

Introduction

This manual contains technical data, design and functional descriptions, as well as instructions as regards the operation and the adjustment of machine settings. The document includes a number of drawings, functional schematics, as well as detailed views of units and assemblies of **LIEBHERR hydraulic excavators**.

The documentation has been designed to support customer support services, but does of course not replace proper technical training and qualification of the user, and participation in LIEBHERR operator training courses.

General basic technical information is not included in the manual. For operating instructions and information on spare parts, please refer to the separate documentation.

During all work on the machine, strictly adhere to the relevant accident prevention and safety regulations.

1 Symbols used in this manual

Tasks and procedures that are associated with specific dangers are accompanied by safety instructions. The safety instructions are graded according to the severity of the risk and are identified with the terms **DANGER**, **CAUTION** and **NOTE** and the respective danger symbol:

These terms are used in combination with the following symbols:



Danger

Warning referring to a danger where there is a high probability of death or serious injury to operators, unless the prescribed safety measures are taken.



Caution

Warning relating to dangers that might lead to injury or damage to the machine, unless the prescribed safety measures are taken.



Note

This symbol accompanies instructions and tips regarding the operation, maintenance and repair of the equipment. If adhered to, the service life of the machine can be prolonged and/or procedures are made easier.

- This symbol precedes entries in a list.
 - This symbol precedes entries in a sub-list.
- ☐ This symbol identifies "Pre-condition MUST be fulfilled"
- ▶ This symbol indicates a single procedure in a sequence of procedures.
 - ↪ This symbol indicates a result of an action.

This manual has been exclusively compiled for internal use by the registered machine owner.

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This service manual shall be amended without prior notice to reflect new technical developments and machine series. LIEBHERR reserves the right to make minor technical amendments to the machines that might not be reflected in the accompanying documentation.

Symbols used in this manual

Depending on the series development, the service manual shall be revised in electronic format. Changes and amendments are listed in group 1.02.

This manual might be complemented by additional service information sheets issued by LIEBHERR.

Compiled by the Technical Documentation Department.

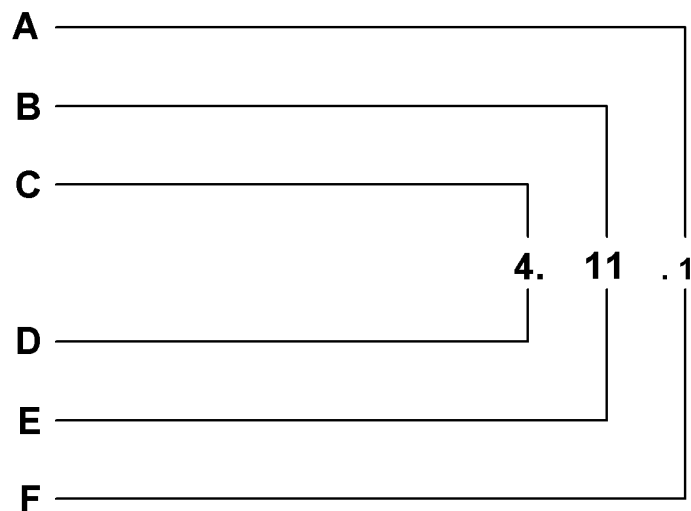
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of **LIEBHERR-HYDRAULIKBAGGER GMBH 88457 Kirchdorf / Iller, Germany.**

We hope that the information in this documentation aimed at improving the service of LIEBHERR excavators is of use to you.

1.1 Explanation

In order to make it easy for users to find specific information regarding revised or amended documents, each page is identified as follows:



A Page number

B Subgroup

C Main group

D Drive motor

E Diesel engine

F Page

The main groups are listed in the main group directory.

The subgroups are listed on the first page of each main group section. The subgroup list also includes the machines and serial numbers to which the subgroup is relevant.

In the event of minor changes, we will send you the amended page showing the current date.

If an existing subgroup is completely revised and re-edited, the new version will be assigned a new subgroup number.

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Safety instructions

Working with the machine holds dangers to which you as the owner, machine operator or maintenance expert could be exposed. If you regularly read and observe the safety information, you can guard against dangers and accidents. This applies especially to persons, who are working on the machine only occasionally, such as for maintenance work. The following information comprises safety regulations which, if followed conscientiously, will guarantee your safety and that of other persons, as well as avoid damage to the machine.

Following these regulations does not release you from the responsibility to follow all safety regulations and guidelines valid for the jobsite, as required by law or issued by trade associations.

For EU countries, guideline 89/655/EEC contains the minimum safety information applicable to the operator.

