

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 146

Design of generation and distribution of hydraulic energy

09	11/2012	Revised as per marking
08	01/2012	Revised as per marking
07	01/2011	Revised as per marking
06	10/2008	Revised as per marking
00	10/2002	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC

Managing entity: DEV/TEC/INS

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1. Scope

This specification defines the principles of design and construction of a hydraulic power generation system and its distribution network.

Hydraulic power units shall be supplied in compliance with this specification, and shall be complemented by project specifications and other general specifications referenced here-after.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ATEX European Directive 94/9/EC	European Directive on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
IEC 60079	Parts related to the Electrical apparatus for explosive gas atmospheres
IEC 60529	Degrees of protection provided by enclosures (IP code)
IECEX	IEC System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX System)
ISO 4406-1999	Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 079	Electrical apparatus for potentially explosive gas atmospheres
GS EP INS 101	Instrumentation engineering, supply and construction general requirements
GS EP INS 102	Instrumentation identification
GS EP INS 107	Design and installation of instrumentation links
GS EP INS 110	Instrumentation for package units
GS EP INS 147	Design and Supply of wellhead control panels

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Reference	Title
GS EP INS 900	Instrument hook-up diagrams
GS EP PVV 112	Piping material classes
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS EP PVV 212	Design and fabrication of pressure vessels according to BSI PD 5500
GS EP SAF 226	Completed wells safety systems and safety rules
GS EP SAF 261	Emergency shutdown and Emergency De-pressurisation (ESD & EDP)
GS EP SPS 019	Subsea production control system
GS EP SPS 023	Cleaning and Flushing of Hydraulic Systems

3. Details and deviations from reference documents

All services provided shall comply with the above listed documents.

However, regulations or directives applicable in the country of destination of the hydraulic system shall be taken into consideration when they are more constraining than the reference documents.

Hydraulic system detailed requirements shall be given in a project specification. This specification shall detail environmental data, sizing criteria, construction and operation requirements. It shall include the hydraulic power generation, the distribution network, and the wellhead safety valves control panel when required. The functional analysis shall also be part of this specification.

3.1 General

The statements and requirements of this specification shall be completed by those of Company's General Specifications [GS EP ELE 079](#), [GS EP INS 102](#), [GS EP INS 107](#), [GS EP INS 147](#), [GS EP INS 900](#), [GS EP PVV 211](#), [GS EP PVV 212](#), [GS EP SAF 226](#), [GS EP SAF 261](#) and [GS EP SPS 019](#).

Recommendations and prescriptions of [IEC 60079](#) shall also be followed.

The hydraulic system shall be designed to power valves actuators as per project requirements. These can be on/off and proportional valves.

It shall be considered as a packaged Hydraulic Power Unit in combination with a custom-designed distribution network.

The distribution network shall comprise supply and return lines.

For drilling platforms, the hydraulic system shall also integrate the wellhead safety valves control panel, including specific hydraulic energy generation. The Wellhead Control Panel shall be based on a modular design, thus allowing further extensions.

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Dedicated hydraulic system shall always be provided for subsea control application and this hydraulic system shall not be shared with any other application.

Sizing of the hydraulic system shall consider future extensions, especially Xmas tree valves for future wells.

All wetted parts of the hydraulic systems shall be made of 316/316L stainless steel with the following exceptions: accumulators, instrument tubings, pump suction filter cartridge.

- Accumulators shall only be made of 316L stainless steel
- Instrument tubing material shall be in accordance with [GS EP INS 107](#)

Instruments shall be designed according to the requirements of [GS EP INS 101](#).

All equipment must comply with the requirements of the specific hazardous area where they are installed

For any installation, [ATEX European Directive 94/9/EC / IECEx](#) standards shall be followed.

All field instruments shall be certified for zone1.

3.2 Hydraulic Power Unit

3.2.1 Design principles

The HPU shall typically be composed of hydraulic oil tanks, pumps, filters, pressure controllers and hydraulic accumulators.

In principle, there are two design basis:

- Low flow pumps with large accumulator volume
- Large flow pumps with small accumulator volume.

The specific design basis shall be selected taking into account the particular application (general on/off valve actuation, well head control panel, subsea control, etc) and the operation requirements (start-up, normal operations, shut-down, power availability, etc.).

The HPU shall be designed so that in case of loss of any control signal or power, the concerned component is locked in a position where it does not jeopardize panel healthy functioning.

The back pressure shall also be considered to counterbalance the head static pressure, especially for low pressure return with hydraulic operated logic supply; it will of course depend on the general hydraulic lay out (i.e. valve position below the HPU).

