



Exploration & Production

GENERAL SPECIFICATION

Field Operations

GS EP EXP 213

Minimum maintenance requirements

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1. Scope

1.1 Preamble

This General Specification provides the basis for a project or subsidiary's elementary maintenance strategy, by type of equipment. The implementation of this strategy is therefore to provide to projects and subsidiaries the fundamentals for the maintenance strategy based on the Total E&P integrity standards.

It is the responsibility of the head of maintenance of operational subsidiary to determine and apply the optimum level of maintenance to reach plant required availability and therefore these minimum requirements should only be seen as a minimum below which maintenance plan shall never fall.

1.2 Application

The scope of this document covers the equipments inbound the plant in on shore installation, and above the sea level for off shore installation.

The requirements of this document apply to:

- All new projects planned, designed and constructed by and for the Company,
- All oil and gas installations, operated by the Company.

Any deviation from the minimum inspection requirements stipulated hereafter must be cleared through a formal Request for Exemption.

The requirements are minimum established for each class of equipment, however, Manufacturer recommendations shall be studied and reported in the maintenance plan, in accordance with the global plant maintenance strategy.

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.

Standards

Reference	Title
IEC 60364	Low-voltage electrical installations – Part 6: Verification
IEC 62402	Obsolescence management – Application guide
IEC 61936	Power installations exceeding 1 kV a.c.
IEC 60079	Explosive atmospheres

**Professional Documents**

Reference	Title
Not applicable	

Regulations

Reference	Title
DIRECTIVE 94/9/EC	Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)
SOLAS III/20	Life saving appliances and arrangements, Operational readiness, maintenance and inspections
MSC Circ 850	Guidelines for the maintenance and inspection of fire protection systems and appliances
MSC Circ 851	Guidelines on engine room oil fuel systems
MSC 1 Circ 1318	Annex guidelines for the maintenance and inspection of fixed carbon dioxide fire extinguishing systems

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
GS EP ELE 031	Design of earthing and bonding systems
GS EP ELE 079	Electrical apparatus for potentially explosive gas atmospheres
GS EP ELE 081	Lighting
GS EP ELE 141	Power transformers
GS EP INS 111	Design and supply of liquid custody transfer metering units
GS EP INS 112	Design and supply of gas custody transfer metering units
GS EP INS 120	Control valves
GS EP INS 135	Cyber Security requirements for design and supply of ICSS and Package Systems
GS EP INS 137	Off/on valve control panel and actuators functional and construction requirements
GS EP EXP 107	Commissioning execution
GS EP EXP 311	Plant integrity. Minimum inspection requirements.
GS EP SAF 216	Area classification
GS EP SAF 261	Emergency Shut-Down and Emergency De-Pressurisation (ESD & EDP)
GS EP SAF 371	Emergency control facilities
GS EP TEC 007	Obsolescence and lifetime cycle management



3. Definitions, abbreviations and terminology

BDV:	Blow Down Valve
BSW:	Basic Sediment Water
CCR:	Central Control Room
CMMS:	Computerized Maintenance Management System
ESDV:	Emergency Shut Down Valve
F&G:	Fire and Gas
FPSO:	Floating Production Storage and Off-loading unit
GMC:	General Maintenance Contractor
HMI:	Human Machine Interface
ICSS:	Integrated Control and Safety System
MAINTENANCE:	Activities required to preserve as nearly, and as long, as possible the original condition of an asset normal wear and tear.
MANUFACTURER:	Company which designed and manufactured the equipment.
MIEC:	Maintenance & Inspection Engineering Contract
OEM:	Original Equipment Manufacturer
PAGA:	Public Address and General Alarm
PC:	Predictive maintenance (stands for Préventive Conditionnelle)
PCS:	Process Control System
PDMS:	Process Data Management System
PLC:	Programmable Logic Controller
PPE:	Personal Protection Equipment
PS:	Preventive Maintenance (stands for Préventive Systematique).
PSS:	Process Safety System
PSV:	Pressure Safety Valve
RCM:	Reliability Centered Maintenance
SAP:	Systems, Applications, and Products in Data Processing (business software, including a CMMS module – SAP/PM)
SCE:	Safety Critical Equipments
SCS:	Subsea Control System
SDV:	Shut Down Valve
SIM:	SuperIntendant de Maintenance
SSS:	Safety Shutdown System
UCP:	Unit Control Panel

4. Pumps

Pumps are devices used to move fluids and are commonly grouped in two types; centrifugal and volumetric pumps. Essentially, this classification describes the method used by them to move fluids; flow and pressure.

4.1 Centrifugal pumps

4.1.1 Technology

In this category of pumps, the liquid flows in along the axis of the pump via the distributor and the centrifugal force generated by the vaned wheel's rotation drives it toward the outside of the wheel (impeller). It acquires high kinetic energy, which is converted into pressure energy in the manifold, where the cross-section increases.

Often simply referred to as centrifugal pumps, according to their disposition they can be grouped into; vertical or horizontal and classified and classified by the number of impellers; one-stage or multistage pumps.

A centrifugal pump consists of a rotor-dynamic organ; impeller and a static diffuser; volute. Other component parts according to their function; to control the clearance between the wheel and the body, and to limit the inevitable leakage of fluid at the wheel outlet to the suction (Sealing rings or wear rings ...); and rotating mechanical components (ball bearing, roller bearing, bearing bush...).

4.2 Maintenance of centrifugal pumps

Generally, centrifugal pumps are reliable equipments mainly because, they have very few moving parts. However, they include a certain numbers of components which must be followed closely; bushing bearings (roller / balls bearings or plan bearings) and the sealing systems (braided packing, mechanical seals and others).

- Any rotating mechanical component (roller and/or ball bearings, plain bearings ...), requires appropriate lubrication. The use of an appropriate lubricant (by oil or grease) regular contributes to an increase of their life. Besides, they are part of organs which are followed in conditional monitoring.
- Sealing systems: by definition, a pump is used for raising the pressure of a liquid, so the interior of a pump contains a pressurized liquid, which can escape into the atmosphere along the shaft. Mechanical seals are greatly used for sealing pumps or rotating machines in general and they have very different specifications according to the fluid to be sealed. To operate correctly they may be cooled and continuously supplied with a flushing fluid. Parameters to be monitored:
 - Laks (visual inspection or monitoring with a flow-meter),
 - Monitoring the mechanical seal assembly temperature,
 - Flushing fluid level and temperature.



Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre-commissioning tests, these data include: • Factory acceptance tests report • Cold alignment records • Preliminary check results	Before start up		
Verification of all as-built drawings			
Make sure that both suction and discharge piping have been properly installed and are free of stress			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
Make sure that the suction strainer is installed (if necessary)			
General external visual inspection (site survey) and witness functional tests			To be done in compliance with GS EP EXP 107
Operational Phase			
First in-service operations (General pumps)			
General external visual inspection	Start up	PC	
Hydraulic performance evaluation at start up		PC	To be compared with FAT
Bearing temperature and vibrations measurements		PC	See MANUFACTURER's requirements
In-service Maintenance activities ¹⁾ (General pumps)			
Bearing temperature and vibrations measurements	1 Month	PC	See the referential for guidelines
Carry out 1 st level of maintenance (washing, greasing, painting, general checks)	1 Month	PS	
In-service Maintenance activities (additional requirements for multi stage pumps)			
Process parameters records	1 Month	PC	See the referential for guidelines
Oil sampling for analysis if required	6 Months	PC	
Hydraulic performance test (to be recorded)	6 Months	PC	Carried out by GMC

Maintenance operations	When	Maint. type	Comments
Other time-based Maintenance activities			
General overhaul in a specialized workshop (in accordance with hydraulic performance test results and vibrations level)		PC	Carried out by GMC or SMC

- 1) Generally, when they are not followed-up in condition based maintenance, small centrifugal pumps (with a power of less than 30 kW) are overhauled after damage (break down based maintenance).

Maintenance operations	When	Maint. type	Comments
Standards performances			
Check the pressure at zero flow	Yearly	PC	
Measure the flow at operation pressure	Yearly	PC	
Measure the electric current intensity at operation pressure	Yearly	PC	

Table 1: Minimum maintenance requirements for centrifugal pumps

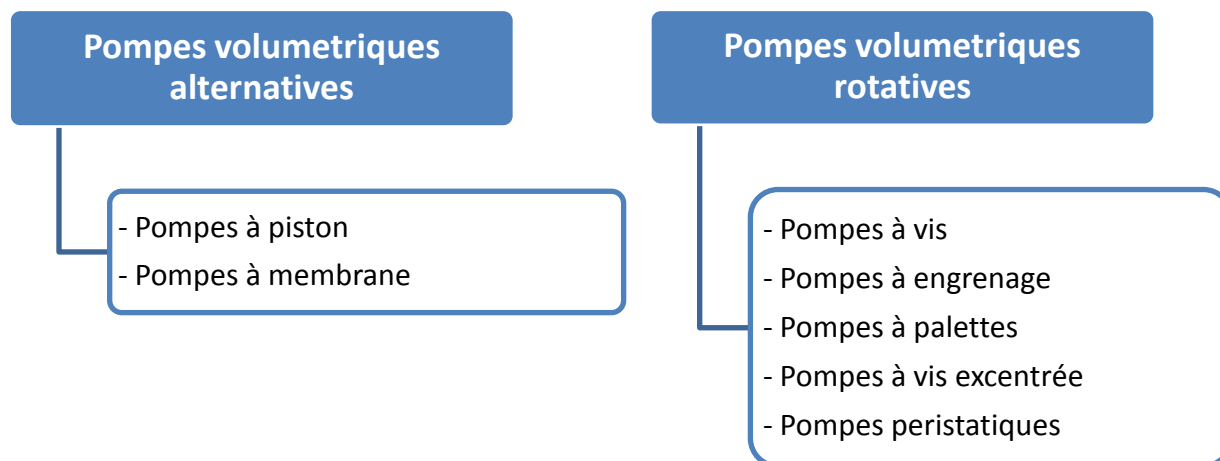
4.3 Positive displacement pumps (volumetric)

4.3.1 Technology

Positive displacement pumps consist of an air-tight enclosed volume (pump barrel) with a moving element inside which alternately increases and decreases the volume of the chambers as it moves. The movement is cyclic: a given volume of liquid is sucked in at the beginning and is discharged at the end.

Different types of positive displacement pumps are based two operating principles; either rotary-type or reciprocating-type (alternative) mechanisms.

