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05-Mechanic
Hydraulic System

Doc. no.: NA-05-STS-011

This standard technical specification is subject to change without prior notice. The most current issue will at all times be located on the Norðurál web site, www.nordural.is.

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1 Responsibility

This Standard Technical Specification (STS) is of responsibility of the owner. The revision and date of issue are on the front page.

All deviations from the specifications must be approved in writing by the Owner.

2 Scope and field of application

2.1 Scope Definition

This Standard Technical Specification details the minimum technical requirements including but not limited to, the design, material quality and workmanship, installation, testing, inspection and identification for hydraulic installation.

The provision of this Standard Technical Specification for hydraulic systems applies to the production area of Norðurál's aluminum smelter.

2.2 Document Conflicts

Any conflicts between the referenced documents shall be brought to the attention of the Owner without delay and in writing for resolution.

3 References and Definitions

3.1 References

All equipment, materials, workmanship, design calculation and tests shall be performed in compliance and read in conjunction with the NA-00-STS001 General Technical Standard and other relevant standards.

The relevance order of standards shall be according to NA-00-STS001. All materials intended for use at Norðurál shall be approved by the Owner. All Norðurál Standard Technical Specifications can be accessed on Norðurál website, www.nordural.is/islenska/fyrirtaekid/innkaup/stadlar

The following referenced documents should be considered for the application of this document. For dated references, only the edition cited applies. For all references, dated and undated, the latest edition of the referenced document (including any amendments) applies.

Standard Nr.	Subject/Name
Directive: 2006/42/EC	Machine Directive
Directive: 2003/10/EC	Noise
NA-03-STS001	Surface treatment and painting
NA-06-STS002	Specification for LOTOV
DIN 2401	Pressure and temperature specifications for components subjected to internal and external pressure; concepts and nominal pressure stages
DIN 24550	Fluid power - Hydraulic filters
DIN 51524-1	Pressure fluids - Hydraulic oils - Part 1: HL hydraulic oils; Minimum requirements
EN ISO 12100, parts 1 and 2	Safety of Machinery
EN ISO 14121, parts 1 and 2	Safety of Machinery – Risk Assessment
EN ISO 13849, parts 1 and 2	Safety of Machinery – Safety-related parts of control systems
EN ISO 13850	Safety of machinery -- Emergency stop -- Principles for design

ISO 1219	Fluid power systems and components -- Graphical symbols and circuit diagrams
ISO 1436	Rubber hoses and hose assemblies -- Wire-braid-reinforced hydraulic types for oil-based or water-based fluids -- Specification
ISO 1629.	Rubber and latices -- Nomenclature
ISO 4413:2010	Hydraulic fluid power -- General rules and safety requirements for systems and their components
ISO 3448:2010-2	Industrial liquid lubricants - ISO viscosity classification
ISO 4401	Hydraulic fluid power -- Four-port directional control valves -- Mounting surfaces
ISO 4406	Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles
ISO 6164	Hydraulic fluid power -- Four-screw, one-piece square-flange connections for use at pressures of 25 MPa and 40 MPa (250 bar and 400 bar)
ISO 6547	Hydraulic fluid power - Cylinders -- Piston seal housings incorporating bearing rings - Dimensions and tolerances
ISO 6743-4	Lubricants, industrial oils and related products (class L) – classification – Part 4: family H (hydraulic systems)
ISO 8434, Part 1 and 2	Metallic tube connections for fluid power and general use
ISO 10763	Hydraulic fluid power -- Plain-end, seamless and welded precision steel tubes -- Dimensions and nominal working pressures
ISO 11158	Lubricants, industrial oils and related products (class L) -- Family H (hydraulic systems) - Specifications for categories HH, HL, HM, HV and HG
ISO 17165-2	Hydraulic fluid power – Hose assemblies Part 2 practices for hydraulic hose assemblies
ISO 16889	Hydraulic fluid power -- Filters -- Multi-pass method for evaluating filtration performance of a filter element
ISO 17165-1:2007	Hydraulic fluid power -- Hose assemblies -- Part 1: Dimensions and requirements
ISO 23309	Hydraulic fluid power system—Assembled system—Methods of cleaning lines by flushing

3.2 Abbreviations

AKS Aluminum Kennzeichen System
EN European Norm (CEN)

3.3 CE Marking

Equipment shall be designed considering inherent safety aspects in operation and maintenance in accordance with European code: 2006/42/EC Machinery Directive.

