

INTERPLANT STANDARD — STEEL INDUSTRY



GUIDE FOR APPLICATION AND INSTALLATION OF OIL HYDRAULIC SYSTEM IN STEEL PLANTS

IPSS : 1-02-040-86

CORRESPONDING INDIAN STANDARD DOES NOT EXIST

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0. Foreword

0.1 Interplant Standardization activity in steel industry has been initiated under the aegis of the Indian Standards Institution (ISI) and the Steel Authority of India Limited (SAIL). This Interplant Standard prepared by the Standards Committee on Basic Standards and Hydraulic, Pneumatic and Lubricating Equipment, IPSS 1 : 2 with the active participation of the representative of all the steel plants and established manufacturers of Hydraulic Systems for Steel Plants was adopted by the Approval Committee on Consumable Stores and General Equipment, IPSS 1, on 1 August 1986.

0.2 Interplant Standards for steel industry primarily aim at achieving rationalization and unification of parts and sub-assemblies used in plant equipment and provide guidance in indenting stores or equipment for existing or new installations by individual steel plants. For exercising effective control on the inventories, it is advisable to select a fewer number of sizes (or types) from among those mentioned in this standard for the purpose of company standards of individual steel plants. It is not desirable to make deviations in technical requirements.

0.3 For individual hydraulic components the respective available Interplant Standards shown against each and those subsequently formulated shall be adhered to:

- i) 'O' Rings — IPSS : 1-02-001
- ii) Rotary shaft oil seals — IPSS : 1-02-013-81
- iii) Wire braided high pressure hydraulic hose — IPSS : 1-02-003-84
- iv) Ferrule type male stud coupling and male stud coupling body for hydraulic pipe connections — IPSS : 1-02-005-84
- v) Ferrule and metric coupling nut for male stud couplings — IPSS : 1-02-006-84
- vi) Male stud coupling body of permanently attached hose end fittings for hydraulic lines — IPSS : 1-02-007-84
- vii) Coupling nut for male stud coupling body of permanently attached hose end fittings — IPSS : 1-02-008-84
- viii) Set of V-packings — IPSS : 1-02-016-84
- ix) High pressure hydraulic hose assemblies with permanently attached end fittings — IPSS : 1-02-017-84
- x) High pressure hydraulic hose assemblies with permanently attached end fittings, female, 37° flared swivel (both sides) type — IPSS : 1-02-025-84.

Also, in the design of components guidelines of IPSS : 1-02-020-84 'Basic parameters for selection of steel plant equipment' shall be adhered to.

0.3.1 The guidance and recommendations in this document have no legal status except those paragraphs that may be included in contractual agreements between the purchaser and the supplier.

0.3.2 Deviation from those parts of this document included in contractual agreements shall be agreed to in writing by the purchaser and the supplier.

0.3.3 Apart from the guidelines given in this standard the accumulator shall conform to all the statutory regulations and legal codes regarding their manufacture, transportation and installation.

0.3.4 Recommendations which contain the verb 'shall' requirements are good engineering practices universally applicable with rare exception. Use of the word 'should' in the document is not a indication of choice but an indication that the desirable engineering practices described may have to be modified due to peculiarities of certain processes, environmental conditions or equipment size.

0.3.5 Titles which are marked with an asterisk(*) indicate clauses that need discussions between the purchaser and the supplier to define the requirements and responsibility. Attention shall be drawn by the purchaser or supplier to the applicable national and local codes or laws.

Amendments issued (to be filled up by the user department):

No.	Date of Issue	No.	Date of Issue
1		3	
2		4	

0.3.6 Use of this document assists:

- a) in establishing safety requirements and safe practices (the titles of sections relating to safety are given in capital *ITALICS*. The use of word hazard implies possible risk or danger to personnel);
- b) a purchaser in drafting specification for hydraulic equipment;
- c) a purchaser in establishing the relative merits of similar hydraulic equipment; and
- d) a manufacturer in producing acceptable hydraulic equipment to either his or customers specifications.

0.3.7 For definition of terms and terminology used in this standard references shall be made to IS : 10416-1982 'Glossary of terms relating to fluid power systems'. For the symbols used in this standard reference shall be made to IS : 7513-1974 'Graphic symbols for fluid power systems'.

1. Scope

1.1 Provides recommendations relating to hydraulic systems on machinery used in steel plants. It is intended as a guide for both the manufacturers and the purchasers of steel plants.

1.2 Standardization of requirements covering the construction installation, operation performance test and maintenance of complete oil hydraulic system.

1.3 Establishment of guidance for the manufacturers and users of fluid power equipment on its application to power transmission and control system for steel plant equipments with a view to ensure:

- a) safety to personnel,
- b) ease and economy of maintenance,
- c) uninterrupted production — productivity, and
- d) long life of equipment.

2. General Requirements

2.1 Safety

2.1.1 *Fail safe concept* — When designing hydraulic circuit all aspects of possible methods of failure shall be considered. In each case components shall be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel shall be the prime consideration and damage to equipment minimized.

2.1.2 Application concept:

- a) All components within the system shall operate within their manufacturers specifications;
- b) All parts of the system shall be protected against overpressure;
- c) The system shall be designed and constructed so that components are located where they are accessible and can be safely adjusted and serviced;
- d) Circuits shall be designed, constructed and adjusted to minimize surge pressure;
- e) Surge pressure or loss of pressure shall not cause hazard;
- f) Wherever specified hydraulic systems shall be designed to work with fire resistant fluid as a media;
- g) To minimise piping, joints and to ensure ease of maintenance, manifold type mounting, panel mounting shall be adopted to the extent possible; and
- h) Provision shall be made for collecting the leakage oil.

2.1.3 *Safety requirements* — Summary of safety requirements is given in Appendix A.

2.2 Specific Requirements

2.2.1 *Special site conditions* — The supplier shall obtain from the purchaser information on special site conditions and shall design the system to take account of these. Examples of the information required are as follows:

- a) Ambient conditions, such as temperature, humidity, contamination, vibration, shock, corrosion, etc, shall be as per IPSS : 1-02-020-84;
- b) The setting of equipment at altitudes above 1 000 m above sea level;
- c) The possible existence of fire hazard; and
- d) The standard of maintenance facilities available.

2.2.2 System temperature

2.2.2.1 *Heat generation* — Hydraulic circuits shall be designed to minimize unnecessary heat generation and maximize energy conservation.