Positive displacement pumps can be divided into two main classes:



4.4 Maintenance of volumetric pumps

In comparison to the rotary-type pumps, the reciprocating-type pumps are those who are the most complex to maintain, reflecting the assembly of a considerable number of moving parts and their associated dysfunctions. The most common troubleshooting associated are concerned with: seals, outflow valves, pistons, braided packing conditions, sealing systems (lack or excessive lubrication), bearings (mechanical defectiveness or defect of lubrication), etc.

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include: • Factory acceptance tests report • Cold alignment records • Preliminary check results	Before start up		
Verification of all as-built drawings			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
Make sure that both suction and discharge piping have been properly installed and are free of stress			
Make sure that the suction strainer is installed (if necessary)			
General external visual inspection (site survey) and witness functional tests	Comm. Team		To be done in compliance with GS EP EXP 107
Operational Phase			
First in-service operations (General pumps)			
General inspection of pump	Start up	PC	
Hydraulic performance evaluation at start up	Start up	PC	To be compared with FAT
Process and equipment parameters records	Start up	PC	See the referential for guidelines
In-service Maintenance (Reciprocating pumps)			
Process and operating parameters records and daily maintenance routine	Daily	PC	See the referential for guidelines
Carry out 1 st level of maintenance (washing, greasing, painting, general checks)	1 Month	PS	
Oil sampling for analysis when required	3 Months	PC	

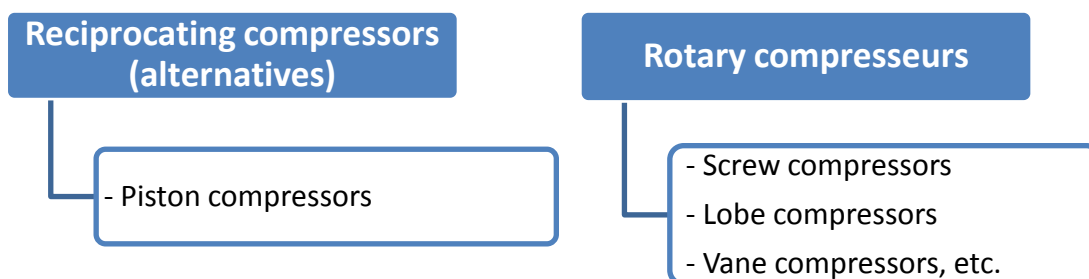
Check all shock absorbers	3 Months	PS	
Other time-based Maintenance activities (reciprocating pumps)			
Tests of all relief valves for proper operation and setting	8 Khrs	PS	Based upon MANUFACTURE'S requirements and RCM
Biennial Maintenance	16 Khrs	PS	
General overhaul in a specialized workshop	32/ 48 Khrs	PS	
Standards performances			
Measure flow and pressure at operation speed	Yearly	PC	Based upon MANUFACTURE'S requirements and RCM
Test the pressure safety valve if possible	Yearly	PC	

Table 2: Minimum maintenance requirements for positive-displacement pumps

5. Compressors

As gases are compressible, a compressor is a machine that, by a purely mechanical process, increases the pressure of a gas by reducing its volume. Compressors can be classified in two groups: the volumetric and centrifugal compressors.

The volumetric compressors can be grouped into two main categories: the reciprocating (alternative) compressors and the rotary compressors. Piston compressors and screw compressors are those who are the most common in oil refinery and in chemical industry.



5.1 Reciprocating compressors - Piston

5.1.1 Technology

Taking into account the multitude of the elements which compose this type of compressors, they can be further classified according to their two constituting mechanisms:

- The "**cylindrical**" group which regroups the elements which are in contact with gas and that participate directly in compression (pistons, segments, valves, etc),
- The "**motive drive**" which is outside and provides drive to the compressor that transforms the rotation movement of the machine into an alternative movement requested by the "cylindrical" group (crankshaft, connecting rods, etc).

They also include auxiliary systems and several other elements, to ensure the operation of the above mechanisms: lubrication, cooling system, etc.



5.2 Maintenance of reciprocating compressors

Reciprocating compressors are very complex machines to maintain, mainly due to their considerable number of moving components. The main breakdowns concerning this type of machines are: segments and valves.

The majority of the valves used nowadays are known as “passive” type: their movement of opening or closing is acquired by the difference of pressure applied on their two sides; the closing is nevertheless helped by springs. There are three big categories of valves: valves with small strips, valves with discs and valves with concentric rings.

Typical compressors breakdowns associated to valves failure, can be grouped in several categories: mechanical stress or wear in the moving parts, particles conveyed by the gas, existence of corrosion in the elements that contact directly the compressed fluid (may be due to the gas characteristics), etc.

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include : • Factory acceptance tests report • Cold alignment records • Preliminary check results	Before start up		
Verification of all as-built drawings			
Connection of gas process piping and make sure that they are not subject to stress			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
Make sure that all electrical wiring and instrumentation are connected			
Connection of auxiliary systems and other utilities			
General external visual inspection (site survey) and witness functional tests			In conformity with GS EP EXP 107

Maintenance operations	When	Maint. type	Comments
Operational Phase			
First in-service operations			
General external visual inspection	Start up	PC	
Vibration and bearing temperature measurement of all auxiliary electric motors; (oil pump, cooling water pump, etc.)	Start up	PC	Based upon MANUFACTURE'S requirements
Process and operating parameters records	Start up	PC	See the referential for guidelines
In-service Maintenance activities			
Process and operating parameters records and daily maintenance routine.	Daily	PC	See the referential for guidelines
Vibration and bearing temperature measurements for all auxiliary electric pumps; (oil, cooling water, etc.)	Monthly	PC	
Oil sampling for analysis when required.	3 Months	PC	
Other time-based Maintenance activities			
Semi-annual Maintenance	4 Khrs	PS	Based upon MANUFACTURE'S requirements and RCM
Annual Maintenance (valves, pistons rings, rods packings)	8 Khrs	PS	
Biennial Maintenance (8 KH + crankshaft bearings, connecting rod sleeves, cylinder liners)	16 Khrs	PS	
4-years Maintenance – complete overhaul of unit.	32 Khrs	PS	

Table 3: Minimum maintenance requirements for reciprocating compressors

5.3 Volumetric compressors - Rotary

5.3.1 Technology

Rotary compressors; screw, vanes and lobes are the most common types in the oil industry. They are volumetric type of machines, with a low working pulsation rate and significantly quieter operation. The global efficiency of a rotary compressor is typically intermediate, comparing an equivalent alternative type unit and a centrifugal compressor.

Liquid ring and lobe compressors are inherently of low friction design, with the rotor being the only moving part and sliding friction being limited to the shaft seals. From the technological point of view, all common maintenance operations can easier be performed by local personnel and with a minimum range of tools.

Screw compressors

As the centrifugal type of compressors, the rotary screw compressor is also a positive displacement machine that operates without the need for suction or discharge valves. The only



significant moving parts in a screw compressor are the male and female rotors. There are no valves, pistons, rings, or connecting rods that require regular maintenance.

A screw compressor is often delivered in form of 'package' ready to be connected electrically and it may include all required components; (filters, separators, cooling systems, dryers, valves,...).

They are usually be classified in two categories: the **oil lubricated screw compressors** (oil-flooded heavy duty process gas machines) and **oil-less screw compressors**.

Oil lubricated screw compressors

Screw oil-lubricated compressors are commonly used in our installations, in particular to produce and supply compressed-air, essential to equipments such as **instruments** and in general to feed the **compressed-air network**.

A rotary screw compressor is very simple in design. Some of the major components include one set of male and female helically grooved rotors (screws), a set of axial and radial bearings and a slide valve, all encased in a common housing. The continuous rotation of both screws allows the aspiration, compression and pushing back of air.

In an oil-flooded rotary screw compressor, oil is injected into the compression cavities to aid sealing, to lubricate and provide cooling media for the moving parts. The oil is separated from the discharge stream, then cooled, filtered and recycled. This is rectified (by the installation of receiver tanks) that allow oil to condense and drop out of the air stream.

To ensure the optimum operating conditions, oil-lubricated screw compressors, include other components/systems:

- Air intake filters,
- Compressed air cooling system,
- Oil and water separators in the compressed air stream,
- Compressed air dryer to retain water condensates,
- Output regulation valves to supply compressed air to pneumatic equipments below their maximum admissible pressure,
- Pressure safety valve – PSV.

Oil-less screw compressors

Thanks to their functioning without oil, the 'oil-less compressors' produce quality air and completely exempt from particles of oil. However, this does not preclude the need for filtration as hydrocarbons and other contaminants captured from the atmospheric air must also be removed prior to the point-of-use.

Oil-free compressors are used in applications where entrained oil carry-over is not acceptable. Under certain working conditions, mixture air - oil can have consequences not negligible; ignition, fire, etc.

The two rotors are meshed together thanks to a pair of synchronization gears located outside the machine, enabling the screws to operate without touching each other. The absence of metal-to-metal contact practically eliminates all risk of wear to the compression parts, and avoids any loss of power due to friction.

On the other hand, oil-lubricated screw compressor is significantly quieter in operation than equivalent oil-less screw compressor which, heats up and vibrates lightly more.

Vane and lobe compressors

Not relevant in oil industry or low usage in our installations. This type of volumetric compressors will not be included in the present guide.

5.4 Maintenance of rotary compressors

Screw compressors are usually reliable equipments (exception for vane compressors) and this is mainly due to their fewer components, comparing equivalent alternative compressors.

However, certain components have to be given particular attention. Rotors are supported by bearings (ball or roll bearings, plain bearings), sealing between the internal chambers and packing glands, sealing rings which are usually installed on the ends of the rotor shaft to prevent leakage. As a result of operational conditions, the reduced clearance between the two rotors can increase and the wear may induce contact between them.