For instruction, refer to:

NA-00-STS001 General Standard Technical Specification.

4 Design Requirements

4.1 General

The design shall provide a means for spilled oil to be contained and disposed without contaminating the environment. Spilled fluid shall not be allowed to return directly to the system.

All hydraulic systems shall be fitted with a lockable sampling test point fittings upstream /down stream of directional control valves. The sampling point shall ideally be located in the manifold block and pump. The vendor shall install these test point fittings to monitor before and after the following equipment: Pumps, filters, control valve, outlet flanges and other locations where test point fittings will provide advantages for failure analysis and repair. Mini plug are acceptable.

The design of hydraulic equipment components shall allow for space and access required for inspection and maintenance of equipment and for replacement of components.

All components, equipment or assemblies having a mass greater than 25 kg shall have an accessibility for lifting equipment.

4.2 Sound-Proofing

Noise level from a hydraulic system shall not exceed Icelandic requirements or L_{equ}, 8h = 85 dB(A) (Directive 2003/10/EC). Hydraulic systems shall be designed to reduce noise level as possible.

If necessary to meet the noise level requirements, the hydraulic power pack shall be located in a ventilated noise and dust proof enclosure.

4.3 Fluid Leakage

Leakage from the hydraulic system shall not be accepted. In the event of breakdown of systems, equipment or components a suitable capture of leaked fluids shall be incorporated into the design.

4.4 Testing

Hydraulic systems shall be performance tested to determine compliance with the contract specification, prior to delivery on discrete packages, or once installed on Site if more complex.

4.5 Electrical equipment

Refer to Norðurál Standard Technical Specifications:

NA-06-STS001 – Low Voltage Standards
NA-06-STS002 – Specification of LOTOV
NA-07-STS009 – PLC programming
NA-07-STS011 – SCADA programming

4.6 Paintwork of a hydraulic system

Refer to Standard Technical Specification:

NA-03-STS001 – Surface Treatment and Painting

Paint shall be compatible with the hydraulic fluids and lubricants associated with the system and all parts of a hydraulic system shall be sandblasted, where required.

4.7 Emergency Shut-off

Emergency stop devices shall conform to the requirements specified in:

ISO 13850 (function) and
IEC 60947-5-5 (device)
NA-06-STS002 – Specification for LOTOV of electrical equipment

5 DESIGN CRITERIA

5.1 Functional Safety

When designing hydraulic circuits, all aspects of possible methods of failure shall be considered. The standards: EN ISO 12100, parts 1 and 2, EN ISO 14121, parts 1 and 2 and EN ISO 13849, parts 1 and 2 and ÍST EN ISO 4413 shall be laid down as basis for analysis of safety of hydraulic systems.

Note: Hydraulic circuits installed within facilities that reach high temperatures present a fire risk.

5.2 System Design

5.2.1 Manual Operation

This mode shall be followed, especially if adjustment have to be made and operations resumed after an emergence shut down.

At all stages in the cycle, handling of automatic start/manual start selector shall not cause any movement.

The operator shall be able to activate any movement separately.

5.2.2 Automatic Operation

A machine or facility is in “automatic Operation” when cycle sequences follow on another without manual intervention.

At any moment in the cycle, the maximum or intermediate positon of any component that may cause a mechanical incident shall be controlled by apposition control device.

Switching from rapid forward to slow forward by means of a distributor shall always be effected by de-energizing and not energizing the distributor control

Where applicable, operators shall keep their hands on control levers and buttons at all times during periods of hazardous movements.

5.2.3 Non-repetition and End-of-cycle Shut-off

A manual control, separate from the emergency shut-off controls, shall enable movements to be stopped at the end of cycle. Refer to NA-06-STS001 – Low Voltage Standard

5.2.4 Emergency Shut-off

All equipment shall include one or more (in exceptional circumstances) emergency shut-off control to which the operator or operators have quick access. The positons of these emergency shutoff controls shall be discussed with the Owner. Emergency shut-off controls shall be be in accordance with NA-06-STS002 Specification for LOTOV.

Depending on the operating conditions, activation of the emergency shut-off device shall result in the following action, depending on the situation:

- A cessation for all movement through prevention of any transmission of power, even residual power.
- A resumption of movement or movements in progress according to a release cycle, provided these movement do not present a risk to employees and machine components.