1 Proper use

- The hydraulic excavator is a machine with attachments (such as backhoe, grapple, bucket) designed to loosen, take on, transport and dump soil, rocks and other materials, where the load is predominantly transported without moving the machine. Moving the machine when it is carrying a load must be carried out by observing the appropriate safety measures (see section "Notes for machine operating safety").
- Machines used for load-lifting work are subject to specific conditions and must be equipped with the stipulated safety devices (see section "Load-lifting work").
- Other or additional usage, such as for demolition or material handling work, requires special equipment and may also require special safety devices. These attachments (e.g. log grapple, demolition hammer, concrete cutter etc.) may only be attached and used with approval and in accordance with the basic machine manufacturer.
- Transporting persons is not deemed to be intended use. The manufacturer is not liable for damage resulting from this action. The risk must be assumed solely by the user.
- Observing the operating instructions and the inspection / maintenance instructions is also deemed to be appropriate and destined use in accordance with regulations.

2 General Safety instructions

- Please familiarize yourself with the operating instructions before starting the machine.
- Please verify that you have read and understood supplemental instructions (this may concern special options for the machine).
- Only explicitly authorized personnel may operate, maintain or repair the machine. The legal minimum age must be observed.
- Use only trained or instructed personnel. Clearly define who is responsible for the operation or set up, maintenance and repair. Reject unsafe instructions by third parties and/or allow your personnel to reject these. This also applies in regards to traffic regulations.
- Any person still in training should only operate or work on the machine under the constant supervision and guidance of an experienced person.
- Check and observe all persons working or operating the machine at least periodically to ensure that they observe safety instructions and guidelines given in the operating manual.
- Wear proper work clothing when operating or working on the machine. Avoid wearing rings, watches, ties, scarves, open jackets or loose clothing. There is a danger of injury, as these items could get caught or be pulled in.
Wear task-appropriate personal protective equipment at all times.
- Consult the supervisor for any special safety procedures applicable to your job site.
- Always raise the safety lever before leaving the operator's seat.

Crushing and burn prevention

- Keep steps, ladders and handholds (handles) in proper condition. Make especially sure that they are free of dirt, oil, ice and snow.
NOTE: To ensure that the doors open in all weather conditions, lubricate the weather strips at least every two months, or more often, if necessary, with talcum powder or silicon. Lubricate the door hinges and locks regularly.
- When entering or leaving the cab, do not use the steering column, the control panel or the joysticks as handholds.
- Never jump off the machine, always use the steps, ladders, rails and handles provided to climb off or on the machine.
- Always face towards the machine when climbing on and off it, and always use the three points of contact with the machine (all times either two hands and one foot, or two feet and one hand are in contact with the access system).
- Familiarize yourself with the emergency exit.
- Proceed as described in the operating manual, if no other instructions are available for maintenance and repairs:
 - Place the machine on a solid and level ground and lower the working attachment to the ground.
 - Depressurize the hydraulic system.
 - Move all control levers to the neutral position.
 - Move the safety levers up prior to leaving the machine.
 - Remove the ignition key.
- Before servicing the hydraulic system you must reduce the pressure in the hydraulic system and tank, as described in this operating manual.
- Secure all loose parts on the machine.
- Never start a machine before completing a thorough walkaround inspection. Insure that all required safety signs are in place and legible.
- Do not modify, alter or otherwise change any safety-related systems of components without the specific approval of LIEBHERR.

3 Crushing and burn prevention

- Never work underneath the attachment as long as it is not safely resting on the ground or properly supported.
- Insure that all load supporting systems are in good repair and rated for the required load.
- Always wear work gloves when handling wire ropes.
- When working on the attachment, never align bores with your fingers, always use a suitable alignment tool.
- Keep hands, tools and any other objects away from contact with the cooling fan. The cooling fan can cause severe injury, objects can be catapulted away or destroyed, and the fan can be damaged by the objects.
- At or near operating temperature, the engine cooling system is hot and under pressure. Avoid contact with any components containing coolant. Danger of severe burns.
- Check the coolant level only after the radiator cap on the expansion tank is cool enough to touch. Turn the cap carefully to relieve the pressure.
- At or near operating temperature, the engine and the hydraulic oil are hot. Do not allow your skin to come into contact with hot oil or components containing hot oil.
- Always wear safety glasses and protective gloves when handling batteries. Avoid sparks and naked flames.
- Do not let any assisting personnel hold the attachment, bucket or grapple to assist in any operation.
- When working on the engine area, make sure that the side doors are properly secured to remain open during the service operation.

4 Fire and explosion prevention

- Switch off the diesel engine prior to filling the tank.
- Have skilled personnel immediately repair all defects, such as loose connections, blown fuses and burned out light bulbs, burned or frayed cables.
- Do not smoke and avoid naked flames when filling the tank or loading the batteries.
- Always start the diesel engine according to the operating instructions.
- Never store flammable fluids on the machine except in appropriate storage tanks.
- Regularly inspect all lines, hoses and fittings for leaks and damage.
- Repair any leaks immediately and replace damaged components.
- Be certain that all clamps, guards and heat shields are properly installed to prevent vibration, rubbing and heat build up.
- Do not use cold start aids (ether) near heat sources or naked flames or in insufficiently ventilated areas.
- Do not use ether containing starting aids to start diesel engines with pre-heat system or flame glow systems.
- Familiarize yourself with the location and use of fire extinguishers on the machine as well as the local fire reporting procedures and fire fighting possibilities.