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include : - Factory acceptance tests report - Cold alignment records - Preliminary check results	Before start up		
Verification of all as-built drawings			
Connection of process piping and make sure that they are not subject to stress			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
Make sure that all electrical wiring and instrumentation are connected			
Connection of auxiliary systems and other utilities			
General external visual inspection (site survey) and witness functional tests			In conformity with GS EP EXP 107



Maintenance operations	When	Maint. type	Comments
Operational Phase			
First in-service operations			
General external visual inspection	Start up		
Before coupling, verification of rotation right way,	Start up		
Process and operating parameters records	Start up		To be compared with FAT
In-service Maintenance activities on compressor assembly			
Process and operating parameters records and daily maintenance routine and report any unusual noise.	Daily	PC	
For all filters, check pressure drop across filter and clean or replace as required.	weekly	PC	
Check level of oil and add oil if necessary.	weekly	PS	
Annual maintenance (8 KH). Replacement of filters, oil, replace coupling element.	yearly	PS	Based upon MANUFACTURE'S requirements
Replacement of air, oil and control hoses.	4 years	PS	
In-service Maintenance activities on Control Valves			
Inspect all control valves and adjust as required, or note for future maintenance. Report all discrepancies to supervisor. Inspection shall include checking for: - Air leaks; - Erratic air pressure at inlet or outlet; - Actual pressure compared to pressure setting valve.	Monthly	PS	Based upon MANUFACTURE'S requirements and RCM
In-service Maintenance activities on Safety Relief Valves			
Perform operational test of relief valve either in service or remove and perform test on test bench	4 years	PS	In accordance with GS EP EXP 311
In-service Maintenance activities on Inter-coolers and After-Coolers			
For air-cooled units: Verify cooling surfaces are clear of debris (waste paper, rags, packing material, etc.); clean area as required.	Monthly	PS	Based upon MANUFACTURE'S requirements and RCM

For water-cooled units: - Check inlet and outlet air and coolant temperatures and adjust coolant flow as required; - Visually inspect units for leaks or corrosion and report discrepancies to supervisor.	Monthly	PS	
In-service Maintenance activities on Air Dryer			
General checks and inspections should be performed to verify or determine: - Drains, if present, are clear; - Automatic traps are functioning; - Operating pressure drops, and air and coolant stream temperatures are within normal ranges.	Monthly	PS	Based upon MANUFACTURE'S requirements and RCM
Replacement of desiccant	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
In-service Maintenance activities Instrumentation			
For thermometers, pressure gauges, level, flow indicators, and transmitters: See instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Standards performances			
Process and operating parameters records	6-Months	PC	

Table 4: Minimum maintenance requirements for rotating compressors

5.5 Centrifugal compressors

5.5.1 Technology

Centrifugal compressors are dynamic compression equipments that use aerodynamic processes to increase the pressure of fluid (gas) between one point and another. The rows, alternate between the rotating airfoils (rotors) and stationary airfoils (stators), with the rotors imparting energy into the fluid, and the stators converting the increased rotational kinetic energy into static pressure through diffusion.

Compared with the volumetric compressors, the centrifugal compressors have considerable advantages. In fact, they have less friction components and, as a result, they require less maintenance. Besides, they can have comparatively high efficiencies.

Generally, centrifugal compressors consist of the following rotating and stationary components:

- A compressor casing (one or two elements), which provides the mechanical strength, supports and locates the machine,
- The connections to the process by means of intake and discharge flanges, ensuring the pressure of the gas to be sealed inside, so as to limit leakage towards the outside of the machine; dry-gas seals, labyrinths, lubrication, etc,
- A shaft that drives a central drum, retained by bearings, which has a number of annular airfoil rows attached and ...,
- A similar number of stationary airfoil rows attached to a stationary tubular casing.

A pair of rotating and stationary airfoils is called a stage. The cross-sectional area between rotor drum and casing is reduced in the flow direction to maintain axial velocity as the fluid is compressed.

5.6 Maintenance of centrifugal compressors

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include : • Factory acceptance tests report • Cold alignment records • Preliminary check results	Before start up		
Verification of all as-built drawings			
Connection of process piping and make sure that they are not subject to stress			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
Make sure that all electrical wiring and instrumentation are connected			
Connection of auxiliary systems and other utilities			
General external visual inspection (site survey) and witness functional tests			In conformity with GS EP EXP 107



Maintenance operations	When	Maint. type	Comments
Operational Phase			
First in-service operations			
General external visual inspection	Start up	R	
Performances tests and operating parameters records	Start up	R	To be compared with FAT
In-service Maintenance activities on compressor assembly			
Process and operating parameters records and daily maintenance routine	Daily	PC	See the referential for guidelines
Oil sampling for analysis (wear particles, water, viscosity)	3 Month	PC	
Check drain for proper functioning	3 Month	PS	Based upon MANUFACTURE'S requirements and RCM
Performances tests and operating parameters records	3 Month	PC	To be compared with FAT
Replace filters in Gas/ Air/ Seal oil/ Lube oil circuits (if pressure drop across filter is high),	Yearly	PC	
Check lube oil cooler and gas cooler (whether cleaned or not)	Yearly	PS	
General overhaul in a specialized workshop (in accordance with aerodynamic performance)		PC	
In-service Maintenance activities on local Instruments			
For Thermometers, Pressure Gauges, Level, flow, vibration indicators, and transmitters See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE'S requirements
Check anti-surge protection	Yearly	PS	See alert newsletter Nr° 2009-06

Maintenance operations	When	Maint. type	Comments
In-service maintenance activities on safety protection systems (Fire & Gas, ESD, Pressure Relief Valves)			
Fire and Gas: Calibration and Inspection of all detectors, check indicators and/or messages (LED or local display) on Electronic modules or PLC and HMI (if any)	1-3 Months	PS	In accordance with GS EP SAF 371
ESD: ESD loops,		PS	
Pressure relief valves: Perform operational test of relief valve either in service or remove and perform test on test stand	4 years	PS	In accordance with GS EP EXP 311
In-service Maintenance activities on local Control Systems (if any)			
For PLC, HMI, Electronic Modules, See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE's requirements and RCM

Table 5: Minimum maintenance requirements for centrifugal compressors

6. Diesel and gas engines

6.1 Overview

The major differences between diesel and gas engines (also their technology and number of years in operation), stipulate if all maintenance operations indicated in the following tables will be entirely applied, or not. The maintenance operations will be implemented following the equipment manufactures' recommendations, and carried out by qualified technicians.

Indicated maintenance operations, which regroup the basic maintenance activities, should be carried out on the diesel and gas engines in order to ensure their reliability.

6.2 Performance tests

Engine's performance tests allow an assessment at their status at a given point in time. Data records of those tests will be of significance, if all of them are recorded under the same operational conditions and workload. In the absence of the manufacturer's recommendation, tests of performance will have to be carried out after each cycle of **250 working hours**. Any deviation of data records in the course of a performance test will have to be re-confirmed by another one.

The following readings and analysis/results will have to be recorded after carrying out tests of performance on diesel or gas engines.

6.3 Maintenance

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include : - Factory acceptance tests report - Cold alignment records - Preliminary check results	Before start up		
Verification of all as-built drawings			
Connection of process piping and make sure that they are not subject to stress			
Make sure that all electrical wiring and instrumentation are connected			
Connection of auxiliary systems and other utilities			
General external visual inspection (site survey) and witness functional tests			In conformity with GS EP EXP 107
Operational Phase			
Minimum data for Diesel or gas engine performance trend analysis			
General external visual inspection	Monthly	PC	Based upon MANUFACTURE'S requirements and RCM
Cylinder compression pressures	Yearly	PC	
Cylinder firing pressures	Yearly	PC	
Fuel pump/injector rack or governor power piston position	Yearly	PC	
Cylinder exhaust temperature	Yearly	PC	
Crankcase pressure (or vacuum)	Yearly	PC	
Lube oil pressure at engine inlet or header	Yearly	PC	
Air inlet manifold pressure	Yearly	PC	
Lube oil analysis results, especially for trace metals	6 Months	PC	See the referential for guidelines

Table 6: Minimum maintenance requirements before starting and data for diesel or gas engine performance trend analysis



Diesel engine – standby mode			
Maintenance operations	When	Maint. type	Comments
Weekly maintenance activities			
Check and verify operation of pre-lube pump	weekly	PS	Based upon MANUFACTURE's requirements and RCM
Check and verify operation of keep warm system.	weekly	PS	
Check and verify operation of starting air compressors, oil pump or battery charger.	weekly	PS	
Check and verify starting air/oil pressure is correct or batteries are charged.	weekly	PS	
Verify that control power is available to the control system and all controls are in the proper position to allow automatic starting of the engines.	weekly	PS	
Check for fuel oil and lube oil leaks.	weekly	PS	
Check for cooling leaks.	weekly	PS	
Check day tank area for leaks and level.	weekly	PS	
Check lube oil level; add if required.	weekly	PS	
Inspect air filter; clean/replace if required.	Monthly	PS	Based upon MANUFACTURE's requirements and RCM
Check starting air lubricator; fill if required.	Monthly	PS	
Check oil level in governor; add if required.	Monthly	PS	
Check coolant level in expansion tank.	Monthly	PS	
Record and report any discrepancies.	weekly	PS	

Table 7: Minimum maintenance requirements for Diesel engines – standby mode



Diesel engine – operation mode			
Maintenance operations	When	Maint. type	Comments
Daily maintenance activities			
Check lube oil level in engine crankcase or sump.	daily	PS	Based upon MANUFACTURE's requirements and RCM
Check coolant level in expansion tank.	daily	PS	
Check fuel strainers for water; drain if required.	daily	PS	
Check fuel level in day tank	daily	PS	
Check color and smoke level of exhaust gas.	daily	PS	
Check lube oil and fuel filter pressure drop; change filters as required.	daily	PS	
Inspect air filters; replace as required.	daily	PS	
1000 hrs – based maintenance activities			
Take lube oil sample for test and analysis; change lube oil if indicated by test results or provide additives if recommended by lube oil supplier.	1000 hrs	PC	Based upon MANUFACTURE's requirements and RCM
Check pH of engine coolant; add conditioner as required to meet manufacturer's recommendations.	1000 hrs	PS	
Verify proper operation of all safety shutdown controls and alarms; immediately repair any defective items.	1000 hrs	PS	
Change fuel oil filters; filters should be changed based on maximum recommended pressure differential.	1000 hrs	PS	
Clean and inspect centrifugal lube oil filters if provided.	1000 hrs	PS	
Grease/lubricate auxiliary pump bearings.	1000 hrs	PS	



Maintenance operations	When	Maint. type	Comments
2000 hrs – based months maintenance activities			
Inspect valves and check valve clearance; adjust as required. On two-cycle engines, inspect and clean inlet and exhaust ports.	2000 hrs	PS	Based upon MANUFACTURE's requirements and RCM
Change spark plugs (gas engines).	2000 hrs	PS	
Check injector/magneto timing; adjust as required.	2000 hrs	PS	
Verify proper operation of all instrumentation. See Instrumentation part of this document	2000 hrs	PS	
Inspect blower drive and timing gears if applicable.	2000 hrs	PS	
8000 hrs – based maintenance activities			
Inspect after cooler; clean if required.	8000 hrs	PS	Based upon MANUFACTURE's requirements and RCM
Inspect and clean turbocharger if required.	8000 hrs	PS	
On four-cycle engines, inspect pistons, rings, inlet and exhaust ports, and cylinder liner.	8000 hrs	PS	
Remove and inspect one cylinder head, piston, liner, and connecting rod. Measure all surfaces subject to wear, and record data for use in determining overhaul intervals. Inspect all oil passages and water side surfaces for obstructions and deposits.	8000 hrs	PS	Based upon MANUFACTURE's requirements and RCM
Check foundation bolts for tightness. Where engine and driven equipment are mounted on a skid with spring isolators, inspect spring isolators for proper clearance.	8000 hrs	PS	
Drain and flush cooling system. Replace coolant. Inspect all thermostatic valves or regulators.	8000 hrs	PS	
Inspect all engine-driven pumps.	8000 hrs	PS	
Inspect after cooler and lube oil cooler; clean if required.	8000 hrs	PS	
Inspect all gears and/or chain drives for driven components and auxiliaries for wear; adjust if appropriate.	8000 hrs	PS	
Check alignment of engine and driven equipment.	8000 hrs	PS	