- In the case of machines, lifting suspended weights, the movements concerned shall remain under pressure in position or mechanically locked.
- Circuits for suspending weights may be purged by means of a manual device or device controlled from a console. To facilitate possible manual intervention, the purge procedure shall be permanently affixed to the machine in a visible place near the control devices.
- After an emergency shutoff, it shall be possible, in manual operation mode to terminate the cycle in progress or to return the components of the machine or facility to the starting point.

5.2.5 Adjustment Limit of Controls

Valves for controlling pressure and flow shall be constructed with seals so that they cannot be adjusted to settings outside their safe operating limits.

Valves shall be equipped with a locking mechanism, i.e. seal, so that they cannot be moved from their settings accidentally.

Pressure control valves shall be provided with clear identification showing maximum and minimum possible setting pressures.

5.2.6 Control Adjustments

Pressure and flow adjustment points on hydraulic units shall be located in safe and easily accessible places.

Adjustment shall be equipped with positive locking mechanisms.

5.3 Hydraulic Fluids

5.3.1 General Requirements

Hydraulic systems shall be designed to operate, wherever possible, with mineral based hydraulic fluid, according to ISO 6743-4 or DIN 51524-1

Vendor shall request owner for required hydraulic oil. However, viscosity shall be defined in relation to design and operating specification of the system.

Before filling the system with hydraulic fluid, it is to be ensured that the hydraulic fluid is as specified and that it meets the required cleanliness level, as stated in chapter 6.5.1 Fluid cleanliness level.

Fire resistant fluids, shall be used where mineral based fluids pose a fire hazard. However, before resorting to use a fire resistant fluid, the arrangement of the elements of the hydraulic system must be examined and removed from danger zones. Vendor shall request owner for required fire resistant hydraulic oil type. IRUS fire resistant hydraulic oil is not acceptable.

Under no circumstances shall the Vendor bind the guarantees to the use of a particular brand of fluids.

5.3.2 Fluid Pressure

The nominal pressure is restricted to maximum of 20.700 kPa, (3000 psi). Higher system pressure shall be approved by the Owner.

5.3.3 Fluid Velocities

The maximum fluid velocities in hydraulic lines shall be as follows:

- Lines under pressure: 4,0 m/s
- Suction lines: 0.9 m/s
- Return lines: 2.0 m/s

5.3.4 Temperature

Hydraulic circuits shall be designed so that operation temperature of the hydraulic circuit remains between 40°C and 50°C.

5.4 Strength of Hydraulic Components

5.4.1 Nominal and Working Pressure – Safety Factors

Nominal pressures (PN) represent the acceptable working pressures, with a safety factor of 4, a constant load and temperatures from –20° to +120°C, according to ISO 8434-1 and ISO 8434-2.

Working pressures (PB) represent maximum acceptable pressures, with a safety factor of 2.5, a constant load and temperatures from –20° to +120°C, according to DIN 2401. When higher temperatures and mechanical vibrations are involved, the working pressures should be reduced accordingly.

Nominal pressure to be considered in the choice of various hydraulic components including valves and flexible conduits, shall be 20.700 kPa.

In exceptional cases where the nominal pressures of pumps are higher, components ensuring a minimum safety factor of four (4) shall be selected.

5.4.2 Material

Sub-plates or collector blocks shall be made of carbon steel or stainless steel.

Hot dip galvanized or cadmium-plated steel plates, pipes, fittings and/or components are not permitted for the construction of hydraulic units and systems.

Aluminum is not acceptable.

5.5 Seal Joints

All seal joints shall be compatible with the hydraulic fluids used. Seal joints shall be made of Viton if fire resistant fluid is used.

6 MECHANICAL REQUIREMENTS

6.1 General

The following are general design requirements, common to most hydraulic system installation. However, Manufacture's installation and operation procedure of all components and parts shall be followed and shall supersede these requirements whenever reflecting more stringent requirements.

In general the requirements of the ISO 4413:2010 shall be laid down as basis for safe design, construction and modifications of hydraulic systems and their components.

6.2 Recommended Supplier of Mechanical Equipment

Refer to:

- NA-00-STS010 – Recommended manufactures for plant.

6.3 Pumps

Variable pumps are preferred, all other solutions shall be agreed by owner.

Except for specialized hydraulic units with 4 kW or less, submersible pumps shall not be used in reservoirs.

Back-up pumps with a 100% capacity shall be provided where necessary. The automatic start-up of back-up pumps shall only be authorized where there is an advantage in doing so and where operating and safety restrictions allow or require it.