5 Transport

- Insure that the transporting vehicle or truck trailer is rated for the intended machine weight and size.
- Park the machine on a level surface and chock the track chains and/or wheels.
- During transport, remove parts of the attachment that create an over width or length condition, if necessary.
- Clean the undercarriage. The undercarriage must be swept clean, meaning, the chains / wheels must be free of snow, ice and sludge prior to driving onto the transporting vehicle.
- Align the machine precisely with the loading ramp.
- Attach the manual lever for sensitive driving (crawler excavator) to the driving pedals.
- Have another person guide and signal the operator.
- On wheel models equipped with an uppercarriage locking mechanism, the uppercarriage must be secured to the undercarriage with the locking pin after loading onto the trailer.
- Secure the machine and any loose components with tiedowns in accordance with any applicable national regulations.
- Release all pressure lines (as described in this operating manual), remove the ignition key and pull the safety lever up prior to leaving the machine.
- Close all cab and panel doors.
- Verify that no one remains on the machine during the transport.
- Investigate the travel route, specifically in reference to limits for width, height and weight prior to the transport.
- Pay special attention when driving under electrical lines and bridges and when passing through tunnels.
- Use the same care for unloading as for loading.

6 Bringing the machine into service

- Before starting the machine, perform a thorough walkaround inspection.
- Visually check the machine for loose bolts, cracks, wear, leaks and damage.
- Never start or operate a damaged machine.

Starting the machine

- Make sure to correct any problems immediately.
- Verify that all hoods, covers and doors are closed, however, the locks should remain unlocked.
- Verify that all safety signs are in place.
- Make sure that all windows, as well as the inside and outside mirrors are clean. Secure all doors and windows to prevent unintentional movement.
- Before operating the machine, adjust the operator's seat, the mirror, the armrests and the other items to ensure comfortable and safe working conditions.
- The noise protection devices on the machine must be in working order.
- Never operate the machine without the cab.

7 Starting the machine

- Before start up, check all indicator lights and instruments for proper function, bring all controls into neutral position and insure that the safety lever is in the raised position.
- Blow the horn briefly prior to starting the diesel engine, in order to warn persons located near the machine.
- Only start the machine from the driver's seat.
- Start the diesel engine according to the regulations in the operating instructions, if you have not received any other instructions.
- Lower the safety lever and check all indicators, gauges, warning devices and controls for their proper indication.
- Only operate the diesel engine in a well-ventilated area, if the area is enclosed. If necessary, open doors and windows in the building to provide ample fresh air.
- Bring the engine and hydraulic oil to operating temperature. Low oil temperatures cause a slow reaction of the controls.
- Check that all attachment functions are operating properly.
- Carefully take the machine to an open area and check all control functions.

8 Shutting down the machine

- Park the machine on level and stable ground whenever possible. Otherwise, chock or block wheels when parking on a slope.
- Lower the attachment so that it rests on the ground.
- Move all control elements into the neutral position. Set the parking and slewing gear brake.
- Switch off the diesel engine according to the operating instructions and move the safety lever up, prior to leaving the driver's seat.
- Lock the machine, as well as all hoods, covers and doors; remove all keys and secure the machine against any unauthorized use.

9 Towing the machine

- Always observe the correct procedure: See chapter "Towing the machine" in this operating manual.
- The machine may only be towed in exceptional circumstances, such as moving a disabled machine from a hazardous location.
- Before pulling or towing the machine, check all cables, hooks and couplers for safety and stability.
- Towing equipment must have sufficient tensile strength and must be attached to the undercarriage at the designated tiedown attachment points.
- Never allow anyone to remain in the area of the towing devices.
- During the towing procedure, keep within the required transport position, the permissible speed

and distance.

- Proceed as outlined in the operating manual when putting the machine back into service.

