



Exploration & Production

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS SPS 023

Cleaning and Flushing of Hydraulic Systems

02	08/03	Change of Group name and logo
01	03/03	NAS 1638 replaced by AS 4059
00	10/02	First issue
Rev.	Date	Notes



Contents

1. Scope	3
2. Reference documents.....	3
3. Responsibilities.....	4
4. Flushing and cleanliness requirements	4
4.1 General requirements	4
4.2 Cleaning of hydraulic components and systems.....	4
4.3 Flushing of hydraulic components and systems	5
4.4 Fluid sampling.....	6
4.5 Fluid analysis/cleanliness verification.....	7
5. Hydraulic housekeeping.....	7
5.1 Assembly/Manufacturing.....	7
5.2 Testing/FAT	8
5.3 Storage after completed Work or testing	9
5.4 Transportation.....	9



1. Scope

The present specification covers the minimum requirements for cleaning and flushing of hydraulic systems used for subsea equipment.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Cleanliness with respect to particles shall be classified according to latest revision of:

- [AS 4059](#)

For particle analyses performed by filtration/microscope techniques:

- [ARP \(SAE\) 598 B](#)

Standards

Reference	Title
AS 4059	Cleanliness classification for hydraulic fluids
ARP (SAE) 598 B	The determination of particulate contamination in liquid by the particle count method.

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
Not applicable	

3. Responsibilities

Taking into consideration the requirements of this specification, the equipment VENDOR shall develop the detailed procedures for flushing and cleaning in the workshop each part of the supply. These procedures shall be formally reviewed and accepted by COMPANY. An important part of these procedures will be the verification of the resulting cleanliness, which shall be witnessed by a COMPANY representative before considering the equipment as “ready for shipment”.

The equipment VENDOR shall also develop a site flushing and cleaning procedure, which should be used:

- During site installation if preservation and storage quality was inadequate
- After operation on site in case of major intervention on the hydraulic equipment.

4. Flushing and cleanliness requirements

4.1 General requirements

All hydraulic systems shall be delivered with verified [AS 4059](#) Class 6 B-F cleanliness.

4.2 Cleaning of hydraulic components and systems

All equipment subject to cleanliness requirements shall be identified. For this equipment, the following activities shall be described and implemented:

- Cleaning methods and equipment
- Inspection methods to verify cleanliness
- Preparation for storage

4.2.1 Cleaning methods

- Cleaning methods for tubing shall be selected within:
 - Shop air flushing
 - Solvent cleaning
 - Cleaning pigs
 - Connection to a flushing rig

Tubing shall be flushed after cutting and bending and prior to assembly onto equipment. The tubing shall be capped after flushing.

- Cleaning methods for components shall be selected from:
 - Solvent cleaning

- Connection to a flushing rig
- Ultrasonic cleaning
- Shop air

Cleaning aspects shall be emphasised during the design stages. For example:

- Avoid blind bores
- Avoid welding and grinding on assembled components
- Provide access for cleaning of tanks
- Design tubing systems so that turbulent flow is possible, i.e. no unnecessary flow restrictions
- The systems shall be prevented from being contaminated during filling operations
- External connections shall be protected by permanently attached caps or similar to prevent contamination when not connected

4.2.2 Facilities

Cleaning activities shall only be carried out in designated areas.

Aspects relating to cleanliness shall be addressed:

- General condition of the facility
- Quality of ventilation, if any
- Suitability for working with clean hydraulic systems
- Other work and other type of work within the facility

4.3 Flushing of hydraulic components and systems

Flushing shall be performed, and a corresponding procedure shall therefore be written, for all components and systems that are subject to requirements for cleanliness level according to [AS 4059](#) standard.

The procedure shall contain a detailed description of:

- Flushing rig and connection to equipment
- Flushing programme including operational parameters and contingency plans
- Step by step procedure on how to perform the flushing. The procedure shall include a diagram specifying inlet/outlet of the fluid (exact location) and the required flow, temperature and pressure to achieve efficient flushing conditions
- Verification of cleanliness
- Completion of flushing and disconnection of equipment

Cleanliness of fluid from the flushing rig shall be checked to [AS 4059](#) Class 6 B-F or preferably lower.

Flushing shall be performed at the following steps:

- Following manufacturing and assembly or when commissioning the component or system

- After any repair or maintenance work, and after the system has been opened up
- Prior to use if system has been stored for a period exceeding than three months.

Max. temperature for flushing is 50°C, but shall be equal to or greater than system temperature during normal operation.

The flow rate during flushing shall be monitored so that the predetermined flushing programme is followed. General rules for flushing indicate that circulating the oil 150-200 times the volume should be sufficient. In the case of actuators in the system to be flushed, these should not be stroked more than 30 times.

The step by step procedure for performing the actual flushing shall include:

- Specification of connection points
- Sequence of valve operation
- Ensure that flushing is carried out from the critical components through the piping to less critical components
- Careful handling of critical components such as actuators

Contingency plans for unsuccessful flushing within the predetermined plans shall be established. CONTRACTOR shall identify the reason for not being able to reach the specified cleanliness, then repeat the necessary cleaning operation, and notify COMPANY if unsuccessful.

Upon completion of flushing, disconnect the equipment from test stand and flushing rig, cover all open ends and prepare for storage.

4.3.1 Flushing equipment

The flushing rig itself shall avoid potential contamination of the hydraulic components and systems.