6.4 Reservoirs

In general shall following requirements of ISO 4413:2010, 5.4.5.2 – Reservoirs. Additionally, reservoirs shall be fitted with:

- Service openings. Preferred location is on the side or on top. The location and size shall facilitate cleaning. The opening cover shall be sealed with a reusable joint that is suitable for the fluid being used.
- Desiccant air breather. 3 micron filter and visual indicator to gives an indication of the status of the air breather.
- Internal baffle plates to prevent direct flow between the returning and suction line. However, the plates shall not restrict the flow and allow complete drainage of the reservoir from at least one drain point.
- Auxiliary minimum 3/4” quick coupling to allow filling the reservoir.
- A plug for oil sampling, mini plugs.
- A visual level display (sight glass).
- A low fluid level sensor activated when at least 40% of the tank volume is remaining in the tank engaging a warning.
- A low level sensor located below the warning light sensor that shuts down the system.
- A visual thermometer.
- A low temperature sensor preventing startup of the system. If temperature is out of operating range.
- A temperature sensor activated shut off when the oil temperature reaches maximum value.
- A drainage pipe with a ball valve and closing cap.

6.5 Filtration

6.5.1 Fluid cleanliness level

The cleanliness level rating of fluid provided to the system from the reservoir shall be no less than 15/13/10 or by ISO 4406.

Filtration of fluid shall confirm to the required grade of oil to achieve the cleanliness level laid out in order to obtain the desired reliability.

The Owner shall review the cleanliness level specification and relating means of filtration.

6.5.2 Filter sizing

Filter performance rating shall be in accordance with the required fluid cleanliness level.

Filtration shall reach a minimum filter efficiency expressed in beta rating by ISO16889 of $\beta_{[3]}>200$

On the return side of the system the filters shall be designed for a load loss of 10 to 35 kPa

On the high-pressure side of the circuit the filters shall be designed for a load loss of max 70 kPa (complete filter, new filter element). Filtration shall reach a minimum filter efficiency expressed in beta rating by ISO16889 of $\beta_{[3]}>200$

Filters on suction line are forbidden.

The filter shall provide sufficient dirt holding capacity for an acceptable interval between changes of the filtration elements

The filter sizing should allow for a cold start whereby the viscosity of the oil at the lowest cold start temperature will not generate a differential pressure in excess of the trip point for the differential pressure indicator.

The filter sizing should allow for a clean differential pressure of between 0.1 – 0.5 bar.

6.5.3 By-pass Filtration

Reservoirs with a capacity of 600 liters or more shall be equipped with by-pass filtration system. The capacity of system, measured in l/min, shall be at least 1% of the volume of the reservoir.

Filtration shall reach a minimum filter efficiency expressed in beta rating by ISO16889 of $\beta_{[3]}>2300$

Where fitted the by-pass system should incorporate valve to allow for the filling and draining of the tanks.

An identification plate affixed to the filter shall identify the model and the filtration level in by ISO 16889

6.6 Accumulators

Continuous running systems, if applicable, shall be equipped with minimum of two accumulators and each shall be serviceable without affecting the operation of the other. Accumulators shall be located on serviceable area.

6.7 Hydraulic valves

6.7.1 Directional control valves

Valves are preferred on sub-plate mount to ISO 4401 wherever possible. Where sub-plate mount are not relevant valves shall be located in logical order on serviceable area.

Taking into account the load losses produced by simultaneous movements, the number of installation planes, for mounting sub-plate valves on an assembly base, shall not affect normal system behavior due to pressure losses.

The unit must be designed and set up in such a way that all components are easily accessible.

Solenoid operated valves shall be equipped with indicator light and manual override.

6.7.2 Safety Valve

Safety valve is required to bypass oil into reservoir in case of load over design pressure. Safety valve shall be equipped with lockable device.

6.8 Hydraulic Cylinders

Only cylinders from a standard range of supply shall be installed. Each cylinder shall incorporate rod wiper rings and stuffing box. Seals shall be selected from a standard range.

Hose braking valve are requested to secure suspended load from falling.

6.8.1 Shock Absorbers (on a request from Norðurál)

Both ends of all cylinders shall be equipped with adjustable shock absorbing stroke cushions and needle valves.

The shock absorbing cushion shall be designed with sufficient play at the end of the stroke to prevent any contact between the piston and the head.