2.2.2.2 *Operating temperature* — The full range of ambient temperature in which the equipment will be located shall be stated. The pump inlet temperature should not exceed 60°C for mineral oil when

maximum ambient temperature exists. The equipment shall operate satisfactorily under the specified ambient conditions, special conditions may apply for other fluids.

2.2.3 Service requirement

2.2.3.1 Equipment location — Hydraulic equipment and piping shall be accessible and so mounted as not to interfere with adjustment or maintenance of the equipment. Particular attention shall be given to the location of the equipment which needs regular maintenance.

2.2.3.2 Component removal — To facilitate servicing, means shall be provided or components so mounted that their removal from the system for servicing shall not lead to excessive loss of fluid nor require draining of the reservoir.

2.2.3.3 Lifting provisions — All components, equipment or assemblies having a mass greater than 15 kg shall have accessibility and provision for lifting.

2.2.4 Layout drawing

2.2.4.1 Floor layout — The supplier shall provide the purchaser with a floor plan and foundation layout wherever applicable. If there are two or more assemblies, the dimensional relationship shall be specified.

2.2.4.2 Piping layout — Where requested on the purchaser's enquiry and confirmed on the supplier's quotation, a piping layout shall be furnished to the supplier. Photographs which clearly show the piping arrangement and assembly may be substituted by agreement.

2.2.5 Procurement of equipment — The supplier shall use commercially available parts (keys, bearings, packings, seals, washers, plugs, fasteners, etc) and part configuration (shaft and spline sizes, part sizes, mountings interface patterns, etc) that are manufactured to available Interplant Standards (Indian Standards shall be followed in the absence of Interplant Standards) and that provide for uniform coding.

2.2.6 Maintenance data — The supplier shall provide the purchaser with maintenance data for oil hydraulic equipment which clearly:

- a) describes start up and shut down procedures;
- b) describes adjustment procedures and also commissioning values for various components;
- c) indicates external lubrication points and the type of lubricant required;
- d) states service procedure of unique assemblies;
- e) locates fluid level indicators, fill points, drains, filters, test points, strainers, magnets, etc. that require regularly scheduled maintenance;
- f) gives further identification of parts in the hydraulic components which are commercially available and manufactured to an established standard that provide for uniform coding. The identification shall be the manufacturer's part number or as provided by the codes;
- g) lists of recommended spare parts;
- h) gives instructions for preventive maintenance and trouble shooting;
- j) specifies the characteristics of the fluid required together with equivalent commercial brand names; and
- k) consolidate list of replaceable items like hoses, rubber products, pipe fittings, 'O' rings, seals, packing rings, etc.

2.2.7 Final tests

2.2.7.1 Performance tests — Hydraulic systems shall be completely performance tested to determine conformity with this standard and the purchaser's specification.

2.2.7.2 Noise limit — Hydraulic systems in steel plants shall not raise the sound pressure level of the equipment above those specified by applicable codes and standards at the time of installation in the user's plant.

2.2.7.3 Leakage — There shall be no unintentional external leakage from the hydraulic system at the time of purchaser's acceptance.

2.2.8 Data to purchaser — The following data shall be provided by the suppliers.

2.2.8.1 Final data — Final diagrams, drawings and texts, including the maintenance data shall be made available to the purchaser not later than the time of equipment delivery.

2.2.8.2 Service manuals* — The suppliers shall supply the purchaser the service manuals for standard equipment, and also supply copies of the service manuals.

2.2.8.3 Modifications — Where modifications are made by the supplier after shipment, the modifications shall be recorded by the supplier on the appropriate documents, and copies of the corrected documents shall be provided to the purchaser.

2.2.9 Preparation for transportation

2.2.9.1 Identification of piping — Where construction of the equipment requires transporting in sections, removed piping runs and their corresponding terminal parts or connections shall be identically marked.

2.2.9.2 Packaging* — All equipment shall be packed in a manner that protects it from damage and distortion, and preserves its identification during transportation.

2.2.9.3 Sealing of opening — Exposed openings in hydraulic equipment shall be sealed and male threads shall be protected during transportation and these seals shall only be removed immediately prior to reassembly. Only sealing caps that require their removal before reassembly can take place shall be used.

2.3 Presentation of Technical Data — In the preparation of circuit diagrams and technical data the following shall be adopted.

2.3.1 Circuit diagrams:

- a) Circuit diagrams shall use symbols in accordance with IS : 7513-1974;
- b) The symbols shall represent units at rest, that is, all power off and ready for start unless otherwise indicated;
- c) Symbols shall be positioned on the diagrams so that the circuit is easy to follow, it is not necessary for the symbol position to correspond to the physical location of the device depicted;
- d) Cross-over of lines should be kept to a minimum;
- e) Each item on the circuit diagram should have a separate designation or identification (see 2.4.2 and 2.4.4);
- f) Ports, test points, bleed points and orifice fittings should be identified (see 2.4.3 and 5.2.6); and
- g) Flow lines between power units and machine shall be identified at both ends.

2.3.2 Technical data — The following information shall be included on or with the circuit diagram:

- a) Identification of all hydraulic equipment by name, catalogue numbers, serial or design number, and the manufacturer's name;
- b) Size and specification of pipe, tube and hose lines;
- c) Cylinder bore and diameter of piston rod, length of stroke, estimated force and speed required for the intended service;
- d) The displacement per revolution or minute (and where important, the estimated torque output) of each hydraulic motor;
- e) The delivery (in l/min) for the particular system and the direction of rotation of each pump as viewed from its drive shaft end;
- f) The power, rev/min, and the type of each pump drive motor;
- g) The pressure setting of each pressure control valve;
- h) The type and capacity of strainer and filters and details and quantity of replacement elements;
- j) Volume of fluid required to fill system to maximum level;
- k) Recommended fluid type and viscosity range;
- m) Time sequence chart, time range of cycle, and data or text, or both, showing operations performed including the function(s) of the related electrical and mechanical controls and actuating equipment;
- n) Clear indication of any circuit encompassed by circuit manifolds; where boundary lines or boundary envelopes are used for this purpose, the boundary indicated shall not include any symbol of a component not mounted on or within the circuit manifold;
- p) Clear indications of the function of each actuator in each direction;
- q) The pre-charge pressure and nominal volumes of accumulators;
- r) The size, type and location of test and bleed points in the circuit;
- s) Identification of all components or manifold ports; and
- t) Expected flow rate and maximum and minimum pressure of cooling media and the maximum temperature of the cooling media supply.

