

# **OPERATING INSTRUCTIONS FOR HYDRAULIC HOSE LINES**

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## Manufacturer

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## 1. Proper use

Hydraulic hose assemblies are hose assemblies used to transmit force in hydraulic systems.

## 2. General information

Hydraulic hose assemblies (with an average service life of six years) are installed virtually everywhere in hydraulic systems. Working with these hose assemblies poses certain risks. For this reason, it is important to know how to handle hydraulic hose assemblies properly and to follow this information to prevent accidents. This knowledge is also an important factor to reduce unplanned downtimes.

## 3. Responsibility of the owner/operator

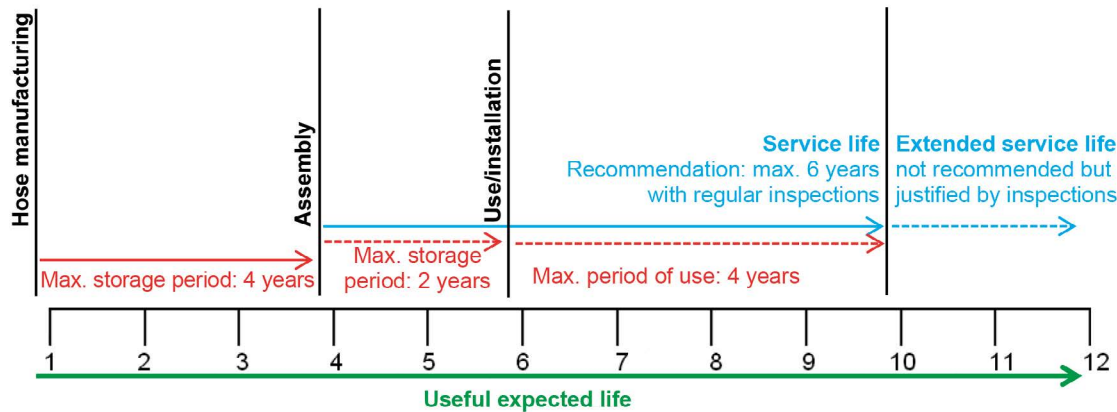
Hydraulic hose assemblies are a type of working equipment. The owner/operator must comply with inspection requirements and deadlines applicable to hydraulic hose assemblies. These include the German Operational Safety Ordinance (Betriebssicherheitsverordnung or BetrSichV) and the new Working Equipment and System Safety Ordinance (Arbeitsmittel- und Anlagensicherheitsverordnung or ArbmittV) as well as DGUV regulation 113-020.

The hose assembly and fittings must fit together in a functional way and functional safety must be confirmed with a suitable test procedure (e.g. hydrostatic requirements in accordance with DIN EN ISO 1402 as well as impulse test requirements in accordance with DIN EN ISO 6803).

## 4. Expected useful life of hydraulic hose assemblies

Hydraulic hose assemblies are wearing parts with a limited service life. They have a limited expected useful life, which is influenced by storage conditions and the amount of strain placed on them. Depending on the hazard potential, load and economic relevance, the determination of fixed recurrent testing and replacement intervals is strongly recommended.

Expected useful life means the entire useful life of the hose assembly from the point of manufacturing and including the entire service life. Service life includes time of usage as well as storage of the hose assembly starting with fabrication.



Conclusions and recommendations regarding the expected useful life in case of normal levels of load/demands in accordance with DIN 20066:

- The hose assembly may be used for up to 10 years (4 + 6 years).
- In case of immediate use after fabrication, the hose assembly may be used for up to 6 years (2 + 4 years).

## 5. Load/increased demands

Increased demands on the hose assembly can significantly shorten the permissible period of use, i.e. use in the limit range of permissible load levels. This includes high temperatures, frequent movements, extremely high impulse frequencies, increased periods of use or multi-shift operation.