10 Working with the machine

- Before starting to work, familiarize yourself with the specific conditions of the job site and any local regulations. These include: the obstacles in the working or movement area, the load carrying capacity of the ground and required safeguards for the job site to protect machines and personnel from public highway traffic.
- Always keep an adequate safety distance to overhangs, edges, embankments and an unsecured substrate.
- Be particularly cautious in conditions of reduced visibility and changing ground conditions.
- Always locate any underground utilities before you dig. Observe the required clearance distances to any underground utilities.
- Familiarize yourself with the location of power lines and use caution when working near them. Observe the required clearance distances to any power lines.
- In the case of contact with a power line:
 - do not move the machine or its attachment,
 - do not leave the operator's platform,
 - warn people in the vicinity not to approach or touch the machine,
 - have the power turned off.
- Before moving the machine, always ensure that the attachments are safely secured.
- When traveling on public roads, observe all traffic regulations, insure that your equipment has all required lighting and marking, and observe any applicable load limitations.
- Always turn on the lights in conditions of poor visibility or darkness.
- Do not permit any passengers on the machine (except on two way excavators).
- Operate the machine only when seated and with the seat belt fastened.
- Report any problems or needed repairs and make sure that all required repairs are carried out immediately.
- Insure that the intended work area is clear of all personnel before beginning work.
- Before starting to work, always check the brake system as outlined in the operating manual.
- Never leave the operator's seat as long as the machine is still moving.
- Never leave the machine unattended while the diesel engine is running.
- Know the loads to be handled and be aware of any stability limitations these loads may create.
- The maximum approved passable incline / traverse slope of the machine depends on the attached equipment as well as the substrate.
- For travel, move the uppercarriage parallel to the undercarriage and hold the load as close as possible to the ground.
EXCEPTION: see WHEN LOADING AND UNLOADING
- Adjust the travel speed to suit local conditions.
- Avoid working movements which could cause the machine to tip over.
- If possible, always work downhill or uphill, never sideways on a slope.
- Travel downhill at the permitted speed or you could lose control over the machine.
- Travel down grades at the appropriate speed to maintain control of the machine. Shift to a lower gear to allow the engine to control the maximum speed of the machine.
- When loading a truck, make sure that the truck driver leaves the cab, even if a rock protection is present.
- Always use the safety devices intended for their specific use for demolition work, clearings, hoisting operations, etc.
- For terrain which is difficult to gain an overview of and whenever necessary, ask for assistance of a guide. Have only one person signal you.
- Only permit experienced personnel to secure loads and signal the machine operator. The guide

must position himself within view of the operator or be in voice contact with him.

- Depending on the attachment combination, there can be a danger of collision between the working tool and the operator's cab, the cab protection or the boom cylinders. To avoid damage, utmost attention is required when the bucket teeth enter this range.

10.1 Use in material handling applications, specifically when travelling with raised loads and attachments

- Material handling applications, especially using a grapple, may require travel with suspended loads. Doing this will shift the machine centre of gravity and reduce stability.
The following practices and precautions should be observed:
 - Match your travel behaviour to the changed machine characteristics and surrounding conditions.
 - Reduce the travel speed to avoid sudden braking or steering manoeuvres.
 - Avoid sudden speed changes, such as braking, acceleration, changes in travel direction.
 - Turn the uppercarriage only if the undercarriage is not travelling.
 - Turn the uppercarriage only after taking on the load.
 - Move the machine only after you have taken on the load, lifted it and turned the uppercarriage in travel position.
 - If so required to the job site conditions, ensure, that you have appropriate windscreen protection. The protective screen (FOPS) must be installed if there is a danger of falling objects from overhead.
 - Do not exceed the grapple rated load. Know the density and weight of materials being handled.
- The working sequences when working with machines with grapples require a properly instructed and trained operator.
- The work application is only permitted after the machine operator has received sufficient training and practical experience.

10.2 Application of machines with tower elevation

- Due to the tower elevation, the centre of gravity of the machine will shift upward in vertical direction. The travel and work behaviour of the machine will thereby be strongly influenced, for example reduction of dynamic stability.
- Due to the elevated centre of gravity, the machine must be aligned in horizontal direction before starting to work. In horizontal direction, the centre of gravity of the uppercarriage is above the centre of the undercarriage, which improves stability.
- The machine can rock despite levelling and tip over!
For that reason, the following rules must be strictly observed:

When driving the machine:

- Driving with loads is not permitted.
- Swing the uppercarriage parallel to the undercarriage (transport position).
- Pull the attachment as close as possible to the machine.
- Only then may the outriggers be retracted and the machine be driven.
- Check the roadway to ensure that the ground is solid and even! Potholes and uneven road surfaces endanger the stability of the machine.
- Match your travel behaviour to the changed machine characteristics (higher centre of gravity) and surrounding conditions.
- Reduce the travel speed to avoid sudden braking or steering manoeuvres.
- Avoid sudden speed changes, such as braking, acceleration, changes in travel direction.
- Travel up or down grades perpendicular (at right angles) to the slope.
- Special care must be taken when driving through narrow passages - drive slowly!

In material handling operation:

- Wheel model: Before moving (turning) the uppercarriage from transport position, the machine must be supported on outriggers and horizontally aligned.

- Make sure to check the placement surface of the outriggers (load carrying capacity of ground). Sinking of an outrigger below ground level would result in devastating consequences!
- Carry out all movements with increased caution.
- When swinging a load, first bring the attachment as low and close to the machine as practical. Note: be aware of the hazard of grapple swing when moving a load toward the operator cab.
- Avoid abrupt slow down or acceleration of the attachment or uppercarriage.
- Never lift a heavier load than stated in the load chart.