2.4 Identification

2.4.1 Components — The following particulars shall be shown in a permanent and readily visible form on all standard hydraulic elements:

- a) Manufacturer's name and brief address;
- b) Designation of type;
- c) Symbols according to IS : 7513-1974 with all parts correctly identified;
- d) Safe maximum continuously rated pressure; and
- e) The particulars given in Table 1.

TABLE 1 ADDITIONAL INFORMATION TO BE GIVEN ON COMPONENTS

SI Components No.	Information and Legend	Remarks
i) Pumps	Displacement/rev direction of rotation	
ii) Hydraulic motors	Displacement/rev direction of rotation relative to porting	
iii) Cylinders	Cylinder bore diameter, piston rod diameter, length of stop tube length of stroke, and cushioning details	If fitted
iv) Pressure control valves	Range of operating pressures	
v) Solenoid-operated valves (marked on the solenoid or coil)	Voltage, type of current, manufacturer's name designation of type and protection classification	In accordance with the relevant standard
vi) Pressure switches	Range of operating pressures, pressure differential range, voltage and current carrying capacity of switch, protection classification	In accordance with the relevant standards
vii) Hydraulic accumulator (on the shell)	Serial number, year of manufacture, total shell volume (litres), Maximum allowable pressure, Prove pressure legal stamp and test date	If legally required
(On a label adjacent to accumulator)	Gas precharge pressure. 'Use only nitrogen'	
viii) Filters	Type number and rating of elements, direction of flow	In accordance with the relevant standards
ix) Heat exchangers	Direction flow of both working and cooling media, nature and maximum pressure	

Note 1 — Other inert gases may be used if agreed to by the manufacturer of the accumulator and the purchaser.

Note 2 — If the space available on the components is too small to include all the above data consistent with good legibility, then the information may be restricted to include at least the manufacturer's name and designation of type.

2.4.2 Components within a system — Each hydraulic component shall be allocated an item number or letter or both. This item number shall be used to identify the component on all diagrams, lists and layouts. It shall be plainly and permanently marked on the installation adjacent to, but not on the component.

2.4.3 Ports — Component ports, including pilot ports, test and bleed point shall be plainly and permanently identified and the same identification shall be used on the circuit diagram.

2.4.4 Actuators

2.4.4.1 Valve actuators — Valve actuators and their functions shall be plainly and permanently identified and the same identification shall be used on the circuit diagram.

2.4.4.2 Solenoid actuators — Solenoid actuators shall be identified on the electrical circuit diagram with the same actuator identification and component item number used on the hydraulic circuit diagram.

2.4.5 Internal devices — Cartridge type and other functional devices (orifice plugs and passages, shuttle valves, check valves, etc) located within a manifold, mounting plate, pad, or fitting shall be identified adjacent to their access openings. Where access openings are located under a component or components, identification shall be adjacent to the component and as close to the access opening as practical, and the identification marked 'Concealed'.

2.4.6 Control station name plate — A name plate shall be provided for each control station component and located where it can be easily read by the equipment operator. The name plate information shall be relevant and easily interpreted, providing positive identification of the actuator function controlled.

3. Energy Conversion

3.1 Pumps and Motors

3.1.1 General

3.1.1.1 Protection — Pumps and motors shall either be mounted where they are protected from damage, or be suitably guarded.

3.1.1.2 Drains — The size and termination of pump and motor drains shall meet the component manufacturer's specification. They shall be piped separately to the reservoir.

3.1.1.3 Pre-filling of housing priming of pumps — Where the manufacturer's specifications require pre-filling/priming the housings of pumps or motors with fluid prior to startup, a readily accessible means for pre-filling/priming shall be provided and be so located to ensure that air is not entrapped in the housing.

3.1.1.4 Drive

a) **Type and alignment** — Couplings or any other drive shall be of a type approved by the pump manufacturer for the specified type of pump mounting and alignment tolerances.

- b) *Fitting procedure* — Pump manufacturer's recommended procedure shall be used when fitting the coupling to the pump shaft.

3.1.1.5 Coupling guards — Rotating shafts and couplings shall be guarded to provide adequate personnel safety at all times.

3.1.2 Pumps

3.1.2.1 Mountings — Pump and drive motor shall be mounted so as to ensure adequate alignment at all times.

3.1.2.2 Inlet connections:

- a) Pump inlet piping shall be so designed that inlet pressure cleanliness, fluid viscosity, temperature and other conditions are in accordance with the pump manufacturer's recommendations. Pump shall be so mounted that positive suction head is ensured, as far as possible;
- b) Inlet pipes should be short, contain a minimum number of bends and should be free from sudden changes in cross-section; and
- c) Inlet pipes, strainers and filters shall be free from air leaks and should contain no pickets which could collect air bubbles.

3.1.2.3 Discharge connections — Drain, air bleeds, etc, shall be so installed that they do not allow ingress of air into the system.

3.1.3 Hydraulic motors

3.1.3.1 Mountings — The mounting of motors on or in relation to their drive assemblies shall be such as to ensure adequate alignment at all times.

3.1.3.2 Output characteristics — The starting and stall torques, the effect of load variations, and the kinetic energy of the moving load, shall be considered in the application of rotary motors.

3.2 Cylinders

3.2.1 Resistance to buckling — Special attention shall be given to stroke length, loading and the conditions of assembly in order to avoid abnormal bending or buckling of the cylinder piston rod in extended condition. This is particularly important if the cylinder has non-rigid mountings.

3.2.2 Alignment — The alignment of rigidly mounted cylinders with dependent slides and other guided equipment elements shall apply no undue side load to the piston rod.

3.2.3 Mounting

3.2.3.1 Fixing screws — Fixing screws for foot mounted cylinders shall be of adequate size to withstand the shear forces without any safety risk.

3.2.3.2 Mounting surface — Mounting surface shall not distort cylinders and allowances shall be made for thermal expansion.

3.2.4 Servicing — Seals, packings should be accessible and as far as possible should be easily replaceable.

3.2.5 Component replacement — Integral cylinders are undesirable but where they are used they shall have replaceable wearing parts.