Needle valves shall be equipped with a locking device and seals to prevent leaks through the threads.

6.8.2 Piston Seal Housings

Piston seal housing shall conform to the ISO 6547 standard for piston seal housings incorporating bearing rings.

6.8.3 Sealing Material

The preferred sealing for the typical operating conditions specified by ISO 1629. Viton seals are preferred for fire resistant fluid. Alternative configuration shall be approved by the Owner.

6.8.4 Piston Rods

Hydraulic cylinder piston rods shall be case hardened. They shall be Nickel chrome-plated and polished, or be of non-corrosive steel with super finish.

Piston rods shall be equipped with rod end clevis assemblies.

6.8.5 Vents (on a request from Norðurál)

Hydraulic cylinders shall be provided with vents at each end. Vents shall be located such as to allow air trapped in all parts of the cylinder to escape.

6.8.6 Identification Plate

All cylinders shall be provided with a stamped stainless steel identification plate indicating bore, stroke, rating, nominal design pressure, model number and serial number.

6.8.7 Cylinders Synchronization

If the strokes of two or more cylinders require synchronization, provision for a mechanical system outside the cylinder shall be made to synchronize the movements.

6.9 Hydraulic Pipes and Pipe Systems

6.9.1 General

In general ISO 10763 shall be laid down as basis for safety factor of hydraulic tubes and pipes.

Where applicable, the use of manifolds shall be considered instead of individual lines.

Piping shall be installed to permit removal without disturbing circuit components and without excessive bending or springing.

The number of connections and elbows in an installation must be kept to a minimum. Whereas possible, curved elbows shall be used.

Hydraulic pipes shall fulfil the following requirements according to EN 10305-4.

Seamless cold-drawn precision steel pipes.

E235N (St 37.4) – NBK/ZN

Normalized, phosphated and oiled inside and outside, electric zinc plated with Cr-VI-free passivation.

E355N (St 52.4) – NBK/ZN

Normalized, phosphated and oiled inside and outside, electric zinc plated with Cr-VI-free passivation.

In return lines and drain lines welded cold drawn pipes are allowed in accordance to

EN 10305-2 (DIN 2393) standards.

Anti-Seize compound (nickel basis) shall be used on all threaded stainless steel connections.

All hot-dip galvanized pipes are prohibited.

6.9.2 Pipe Dimensions

Pipes shall be chosen in accordance to the system pressure and also the environment, i.e. if the environment is possible causing corrosion.

Pipes shall be identified by O.D. and wall thickness, e.g. ∅ 25x3.

Pipe diameters shall be determined to ensure the flow velocity limit.

Pipe wall thickness shall be determined to withstand the system pressure.

Standard pipe sizes are required.

If pressure limit of a standard pipe size is lower than system pressure, selection shall be approved by owner.

Pipe range diameters are from 6 - 42 mm (except 14 mm).

Pipe diameters greater than 42 mm shall be flared and in accordance to JIC 518 standard.

The following table indicates recommended hydraulic steel pipe outer diameter [O.D] and wall thickness [W.T] in millimeters [mm].

O.D. x W.T. [mm]													
6x1	8x1	10x1.5	12x1.5	15x1.5	16x2	18x1.5	20x2.5	22x2	25x3	28x2	30x3	35x3	38x4	42x3

6.9.3 Pipe/Tube Fittings

Fittings with NPT threads shall not be accepted.

The following table indicates recommended fittings for pipes of O.D. 6 - 42 mm.

Item		Type	Thread size BSP (in)	Class	Standard	Material
Pipe O.D. 6 – 42 mm	Straight coupling	G	1/8“ – 2“	L-Series / S-Series (Light range / Heavy range)	ISO 8434-1 (DIN 2353)	C15S10 1.01718 (EN 10277-3)
	Straight reducing coupling	GR				
	Tee	T				
	Elbow	W				
	Cross	K				
	Adjustable tee	EVL				
	Adjustable tee	EVT				
	Adjustable elbow	EVW				
	Male stud coupling	GE				
	Adjustable straight stud	EVGE				
	Straight coupling w/swivel nut	SNV				
	Welding bulkhead coupling	ESV				
	Threaded bulkhead coupling	SV				
	Threaded elbow bulkhead coupling	WSV				
	Welding straight coupling	AS				
	Threaded male stud elbow	WE				
	Straight female stud coupling	GAI				
	Gauge coupling	MAV				
	Adjustable gauge coupling	MAVEV				
	Reducing standpipes	KOR				
	Reduction male/female	RI				
	Closure plug w/hexagon socket and threads	VSTI				
	Blanking plug	BUZ				
	Nut	M				
	Cutting ring	DS				

6.9.4 Pipe/Tube Fittings 97-115 mm and 130-273 mm

Fittings with NPT threads shall not be accepted.