Maintenance operations	When	Maint. type	Comments
In-service Maintenance activities on local Instruments			
For Thermometers, Pressure Gauges, Level, flow, vibration indicators, and transmitters See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE's requirements
In-service Maintenance activities on Safety protection systems (Fire & Gas, ESD)			
Fire and Gas: Calibration and Inspection of all detectors, check indicators and/or messages (LED or local display) on Electronic modules or PLC and HMI (if any) - ESD - ESD loops	1-3 Months	PS	In accordance with GS EP SAF 371
In-service Maintenance activities on local Control Systems (if any)			
For PLC, HMI, Electronic Modules, See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE's requirements and RCM

Table 8: Minimum maintenance requirements for Diesel engines – operation mode

7. Gas turbines

7.1 Overview

The operations, included in the following tables, establish the minimal activities of maintenance which are elementary to ensure the reliability of our gas turbines. Nevertheless, those operations will be entirely applied, or not, depending on turbines' technological generation and their number of years in operation. Besides, frequencies of operations (major inspections and/or overhauls) may be inherent at each type of machine.

The routines of maintenance and frequencies to be implemented will be chosen and carried out as per the manufacturers' recommendations.

7.2 Major interventions

A deterioration of a machine's performance, can justify an intervention (inspection of combustion, inspection of hot chambers, major overhaul). The following symptoms can be considered as signs anticipating a later degradation of a turbine's performance.

- Increasing temperatures between the gas generator (GG) and turbine (PT),
- Decreasing of compressor outlet pressure,
- Debris or other deposits in the blades of the turbine and/or compressor,
- Damages in the blades of the turbine and/or compressor,
- Vibrations and noise,



- Decreasing run-down time.

7.3 Gas turbines performance tests

The turbine performance tests are important tools, firstly because they allow to diagnose in real-time the machines' status, and secondly, they allow better planning and preparation of interventions in case of deterioration.

To be effective, performance tests must be able to allow taking minimum parameters of the machine in operation. These parameters, once collected, will be able to be recorded either on SAP PM, in spreadsheet files, or a dedicated software, allowing later detailed analysis; historic, trends, etc. Referential documents and specifications define the methodology, as well the parameters to be collected and recorded.

7.4 Maintenance

Adopting a good practice by monitoring the operating parameters (readings, analysis, etc.), combined with a sound on-site preventive maintenance plan, will ensure an optimum level of turbo-machines maintenance.

A maintenance strategy structured in those two components should minimize the equipments' premature degradation, providing earlier diagnosis, and will improve the availability and reliability of the turbo machines operating in our installations.

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre-commissioning tests, these data include : • Factory acceptance tests report • Cold alignment records • Preliminary check results	Before start up		
Verification of all as-built drawings			
Connection of process piping and make sure that they are not subject to stress			
Make sure that all electrical wiring and instrumentation are connected			
Connection of auxiliary systems and other utilities			
General external visual inspection (site survey) and witness functional tests			In conformity with GS EP EXP 107



Operation Phase			
Maintenance operations	When	Maint. type	Comments
Daily maintenance activities			
Inspect engine and listen for any unusual noise. Check for fuel oil and lube oil leaks	Daily	PC	Based upon MANUFACTURE's requirements and RCM
Check and records the data indicated on the engine instrument panel. Note any unusual readings and investigate	Daily	PC	
Check lube oil level in sump (also check level in gear if it is a separate system)	Daily	PC	
Check lube oil and fuel pressure drop and change filters if required	Daily	PC	
Check for unusual noises in gears, bearings, couplings, and pumps.	Daily	PC	
Inspect exterior of engine and auxiliary components for broken lock wires, loose nuts or bolts, and general security of installation.	Daily	PC	
Remove and inspect magnetic plugs for accumulation of metal particles	Daily	PC	
Record air filters differential pressure and replace if required.	Daily	PC	
Lube oil sampling for analysis (wear particles, foaming and deaeration, viscosity)	3 Months	PC	See the referential for guidelines
Annual maintenance activities			
Verify proper operation of all safety shutdown controls and alarms. Immediately repair any defective items	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Inspect bleed valves. Check valves for air leaks.	Yearly	PS	
Inspect air filters.	Yearly	PS	
Check operation and calibrate speed and temperature control system.	Yearly	PS	

Maintenance operations	When	Maint. type	Comments
In-service Maintenance activities on Safety protection systems (Fire & Gas, ESD, Pressure Relief Valves)			
Fire and Gas: - Calibration and Inspection of all detectors (Fire and Gas) ; - Check indicators and/or messages (LED or local display) on Electronic modules or PLC and HMI (if any)		PS	In accordance with GS EP SAF 371
ESD: ESD loops,		PS	In accordance with GS EP SAF 371
Pressure relief valves: Perform operational test of relief valve either in service or remove and perform test on test stand		PS	In accordance with GS EP EXP 311
In-service Maintenance activities on local Control Systems			
For PLC, HMI, Electronic Modules, See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
In-service Maintenance activities on Instruments			
For Thermometers , Pressure gauges, Level, flow indicators, and transmitters See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
In-service Maintenance activities on local Control Systems (if any)			
For PLC, HMI, Electronic Modules See Instrumentation part of this document.	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Other time-based Maintenance activities on Industrial turbines			
Internal inspection by borescope	4 Khrs	PS	
Control of inlet gas vanes (IGV)	8 Khrs	PS	Bulletin n°1 (OPS/TEC)
SIEMENS: Intermediate overhaul	24 Khrs + 3Khrs	PS	Based upon MANUFACTURE'S requirements and RCM
SOLAR: Gas Producer, Power Turbine and accessory Gearbox replacements	30 Khrs	PS	
SIEMENS: complete overhaul (Mayor Inspection)	48 Khrs	PS	

Maintenance operations	When	Maint. type	Comments
Other time-based Maintenance activities on Heavy duty turbines (Frame 3 &5)			
Control of inlet gas vanes (IGV)	8 Khrs	PS	Bulletin n°1 (OPS/TEC)
Internal inspection by borescope + Combustion inspection	8-24-36 Khrs	PS	Based upon MANUFACTURE's requirements and RCM
Hot parts inspection (IPC)	16 – 32 Khrs	PS	
Complete overhaul (Mayor Inspection)	48 khrs	PS	
Other time-based Maintenance activities on Aero derivative gas turbines			
Internal inspection by borescope	4 Khrs	PS	
Control of inlet gas vanes (IGV)	8 Khrs	PS	Bulletin n°1 (OPS/TEC)
Combustion inspection	8 -16 Khrs	PS	Based upon MANUFACTURE's requirements and RCM
LM turbines_ Combustion chamber replacement	24 Khrs	PS	
RB turbines - Bearings replacement, - Module replacement	24 Khrs	PS	
Complete overhaul (Mayor Inspection)	48 Khrs	PS	
Other time-based Maintenance activities on Power turbines			
LM 2500 & PGT25+	24 Khrs	PS	Based upon MANUFACTURE's requirements and RCM
LM 2500 & PGT25+ (if pip installed)	48 khrs	PS	
RB11 – RT 56 – RT 62	96 khrs	PS	

Table 9: Minimum maintenance requirements for Gas Turbines

8. Gearboxes

8.1 Overview

Gearboxes are characterised by a good reliability, rare major failures and light maintenance. However, it is recommended to schedule preventive maintenance in accordance with driver and driven machines major overhauls.



8.2 Maintenance

Major failures comming from gears rotors and bearings, it is recommended to proceed Condition Based Maintenance and monitore gearboxes vibrations and temperatures.

Maintenance operations	When	Maint. type	Comments
Pre-start up Phase			
Commissioning			
Verification of technical records related to pre-commissioning tests, these data include: Factory acceptance tests report Cold alignment records Preliminary check results	Before start up		
Verification of all as-built drawings			
Verification of alignment(s) and distance between shafts ends,			
Before coupling, verification of rotation right way,			
General external visual inspection (site survey) and witness functional tests			
Operational Phase			
First in-service operations			
General external visual inspection	Start up	PC	
Bearing temperature and vibrations measurements		PC	See MANUFACTURER's requirements
In-service Maintenance activities			
Bearing temperature and vibrations measurements	1 Month	PC	See the referential for guidelines
Maintenance operations	When	Maint. type	Comments
Carry out 1st level of maintenance (washing, greasing, painting, general checks)	1 Month	PS	
In-service Maintenance activities			
Oil sampling for analysis if required	6 Months	PC	See MANUFACTURER's requirements

Check oil filter and observe contamination of media	6 Months	PC	
Other time-based Maintenance activities			
Vibrations analysis by expert for bearings condition or teeth damages.	Yearly	PC	
Visual internal inspection of teeth for wear or damages through inspection door	Yearly or opportunity	PC	See MANUFACTURER's requirements
Hours-based Maintenance activities			
Perform teeth contact pattern check by "Dyken red varnish"	50 Khs	PS	See MANUFACTURER's requirements
Replacement of gear shafts and bearings	100 Khs	PS	See MANUFACTURER's requirements

Table 10: Minimum maintenance requirements for gearboxes

9. Lifting equipments

9.1 Overview

Potential risks, associated to the personnel and to the physical damages in case of failure, lifting equipments have to be object of systematic controls (inspection and maintenance), according to regulations.

A preventive maintenance plan based on regulations (national or international), the manufactures' recommendations and, as well the industrial standards must be followed for all lifting equipments and others lifting apparatus (hoisting equipments, cranes, slings, handling, beams, and other lifting gears). The inspection and its associated activities, applied to common cranes and other lifting gears, are fully covered by **GS EP EXP 311**.

9.2 Maintenance

For the maintenance of cranes, hoisting devices and other lifting equipments, recommendations of manufacturers have to be the first source of information before setting up a dedicated maintenance plan. The certification of common cranes, in operation on our industrial installations, will be carried out by APAVE (or other accredited organism). According to regulations, the inspection will be done with a frequency no longer than 1 year.

Other complementary details, to the maintenance of lifting equipments, are covered by the referential documents.