3.2.6 Cushions — Cylinder and stops shall be protected from damages due to high inertia loads.

3.2.7 Piston rods

3.2.7.1 Piston and rod assembly — Pistons shall be positively locked to the piston rod.

3.2.7.2 Materials — Shall be hard chrome plated and polished.

3.2.7.3 Protection — Piston rods shall be protected from predictable damage.

3.2.7.4 Piston rod ends — For assembly purposes, piston rods with male or female screwed ends shall be provided with flats to suit standard spanners.

3.2.8 Air entrapment

3.2.8.1 Port location — Where practicable, cylinders shall be installed with ports uppermost.

3.2.8.2 Air bleeds — Cylinders shall be mounted so that they are self-bleeding or accessible external air bleeds shall be provided.

4. Valves

4.1 Mounting

4.1.1 Attitude — To ensure fail-safe conditions the effect of gravity on spool movement shall be considered when deciding on the mounting attitude of any valve. Solenoids operated directional control valves provided with a drain connection to reduce response time must always be mounted horizontally.

Hydro electric pressure switches without leakage connection should be mounted so that the pressure port is not situated at a higher level than the drain port.

4.1.2 Method — Surface mounted valves should be used wherever practicable, so that they can be replaced without disturbing pipe work.

4.1.3 Orientation — Surface mounted valves shall have means of ensuring correct orientation.

4.2 Electrically Operated Valves

4.2.1 Electrical connections — The electrical connection to solenoid valves should be by a suitable plug or terminal block mounted on the solenoid or the valve.

4.2.2 Terminal block housing — The terminal block housing should have adequate space for the terminal block and for sufficient free cable to allow for easy servicing. Cable entry to the terminal housing and spacing of adjacent valves should allow for the use of protective conduit.

4.2.3 Solenoids:

- a) Shall be capable of operating without malfunction at the nominal voltage within a variation of ± 10 percent, and
- b) Shall be protected against the entry of splashed fluid and dirt.

4.2.4 Manual overrides — Solenoid operated valves shall incorporate manual overrides, unless otherwise specified. It shall not be possible to operate these override unintentionally.

4.3 Detented Valves — Two position, no-spring, spool-type valves shall have their spool position mechanically maintained by detents or equivalent means. Any actuator required to maintain its position during start-up, stopping or in the event of an electrical failure, shall be controlled by a detent located valves.

4.4 Identification of Actuation — Name-plates shall be attached to the valve in such a way that the position and controls represented agree directionally with the actual movement. The type of valves shall be indicated with the help of suitable symbols in accordance with IS : 7513-1974.

5. Energy Transmission and Conditioning

5.1 Fluids

5.1.1 Specification*

5.1.1.1 A fluid recommended for use in a system shall be defined by type characteristics and the equivalent manufacturer's trade-name may be given.

5.1.1.2 Where a fire hazard exists consideration shall be given to the use of fire resistant fluid.

5.1.2 Compatibility

5.1.2.1 All fluids — The hydraulic fluid used shall be compatible with all the components and seals used in the system and be in accordance with the recommendation of the equipment manufacturer.

5.1.2.2 Fire resistant fluids — Additional precautions shall be taken to prevent problems due to incompatibility of the fire resistant fluid with:

- a) protective finishes and other fluids associated with the system, paint, process or service fluids; and
- b) construction and installation material that can be in contact with spilled or leaking resistant fluid, for example, electric cabling, other service supplies and products.

5.1.3 Handling precaution — Advisory information shall be provided by the system supplier on hygiene requirements by personnel when handling the fluid, any toxic or asphixiating hazard in the event of a fire and any problem in the disposal of waste fluid. Such systems shall be distinctly marked on the reservoir.

5.1.4 Maintenance — Means shall be available for carrying out fluid maintenance procedures recommended by the fluid or system manufacturers.

5.1.5 Filling and maintenance of fluid level* — Fluids used for filling and maintaining the fluid level should be filtered during this process through a filter with a similar or finer rating to that used in the system.

5.2 Piping, Fitting and Fluid Passages

5.2.1 Fluid velocity — The fluid velocity through piping, fittings, and manifolds shall be such that the resulting pressure drops at all working temperatures and the conductor fluid capacity do not adversely affect the efficiency and response of the system consistent with its duty.

High fluid velocities and sudden changes in the bore conductors should be avoided as they may produce undue turbulence and cavitation.

5.2.2 Use of fittings — The number of fittings and joints in a system shall be kept to a reasonable minimum. Fittings shall be in accordance with relevant Interplant Standards wherever available, if not Indian Standards.

5.2.3 Piping location — The location of piping shall be such that it does not unduly restrict access for adjustment, repairs, replacement of components or work in progress.

5.2.4 Return lines and drains — Seal drains, pilot control returns and main returns shall be piped separately to reservoir unless other means to prevent interactions are acceptable.

5.2.5 Foreign matter — Pipe fittings and fluid passages including cored and drilled holes shall be free of detrimental foreign matter, such as scale, burrs, swarf, etc, that may restrict flow or be dislodged and cause malfunction. In general pickling is recommended to ensure removal of foreign matter.

5.2.5.1 Pipe pickling

- i) *The finish* — Bent and welded pipes are placed in an unheated pickling bath for approximately 10-12 hours; it should be noted that no oils or greases may adhere to the pipes, because otherwise these spots will not be pickled, and moreover, oils and greases will contaminate the pickling bath. If required, the pipes should therefore be cleaned using suitable means prior to pickling. The addition of an inhibitor will prevent that the steel itself is attacked, that is only scale and slag will be pickled off.

Constituents of pickling liquor/m³ of water:

7 percent of technically pure 33 percent muriatic acid (HCL)

1 percent of technically pure 98/99 percent hydrofluoric acid

0.3 percent of hexamethylene — tetramine as inhibitor.

CAUTION — Hydrofluoric acid is one of the acids which are most dangerous to human skin. Even the smallest causticization should be given medical treatment.

- ii) *Neutralizing of pipes* — Each pipe removed from the pickling bath must be thoroughly rinsed inside and outside with a sharp water jet. Any acid residues remaining on the pipes in the event of inadequate rinsing would contaminate the passivating bath, rendering it unsuitable for further use
- iii) *Passivating of pipes* — Passivating completes the pickling operation and provides the material with a protective coat which prevents immediate formation of new rust. For this purpose, the pipes are placed into the passivating bath for approximately 30 minutes immediately after neutralizing.