If such sizes are intended to use, acceptance is required from owner.

6.10 Pipe Fittings Reducing Branch

The following tables indicates pipe run size and branch pipe reducing option for both L and S type series with KOR standard pipe fittings.

L-Series									
Run Size	**8**	**10**	**12**	**15**	**18**	**22**	**28**	**35**	**42**
Branch Size	6	8	10	12	15	18	22	28	35
		6	8	10	12	15	18	22	28
			6	8	10	12	15	18	22
				6	8	10	12	15	18
					6	8	10	12	15
						6	8	10	12
							6	8	10
								6	8
									6

S-Series								
Run Size	**8**	**10**	**12**	**16**	**20**	**25**	**30**	**38**
Branch Size	6	8	10	12	16	20	25	30
		6	8	10	12	16	20	25
			6	8	10	12	16	20
				6	8	10	12	16
					6	8	10	12
						6	8	10
							6	8
								6

6.10.1 Piping Supports

Structural integrity of the piping support shall be ensured and proven to retrain movements caused by pressure surges.

6.11 Flexible Hoses

Selection of hoses and marking shall be according with ISO 17165-1:2007

ISO 1436 shall be laid down as basis for safety factors of hydraulic hoses.

The covering material on the flexible hoses shall be compatible with the hydraulic fluids used. Particular attention shall be paid to hoses used with fire-resistant fluids.

The flowing table includes flexible hoses preferred by Norðurál.

Standard	Material	Size (in)	Temperature range (°C)	Working pressure (bar)
DIN 20022 1ST/SN	Oil resistant rubber inner tube - One wire braid - Oil and weather resistant rubber cover	3/16" - 2"	-40 to +100 with peaks up to +120	40 - 250
DIN 20022 2ST/SN	Oil resistant rubber inner tube - One wire braid - Oil and weather resistant rubber cover	3/16 - 2"	-40 to +100 with peaks up to +120	80 - 415
SAE 100 R7	Internal core in thermoplastic polyester fiber reinforcement and exterior covering in polyurethane	1/8" - 1"	-40 to +100	70 - 250
SAE 100 R8	Internal core in thermoplastic polyester fiber reinforcement and exterior covering in polyurethane	1/8" - 1"	-40 to +100	145 - 350
DIN 20023-4SH	Oil resistant rubber inner tube - Four spirals of very high tensile strength steel wire - Oil and weather resistant rubber cover	3/4" - 2"	-40 to +100 with peaks up to +120	250 - 420

6.11.1 Hose Fittings

Connections for flexible hoses shall be in mm up to 42 (except 14 mm).

Fittings for flexible hoses greater than 42 shall be of ÍST ISO 6162, JIC 518 (code 61), 3000 psi, flange type.

6.12 Other Components

6.12.1 Pressure Gauges

Pressure gauges shall be supplied with an accuracy of ± 1%, to indicate maximum working pressure and discharge valve adjustments. The dial shall be in SI units with a diameter from 63mm.Pressure gauges shall be provided with isolating valves and shock absorber (pigtail).

6.12.2 Thermometer

A thermometer with a dial in SI units, about 63 mm in diameter, to indicate the working temperature are required. As addition thermometer may also be incorporated into the oil level sight gauge.

7 Hydraulic Circuit Cleaning and Flushing

All hydraulic piping shall be cleaned before put into operation. Flushing of hydraulic circuits shall be in accordance with ISO 23309.

8 SAFETY

Hydraulic systems shall be installed with at least one main system pressure relief valve.

Hydraulic circuits shall be equipped with appropriate safety devices to protect against pressure surges.

Pressure relief valves should be sealed after installation.

For safe maintenance no energy should be stored in the system in maintenance mode. All other variation should be accepted by owner.

9 Identification

The equipment identification system, AKS-Identification System, shall be laid down as basis for Identification of systems and components. AKS-Identification numbering shall be provided by owner.

Where the pipe diameter is not sufficient to allow the printing to be fully visible, tags are to be used. The tags shall be approved by the Owner prior to their use.