10. Heat exchangers and ventilation equipments

10.1 Overview

The heat exchangers and ventilation systems, existent in our installations, are not only important for the personnel comfort inside the working and living quarters, but they also contribute to provide the right environmental temperature for other equipments.

The main purpose of heater exchangers and other ventilation equipments is to transfer the thermal energy of a fluid, said primary, to another, called, secondary fluid, without mixture (air / air, – water / air or water / water). The parameters which intervene in exchange are:

- Temperatures,
- Fluids' velocity and mass flows,
- The thickness of the wall of the tubes and heat (sensitive and latent).

There are several types of heat exchangers, according to their technological development and the complexity which they incorporate; plate heat exchangers, tubular heat exchangers, shell and tube heat exchangers, spiral heat exchangers,...

10.2 Inspection

All minimal operations of inspection which must be carried out on the heat exchangers, are covered by **GS EP EXP 311**.

10.3 Maintenance of heat exchangers

Taking into account the inexistence of moving parts in the thermal heat exchangers the major factors that influence their performance, and to which particular attention should be given, are: the quality of the fluids, their temperature and service pressure. Consequently, to ensure and to maintain their thermal efficiency, the following routine maintenance activities must be carried out in this type of equipments.

Maintenance operations	When	Maint. type	Comments
Monthly maintenance activities			
Check for leaks at all seams on the outer casing, around the bottom, and all connections.	Monthly	PS	
Check Pressure Temperature Relief Valve for proper spring action and disk seating.	Monthly	PS	
Check the operation of the Safety Valve(s) by manually opening it.	Monthly	PS	
Annually maintenance activities			
Flush the vessel and check for evidence of mineral deposits	Yearly	PS	

Check the resistance of the heating elements on electric heaters and compare with Vendor's specifications. An infinite resistance indicates that the element is burned out and needs to be replaced	Yearly	PS	
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Table 10: Minimum maintenance requirements for Heat exchangers

10.4 Ventilation equipment

Ventilation equipment technology may change from one manufacturer to another and the same applies to their complexity. However, all of them are commonly designed with a certain number of elementary components: fans, belt-drives, pulleys, dampers, etc.

10.5 Maintenance of ventilation equipment

10.5 Maintenance of ventilation equipment			
Maintenance operations	When	Maint. type	Comments
V-Belts			
Check belts tension and alignment, adjust if required	Monthly	PS	Based upon MANUFACTURE's requirements and RCM
Check condition of belts and replace if necessary	Monthly	PS	
Check for wear on pulleys and replace if necessary	Monthly	PS	
Maintenance operations	When	Maint. type	Comments
Fans (ventilators)			
Lubricate as required	Monthly	PS	Based upon MANUFACTURE'S requirements and RCM
Check for vibrations and excess noise	Monthly	PC	
Check and clean fan blades as necessary	Annual	PS	
Replace bearings or balance if vibration level is high	Annual	PC	
Dampers			
Inspect and clean dampers	Annual	PS	Based upon MANUFACTURE'S requirements and RCM
Check from freedom motion and lubricate at bearing points	Annual	PS	
Fire dampers should have the fusible link temporarily removed and the damper checked to ensure that it will close under its own weight.	Annual	PS	

Table 11: Minimum maintenance requirements for ventilation equipments

11. Life saving appliances on offshore units

11.1 Overview

The lifeboats and liferafts are sumited to SOLAS requirements for floating units and more generally to **GS EP SAF 371** for all offshore installations. Periodic servicing and maintenance of lifeboats, launching appliances and release gears is an essential point for the safety of the persons. They must be subjected to drills and periodic tests

11.2 Maintenance of lifeboats

Maintenance operations	When	Maint. type	Comments
Monthly maintenance activities			
Checks lifeboats for satisfactory condition and operation of : - lifeboat structure including fixed and loose equipment, - engine and propulsion system, - sprinkler system, - air supply system, - manœuvring system, - power supply system, - bailing system.	Monthly	PS	Based upon MANUFACTURE'S requirements and GS EP SAF 371
Checks launching appliance for satisfactory condition of : - david structure corrosion, deformation and excessive free play, - wires and sheaves for possible damages and corrosion,	Monthly	PS	Based upon MANUFACTURE'S requirements and SOLAS III/20

Maintenance operations	When	Maint. type	Comments
Annually maintenance activities			
Thorough examination of lifeboat by manufacturer representative : - lifeboat structure including fixed and loose equipment,	Yearly	PS	Based upon MANUFACTURE'S requirements and SOLAS III/20

- engine and propulsion system, - sprinkler system, - air supply system, - maneuvering system, - power supply system, - bailing system.			
Thorough examination of launching appliance by manufacturer representative : - david structure corrosion, deformation and excessive free play, - wires and sheaves for possible damages and corrosion, - winch brake, Servicing by manufacturer representative, Dynamic winch brake test with load corresponding to empty boat by manufacturer representative,	Yearly	PS	Based upon MANUFACTURE'S requirements and SOLAS III/20
Lifeboat launching appliances : Dynamic winch brake test (110% overload) by manufacturer representative.	5 years	PS	Based upon MANUFACTURE'S requirements and SOLAS III/20

Table 13 : Minimum maintenance requirements for lifeboats

11.3 Maintenance of liferafts

Maintenance operations	When	Maint. type	Comments
Servicing by approved servicing station, including hydrostatic release unit.	Yearly	PS	Based upon MANUFACTURE'S requirements and SOLAS III/20

Table 12: Minimum maintenance requirements for liferafts

12. Fire fighting systems

12.1 Overview

This chapter covers the maintenance of fire network, extinguishers and fuel systems. All the instrumented equipments are traisted in chapter "Fire and Gas System instrumentation"

12.2 Maintenance of fire fighting systems

Maintenance operations	When	Maint. type	Comments
Fire pumps, hydrants, hoses and nozzles ; - general visual inspection for proper condition and arrangement, - flow test for pressure and capacity	Monthly	PS	Based upon MANUFACTURE'S requirements and GS EP SAF 371
Fire pumps, hydrants, hoses and nozzles ; - test all hydrants,, - leakage test for hoses at maximum pressure, - performance test of pumps,	Yearly	PS	Based upon MANUFACTURE'S requirements, SOLAS III/20. and GS EP SAF 371
Fire extinguishers ; - Visual inspection for pressure, damages and corrosion	Monthly	PS	GS EP SAF 371
Fire extinguishers ; - Servicing by trained personnel,	Yearly	PS	GS EP SAF 371
Fuel systems; - General visual inspection for lagging or shielding of hot surfaces,condition of hoses, remote valves,	Quarterly	PS	MSC Circ 851
Fuel systems; - Test of fuel shut-off valves, - Pressure test of hoses,	5 years	PS	MSC Circ 851

Table 13: Minimum maintenance requirements for fire fighting systems



13. Drawings of mechanical equipments

13.1 Overview

Mechanical blueprints (drawings) are not as critical as the electrical diagrams/schemes. Often, if not in most of the situations, modifications introduced in the equipments are visible to the maintenance staff. However, if such is not case, the safety of the maintenance technicians can be threatened, if mechanical drawings are not updated or are not available.

It is therefore, recommended to update those drawings, after each modification/project and to make them available to the maintenance staff.

13.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Mechanical drawings			
Critical mechanical drawings and schematics	Current and available	PS	

Table 14: Minimum maintenance requirements for mechanical drawings

14. Periodic verification of electrical installation

Regular inspection according to [IEC 60364](#) part 6 § 62 for Low Voltage, [IEC 61936](#) for High Voltage, [IEC 60079](#) for hazardous locations shall be organized at least every 3 years and **Company** should manage it through a THIRD PARTY contract.

THIRD PARTY shall supply his services independently of the inspections and checks directly made by **Company** or its representatives, even if these services are duplicated.

THIRD PARTY shall be an independent society, worldwide recognized. **THIRD PARTY** shall not be a construction **Contractor**, an engineering **company** or a maintenance services company or **Company** commissioning team.

15. Earthing Systems

15.1 Overview

A correct earthing is required for personal safety but also for installation and equipment protection. It allows also to divert default current, electrostatic charge (stormy and dry weather), electromagnetic interferences and HF interferences. Earthing methodology is described in [GS EP ELE 031](#).

15.2 Maintenance

Within the limits of the maintenance of our plants, earthing conformity is controlled by a third party as mentioned in §14.

Inspection and repair is normally part of preventive maintenance performed on equipment. Routine site inspection by maintenance personnel shall also pay particular attention to earthing during daily routes.

Maintenance operations	When	Maint. type	Comments
Earthing systems			
Inspect grounding system for the following. - Inspect conductors for damage. - Inspect electrical connections for degradation. - Inspect electrical insulation for discoloration and degradation (for buried network and corrosive soil)	Yearly	PS	Depending on the site's size, such activity shall be distributed over the period of time after receiving approval from competent authorities
Earth electrode measurements. Measure ground impedance	Yearly	PS	
Measure critical grounding bond resistances	Yearly	PS	

Table 15: Minimum maintenance requirements for earthing system

16. Electrical generators

16.1 Overview

Generators are equipments converting mechanical power onto electrical power. Mechanical driver is usually a gas turbine or a heat engine. Commonly this is the main power supply on a plant, or an emergency power supply. In such a case, it may be classified as a SCE.

16.2 Maintenance

Maintenance operations	When	Maint. type	Comments
In-service Maintenance activities			
Operating parameters records and daily maintenance routine	Daily	PC	See the referential for guidelines
Verify equipment grounding	Yearly	PS	
Stator winding			
DC insulation resistance test (non destructive)	8 Kh – 24 Kh	PS	Based upon MANUFACTURE'S requirements and RCM
Other time-based Maintenance activities			
Semi-annual Maintenance	4 kHrs	PS	Based upon MANUFACTURE'S

Annual Maintenance	8 kHrs	PS	requirements and RCM
Complete overhaul in a specialized workshop	48 – 60 kHrs	PS	

Table 16: Minimum maintenance requirements for electric generators

17. Batteries and Battery Chargers

17.1 Batteries - Technology

Batteries deliver emergency power supply for communication equipments, control and protection of the installations, when main power supply is out of order. Batteries as part of UPS for ESD system are classified as **SCE**. Thus maintenance plan must adequately defined.