Constituents of passivating bath/m³ of water:

0.5-0.8 percent of ammonia

0.4 percent of sodium nitrate

As the ammonia is highly volatile, approximately 30 litres of it have to be added per week.

- iv) *Post treatment of pipes* — The pipes removed from the passivating bath must be dried with a compressed air jet and subjected to a visual inspection. Then, they are sprayed with hydraulic oil on the inside and closed at both ends or fitted immediately; they should be given an external coat of priming paint within two weeks at the latest.
- v) *Neutralizing and draining of pickling and passivating liquors* — On principle, the following must be noted to prevent environment contamination. Quick lime or caustic soda must be added to the pickling liquor until a pH value of 7 or 8 is attained. The pH value is ascertained using pH paper (litmus paper). When the aforementioned value is attained, the liquor is harmless and can be drained.

The passivating liquor is harmless and can be drained directly; however, it should be noted that the neutralized pickling liquor and the passivating liquor must not be allowed to mix because otherwise harmful vapours will form. It is also expedient to drain both liquors with an interval of approximately 5 days in between.

5.2.6 Orifice fitting — The size, function, location and identification of orifices within fittings shall be as shown on the circuit diagram. Fittings with orifices shall be permanently identified with the same identification shown on the circuit diagram.

5.2.7 Piping

5.2.7.1 Plastic piping may be used in suitable application and environments for circuit constructions by agreement between the purchaser and the supplier.

5.2.7.2 Pipe sizes — Pipe sizes in accordance with relevant Interplant Standards shall be used for circuit construction.

5.2.8 Flexible lines

5.2.8.1 Application — Flexible hose shall only be used:

- a) between relatively moving elements of the equipment,
- b) to facilitate the interchange of similar equipment, and
- c) to suppress the transmission of mechanical vibration and noise.

5.2.8.2 Installation — Installations of flexible hose shall:

- a) have minimum length necessary to avoid sharp flexing and straining of the hose during the equipment operation,
- b) minimize torsional deflection of the hose during installation or use,

c) be located or protected to minimize abrasive rubbing of the hose wall and

d) be adequately supported or have vertical terminations when the weight of the hose could cause undue strain.

5.2.8.3 Failure — If the failure of a flexible hose constitutes hazard the hose shall be restrained or shielded.

5.2.9 Supports

5.2.9.1 Support requirements — Piping shall be securely supported both at the ends and along its length

5.2.9.2 Support installations — The pipe supports shall not be welded to the piping nor shall they damage it.

5.2.9.3 Spacing of piping supports — The following table gives guidance as to the maximum distance between piping supports:

<i>Pipe Outside Dia in</i> mm	<i>Length Between Supports in</i> m
Up to 10	1.00
Over 10 and up to 25	1.50
Over 25	2.00

5.2.9.4 Equipment support — Pipe work shall not be used to support associated equipment manifolds.

5.2.10 Accessibility

5.2.10.1 Piping connections — As far as possible every connection to flexible lines or piping runs shall be accessible for tightening without disturbing adjacent piping or equipment particularly where flexible lines and piping runs terminate in cluster of fittings.

5.2.10.2 Removal of piping runs — Flexible lines and piping runs should be removable without disturbing the terminal components.

5.2.11 Test port locations*

5.2.11.1 Test port in piping — An accessible test port like mininess shall be provided in the piping where a pressure control component is not so equipped.

5.2.11.2 Feed pressure — An accessible test port mininess should be provided between each feed producing actuator and its governing flow control.

5.2.11.3 Multiple pressure test stations — Where several pressures are required to be checked, a multiple port test station with one gauge and selector valve, or push-to-read valves with locking devices should be considered. Multiple part test stations shall be shown on the circuit diagram and each pipe identified.

5.2.12 Fluid conducting manifold

5.2.12.1 Distortion — Surface flatness and finish shall be in accordance with valve manufacturer's recommendations. Circuit manifolds shall not distort under operating pressures and temperatures so as to cause components malfunction.

5.2.12.2 Handling provisions — Manifolds and manifold assemblies weighing more than 15 kg shall have provision for lifting the manifold with attached components.

5.2.12.3 Supports — Manifolds shall be rigidly and securely mounted.

5.3 Fluid Reservoirs

5.3.1 Basic requirements — The design of the reservoir shall be such that it will:

- adequately dissipate heat from the fluid under all normal working conditions, in particular, when heat exchangers are not installed in the system.
- provide a glow recirculating velocity which will allow for the release of entrained air and the precipitation of heavy contaminants.
- separate the fluid returning from pipe intake points by baffles or other means. If baffles are used, they shall not hinder thorough cleaning of the reservoir.
- contain all the fluid that can flow from the system under normal operation or maintenance conditions; and
- maintain the fluid level at a safe working height during all operating cycles, and allow adequate space for thermal expansion and air evaporation.

5.3.1.1 Marking — The maximum fluid capacity of the reservoir shall be clearly marked preferably adjacent to the reservoir filling points.

5.3.2 Construction

5.3.2.1 General — Reservoirs should be separate and removable from the equipment frame.

5.3.2.2 Spillage — Provision shall be made to contain fluid spillage and also to:

- a) prevent spilled fluid returning direct to reservoir;
- b) prevent spilled fluid from contaminating the surrounding equipment and environment, and
- c) enable the spilled fluid to be easily collected for disposal.

5.3.2.3 Supporting structure — The supporting structure of the reservoir shall:

- a) raise the base of the reservoir to a height not less than 150 mm above site floor level to facilitate handling, draining and to improve heat dissipation except for reservoirs mounted on equipment; and
- b) have supports of sufficient area to allow for levelling by shims, etc, during assembly and installation.

5.3.2.4 Baffles — Rigid baffles, if used, shall be provided within the reservoir which:

- a) are so located that they separate actual returning fluid from the pump intake points but do not restrict air passage between reservoir chambers;
- b) Create peripheral flow of returning fluid along the reservoir side walls;
- c) have sufficient cut outs to prevent the formation of stagnant pockets of fluid, vortices or turbulent current and be of adequate size such that the fluid flow velocity through the openings does not exceed 6.6 m/sec,
- d) do not hinder thorough cleaning of the reservoir; and
- e) if the baffles are of the reversible type, in order to facilitate cleaning they shall be of a design which ensures that they shall be correctly replaced, aligned and held captive.