10.3 Additional notes for machines with fixed cab raiser

- To enter and exit the machine, park the machine on level ground. Position the uppercarriage to the undercarriage in such a way that the steps and ladders are aligned.
- When entering or leaving the machine, always face the machine and use the three points of contact with the machine.
- When you can reach the door handle with your free hand, open the door first before climbing higher. Note that factors such as wind, can make it more difficult to open the door. For that reason, always guide the door by hand when opening the door. Make sure that the door is properly latched open.
- Continue to climb up and immediately sit on the operator's seat in the cab. Then close the door and fasten the safety belt.
- Proceed with the same care when exiting and climbing down as when entering and climbing up the machine.
- Park the machine only on firm and level ground. Position the uppercarriage to the undercarriage in such a way that the steps and ladders are aligned.
- Release the safety belt. When exiting, face the machine and use the three-point support. Climb down until you can close the door safely. Always guide the door by hand when closing the door.
- Finally climb down to the ground.

10.4 Protection from vibrations

- The vibration impact on mobile construction machinery is usually the result of the manner of utilization. Especially the following parameters have a significant influence:
 - Terrain conditions: Unevenness and potholes;
 - Operating techniques: Speed, steering, braking, control of operating elements of the machine during travel as well as working.
- The machine operator determines the vibration impact to a great part, since he himself selects the speed, the gear ratio, the working manner and the travel route. This results in a wide range of various vibration impacts for the same machine type.

The full body vibration impact for the machine operator can be reduced if the following recommendations are observed:

- Select the appropriate machine, equipment parts and auxiliary devices for the corresponding tasks.
- Keep the seat in good order and adjust it as follows:
 - The seat adjustment and the suspension should be made according to the weight and the size of the operator.
 - Check the suspension and the adjustment mechanism regularly and make sure that the characteristics of the seat remain as specified by the seat manufacturer.
- Check the maintenance condition of the machine, especially regarding: Tire pressure, brakes, steering, mechanical connections, etc.
- Do not steer, brake, accelerate and shift or move and load the attachment of the machine in a jerky manner.
- Match the machine speed to the travel route to avoid vibration impacts.
 - Decrease the speed when driving on pathless terrain;

Installation and removal of attachment parts

- Drive around obstacles and avoid very impassable terrain.
- Keep the quality of the terrain where the machine is working and travelling in good order:
 - Remove large rocks and obstacles;
 - Fill furrows and holes;
 - To establish and retain suitable terrain conditions, keep machines available and allow for sufficient time.
- Travel longer distances (i.e. on public roads) with suitable (medium) speed.
- For machines, which are frequently used for travel, consider use of auxiliary ride control systems, and also monitor speed to minimize buildup of "pitching" vehicle movement.

11 Installation and removal of attachment parts

- Equipment and attachment parts made by other manufacturers or those which do not have LIEBHERR's general approval for installation may not be installed on the machine without prior written approval by LIEBHERR.
LIEBHERR must be provided with the required technical documentation necessary for this purpose.
- Set the machine on a level and stable ground prior to any work with attachments.
- Lock the uppercarriage with the locking pin to the undercarriage.
- Do not position yourself under a raised attachment that has not been adequately and securely supported.
- Never place yourself under a machine while it is elevated.
- Remove hydraulic system pressure before working on any attachments (as described in this operating manual).
- Do not attempt to lift heavy parts. Use suitable lifting devices with sufficient load carrying capacity.
- Insure any lifting system or lifting device that is used is in good repair and adequately rated for the component or machine to be supported. Always wear work gloves when handling wire cables.
- When working on the equipment: Switch off the diesel engine, remove the key and turn the safety lever upward.
- During repairs: Make sure that the hydraulic lines are properly attached and that all fittings and connections are properly tightened.
- As soon as an attachment part is removed and supported, cover or cap the openings in the hydraulic circuit to prevent dirt infiltration. Permit only authorized persons near the machine or the lifting device.

11.1 Removal and installation of attachment pins

- Never use your fingers to align pin bores. If possible, always use a hydraulic pin pulling device to push out the pins on the attachment.
- If pins must be removed with a sledge hammer, use a punch and a guide tube held by another person.
- To drive out a pin, install the impact screw from the tool box in the threaded bore of the pin and hit the screw only.
- For the installation of a pin retained with castle nut and cotter pin, drive the pin in first to the stop, then install the castle nut by hand until contact and tighten it only to the point where the cotter pin can be installed.