17.2 Maintenance of Batteries

Maintenance operations	When	Maint. type	Comments
Lead acid Batteries (sealed, vented and valve regulated)			
Visual inspection	Monthly	PS	Based upon MANUFACTURE's requirements and RCM
Limited battery discharge test as part of charger checks, During the boost recharge of batteries, check current and voltage in boost mode,	6-Months	PS	
Temperature : Check for hot spots during the boost charge after the load test, (performed after any discharge or load test)	6-Months	PS	
Intercell connection retorque based on infrared scan,	Yearly	PC	
• Check float voltage (charger off) on all cells, • Specific gravity of all cells, • Test of autonomy : battery bank discharge test at 20% AH rating until reaching threshold voltage of cells,	Yearly	PS	
Valve regulated lead acid capacity testing	Yearly	PS	
Vented lead acid capacity testing	5-years	PS	
Vented and Recombined Nickel Cadmium Batteries			
Visual inspection of battery bank	Monthly	PS	Based upon

Limited battery discharge test as part of charger checks, During the boost recharge of batteries, check current and voltage in boost mode,	6-Months	PS	MANUFACTURE's requirements and RCM
Temperature : Check for hot spots during the boost charge after the load test, (performed after any discharge or load test)	6-Months	PS	
Intercell connection retorque based on infrared scan,	Yearly	PC	
Check float voltage (charger off) on all cells,	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Test of autonomy : battery bank discharge test at 20% AH rating until reaching threshold voltage of cells,	Yearly	PS	

Table 17: Minimum maintenance requirements for lead acid and Nickel Cadmium batteries

17.3 Battery Chargers - Technology

Chargers control and regulate batteries charge. Their trouble free operation is required for extended life of batteries, thus maintenance is vital.

17.4 Maintenance of Battery Chargers

Maintenance operations	When	Maint. type	Comments
Battery chargers			
Check each charger by turning off one, then the other, and see if each charger will carry the total load. Check floating and boost voltage settings	6-Months	PS	Based upon MANUFACTURE's requirements and RCM
Check the accuracy of the charger panel voltmeter with the digital meter	Yearly	PS	
Infrared scan cables and connections if visible	Yearly	PS	
After battery discharge test, ensure that the battery charger boost voltage and current is within design limits	Yearly	PS	

Table 20: Minimum maintenance requirements for battery chargers

18. Inverters and Rectifiers, Uninterrupted power supply

18.1 Overview

On our plants, inverters, rectifiers, batteries and chargers are parts of most commonly called an Uninterruptible Power Supply. The purpose is to insure a stable electrical feeding whatever is occurring on the main electrical network. Batteries and chargers are treated in §17.

A UPS can protect electronic devices against hazardous electrical events on network. It is normally placed as an interface between the main electrical network and the equipment to be protected. It allows to switch the power feeding from normal network to batteries in case of power shut down, or in case of low-voltage or high-voltage.

Three categories of UPS are used:

- **Off-line UPS:** these equipment switch the power feeding to batteries feeding when a low-voltage is detected,
- **In-line UPS:** (smart UPS), they are controlled by a microprocessor, and avoided the use of batteries during low voltage (extending life of batteries),
- **On-line inverters:** they are commonly used in our plants. Distributed voltage is continuously regulated, batteries permanently connected to the inverter. Downstream voltage is optimized. In are installation, the set rectifier/batteries/inverter is normally by passable.

18.2 Maintenance

10.12 Maintenance

Maintenance operations	When	Maint. type	Comments
Inverters			
Inspect equipment enclosures for damage, unauthorized openings, and corrosion of metallic objects.	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Inspect equipment grounding components such as conductors and connections	Yearly	PS	
Inspect equipment's internal air passages and remove any blockage.	Yearly	PS	
Using a volt-ohmmeter, verify correct operation of all switches.	Yearly	PS	
Infrared scan of the equipment to ensure the absence of hot spots and loose connections	Yearly	PC	
Major servicing by manufacturer representative.	5 Years	PS	
Rectifiers			
Infrared scan of the equipment to ensure the absence of hot spots and loose connections	Yearly	PC	Based upon MANUFACTURE's



For forced cooling type units make sure that the cooling medium is operating properly.	Yearly	PS	requirements and RCM
Clean any dirt accumulation with a solvent that is safe to use on that piece of equipment.	Yearly	PS	
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Major servicing by manufacturer representative.	5 Years	PS	

Table 18: Minimum maintenance requirements for inverters and rectifiers

19. Electrical motors

19.1 Overview

Electrical motors convert electrical power into mechanical power (rotating machines). According to electrical feeding nature, various type of motor exists:

- Direct current motor (with variable speed possibilities),
- Asynchronous motors (the most common on industrial plants),
- Synchronous motors.

In most of the cases, alternatives current motors are constituted of a stator (winding), a rotor, bearings, and a cooling ventilator. AC motors are the most common motors in our installation hence maintenance of other types is not described in this document. Reference to manufacturer recommendation shall be observed for such DC motor.

Selection of electrical motor in case on change shall be done according to EX zone plan. The methodology to determine the EX class zone is described in [GS EP SAF 216](#). Thus, according to EX zone, an electrical motor with protection and safety criteria shall be selected according to [GS EP ELE 079](#).

19.2 Maintenance

Due to their architecture, normal damaging mode of electrical motor is a slow process. Most common breakdown (excepted normal wearing of mechanical parts such as bearings) is mainly due to abnormal use or use to a higher load as recommended by manufacturer.

The minimum maintenance requirements here under described in tables are those to be performed on motor the power of which is higher than 368kW (500 hp).

Maintenance operations	When	Maint. type	Comments
In-service Maintenance activities			
Overall visual inspection	Weekly	PS	Based upon MANUFACTURE's requirements and RCM
Ensure bearings are lubricated as demanded by manufacturer.	Monthly	PS	
Operating parameters records	Monthly	PC	See the referential



			for guidelines
Remove dust and dirt to facilitate cooling.	Monthly	PS	
Infrared scan of equipment Tighten any loose connections	Yearly	PS	
Out of service maintenance activities			
Verification of connections integrity	5 years	PS	
Verification of insulation resistance	5 years	PS	

Table 19: Minimum maintenance requirements for electric motors

20. Power Transformers

20.1 Overview

An electrical transformer is an equipment that transform alternative courant into an other alternative courant (voltage and courant can be different) but with same frequency. These are critical equipment of the electrical installation, redundancy being sometime only partial, thus maintenance must be optimized.

Such as electrical motor, electrical transformers are subjected to the **DIRECTIVE 94/9/EC** if installed in an explosive area. The **GS EP ELE 141** requires that a conformity certificate must be delivered by an independent company.

20.2 Maintenance

Power transformers shall be of one of the following types (**GS EP ELE 141**), unless otherwise specified in the project particular specification/data-sheets:

- Oil immersed, completely filled hermetically sealed up to 15 MVA. The SUPPLIER can offer this type of transformer for ratings above 15 MVA with prior Company approval. Gas cushion type transformer is not allowed,
- Oil immersed breathing type (expansion transformers) for all ratings above 10 MVA,
- Dry-type for indoor installation only.

Maintenance of these three types of transformers depends on manufacturer and design.

Maintenance operations	When	Maint. type	Comments
Dry-type power transformers			
Visual inspection/cleaning	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Check fan operation	Yearly	PS	
Clean fans and filters (if any)	Yearly	PS	
Infrared scan	Yearly	PC	
DC insulation resistance test	Yearly	PS	

Turns ratio test	3-years	PS	
Review equipment ratings	5-years	PS	
Oil filled power transformers			
Bushings - check oil level	Monthly	PS	Based upon MANUFACTURE's requirements and RCM
Transformer physical inspection	Yearly	PS	
Transformer and bushings - infrared scan	Yearly	PC	
DC insulation resistance test	Yearly	PS	
Cooling fans – inspect and test (if any)	Yearly	PS	
Oil pumps and motors - inspect and test (if any)	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Check the functionality of safety apparatus	Yearly	PS	
Check air dryer (if any)	Yearly	PS	
Insulating oil, physical, and chemical tests	5 Years	PS	

Table 20: Minimum maintenance requirements for Power Transformers

21. Lighting

21.1 Overview

Maintenance cycle is a repetition of lamp replacement, lamp/luminaire cleaning and room surface cleaning intervals. As mentioned in **GS EP ELE 081**:

• Maintenance Factor (MF)

Ratio of illuminance (E_m) produced by the lighting system after a certain period to the illuminance (E_{in}) produced by the system when new:

$$MF = LLMF \times LSF \times LMF \times RSMF = E_m / E_{in}$$

Lamp Lumen Maintenance Factor (LLMF): ratio of the luminous flux of a lamp at a given time in its life to initial luminous flux in accordance with the lamp type.

Lamp Survival Factor (LSF): fraction of the total number of lamps which continue to operate under defined conditions and switching frequency at a given time in accordance with the lamp type.

Luminaire Maintenance Factor (LMF): ratio of the light output ratio of a luminaire at a given time to the initial light output ratio in accordance with the luminaire type and the dust environments.

Room Surface Maintenance Factor (RSMF): ratio of room surface reflectance at a given time to the initial reflectance value in accordance with the room indexes and the dust environments.

The maintenance factor must be higher than 0,7.

Datas to calculate the maintenance factor are given by the manufacturer. Typical service life is widely different according to the chosen lamp model. For example, the fluorescent lamps service is between 15 000 hours and 50 000 hours. Thus a good way to describe the required performance is:

- No more than 5% of the lamp out of service,
 - No dark area.
- Maintenance schedule requirements

Work plane locations and cleanliness categories:

- "D" (dirty) for outdoor lighting, stores and workshops
- "N" (normal) for indoor lighting (except the previous listed rooms).