5.3.2.5 The reservoir top shall:

- a) be positively fastened to the reservoir body;
- b) prevent the ingress of contamination by having a reusable peripheral seal between it and the reservoir body when secured by threaded fasteners;
- c) be so designed and constructed that it avoids the formation of areas that will collect and trap external solid contaminants and waste;
- d) have sufficient structural rigidity to:
 - i) maintain coaxial alignment of pump and motor at all times;
 - ii) minimize structurally borne vibration and noise; and
 - iii) provide for necessary items, that is, filters, manifolds, heat exchangers, when required; and
- e) use a 'blind' (not through hole) method of fastening for attaching reservoir top to body, access covers, and any agreed components.

5.3.2.6 Servicing facilities — The following facilities shall be provided:

- a) Duplicate drain and filter points shall be provided, unless the permanent accessibility of the installation is ensured.
- b) The reservoir bottom shall be shaped to allow complete drainage.
- c) One or more drain points shall be provided at the low points of the reservoir bottom.
- d) When more than one drain point is provided they shall be on opposite ends or sides of the reservoir near access openings. They may be fitted with shut off valves when agreed to between the purchaser and the supplier.
- e) One or more access panels for cleaning the reservoir shall be provided with a minimum size of 150 × 150 mm or 150 mm diameter. For larger reservoirs manholes shall be provided.
- f) The access panels shall be sited such that cleaning can take place without disturbing internal piping.
- g) Access panel covers shall be capable of being removed and replaced easily.
- h) Access panel cover shall be sealed with reusable gaskets compatible with the system fluid and capable of preventing leakage from the reservoir and ingress of contaminants into the reservoir.

5.3.2.7 Pipe entry and exit:

- a) The return and suction lines shall be kept separated by baffles or other means;
- b) Return lines shall be terminated below the minimum fluid level at a point not less than 50 mm or 1.5 times the pipe inside diameter from the highest point of the reservoir bottom;
- c) The ends of return lines shall be bial cut to a 45 angle or an effective diffus shall be provided;
- d) Any pipe access into the reservoir top shall be effectively sealed;

- e) Where access connections are made below the maximum fluid level means shall be provided to prevent reservoir drainage during maintenance; and
- f) The suction intake shall terminate at a point which is not less than 50 mm above the highest point of the reservoir bottom. The top of the inlet strainer or inlet opening shall be not less than 75 mm or 1.5 times the pipe inside diameter (whichever is greater) below the minimum operating level of the fluid.

5.3.2.8 Surface treatment:

- a) All interior surfaces shall be thoroughly cleaned and all moisture, dirt, chips, flux, scale, slag, fibrous materials and any other contaminants removed.
- b) Any interior finishes applied shall be compatible with the hydraulic fluid used in the system and shall be applied as recommended by the manufacturer.
- c) Interior ferrous surfaces shall be coated with rust inhibitor compatible with the hydraulic fluid being used when other interior finishes are not used, and
- d) Exterior finishes used shall be compatible with the hydraulic fluid used.

5.3.2.9 Handling:

- a) The reservoir shall be constructed in such a manner that handling by a fork lift, slings and crane can be carried out with the reservoir filled with fluid and permanent distortion results; and
- b) The approximate weights of the reservoir, when empty and filled to maximum level, should be clearly marked on the reservoir.

5.3.2.10 *Lifting points* — Safe and clearly identified lifting points shall be provided.

5.3.3 Accessories

5.3.3.1 Fluid level indicators:

- a) All indicators shall be adequately protected.
- b) Fluid level indicators shall be provided such that these are clearly visible when filling;
- c) Each indicator shall be permanently marked against a contrasting background, with system 'high' and 'low' levels; and
- d) The high fluid level mark shall be the maximum level of fluid in the reservoir during normal operation.

5.3.3.2 Filling points:

- a) Filling points shall be fitted with covers that prevent the ingress of contaminants;
- b) When more than one filling point is fitted; they shall be located on opposite sides or ends of the reservoir;
- c) When the filler assemblies are located on top of the reservoir, the opening shall be a minimum of 200 mm above the reservoir top;
- d) The filling points shall be provided with a fine mesh strainer screen. The screen shall require hand tools for removal;
- e) The filling points shall be capable of passing a minimum of 20 litres of fluid per minute;
- f) The filler assemblies shall be effectively sealed to the reservoir by means of reusable seal; and
- g) The filler covers shall be attached to the filler assemblies by durable captive connectors;

5.3.3.3 *Breathers* — On vented reservoirs, air breathers or filter breather assemblies shall be provided to:

- a) maintain approximately atmospheric or a small positive pressure in the reservoir during changes in fluid level, and
- b) to filter air entering the reservoir to a cleanliness level compatible with the system components taking into consideration the environmental conditions in which the system is to be installed.

5.3.3.4 Warning system:

- a) Float switches shall be provided with electrical warning signals for high and low levels.
- b) Contact thermometers shall be installed with warning signal to indicate high and low temperatures of system fluid.
- c) Provision for heating the system fluid shall be made if required by the consumer.
- d) For large reservoirs a device (water warmer) to signal excessive water content in the system fluid shall be installed.

5.4 Design Characteristics

5.4.1 *Disassembly* — All detachable components of an accumulator which are exposed pressure shall be so designed and constructed that the following safeguard is complied with.

5.4.1.1 *Preferred safe guards* — It shall not be possible to remove any detachable component from the accumulator while the latter is pressurised in such a way that the pressurised gas would propel them in a hazardous manner.

5.4.1.2 Alternate safeguards — If the safeguards specified in 5.4.1.1 cannot be ensured, the accumulator design shall be such that one attempting to remove components from an accumulator shall receive adequate warning that the accumulator is preloaded. Adequate disassembly instructions shall be provided.

5.4.2 Automatic vent — Hydraulic circuits incorporating accumulators shall automatically vent the accumulator liquid pressure or positively isolate the accumulator when the equipment is shut off.

5.4.3 Pressure isolation — Where deviation is agreed to or a circuit application utilises accumulator liquid pressure isolation only (not automatically vented) when equipment is shut off, complete information for safe servicing shall be given on or near the accumulators in a visible location. Information shall include the statement 'CAUTION — Pressurised Vessel'. Duplicate information shall be provided on the circuit diagram.