12 Maintenance

12.1 General safety instructions

- Maintenance and repairs may only be carried out by trained expert technicians.
- Always note the frequency intervals for inspections as contained in this operating manual.
- Insure that an adequately equipped workshop is available to perform these tasks, and note the designated qualifications of the personnel responsible for each inspection.
- The maintenance and inspection schedule sets out precisely who should, or is allowed to carry out which jobs.
The machine operator (and his staff) are allowed to carry out certain jobs, but other jobs must be carried out only by qualified and trained staff.
- Spare parts must meet the technical requirements set forth by the manufacturer. This is always ensured with original spare parts.
- Wear task-appropriate personal protective equipment at all times. Example: In addition to a protective helmet and safety boots, for certain jobs protective goggles and gloves are also necessary.
- Keep unauthorized personnel away from the machine during maintenance.
- Secure a wide-ranging area for maintenance, as necessary.
- Inform the operator before starting to carry out special tasks and maintenance work. Make sure he knows the person who is in charge of the work.
- Perform all maintenance operations on the machine on a level and stable ground with the working equipment lowered and the diesel engine turned off, unless described otherwise in the operating manual.
- Hang a well visible warning label “do not switch on” onto the ignition during maintenance operations, especially when working under the machine. Remove the ignition key and set the main battery switch to position 0.
- Re-torque all bolts at the completion of the maintenance procedure to the required torque specification.
- If the dismantling of safety equipment is necessary, the safety equipment must be re-attached and inspected directly upon conclusion of the operations.

12.2 Checking for cracks

- Machines are subject to different loads, depending on application, job site, duration of use and conditions of use. The different load conditions result in different service lives for various machines components. This could lead to cracks and loose connections, particularly on load-bearing parts. This applies particularly to machines used in material handling or industrial applications or for machines with special equipment, such as demolition excavators. To ensure that operating safety is maintained, the machine must be checked regularly for cracks, loose connections or other visible damage.
- To check for cracks, it is necessary to keep the machine clean and to clean it regularly.
- The inspection must be carried out according to the inspection and maintenance schedule.
- It is advisable to carry out these inspections with the machine supported, on firm and level ground.
- Specific attention should be given to the following:
 - The steel structure undercarriage with axle and gear mounting, support, lower slewing ring seating with tower and slewing ring.
 - The steel structure uppercarriage with bearing block for boom and boom cylinder, upper slewing ring seating, cab bearing, mounting of slewing gear and counterweight.
 - Steel structure of working attachments, e. g. boom, stick, quick change adapter, digging tool and grapple.
 - Hydraulic cylinder, axles, steering, pins and pin connections, steps, ladders and mounting elements.

Maintenance

- Check for cracks visually. If a crack is suspected or is in areas which are not easily visible, such as the slewing ring seating, then the dye penetration procedure should be used to check for cracks.
- Any damage found must be fixed immediately. Welding on load-bearing parts of earth moving machines, material handling and transport units may only be made by certified welders in accordance with acceptable welding practices. Contact LIEBHERR Service to discuss suitable measures.

12.3 Welding

- Welding, cutting and grinding should only be done with the specific approval of LIEBHERR. Prior to any welding, cutting or grinding, clean the machine and surrounding area to remove dust and flammable materials.
- Insure adequate ventilation.

12.4 Fuels, lubricants and process chemicals

- When handling oils, greases and other chemical substances, always observe the applicable safety regulations for the corresponding product.
- Ensure safe and environmentally friendly disposal of operating and service fluids as well as exchange parts.
- Handle hot operating and service fluids carefully (danger of burning and scalding).

12.5 Repair

- Do not attempt to lift heavy parts. Use lifting devices with sufficient load carrying capacity. When replacing parts or large sub-assemblies, use appropriate and functioning lifting devices and adequate load carrying capacity to insure safe movement during installation. Never stand or work under suspended loads.
- Always wear work gloves when handling wire ropes.
- Only permit experienced personnel to secure loads and signal the crane operator. The guide must position himself within view of the operator or be in voice contact with him.
- When working overhead, use appropriate safe access ladders and working platforms. Do not use parts of the machine as climbing devices, if they are not designed for this purpose. Wear a harness when working at great heights. Keep handles, steps, railings, platforms, and ladders free of dirt, ice and snow.
- When working on the attachment (for example when replacing teeth), make sure the machine is properly supported. Never use metal-on-metal support.
- Never stand underneath a machine that has been raised with the aid of work equipment unless it has been properly and securely supported.
- Always support the machine in such a ways that any shifting weight will not endanger the stability of the machine and avoid metal to metal contact.
- Work on travel gears, brake and steering systems may only be carried out by specially trained expert personnel.
- If the machine must be repaired on an incline, block the track chains with chocks and secure the uppercarriage to the undercarriage with the locking pin.
- Only qualified, specially trained personnel may work on the hydraulic system.
- Do not check for hydraulic leaks with your hand. Use cardboard or similar material to detect leaks. Wear work gloves.
- Do not loosen any lines or bolts before lowering the equipment, turning off the diesel engine and relieving the hydraulic system. After the diesel engine has been turned off, you must move all pilot controls (right handed joystick and pedals) into all directions to reduce the control pressure and the dynamic pressure in the work cycles. Then release the pressure in the tank, as described in

this operating manual.