21.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Normal lighting type “D”			
Check the presence of condensation	Yearly	PC	Based upon MANUFACTURE’s requirements and RCM
Check the cleanliness of basins	Yearly	PS	
Normal lighting type “N”			
Check the presence of condensation	Every 2 years	PC	Based upon MANUFACTURE’s requirements and RCM
Check the cleanliness of basins	Every 2 years	PS	
Emergency lighting			
Test based on the power loss	Monthly	PS	NFC 71-830
Periodic autonomy tests based on the power loss	Yearly	PS	

Table 21: Minimum maintenance requirements for lighting equipments

22. Electrical switchboards, Interrupters, Contactors and circuit breakers

22.1 Maintenance of HV switch boards

Maintenance operations	When	Maint. type	Comments
Electric control panel			
Visual inspection for discolouration of wiring, loose connections and cleanliness.	6-Months	PS	Based upon MANUFACTURE's requirements and RCM
Test protective relays to trip breakers.	Yearly	PS	
Exercise the breaker mechanism.	Yearly	PS	
Infrared scanning is recommended to detect hot spots, loose connections, overloaded circuits	Yearly	PS	
Verification of insulators and bus bars based on infrared scan result	5 years	PS	Based upon MANUFACTURE's requirements and RCM

Table 22: Minimum maintenance requirements for HV switch boards

22.2 Maintenance of LV switch boards

Maintenance operations	When	Maint. type	Comments
Electric control panel			
Visual inspection for discoloration of wiring,	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Eliminate any loose connection based on infrared scan	Yearly	PS	
Test protective relays to trip breakers.	Yearly	PS	
Exercise the breaker mechanism.	Yearly	PS	
Infrared scanning is recommended to detect hot spots, loose connections, overloaded circuits	Yearly	PS	
Verification of bus bar connections based on infrared scan	5 years	PS	

Table 23: Minimum maintenance requirements for LV switch boards
22.3 Maintenance of HV Interrupters, Contactors, Circuit breakers

Maintenance operations	When	Maint. type	Comments
Verification of the proper functionality of the breaker and applying special grease	5 years	PS	Based upon MANUFACTURE's requirements and RCM
Verification of pole contact resistance	5 years	PS	
Verification of disconnecting device	5 years	PS	
Inspection of all mechanical wear parts	5 years	PS	
Verification of the HV fuses	5 years	PS	
Verification of the physical measurement gear (PT, CT)	5 years	PS	
Major overhaul of the breaker (OEM)	5 years	PS	

Table 24: Minimum maintenance requirements for HV Interrupters, Contactors and Circuit breakers
23. Cables

Maintenance operations	When	Maint. type	Comments
Insulation resistance measurement	10 years	PS	Should the requirement of the third party be different from this document, an agreement shall be found with the third party
Visual inspection of the cable, conduits and cable trays	10 years	PS	
Polarization Index tests to be performed on subsea cables	5 years	PS	
Acoustic system (Ultrasound) tests to be performed to ensure any eventual defect in the subsea cables	5 years	PS	

Table 25: Minimum maintenance requirements for cables

24. Electric diagrams

24.1 Overview

Electric diagrams are necessary to operate safely. As such, the updating is to be considered as an HSE requirement.

A dedicated part of the management of change must explicit the updating workflow of electrical diagram after any change on the plant. It must clarify how the physical change of electrical network is reported in real time to electrician operators.

24.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Electrical drawings			
Key control and protection schematics	Current and available	PS	
Key wiring diagrams and relay data sheets	Current and available	PS	
Ensure availability of updated drawings	Yearly	PS	

Table 26: Minimum maintenance requirements for electric diagrams

25. "Blackstart generators"

25.1 Overview

The «blackstart» is the process that allow restart of electrical generator after loss of all electrical power generators and power supply (accidentally or voluntary). It is usually an override that allows restart of generators or a "black start generator".

The test of diesel generator must not be performed at low load, to preserve integrity of diesel motor. An operation procedure will be developed to test de generator at least during 30mn and at 75% load.

25.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Blackstart generators			
Each unit tested to verify it can start and operate without being connected to the system, record parameters	2 Weeks	PS	Based upon MANUFACTURE's requirements and RCM
Each unit tested in full load conditionfor at least 2 hours, record parameters,	Monthly	PS	



Verify the insulation resistance of stator winding	Yearly	PS	
Infrared scan during load test, Tight loose connections based on infrared scan result	Yearly	PS	

Table 30: Minimum maintenance requirements for black start generators

26. Process Control System instrumentation (PCS)

26.1 Overview

Instruments belonging to this system can be, as a minimum:

- Gauges, thermometers,
- Pressure, temperature, level, flow indicator or transmitter (pneumatic or electronic), push buttons, telemetry equipment
- Control valves
- On/Off Valves (XV)
- Flow meter (process control, allocation or sale purposes metering points)
- In Line analyzers (BSW, hydrocarbons, smoke, Ph, H₂S)
- Electronic modules, Programmable Logic Controller (PLC), Human Machine Interface (HMI), Integrated Control and Safety Systems (ICSS)

In case this instrumentation is part of a mechanical, electrical, or specific package, please refer to the relevant chapter of this document.

26.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Pre-startup Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include Factory acceptance tests reports. Verification of all as documentation and drawings	Before start up		
Power-up, commissioning tests records, Site acceptance tests reports. Verification of all as documentation and drawings status "As built".			

Operational Phase			
In-service maintenance activities for gauges, detectors, indicators, transmitters, switches			
Visual inspection for external damages. Remove any dirt, grime or oil from the instrument body. Check protection grease on cable glands and replace if needed	6-Months	PS	Based upon MANUFACTURE's requirements and RCM
For Level Transmitter-Differential Pressure-With Drain pot: purge drain pot For Level Transmitter-Differential Pressure-Filled System: check reserve pot For Level Transmitter-Differential Pressure or Pressure transmitter, with Remote Diaphragm Seal: flush	6-Months	PS	
Test (for push-buttons, solenoid valve (only if not done through regular operation)	Yearly	PS	
Test and calibration (for transmitters, gauges, indicators, switches)	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Check the presence of condensation in junction boxes	Yearly	PS	
Replace transmitter's battery (for wireless transmitters)	5-Years	PS	Based upon MANUFACTURE'S requirements and RCM

Table 31: Minimum maintenance requirements for gauges, detectors, indicators, transmitters, switches

Maintenance operations	When	Maint. type	Comments
In-service maintenance activities for Valves and Actuators			
Due to the various types of valves, a complete list of maintenance operations cannot be detailed here. Consequently Vendors documentation (Installation/Maintenance manuals and user's guides) must be considered first. The following maintenance operations must be used as a guide line.			
Control valves			
Examine the valve stem for cleanliness and lubrication.	3-Months	PS	In accordance with GS EP INS 120
Visual inspection for external damages, If some areas are damaged, to repair the paint-coat according to the applicable specification. Remove any dirt, grime or oil from the valve body and bonnet. Check protection grease on cable glands and replace if needed.	6-Months	PS	
Some valves have grease fitting in the bonnet or yoke. If it is dry, lubricate with a hand grease gun.	6-Months	PS	
Open and close the valve (only if not done through regular operation).	6-Months	PS	
If valve is in service and under pressure: - Examine the body to bonnet connection for leakage through the gasket. - Check the stem packing for any leakage during the opening and closing action.	Yearly	PS	
Test and calibration (for positioners, position transmitters, indicators, limit switches)	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Check the presence of condensation in junction boxes	Yearly	PS	
Complete overhaul in a specialized workshop	3 or 4 years	PS	Based upon MANUFACTURE's reqts. and RCM
On/Off valves (XV)			
Visual inspection for external damages, If some areas are damaged, to repair the paint-coat according to the applicable specification. Remove any dirt, grime or oil from the valve body and bonnet. Check protection grease on cable glands and replace if needed.	6-Months	PS	
Open and close the valve (only if not done through regular operation).	6-Months	PS	

If valve is in service and under pressure: - Examine the body to bonnet connection for leakage through the gasket. - Check the stem packing for any leakage during the opening and closing action.	Yearly	PS	
Complete overhaul in a specialized workshop	3 or 4 Years	PS	
Test and calibration (for position transmitters, indicators, limit switches)	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Check the presence of condensation in junction boxes	Yearly	PS	
Actuators (pneumatic or hydraulic)			
Visual inspection for external damage, If some areas are damaged, to repair the paint-coat according to the applicable specification. Remove any dirt, grime or oil from the actuator body. Check protection grease on cable glands and replace if needed.	6-Months	PS	
Check that there are no leakages in the pneumatic or hydraulic connections. If necessary tighten the nuts of the pipe fittings	6-Months	PS	Based upon MANUFACTURE'S requirements and RCM
Check that the actuator operates the valve correctly and with the required operating times.	Yearly	PS	IN accordance with GS EP INS 137
Check that the air or hydraulic supply pressure value is within the required range	Yearly	PS	
Inspect spring, stem, and diagram	3 or 4 Years	PS	
Complete overhaul in a specialized workshop (to be done in accordance with valve maintenance if possible)	3 or 4 Years	PS	
Actuators (electric)			
Visual inspection for external damages, If some areas are damaged, to repair the paint-coat according to the applicable specification. Remove any dirt, grime or oil from the actuator body. Check protection grease on cable glands and replace if needed.	6-Months	PS	
Check that the actuator operates the valve correctly and with the required operating times	Yearly	PS	

Complete overhaul in a specialized workshop (to be done in accordance with valve maintenance if possible)	3 or 4 Years	PS	
Valve Control Panel			
Visual inspection for external damages. Check protection grease on cable glands and replace if needed.	6-Months	PS	
Check that the actuator operates the valve correctly and with the required operating times.	Yearly	PS	
Check that there are no leakages in the pneumatic or hydraulic connections. If necessary tighten the nuts of the pipe fittings. Air or gas pressure regulator: to be checked and drained if not self-drained.	6-Months	PS	Based upon MANUFACTURE's requirements and RCM
Check that the air/gas or hydraulic supply pressure value is within the required range.	Yearly	PS	
For gauges, transmitters, switches on valve control panel: see § "In-service Maintenance activities for gauges, detectors, indicators, transmitters, switches" above.			

Table 32: Minimum maintenance requirements for valves and actuators

Maintenance operations	When	Maint. type	Comments
In-service maintenance activities for Metering Points			
Preventive maintenance periodicity for metering points depends on the reliability and availability requested. Due to their technology, multiphase flow meters usually require a dedicated maintenance specific contract.			
Visual inspection for external damages. Check protection grease on cable glands and replace if needed. Check equipment status (fault, error,...) on local indicator (if any).	6-Months	PS	In accordance with GS EP INS 111 & GS EP INS 112
Test and calibration	Yearly	PS	Based upon MANUFACTURE's requirements and RCM
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Check the presence of condensation in junction boxes	Yearly	PS	

Table 27: Minimum maintenance requirements for metering points



Maintenance operations	When	Maint. type	Comments
In-service maintenance activities for on-line Analyzers			
Visual inspection for external damages. Check protection grease on cable glands and replace if needed. Check equipment status (fault, error,...) on local indicator (if any).	6-Months	PS	
Test and calibration	Yearly	PS	Based upon MANUFACTURE'S requirements and RCM
Check for looseness of connections and mounting and tighten if necessary.	Yearly	PS	
Check the presence of condensation in junction boxes	Yearly	PS	

Table 28: Minimum maintenance requirements for on-line analyzers

Maintenance operations	When	Maint. type	Comments
In-service maintenance activities for electronic modules, PLC, HMI, ICSS, SCS *			
* ICSS & SCS are usually subject to a dedicated Maintenance Specific Contract including an annual visit.			
Visual inspection on ICSS/ SCS / PLC / HMI : Print system alarm and networks logs alarm event if any.	Daily	PS	
Electronic Modules / PLC: Visual inspection (LED indication on Electronic modules or PLC cards to check status of: CPU board, communication, I/O, Power supply status, Telemetry systems on remote cabinets...)	6-Months	PS	
HMI / ICSS (hardware): Visual inspection (screen), system and networks alarms display, system events file, purge temporary files if not done automatically, check Hard Drives free capacity.	6-Months	PS	
System Software and application programs: Check OEM software licenses available, OEM software backups available,	Yearly	PS	
Application programs: Check application programs (rev. n and n-1) backups available. Check detail maintenance plan with due date for system backups . Check preventive action related to hardware and software items in the CMMS	6-Months	PS	In accordance with GS EP INS 135
Antivirus software: On all PC Windows based systems, check anti-virus software updated.	Yearly	PS	
Virus definition: Check virus definition file updated	Monthly	PS	

Table 35: Minimum maintenance requirements for electronic modules, PLC, HMI and ICSS / SCS / Telemetry systems



27. Process Safety System instrumentation (PSS)

27.1 Overview

Instruments belonging to this system can be, as a minimum:

- Gauges, thermometers,
- Pressure, temperature, level, flow indicator or transmitter (pneumatic or electronic), push buttons, telemetry equipment
- On/Off valves (ESDV, SDV, BDV, SCSSV, SSV). For more details on safety valve functional requirements, see [GS EP SAF 261](#)
- Modules, Programmable Logic Controller (PLC), Human Machine Interface (HMI), Integrated Control and Safety Systems (ICSS), Subsea control system (SCM)

In case this instrumentation is part of a mechanical, electrical, or specific package, please refer to the relevant chapter of this document.