5.4.4 Discharge rate — Accumulator discharge rate shall be restricted to the demands of the intended service.

5.4.5 Charging medium — Gas accumulators shall be charged with dry nitrogen or any other inert gas.

5.4.6 An inbuilt pressure — Limiting relief valve shall be provided in the accumulator valve manifold.

5.5 Filtration and Fluid Conditioning

5.5.1 Removal of contaminants

5.5.1.1 Filters — Filters shall be provided to remove solid particulate contaminant from the hydraulic fluid.

5.5.1.2 Filtration — The degree of filtration shall be consistent with the requirements for the components and environmental conditions.

5.5.1.3 Filter size — The size of the filter shall be adequate for the intended frequency of routine servicing.

5.5.1.4 Filter pressure drop — The maximum pressure drop across the filter element shall be limited to the manufacturers' specification.

5.5.1.5 Filter element — The filter element shall be compatible with the system fluid. Generally, filter, element shall be of reusable type and made out of non corrosive metallic wire.

5.5.2 Filtration System

5.5.2.1 Pulsations — Filters should not be located in flow lines subject to pressure pulsations likely to affect filtration efficiency.

5.5.2.2 The use of separately pumped filtration system should be given due consideration.

5.5.3 Filter servicing

5.5.3.1 Installation — Filters shall be installed where they are readily accessible and there shall be adequate space allowed for servicing.

5.5.3.2 Condition indicator — Means shall be provided either permanently to indicate or to install test equipment to show when a filter requires servicing or electric device for signaling the filter contamination.

5.5.3.3 Element identification — The filter element identification number and quantity required shall be permanently marked on the filter housing.

5.5.3.4 Servicing without shutdown — When specified, means shall be provided for exchanging filter elements without stopping the equipment.

5.5.4 Suction strainer or filters

5.5.4.1 Accessibility — Where suction strainers are used they shall be accessible for servicing without draining the reservoir.

5.5.4.2 Selection — Suction strainers should be selected and installed so that the inlet conditions at the pump are within the manufacturers' specification. Particular attention should be paid to this condition when fire resistant fluids are used.

5.5.5 Magnets — If magnets are used they shall be so sited that any collected contaminant which might be dislodged during use or service is prevented from entering the hydraulic system where it could cause damage. The magnet shall be accessible for servicing without draining fluid from the reservoir.

5.6 Heat Exchangers

5.6.1 Use of thermal controls — Where the use of heat exchangers is approved automatic thermal controls should be used as required to maintain the operating temperature range of the hydraulic fluid. Cooling media control valves should be on the input line. A shut off valve shall be provided in the media supply line for servicing.

5.6.2 Cooling media — The purchaser shall advise the supplier if special cooling media is to be used or if water supply is likely to be dirty, corrosive or limited.

5.6.3 Temperature measurement — Temperature measuring points should be desirable for both hydraulic fluid and cooling media.

5.6.4 Air coolers

5.6.4.1 Air supply — If air coolers are used an adequate supply of clean air be available to prevent choking of air passage in the cooler.

5.6.4.2 Air-exhaust — Discharge of air shall not cause a nuisance to nearby personnel.

5.6.5 Heaters — When heaters are used the dissipated power shall not exceed 0.7 W/cm^2 of heater surface area.

6. Control Mechanisms Circuit Protection

6.1 Circuit Protection

6.1.1 Tamper resistant protection — Where hazard or damage may result if operating pressures are exceeded, tamper resistant (internal positive stop, non-adjustable) over pressure protection shall be provided.

6.1.2 Safe working range of adjustable controls — Pressure and flow control components shall be constructed in a manner that prevents adjustment outside the working range as specified in the name plate.

6.1.3 Securing of adjustable component settings — Adjustable controls shall hold their settings until reset.

6.1.4 Locking of adjustable component settings — When specified, means should be provided for locking the setting of adjustable components or of locking their enclosures.

6.1.5 Control power supply failure:

- Hydraulic devices controlled electrically, pneumatically, or hydraulically shall be selected and applies so that failure of the control power supply does not cause hazard or damage to the equipment;
- In case of complete shut off of power a device for manually operating the system may be provided as a means of safeguarding critical components of the drive; and
- In case of electronic failures provision shall be made for manual operation with ac supply for critical equipments.

6.1.6 Control of multiple devices — Where there is more than one interrelated automatic or manually controlled devices on the equipment, and where failure of any of these devices could cause hazard or damage to the equipment, protective interlocks should interrupt all operations, provided such interruption does not itself cause hazard or damage to the equipment.

6.1.7 Fluid loss prevention — Means shall be provided to prevent the fluid contained in valves, pipes and actuators from draining back into the reservoir when the system is in the 'OFF' position if such drainage could cause hazard or damage to equipment.

6.1.8 Protection against inertia loads — Means shall be provided to prevent unacceptable pressure buildup where high inertia loads are reflected on actuators.

6.1.9 Uncontrolled movement — Circuits shall be designed to prevent uncontrolled movement and improper sequencing of hydraulic actuators particularly vertical and inclined motions during all phases of the equipment cycle, which includes start up, shut down, idling and setting up, and hydraulic failure.

6.1.10 Control stability — While selecting and positioning the pressure and flow control components in a system, due consideration shall be given to the effects of changes in working pressures, temperature and load on the component response, repeatability and stability relative to the requirements of the system application.

6.2 Manual Controls

6.2.1 Emergency controls

6.2.1.1 Emergency stop and emergency return — All equipments shall incorporate an emergency stop or emergency return control, whichever provides maximum safety.

6.2.1.2 Features of emergency stop and emergency return — Emergency stop and emergency return controls:

- shall operate immediately;
- shall not require operation of more than one manual control for all emergency functions;
- shall be independent of, and unaffected by, the adjustment of other controls or flow restrictions;
- shall be provided at each operator's working position and be readily accessible under all conditions of working. Additional controls may be necessary to fulfill this requirement;
- shall not create additional hazard;
- shall not require that any actuator be energized; and
- shall be readily identifiable.

For an emergency stop, adequate braking valves should be provided in the actuator lines from a servo-valve, if specified by the purchaser.