A procedure shall be established which contains a step by step description of how to properly operate and check the flushing rig.

Flushing rig cleanliness and water content shall be checked and verified at regular intervals:

- Every time when flushing an assembly
- When the flushing rig has been moved, opened or worked on
- When the flushing rig has not been operated for two weeks or more. Operation of the flushing rig shall be recorded in the Cleanliness Log

4.4 Fluid sampling

The Control System CONTRACTOR shall establish the actual design of the sampling points.

A detailed description of how, when and where to take oil samples shall be established.

The sampling point shall be located in the return line upstream of the filters at a location that ensures turbulent flow.

Systems including tanks for hydraulic fluid shall be equipped with sampling point for water content.



The hydraulic fluid shall be circulated for a minimum of 15 minutes before taking a sample to ensure evenly distributed particles and representative samples.

Use standardised sampling kit, automatic sampling system or manual glass bottles, and strictly follow the instructions for use.

4.5 Fluid analysis/cleanliness verification

A detailed description and plan for performing fluid analysis shall be established to ensure reliable data suitable for cleanliness verification.

Analysis equipment shall be specified:

- Particles count using single lens microscope or double lens comparison microscope. These two may be suitable for in-house check at intermediate stages
- On-line automatic particles counter or wear probe. These are suitable for in-house checks
- Laboratory particle counter shall be used for final verification of cleanliness level

As a part of FAT the final acceptance criterion is that three consecutive samples shall be within the specified cleanliness level. Whenever requested by COMPANY samples shall be verified by third party laboratory and documentation of verified cleanliness level is to be attached to the FAT report.

The procedure shall contain a contingency plan for analyses (other than particle counting) to be used to establish reasons in case the specified cleanliness level is difficult to obtain. These analyses may include:

- Visual inspection in microscope to determine source of contamination
- Spectrometric analysis

A Cleanliness Log shall be established for all equipment where cleanliness requirements are specified.

The Cleanliness Log shall contain the following information:

- All relevant procedures
- Log of all activities performed (with respect to Cleanliness) as compared with the specifications in the procedures

The Cleanliness log shall follow the hydraulic equipment.

5. Hydraulic housekeeping

5.1 Assembly/Manufacturing

Hydraulic housekeeping routines and inputs to the procedure:

- The goal of all assembly and manufacturing work (as for other activities) is to have hydraulic housekeeping routines, which maintain cleanliness to an extent where final flushing is merely a verification of cleanliness. This procedure shall specify how to achieve this goal
- A plan shall be established for pre-cleaning of all components prior to assembly and manufacturing

- The pre-cleaning plan shall specify which methods and/or tools, solvents, rags, etc. to use for which component
- Evaluate and, if necessary verify that aids and tools used during the process do not contaminate unnecessarily. For example, check shop air used for pipe cleaning with relation to particles and oil content, intermediate storage bins shall be cleaned prior to use. If pallets or wooden boxes are used, they shall as a minimum be covered by suitable cardboard
- New components or subsystems mounted or connected to the assembly shall not contaminate the assembly
- All assembly and manufacturing activities shall be performed by designated and trained personnel
- Examples of hydraulic housekeeping rules which shall be implemented in the procedure:
 - No metal work (grinding, welding, etc.) in assembly areas. Such work shall be performed in separate rooms or separated by walls extending to the ceiling or crane beams
 - Sufficient ventilation shall be provided
 - Open doors shall be avoided
 - Large assembly halls/crane areas are normally not suitable for [AS 4059](#) Class 6 B-F conditions
 - No Teflon tape on threads
 - Avoid NPT and other conical threads
 - Use Loctite, but not excessively
 - Cover open ends at all times, but do not use metal plugs or sticky tape
 - Use lint free rags
 - Gradation of tube cuts shall be performed
 - Avoid using the floor as direct working or storage area
 - Avoid using grease for assembly lubrication, use the designated hydraulic fluid
 - End plugs shall be installed and kept in place at all times.

5.2 Testing/FAT

Hydraulic housekeeping routines and inputs to the procedure:

- General rule I: All accessory systems such as pressure test equipment, flushing rig, test stand, etc. shall be checked and verified with relation to cleanliness level prior to connection
The same requirements are valid when connecting one subsea module to another
- General rule II: The fluid used for flushing shall be the specified hydraulic fluid. Deviations from this rule are subject to COMPANY Approval after compatibility has been established and checked

The two above rules shall be implemented in the procedure.

5.3 Storage after completed Work or testing

Hydraulic housekeeping routines and inputs to the procedure:

- The procedure shall contain a plan for where and how to store the components and systems
- Appropriate preservation packaging shall be provided
- A plan for corrosion protection shall be established regardless of storage time
- The hydraulic fluid shall be used as preservation fluid
- The storage facilities shall be designated, evaluated and, if necessary, re-furbished
- If possible, storage temperature should be kept constant to avoid condensation problems
- Outside storage should be avoided, but provisions for preservation necessary to withstand at least 48 months storage time in outdoor marine atmosphere shall be provided.

5.4 Transportation

Hydraulic housekeeping routines and inputs to the procedure:

- The procedure shall contain a plan specifying the transport conditions of the items in question
- Sufficient transport packaging shall be provided to meet requirements for moisture control, handling protection and temperature variations
- Provisions made during storage should be sufficient also for transport
- Preservation packaging shall be suitable for on deck sea transport.