12.6 Electrical system

- Check the electrical system regularly.
All defects, such as loose connections, burnt out fuses and bulbs, burnt or damaged wires or cables must be repaired immediately by an electrician or specially trained personnel.
- Only use original fuses with the correct amperage.
- Only qualified technicians should attempt troubleshooting or repairs on high voltage systems.
- DO NOT work on energized attachments.
- When working on mid and high voltage components, shut off the voltage and connect the supply cable to the ground to discharge any stored energy.
- Check all disconnected parts if they are truly free of current, ground them and short circuit them. Insulate adjacent, current carrying parts.
- Disconnect the battery before working on the electrical system or before carrying out any arc welding work on the machine.

12.7 Pressure accumulator

- Pressure accumulators contain stored energy and operate at high pressures. Only specially trained personnel may work on pressure accumulators.
- Do not operate damaged pressure accumulators.
- You must reduce the pressure in the hydraulic system as described in this operating manual prior to working on a hydraulic accumulator.
- Do not weld or solder on the pressure accumulator and do not carry out any mechanical work on them.
- Fill the pressure accumulator only with nitrogen.
- The accumulator housing can become hot during operation, there is a danger of burning.
- New pressure accumulators must be charged to the required pressure for the application before use.
- The operating data (minimum and maximum pressure) is marked permanently on the pressure accumulators. Make sure that the marking remains visible.

12.8 Hydraulic hoses and lines

- Hydraulic lines and hoses may never be repaired!
- All hoses, lines and fittings must be checked every two weeks for leaks and visible damage. Damaged parts must be replaced immediately. Remember that escaping high pressure oil can penetrate skin. Escaping oil can also cause fires.
- Even if hoses are properly stored and used, they undergo a natural aging process. For that reason, their service life is limited.
 - Improper storage, mechanical damage and impermissible use are the most frequent causes of failure.
 - Using hoses and lines close to the limit ranges of permitted use can shorten the service life (for example in high temperatures, frequent work cycles, extremely high impulse frequencies, multi shift operation).
- Hoses and lines must be replaced when the following conditions are found during inspection:
 - Damage to the outer layer as far as the intermediate layer (e.g. chafing, cuts and cracks);
 - Brittleness of the outer layer (hose material cracking);
 - Deformations, which differ from the natural shape of the hose or hose line, when under pressure or not under pressure, or in bends (e.g. separation of layers, blisters or bubbles);
 - Leaks;

- Failure to follow installation instructions;
- Damage or deformation of hose fittings, which reduce the strength of the fitting or the hose / fitting connection;
- Hose slipping out of the fitting;
- Corrosion on the fittings, which reduces function and strength;
- When replacing hoses and lines, observe the following:
 - Use only original spare parts.
 - Route and install hoses and lines properly, observe correct connection points.
 - Always ensure that the hoses and lines are free of torsion when routing. On high pressure hoses, always attach the screws of half clamps or full flange on both ends of hose first and then tighten.
 - When using high pressure hoses and lines with a bent fitting, always tighten the end with the bent fitting first when tightening the flanges, then the end with the straight fitting.
 - Any existing mounting clamps in the centre of the hose may only be installed and tightened thereafter.
 - Check daily to ensure that all clamps, covers and protective devices are properly mounted. This prevents vibration and damage during operation.
 - Route the hoses and lines in such a way that chafing with other hoses or other structures is prevented.
 - A minimum distance of approximately $\frac{1}{2}$ of the outer hose diameter to the other parts is recommended. The distance should not be less than 10 to 15 mm (1/2 inch).
 - When replacing hoses and lines on movable parts (e.g. from boom to stick), check for hose interference and kinking over the complete range of motion.

12.9 Cab protection (FOPS)

For certain machine applications LIEBHERR offers optional cab protection systems of various designs. These systems consist of a full length FOPS (falling objects protective structure) or a top guard and front guard to protect the operator's cab and windscreen area from falling objects (for example rocks or debris).

The full length FOPS wraps around the operator's cab, is mounted to the uppercarriage and is a stand-alone system.

The top and front guards are either bolted individually or in combination to the cab structure. In that case the operator's cab is also part of the cab protection system and is subject to the following instructions.

- Never operate a machine if one of these protections is damaged in any way.
- Damages may occur due to:
 - structural modifications or repairs (for example welding, cutting or drilling)
 - deformation after an accident
 - falling objects
- Structural modifications or repairs of any kind are prohibited without the expressed, written approval of LIEBHERR.

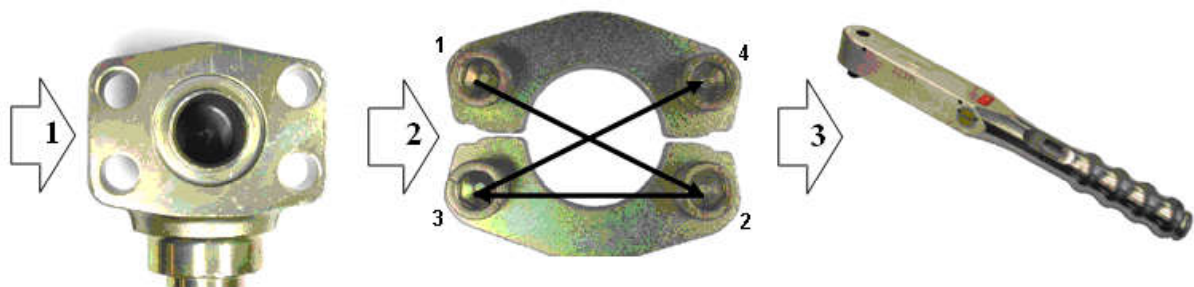
Tightening torques for screws in hydraulic flange connections

1. Scope and purpose:

By tightening the 4 screws of a flange connection conforming to ISO 6162-1/2 (SAE J518), the force necessary to compress the seal and to hold the two flange sections together is applied.