## 6. Storage conditions

The DIN EN ISO 8331 or DIN 7716 standards include information about the optimum storage conditions for hoses and hose assemblies:

- Dry, cool and low dust levels
- Relative humidity < 70%
- Storage temperature below 25 °C. The service life of the hose assembly decreases at higher temperatures (It is crucial to avoid temperatures above 50 °C or below - 30 °C as well as significant temperature fluctuations)
- Avoid exposure to direct sunlight or UV light
- Shield from heat sources
- Protect against exposure to ozone
- Keep free of loads (no tensile or compressive loads)
- Do not store in the same place as solvents, fuels or lubricants
- Protect against rodents
- Best to store in rolls without winding tighter than the bending radius

Always strive for ideal storage conditions in accordance with this standard. If local conditions and/or cost-efficiency requirements do not allow for ideal storage conditions, the hose assemblies can also be stored in an enclosed room under normal workshop conditions. In this case, keep the following points in mind:

- Different types of hose assemblies exhibit different types of performance losses. Braided hose assemblies perform worse than spiral hose assemblies, for example.
- Changes to the hose assembly material or surface due to age are barely visible to the naked eye.
- Seemingly flawless external conditions do not guarantee that a hose assembly is free of defects.

It is NOT permissible to store hose assemblies outside permanently. Research has shown that hose assembly materials suffer significant performance loss when stored outside.

## Keep the following in mind for storing fabricated hose assemblies:

The ends of the hydraulic hose assembly must be sealed. Storage times for fabricated hose assemblies should be as short as possible due to the effects of cold flow. Cold flow refers to the deformation of certain elastic materials, particular thermoplastics, which are exposed to constant loads in a cold or normal state. Elasticity and thus elastic tension levels decrease. Cold flow takes effect following assembly.

## 7. Marking of hose assemblies

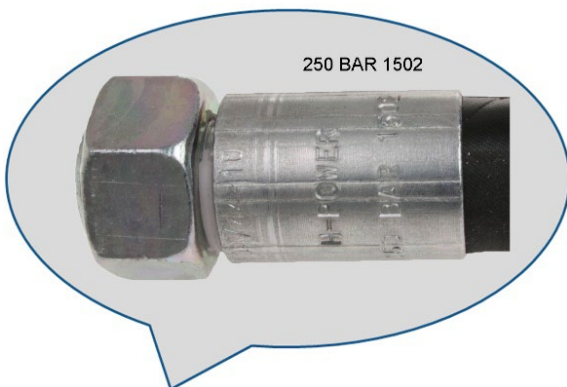
Only hose assemblies permanently marked with at least the following information may be used:

### On the hose:

- Manufacturer name or marking
- Product standard number (e.g. EN 853)
- Hose type (e.g. 2SN)
- Nominal diameter in mm (e.g. DN 10)
- Manufacturing date of the hose (quarter/year)

### On the hose assembly (e.g. using labels, stamped sleeve, etc.)

- Manufacturer name or marking
- Maximum permissible operating pressure in bar or MPa/psi
- Manufacturing date of the hose assembly (the last two digits of the production year and month of manufacture)



**Important notice:** The markings on the hose assembly and the press-fitting sleeve can differ. The lower value applies to the hose assembly: 250 bar (= 25 MPa)!

## 8. Defective materials (inspection/testing)

The user has to carry out a risk assessment before commissioning any type of equipment. This assessment provides safety-relevant information applicable to hose assemblies.

## 8.1 Inspection criteria for hydraulic hose assemblies

Hose assemblies must be inspected to check proper function at regular intervals during their operating life. These general rules apply: Hose assemblies must be replaced or retrofitted immediately if any of the following is detected during an inspection:

- The markings on the hose assembly material and press-fitting sleeve are missing or faulty
- Damage to the outer layer (cracks, cuts and chafe marks down to the reinforcement layer)
- Embrittlement of the outer layer (cracks forming on the hose assembly cover)
- Deformations not conforming to the natural shape of the hose or hose assembly. This rule applies whether the hose assembly is in a pressurized or unpressurized state or if it is bent (e.g. formation of bubbles/blisters, pinched areas, kinks, layer separation).
- Leaking
- Damage to or deformation of the hose assembly fittings (the sealing function is compromised)
- The hose assembly wandering out of the fitting
- Signs of corrosion on the fitting which impede its sturdiness or function
- Storage and service life has been exceeded
- Installation requirements have not been observed
- Missing safety-relevant protective measures

## 8.2 Inspection intervals for hose assemblies

Hydraulic hose assemblies must be inspected regularly at predetermined intervals since they are subject to damaging forces which may lead to hazardous situations. These inspections are intended to detect and rectify damage in a timely manner.