3.2.2 HPU construction

All equipment shall be skid mounted or incorporated inside a cabinet fabricated from welded or bent 316L stainless steel plates; the plates shall be welded on a 316L stainless steel frame which shall be rigid enough to allow lifting of the panel.

The minimum thickness of the SS plates shall be 2 mm.

The top face shall have lifting-eyes fixed on the panel frame. The Vendor shall provide a lifting procedure which shall include lifting strain calculations.

Louvres shall be installed for panel venting.

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All framing, brackets, tubes, couplings, bolts, nuts, etc., used for the cabinet fabrication shall be made of 316/316L/904 stainless steel according to the environmental conditions.

A drip tray for collecting possible oil spills and overflows shall be provided; it shall be sloped and have a drain connection at its lowest point. The plinth shall be sized so as to be capable of receiving the complete volume of oil inside the hydraulic system. Grating shall be installed above the drip tray and neither cables, tubes nor any piece of equipment shall be located inside this volume.

The layout shall allow easy access to all components for maintenance. Special attention shall be given to heavy equipment that could require use of handling means for removal.

Generally instrument cables shall be routed up to junction boxes when electrical cables will generally be routed straight to the electrical room.

All cables shall be routed on AISI 316L SS cable trays. Routing shall preserve cables from hydraulic oil spills.

Specific requirements in case of cabinet:

The cabinet back panel shall have lift-off hinged mounted door(s) with oil resistant gaskets to maintain the required IP rating. Doors shall have lockable handles.

The panel shall be provided with internal lighting. The on/off switch shall be inside the panel.

The panel shall be IP55 according to [IEC 60529](#).

Penetrations should preferably be through cabinet side-walls. Any other location shall be submitted to Company written agreement.

All tubes penetrations shall be through bulkhead connectors.

All cables penetrations shall be through MCT's.

3.2.3 Grounding

All electrical equipment and instruments shall be grounded by means of individual ground conductors connected to an internal busbar.

All articulated mechanical connections such as door hinges, etc, shall be connected with wire braid straps to ensure an effective grounding continuity.

The cabinet shall have two outside earthing lugs, located at the bottom of each side wall, allowing connection of a 35 mm² wire braid strap.

3.2.4 Front panel

The cabinet front panel shall support all control and monitoring devices required for normal operation. This includes, but is not limited to reservoirs sight glasses, pressure gauges, local control devices, local alarm devices, etc.

All instrument mounted in the panel face shall be sealed in order to achieve the required IP.

The front panel shall be reinforced after cut-outs for instruments in order to recover the original mechanical resistance.

When the wellhead valves control panel is part of the cabinet, the layout of the front panel shall be clearly separated into power control and well control modules parts.

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The front panel shall be fitted with a canopy to protect instruments from dripping liquids.

3.2.5 Tanks

Tanks shall be fabricated from 316L stainless steel plates; plates shall not be bolted.

Tanks shall have a screwed and sealed inspection hatch.

Tanks bottom shall be of the “diamond” type with a drain connection. It shall be fitted with a magnetic plug for recovering metal particles.

The drain line shall be fitted with a 1/2” ball valve and shall be piped down to the containing plinth.

Tanks shall have a breather vent fitted with a 5 microns filter and connected to the plant venting system, unless fitted with a flame arrestor. For large units, nitrogen blanketing shall be envisaged.

Overflow device shall be connected to the drain system.

Tanks shall be equipped with an armoured glass sight gauge.

3.2.5.1 Reserve and Return tank

The combined tank shall be sufficiently sized to contain 150% of the complete cold fill of the hydraulic system, including all valves actuators.

The tank shall comprise a settlement chamber, accepting the fluid return lines.

Filling of the tank shall be possible from outside of the panel. The filling system shall have a captive plug and a filter. The filter shall be easily accessible for maintenance.

The reservoir shall be fitted with level transmitters for control and safety purposes.

For subsea control applications, separate supply and return reservoirs shall be provided.

3.2.5.2 DHSV Dedicated return tank

When the HPU application is for wellhead control panel or subsea control with close circuit fluid system, a dedicated return tank within the panel shall be used for DHSV as well as for returns from downhole intelligent well control valves

The oil return tank shall be sufficiently sized to contain 115% of the total volume of all DHSV actuators.

The tank shall comprise a settlement chamber, accepting the fluid return line, with a pipe from this chamber to the reserve tank. This pipe shall be filled by overflow from the settlement chamber. The flow of hydraulic fluid through this pipe to the reserve tank shall pass through a filter by gravity feed.

The tank shall be fitted with one level transmitter for monitoring purpose.

3.2.6 Pumps

Hydraulic power generation shall be done using automatically controlled pumps.