This standard is valid for LHB.

2. Description



- Ensure that the sealing faces are **free** of burrs, grooves, scratches and foreign objects.
- Tighten the screws by hand (10 Nm) crosswise from 1 to 4, as shown in figure 2.
- Tighten the screws with the prescribed torque crosswise from 1 to 4 as shown in figure 2.
- For tightening torques, refer to the table below.

Flange Series C.61	Flange series C.62	Bolt circle (BC)	Metric screw 10.9	Torque* [Nm]
1/2"	1/2"	BC 55	M8	31
3/4"; 1"; 1 1/4"	3/4"	BC 51; BC 56; BC 62	M10	60
1 1/2"; 2"; 2 1/2"	1"; 1 1/4"	BC 72.5	M12	103
(3")	(1 1/4")		M14	164
3"; 3 1/2"; 4"; 5"	1 1/2"		M16	253
			M18	352
	2"		M20	496
			M22	678
			M24	854

* The tightening torques are calculated according to VDI 2230 (July 1986) for strength class 10.9 and coefficient of friction $\mu = 0.1$.

(The values of the edition of February 2003 have not been included in the table, as this would not be justified according to our experience.)

The tightening torques specified in drawings have precedence over those in the table and must be strictly adhered to.

PRELOADS AND TIGHTENING TORQUES FOR SCREWS WITH METRIC COARSE AND FINE THREADS ACCORDING TO DIN ISO 261

The preloads and torques included in the table are based on the VDI regulations 2230 of July 1986.
(The values of the edition from February 2003 have not been included in the table, as this would not be justified according to our experience.)

Assembly preloads F_M and tightening torques M_A at $v = 0.9$ for headless screws with metric coarse or fine threads according to DIN ISO 262 (and DIN ISO 965-2);

Head dimensions of hex head screws according to DIN EN ISO 4014 to 4018, screws with hexalobular external driving heads according to DIN 34800 or Allen head screws according to DIN EN ISO 4762 and "centre" bores according to DIN EN 20273

Metric coarse thread				Metric fine thread			
Surface finish: - black-chrome finish or phosphatised - electro-galvanised - flZn = zinc flake coating (LH standard 10021432, DAC)				Surface finish: - black-chrome finish or phosphatised - electro-galvanised - flZn = zinc flake coating (LH standard 10021432, DAC)			
oiled				oiled			
Thread	Class	Assembly preloads F_M in N	Tightening torques M_A in Nm	Thread	Class	Assembly preloads F_M in N	Tightening torques M_A in Nm
for mean friction factor $\mu_G = 0.12$				for mean friction factor $\mu_G = 0.12$			
M4	8.8	4 050	2,8				
	10.9	6 000	4,1				
	12.9	7 000	4,8				
M5	8.8	6 600	5,5				
	10.9	9 700	8,1				
	12.9	11 400	9,5				
M6	8.8	9 400	9,5				
	10.9	13 700	14,0				
	12.9	16 100	16,5				
M7	8.8	13 700	15,5				
	10.9	20 100	23,0				
	12.9	23 500	27				
M8	8.8	17 200	23	M8x1	8.8	18 800	24,5
	10.9	25 000	34		10.9	27 500	36
	12.9	29 500	40		12.9	32 500	43
				M9x1	8.8	24 800	36
					10.9	36 500	53
					12.9	42 500	62
M10	8.8	27 500	46	M10x1	8.8	31 500	52
	10.9	40 000	68		10.9	46 500	76
	12.9	47 000	79		12.9	54 000	89
				M10x1,25	8.8	29 500	49
					10.9	43 000	72
					12.9	51 000	84
M12	8.8	40 000	79	M12x1,25	8.8	45 000	87
	10.9	59 000	117		10.9	66 000	125
	12.9	69 000	135		12.9	77 000	150
				M12x1,5	8.8	42 500	83
					10.9	62 000	122
					12.9	73 000	145
M14	8.8	55 000	125	M14x1,5	8.8	61 000	135
	10.9	80 000	185		10.9	89 000	200
	12.9	94 000	215		12.9	104 000	235
M16	8.8	75 000	195	M16x1,5	8.8	82 000	205
	10.9	111 000	280		10.9	121 000	300
	12.9	130 000	330		12.9	141 000	360

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