Unless differing company and/or machine-specific inspection intervals (e.g. stipulated by the manufacturer) exist, the following regular inspection intervals are recommended:

| Demands on the hydraulic hose assembly     | Empfohlene Prüffrist |
|--------------------------------------------|----------------------|
| normal levels of demand                    | 12 months            |
| increased levels of demand (see Chapter 5) | 6 months             |

## 9. Safe installation/removal of hydraulic hose assemblies

It is crucial to comply with the information from the risk assessment as well as specifications put forth in the German BGI 5100 regulation.

### 9.1 Installation criteria

Hydraulic hose assemblies must be installed in a manner that ensures the following:

- The hose assembly has the required length to prevent kinks as well as tensile and compression loads during operation.
- The bending radius does not fall below the minimum required value.
- The risk of torsion, swinging or lashing of the hose assembly due to faulty installation or during operation has been reduced to a minimum.
- The hose assemblies have been arranged or protected in a way that minimizes abrasion of the outer layer and prevents kinks.
- The hose assemblies have been affixed properly in cases where the weight of the hose assembly may lead to impermissible loads.
- The hose assemblies are not used as a climbing aid or repurposed in any other way.
- The hose assemblies are protected against the damaging effects from the internal or external temperature.
- Pressure peaks do not exceed the permissible operation pressure value. If hose assembly and fitting indicate different permissible nominal pressure values, the lower value is to be used as the operating pressure of the hose assembly.
- Persons in close proximity to the machine (e.g. machine operators, drivers, front or rear passengers, persons present in the general traffic route vicinity) are not at risk in case the hydraulic hose assembly malfunctions (e.g. risk from jets spraying from pinholes or lashing of the hose assembly).
- Suitable collecting trays have been placed below the respective components to catch any leaking hydraulic fluid.
- The hose assemblies are not re-coated since this can have a negative effect on the service life of the hose assembly and can make markings illegible.

## 9.2 Removal criteria

To safely remove hydraulic hose assemblies, ensure the following:

- The system has been depressurized before beginning any removal work.
- The hydraulic pump has been switched off and has been secured to prevent it from being switched back on.
- The correct connection has been selected.
- Any existing pressure accumulator has been disconnected from the control system and the system has been de-energized.
- Raised loads (including machine parts) have been lowered, secured or propped up in a safe manner.
- The valves have been activated several times to ensure they are no longer pressurized.
- The hose assembly is checked once again to ensure it has been depressurized successfully before opening the associated hose assembly.
- The screw connection can be loosened without pressure.

## 9.3 Damage prevention

- It is not permissible to build hose assemblies by using hoses and fittings that were previously part of a different hose assembly.
- Hose assemblies must fulfill the requirements specified in applicable national, European and/or international regulations and standards.
- Comply with separate manufacturer guidelines for storage times for the hose assemblies.
- Take recommendations for the length of the operating life for the hose assemblies into account.
- If damage to a hose assembly poses a risk due to lashing, the hose assembly must be restrained (e.g. with a hose assembly safety catch) or shielded.
- If a hose assembly poses a risk because hydraulic fluid is leaking uncontrollably (pinhole or bursting of the hose assembly), it must be equipped with suitable protective measures (panels, burst-proof hose assemblies).
- A defective hose or hose assembly must be replaced immediately.
- Once a new hydraulic hose assembly has been installed successfully, the hydraulic system must be filled and bled in accordance with the manufacturer's specifications. If the system is not bled completely, unexpected sudden movements may occur which pose a risk to maintenance staff.
- Once the hydraulic system has been bled, all hydraulic functions must be tested in accordance with the manufacturer's specifications.
- Only remove securing elements used to support raised loads when the load is securely held by the hydraulic system.