Pumps shall be redundant, each pump being sized to pressurize the hydraulic system from atmospheric pressure within the time as defined in the project specification, considering also

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start-up after shut-down. One pump shall also be of sufficient capacity to keep the system pressurized under normal operating conditions.

The rate of opening wellheads shall be realistic.

The design shall allow maintenance of one pump branch without affecting the other branch.

Pumps can be pneumatically or electrically driven as per project requirements except for HPU for subsea control application where only electrically driven pumps are permitted

An auxiliary pump, pneumatic (e.g. nitrogen bottle) or hand driven, shall be installed to back-up the main generation system. This requirement does not apply to HPU for subsea system application.

Instrument air or instrument gas supply line shall include individual filter/regulator.

Exhaust of instrument gas driven pump shall be collected to a vent header routed to a safe location.

In case instrument gas is used, the material of pneumatic circuits shall be chosen considering the chemical composition of the gas and all injected products.

A relief valve with the same capacity as the pump shall be installed at each pump discharge. This relief valve shall discharge into the return tank.

Pumps shall discharge in a common high pressure header. Two (2) pressure transmitters shall be installed for control and safety purposes.

3.2.7 Hydraulic Accumulators

Accumulators shall be bladder or piston type, in both cases filled with nitrogen.

Accumulators shall comply with [GS EP PVV 211](#) or [GS EP PVV 212](#).

Accumulators shall be sized according to the following criteria:

- A minimum of two (2) accumulators, 50% capacity each, shall be installed.
- With one pump in service, the accumulators shall be able to operate all consumers (On/Off valves, control valves, choke, etc.) plus spare depending on operation requirements with no risk of pressure drop and/or loss of flow from the hydraulic plant and the distribution network below the service values.
- Opening of all valves related to one wellhead while retaining supply header pressure above minimum value, without any pump recharge action.

The accumulators shall be fitted with a double block and bleed assembly at a low point.

The accumulators shall be fitted with the equipment needed to monitor the nitrogen pressure and for refilling. Such equipment shall as a minimum include pressure gauges, block and bleed valves and nitrogen filling port.

3.2.8 Filters

Each pump suction line shall be fitted with a strainer.

Dual filters shall be installed downstream of the pumps, filter rating shall be as required in the project specifications but shall not be less than 5 microns. A differential pressure transmitter

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shall be installed for filter clogging monitoring. Filters shall be sized to provide, in normal operating conditions, a service life of at least six months (without changing filter and maintaining fluid quality).

It shall be possible to change any of the filters without shutting down the hydraulic power unit.

3.2.9 Pressure levels

When several pressure levels are required, the generating system shall include as many independent banks of pumps, accumulators, filters, pressure controllers and pressure transmitters as there are pressure levels to be delivered.

For small installations, generation of a second pressure level using pressure reducers will be studied on a case by case basis.

3.3 Hydraulic network

Battery limit between the HPU and hydraulic network shall be the bulkhead connectors included in HPU Vendor scope of supply.

For offshore use, small size hydraulic lines (diameter up to 1/2 inch) shall be in AISI 904L stainless steel. Other applications (i.e. onshore or lines above 1/2 inch) shall be in AISI 316L stainless steel at the minimum.

Whenever possible, the ring technology shall be preferred to individual supply and return lines.

The supply network shall be sized to provide the necessary volume and pressure to all consumers based on the consumption during start-up's. Calculation shall also consider the HPU internal supply circuit.

Isolation valve shall not be fitted on the return path/network.

Return sub headers and header shall be protected against mechanical damage which may reduce or block the hydraulic oil return to the reservoir.

The return network shall be sized taking into account simultaneous moving of all valves to their fail position within the required times as specified in valves data sheets. Calculations shall also consider the HPU internal return circuit. The return network shall remain full in all circumstances.

In case of individual supply/return lines, the same design principle shall be applied.

Contractor shall supply hydraulic network calculation sheets.

The distribution lines shall be fitted with bleed valves at high points.

The hydraulic piping layout, and the positioning of the HPU, shall be designed to ensure that the hydraulic system is not exposed to major heat sources.

Distribution lines shall be totally isolated from each other. In particular, a pressure drop in one distribution line shall not under any circumstances affect the rest of the distribution network.

Appropriate provisions shall be made to avoid any risk of corrosion at the support/network interface (including risks of corrosion due to seawater stagnating between support and pipe).

Each line of the network shall be clearly identified at each end and at its hand operated shut-off valve.

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The design of the hydraulic network shall allow for easy flushing and oil cleaning operations.

4. Additional specifications

4.1 General

To maintain the independence of the hydraulic system with respect to the other plants of the installation, its operation must not under any circumstances depend on the operation of any other installation equipment that is non critical with respect to production.