6.2.1.3 Cycle restart:

- a) Restarting an automatic cycle after an emergency stop shall not cause hazard or damage to the equipment; and
- b) If it is necessary to reset actuators to a start position, safe manual controls shall be provided.

6.2.2 Manual controls levers — The direction of movement of manually actuated levers shall not be confusing, for example, moving a lever up shall not lower the controlled equipment.

6.2.3 Over riding manual controls — Safety manual controls shall be provided for each actuator for setting up.

6.2.4 Two hand controls* — Controls shall be such that the operator cannot be exposed to hazards caused by machine movements. Two handed manual controls shall not be relied on as the only means of operator protection.

If two handed controls are provided, they shall:

- a) require maintained actuation of each control throughout the equipment cycle or until that point in the cycle is reached where the hazard ceases;
- b) be so located, guarded and timed that operation by means other than both hands is prevented; and
- b) be so designed that the equipment cannot be operated unless both manual controls at each control station are released between cycles.

6.3 Controls

6.3.1 Protection — The location and mounting of all controls shall provide adequate protecting from:

- a) malfunction and damage,
- b) high temperature, and
- c) corrosive atmospheres.

6.3.2 Accessibility — Controls shall be easily accessible for adjustments and maintenance.

6.3.3 Manual controls — The location and mounting of manual controls shall:

- a) place and control within reach of the operator from his normal working position;
- b) not require the operator to reach past rotating or moving equipment elements to operate the control;
- c) not interfere with the equipment operators required working movements; and
- d) give due consideration to operational forces.

6.3.4 Automatic controls — The location and mounting of automatic controls:

- a) shall be on a panel or circuit manifold adjacent to the related power unit unless size, function or piping method requires alternate location; and
- b) shall be a minimum of 0.6 metre or a maximum of 1.8 metre above the working floor unless size, function or piping method requires alternate location.

6.3.5 Sequence control — Sequencing by position shall be used wherever practical and shall always be used when a sequencing malfunction of a pressure or time lapse type control alone would cause hazard or damage to equipment.

6.4 Circuit Relationships — The operating conditions in one system or part of a system shall not adversely affect another, particularly when precise controls is required.

6.5 Servo Controlled Circuits

6.5.1 Servo valve location — The servo valve shall be mounted as close to the related actuator as practical to minimize the contained volume between the valve and actuator.

6.5.2 Filter (type and location)

6.5.2.1 Full flow filtration shall be used in the supply line preceeding a servo valve. It shall be close to the servo valve and shall be without by pass but fitted with element condition indicators. Dual filter in series shall be installed in the intake of the valve such that higher micron rating filter is positioned after finer micron rating filter to arrest dirt and dust entering the servo valve while cleaning/replacing the finer micron rating filter element.

6.5.2.2 For large volume systems bulk filtration units like centrifuge for separation of water and other particulars shall be permanently provided in the layout with necessary heaters, strainers, controls, etc.

6.5.3 Fluid sampling — A means of obtaining a representation fluid sample through a properly designed sampling valve shall be provided to allow for checking fluid cleanliness and condition.

6.5.4 Flushing — Servo valves shall not be fitted to the systems until the system has been flushed through flushing plates to achieve the required fluid cleanliness level.

6.5.5 Fluid condition — Systems with servo valves should be filled and the fluid level maintained with fluid filtered to the necessary cleanliness.

7. Supplementary Equipment

7.1 Type-sealing devices for hydraulic circuits, including all static interface seals should be of the pressure sealing type.

7.2 Materials — Sealing device materials shall be compatible with adjacent materials and the environment with which they are in contact. Sealing materials like hemp, putty, etc, shall not be used.

APPENDIX A

(Clause 2.13)

SUMMARY OF SAFETY REQUIREMENTS

A-0. For the sake of convenience the following is the summary of the safety requirements listed out in the main body of this standard and it shall be borne in mind that attention to these details alone does not imply that a safe system will be produced.

A-1. General Requirements

- a) Fail-safe concept (*see 2.1.1*).
- b) Application concept (*see 2.1.2*).
- c) Special site conditions (*see 2.2.1*), and
- d) Components (*see 2.4.1*).

A-2. Energy Conversion — Coupling guards (*see 3.1.1.5*).

A-3. Cylinders

- a) Resistance to buckling (*see 3.2.1*).
- b) Fixing screws (*see 3.2.3.1*).
- c) Cushions (*see 3.2.6*), and
- d) Piston and rod assembly (*see 3.2.7.1*).

A-4. Valves

- a) Attitude (*see 4.1.1*).
- b) Detented valves (*see 4.3*), and
- c) Identification of actuation (*see 4.4*).

A-5. Energy Transmission and Conditioning

- a) Specifications of fluids (*see 5.1.1*).
- b) Fire resistant fluids (*see 5.1.2.2*).
- c) Handling precautions for fluids (*see 5.1.3*), and
- d) Failure of flexible hoses (*see 5.2.8.3*).

A-6. Accumulators

- a) Disassembly (*see 5.4.1*).
- b) Preferred safeguards (*see 5.4.1.1*).
- c) Alternate safeguards (*see 5.4.1.2*).
- d) Automatic vent (*see 5.4.2*).
- e) Pressure isolation (*see 5.4.3*).
- f) Discharge rate (*see 5.4.4*), and
- g) Charging medium for gas accumulator (*see 5.4.5*).

A-7. Control Mechanisms

- a) Tamper resistant protection (*see 6.1.1*).
- b) Safe working range of adjustable control (*see 6.1.2*).
- c) Securing of adjustable component settings (*see 6.1.3*).
- d) Locking of adjustable component settings (*see 6.1.4*).
- e) Control power supply failure (*see 6.1.5*).
- f) Control of multiple devices (*see 6.1.6*).
- g) Fluid loss prevention (*see 6.1.7*).
- h) Protection against inertia loads (*see 6.1.8*).
- j) Uncontrolled movement (*see 6.1.9*), and
- k) Control stability (*see 6.1.10*).

A-8. Manual Controls

- a) Emergency stop and emergency return (*see* 6.2.1.1).
- b) Features of emergency stop and emergency return (*see* 6.2.1.3).
- c) Manual control levers (*see* 6.2.2).
- d) Over riding manual controls (*see* 6.2.3).
- e) Two hand controls (*see* 6.2.4).
- f) Manual controls (*see* 6.3.3), and
- g) Sequence control (*see* 6.3.5).