## 10. Handling hydraulic fluid

Hydraulic fluids are part of the hydraulic equipment of a machine ready for operation. They must not pose a risk to the safety or health of persons or the environment. To guarantee flawless and safe function of the system and the hose assemblies in use, it is crucial to ensure that the fluids used comply with the specifications and recommendations of system and component manufacturers (see operating instructions). Moreover, the purity classes of the hydraulic fluids must match the classes required by the machine manufacturer. Media which do not comply with specified requirements or contain impermissible levels of contamination damage the entire hydraulic system and decrease the service life of the hydraulic hose assemblies in use (see also DIN EN ISO 4413).

### 10.1 Risk of fire/explosion

Hydraulic fluids are flammable. Vapors (released from very intense heating) and mist (created from very high pressure) can form potentially explosive mixtures with the air.

Oil-drenched clothing also poses a risk of ignition. Observe the following protective measures and codes of conduct:

- Stay away from ignition sources.
- Do not smoke.
- Keep containers closed and protect against heating.
- Store drenched rags in non-flammable, closed containers
- Replace cleaning rags regularly.
- Ensure that any incipient fires are extinguished immediately using suitable fire-extinguishing agents and equipment.

### 10.2 Environmental compatibility

Conventional hydraulic fluids are water pollutants and damage the environment. Groundwater contamination is frequently caused by mineral oils leaking from tanks or hydraulic systems and seeping deep within the earth. Aromatic hydrocarbons contained in these oils can be both toxic and carcinogenic and thus pose a hazard to drinking water quality.

In particularly environmentally sensitive areas, it is mandatory to use rapidly biodegradable hydraulic fluids which do not contain any substances belonging to Water Hazard Class 3 (in accordance with RAL-ZU 79). It is important to bear in mind, however, that not every biodegradable fluid is suitable for use in the respective machine or system from a technical point of view. Before switching fluids, obtain approval from the machine or hose assembly manufacturer (see also DIN ISO 15380).

When switching a system to a rapidly biodegradable hydraulic fluid, it is crucial to comply with the fluid change guidelines outlined in DIN ISO 15380! Flushing procedures are necessary since the amount of hydraulic fluid in the tank usually only accounts for approximately 30% of the total fluid volume. The mineral oil content must be below 2% after the fluid has been changed. A higher mineral oil content may cause the biodegradable fluid to lose its rapidly biodegradable capabilities.

Immediately notify the authorities if larger amounts of hydraulic fluid seep into the ground by accident to prevent more extensive environmental damage. The use of biodegradable fluids does not exempt the user from this notification obligation since these fluids still contaminate drinking water. Hydraulic fluids, regardless of type, may not be released into the earth during fluid change procedures.

Comply with the following protective measures and codes of conduct:

- Store hydraulic fluids above collecting trays.
- Report any accidents to the fire department or police.

## 10.3 Hydraulic hose assembly disposal

There is no standardized ordinance regulating hydraulic hose assembly disposal. Old plastic or rubber parts should be disposed by means of waste incineration. Fittings should be disposed as scrap metal unless other recycling processes can be used. The local municipal authority can provide further information.

## 10.4 Health hazard

Hydraulic fluids are a health hazard. Frequent or extended contact with the products can cause skin conditions or allergies. Respirators are required if an unexpected concentration of vapors, aerosols or flue gases (if hydraulic fluid is burnt) escapes.

Comply with the following protective measures and codes of conduct:

- Prevent spraying of the fluid. Thoroughly flush the eyes immediately if fluid gets into the eyes.
- Avoid breathing in vapors, aerosols and gases. Wear a respirator.
- Mark filled containers.
- Never use containers used for foodstuffs or containers which could be mistaken for foodstuff containers.