The hydraulic system shall take the form of an integrated assembly, pre-piped and pre-tested.

The hydraulic system shall be designed to ensure that the fluid retains at least cleanliness codes 17/15/12 as defined by [ISO 4406-1999](#).

In order to further ensure the above cleanliness requirement, pumps should be provided to permit filling of tanks and re-circulating the fluid through dual filters and a sampling point. Provision of these re-circulation/cleaning pumps shall be mandatory in the case of subsea control application.

The dimensioning of the hydraulic system and the distribution network shall take into account the properties of the selected fluid.

Procedures for installing, cleaning, filling and setting up the hydraulic system and the distribution network shall be drawn up by the Contractor and submitted to the Company for approval prior to execution.

Special attention shall be paid to the system of identification and/or marking applied to components of the hydraulic system, in particular to avoid any risk of corrosion affecting the identification itself.

4.2 Hydraulic fluid

The fluid specifications shall be given by Company except for subsea control applications where it shall be specified by the subsea production system supplier.

4.3 Hydraulic system shutdown

The design of the Hydraulic Power Unit and the distribution system shall take into account the safety shutdown procedure of the plant as specified by the Emergency Shutdown Logic Diagram. The safety shutdown conditions shall be defined by the Company for each project.

In case of decompression, it shall be carried out through a bleed system, returning the fluid into the oil tank to the service conditions of the oil tank.

4.3.1 Particular requirements for subsea control

The design of the HPU shall comply with [GS EP SPS 019](#).

Facilities shall be provided to vent subsea lines in order to close all subsea valves in emergency situations. These shall consist of solenoid valves and associated pilots to vent individual subsea lines.

The solenoid valves shall be certified suitable for Safety Integrity Level 3 applications and shall be operated directly by the plant ESD system.

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Care shall be taken in sizing and selection of the solenoid valves, pilots and other accessories to avoid spurious trips and to ensure venting of the subsea lines within the required time and in the right sequence.

Use of closed-coupled stacked manifold block is not allowed for the solenoid valves and pilots.

4.4 Environmental protection

The hydraulic system shall be designed to collect and drain leak and bleed flows without polluting the environment.

Monitoring of the hydraulic oil consumption will be foreseen in the control system and a “high consumption” alarm will be raised.

4.5 Piping class and connections

Hydraulic plant piping diameters and materials shall be in accordance with the appropriate section of the reference API.

The piping class of the system of main and sub-headers shall be in accordance with **GS EP PVV 112**.

Pumps outlet lines or lines connecting to hydraulic actuators that are liable to be disconnected frequently shall be implemented using hoses protected by a fireproof sheathing.

4.6 Hydraulic system control

The hydraulic system will be remote controlled from the Integrated Control and Safety System (ICSS). The means of control shall be defined in the functional analysis.

The hydraulic system shall be equipped with all the instruments necessary for that control.

4.6.1 Local control

Local control shall always be possible. Control devices shall be installed at the front panel.

4.6.2 Control System interface

The information to be relayed to the control system shall be connected via terminal blocks installed in junction boxes. Junction boxes will preferably be located inside the panel so as to limit the number of outgoing cables.

Where a PLC is dedicated to the HPU management, the ICSS interface can be performed through a serial link instead of hardwired links, where the data amount to be exchanged exceeds 20. The PLC shall be provided in accordance with **GS EP INS 110**.

Safety signals shall always be hardwired

The list of signals to be exchanged with the Control System will be as per the functional analysis.

5. Cleaning and Flushing

All Hydraulic components of the HPU shall be suitably cleaned (and flushed as necessary) in order to obtain the cleanliness level as defined in § 4.1.

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Cleaning and Flushing procedure of the HPU shall be developed by the equipment Vendor for both workshop and site requirements. This procedure shall be approved by Company and shall contain as a minimum:

- Cleaning/flushing method
- Cleaning fluids specification
- Calculation of minimum Reynolds number for flushing fluid velocity
- Required equipment specification
- Sampling method
- Acceptance criteria

Cleaning and flushing procedure for HPU for subsea control application shall be in accordance with **GS EP SPS 023**.

6. Testing

Hydraulic Power Units shall be factory tested.

The FAT shall include the test of all functions and a pressure leak test.

At the end of the test, hydraulic oil shall be circulated inside the HPU and filtered to reach cleanliness codes 17/15/12 as defined by [ISO 4406-1999](#). Then the HPU shall be emptied, dried, and all bulkhead connections shall be plugged before shipment.

The Vendor shall be responsible for supplying and implementing all necessary equipment and accessories to demonstrate the panel provides the required service.