**In case of an accident while handling hydraulic fluids, refer to our information sheet for physicians “Code of conduct in the event of accidents involving hydraulic fluid”!**

## 11. References

DGUV Regulation 113-020 (formerly DGUV Regulation 113-007/113-015, BGR 137/237) “Hydraulik-Schlauchleitungen und Hydraulik-Flüssigkeiten – Regeln für den sicheren Einsatz” (Hydraulic hose assemblies and Hydraulic fluids – regulations for safe use)

BGI/GUV-I 5100 “Sicherheit bei der Hydraulik-Instandhaltung” (Safe maintenance of hydraulic systems)

“Hydraulische Leitungstechnik – ein Praxishandbuch” (Hydraulic hose assembly equipment – a practical manual), Helmut Wetteborn

<http://www.oelcheck.de>

## 12. Standards

|                 |                                                                                                       |
|-----------------|-------------------------------------------------------------------------------------------------------|
| DIN EN ISO 1402 | Rubber and plastic hoses and hose assemblies - Hydrostatic testing                                    |
| DIN EN ISO 4413 | Hydraulic fluid power - General rules and safety requirements for systems and their components        |
| DIN EN ISO 6803 | Rubber or plastic hoses and hose assemblies - Hydraulic-pressure impulse test without flexing         |
| DIN EN ISO 8331 | Rubber and plastic hoses and hose assemblies - Guidelines for selection, storage, use and maintenance |
| DIN ISO 15380   | Lubricants, industrial oils and related products                                                      |
| DIN 20066       | Hydraulic fluid power - hose assemblies - dimensions, requirements                                    |
| DIN 7716        | Rubber products; requirements for storage, cleaning and maintenance                                   |
| RAL-ZU 79       | Rapidly biodegradable hydraulic fluids                                                                |

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# Information sheet for the physician for accidents involving hydraulic fluid

## Code of conduct in the event of accidents involving hydraulic fluid (hydraulic oil)

Accidents involving hydraulic fluid, such as the injection of hydraulic fluid under the skin, can lead to severe and even fatal injuries. Affected persons must be taken to the hospital immediately or to an ophthalmic clinic in case of injuries to the eyes. Affected persons must also receive appropriate medical treatment without delay if an injury is only suspected and if only minor external injuries are visible.

## Information for the attending physician

### Technical background

High-pressure systems can discharge mineral oil at pressure levels of up to 800 bar. These pressure levels are strong enough to penetrate clothing and gloves.

### Course of the medical condition (pathogenesis)

An high-pressure jet of hydraulic fluid can penetrate skin down to subcutaneous tissue. It then spreads via the fasciae and tendon sheaths and causes ischemia. Subcutaneous inflammation develops followed by fibrosis and a response in the lymph nodes.

### Clinical occurrence

The index finger of the non-dominant hand is most frequently affected. An injection resulting in a small penetration wound, minor swelling of the area and only minor symptoms often seems insignificant initially. However, symptoms typically worsen within 1 to 2 hours. An affected finger or toe will turn pale and become numb. Edema develops within a few hours (sometimes a few days) and the level of pain increases. An infection develops in some cases. However, the subcutaneous high-pressure injection of hydraulic fluid does not have a systematic toxic effect.

### Treatment

The exact composition of the injected fluid is unimportant for emergency treatment. Many physicians stress the importance of transferring the patient quickly to an emergency facility with a skilled orthopedic or plastic surgeon. The time between initial injury and treatment is considered the most important factor for successful treatment (Flotre, M. (1992): High-pressure injection injuries on the hand).

### Flotre recommends the following treatment steps:

- Apply a cold compress prior to surgery and raise the arm to reduce swelling.
- Administer a broad-spectrum antibiotic parenterally, together a tetanus shot if necessary. Perform surgery under general anesthesia or with local anesthesia of the brachial plexus.
- Avoid cutting off circulation to the fingers since this may result in further ischemia and blood vessel spasms.
- Do not apply an Esmarch bandage if anesthesia of the brachial plexus was used. Use a tourniquet instead after raising the arm for 5 minutes.
- During surgery, carry out a decompression of the affected areas first. Follow this with debridement, flushing and brushing.
- Remove as much of the injected fluid and necrotic tissue as possible. Keep the wound open and cover with iodine dressing or a comparable material. Draining the wound can be beneficial.