27.2 Maintenance

Same as PCS system Instrumentation.

28. Emergency Shut Down System instrumentation (ESD)

28.1 Overview

Instruments belonging to this system can be, as a minimum:

- Switches, push buttons, telemetry equipment
- On/Off valves (ESDV, SDV, SCSSV, SSV, BDV)
- Electronic modules, Programmable Logic Controller (PLC,) HIPS (High Integrity Protection System), Human Machine Interface (HMI), Integrated Control and Safety Systems (ICSS), Subsea control system (SCM),

28.2 Maintenance

Due to their importance regarding installations and personnel safety, the ESD system must be covered by systematic preventive maintenance operations. The table here below is a list of minimum maintenance requirements in order to keep this equipment in good working condition.

Safety valve control panels are most often fitted with specific functions such as: solenoid valve test, partial stroke testing, PSS control, PCS (or UCP) control, smart test facilities.

Maintenance operations	When	Maint. type	Comments
Pre-Startup Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include Factory acceptance tests reports. Verification of all as documentation and drawings	Before start up		
Power-up, commissioning tests records, Site acceptance tests reports. Verification of all as documentation and drawings status "As built".			
Operational Phase			
ESD Systems			
Control Panel	Yearly	PS	In accordance with GS EP SAF 371
ESD loops, including PB's	Yearly	PS	
ESDV's partial stroking	6 Months	PS	
SSV's	Monthly	PS	
Critical alarms/trips	Yearly	PS	
ESD Reset Push button	Yearly	PS	
Solenoid Valve Test	Yearly	PS	
PSS Control solenoid	Yearly	PS	
PCS Control solenoid	Yearly	PS	
Smart test facilities	Yearly	PS	
Alarms and ESD status report in CCR	Yearly	PS	
Electronic modules, PLC, HMI, ICSS, SCS	Same as § "Electronic modules, PLC, HMI, ICSS" for PCS System		

Table 29: Minimum maintenance requirements for Emergency Shut Down System instrumentation



29. Fire and Gas System instrumentation (F&G)

29.1 Overview

Instruments belonging to this system can be, as a minimum:

- Flame detectors,
- Smoke detectors,
- Fusible loops (pneumatic, mechanic),
- Heat sensitive cable,
- Break glass push buttons,
- Extinguishing system (CO₂, FM200, water mist, ...),
- Gas detector (Methane, H₂S, ...),
- Deluge valve, sprinkler,
- Electronic modules, Programmable Logic Controller (PLC), Human Machine Interface (HMI), Integrated Control and Safety Systems (ICSS).

In case this instrumentation is part of a mechanical, electrical, or specific package, please refer to the relevant chapter of this document.

29.2 Maintenance

Due to their importance regarding installations and personnel safety, the F&G system must be covered by systematic preventive maintenance operations. The table here below is a list of minimum maintenance requirements in order to keep this equipment in good working condition.

Minimum maintenance requirements in order to keep this equipment in good working condition.			
Maintenance operations	When	Maint. type	Comments
Pre-startup Phase			
Commissioning			
Verification of technical records related to pre commissioning tests, these data include Factory acceptance tests reports. Verification of all as documentation and drawings	Before start up		
Power-up, commissioning tests records, Site acceptance tests reports. Verification of all as documentation and drawings status "As built".			
Operational Phase			
Fire & Gas detection equipment			
Control panel, functional test,	3 Months	PS	In accordance with GS EP SAF 371
F&G general alarm, functional test	Monthly	PS	

Detectors, calibration and functional test (depending of type)	1 or 3 Months	PS	
F&G Detection report to PAGA system	Yearly	PS	
Alarms and F&G status reported in CCR	Yearly	PS	
Electronic modules, PLC, HMI, ICSS	Same as § “Electronic modules, PLC, HMI, ICSS” for PCS System		
Fire & Gas protection equipment			
Fixed gaseous systems			In accordance with GS EP SAF 371
Deluge/sprinkler systems			
Fixed Fire extinguisher maintenance	Yearly	PS	
Alarms and F&G status reported in CCR	Yearly	PS	
Fire doors and closing arrangements, visual inspection for proper condition	Monthly	PS	MSC Circ 850
Fixed fire fighting and foam system : - Visual inspection of valves and control of correct position, - Visual inspection of piping and pneumatic tubing, - Verification of position of releasing controls systems, - Visual inspection of cylinders.	Monthly	PS	MSC Circ 850 and MCS Circ 1318
Fixed fire fighting and foam system : - Verify cables, pulleys condition and freely move.	Quarterly	PS	MSC Circ 850 and MCS Circ 1318
Fixed fire fighting and foam system : - Control cylinders height and pressure.	6 months	PS	GS EP SAF 371
Fixed fire fighting and foam system : - General inspection of components, hoses, pipes, - Air blowing of pipes and nozzles, - Functionaly test of system and alarms.	Yearly	PS	MSC Circ 850 and MCS Circ 1318
Fixed fire fighting and foam system : - Internal inspection of control valves, - Test activating heads, - Clean and adjust cables, - Leack test of tubings	5 Years	PS	MSC Circ 850 and MCS Circ 1318
Functionaly test of system and alarms.			
Fire doors, closing arrangements, ventilation systems	Quaterly	PS	MSC Circ 850



and fire dampers, test for local operation			
Fire doors and closing arrangements, remotely control for proper release	Yearly	PS	MSC Circ 850
Ventilation systems and fire dampers, - verification that galley exhaust ducts and filters are free of grease build-up, - functional test of remote closing, - test all ventilation controls interconnected with fire protection systems,	Yearly	PS	MSC Circ 850
Electronic modules, PLC, HMI, ICSS	Same as § "Electronic modules, PLC, HMI, ICSS" for PCS System		

Table 30: Minimum maintenance requirements for Fire and Gas System instrumentation

30. Instrumentation diagrams and documentation

30.1 Overview

Drawings such as Trouble shooting loop diagrams (TSLD), one-line diagrams, systems interconnections, systems architectures, instrumentation & system cabinet's layouts, functional analysis's and instrument database are essentials for the instrumentation, automation and ICSS maintenance.

Hence this documentation must be updated or at least checked and each time a modification occurs.



30.2 Maintenance

Maintenance operations	When	Maint. type	Comments
Instrumentation drawings			
TSLD	Current and available	PS	
One-line Diagrams	Current and available	PS	
System architecture	Current and available	PS	
System interconnection diagrams	Current and available	PS	
Cabinet layout	Current and available	PS	
Functional Analysis's	Current and available	PS	
Instrument database	Current and available	PS	
Vendor's documentation	Current and available	PS	

Table 31: Minimum maintenance requirements for instrumentation documentation

31. PSV - Pressure Safety Valves

Please refer to specific [GS EP EXP 311](#).

31.1 Maintenance of PSV - Pressure Safety Valves

Maintenance operations	When	Maint. type	Comments
Pressure safety valves			
Visual inspection for leaks from external fittings and connections	Monthly	PS	Based upon MANUFACTURE'S requirements and RCM
Visual inspection of external surface for presence of corrosion or stress cracks.	Monthly	PS	
Seat leakage detection via gas detection in vent line if fitted or by observing "shimmering" at vent outlet.	Monthly	PS	
Ensure all external bolting fasteners and mounting brackets are torque according to manufactures instructions	6-Months	PS	

Table 32: Minimum maintenance requirements for PSV -Pressure Safety Valves

32. Obsolescence management

32.1 Definitions

The obsolescence and life cycle management shall ensure the safe operations of the facilities and fulfill the requirements of the long term operation and safety philosophies (see [IEC 62402](#)).

The obsolescence and life cycle requirements shall apply to the following phases:

concept and definition;

design and development;

manufacturing;

installation;

operation and maintenance;

long term support and sustainability.

Note: The mentioned packaged units are defined as P3 type in [GS EP INS 110](#).

Obsolescence Plan Management shall include the complete plant lifetime from the beginning of the project in order to evaluate the plant availability and its influencing factors: reliability, maintainability and maintenance support.

The Contractor shall prepare an Obsolescence Management Plan (OMP) dossier for review and acceptance by Company.

The OMP shall incorporate the management of the minimum followings:

plan review;



monitoring plan;
Impact assessment;
lifetime buy;
human skill;
obsolescence dossier;
design requirement;
equipment selection criteria;
recovery from obsolescence strategy.

32.2 Obsolescence management plan

Obsolescence Plan Management shall include the complete plant lifetime from the beginning of the project in order to evaluate the plant availability and its influencing factors: reliability, maintainability and maintenance support.

The Contractor shall prepare an Obsolescence Management Plan (OMP) dossier for review and acceptance by Company.

The OMP shall incorporate the management of the minimum followings:

plan review;
monitoring plan;
Impact assessment;
lifetime buy;
human skill;
obsolescence dossier;
design requirement;
equipment selection criteria;
recovery from obsolescence strategy.

The full structure of OPM is defined in **GS EP TEC 007**.

32.3 Plan review

Contractor shall be able to review on a regular basis with Company the Obsolescence Management Plan and the Obsolescence Monitoring Plan.

Contractor shall define the timings of the Obsolescence Plan Reviews and notify Company accordingly. Contractor shall lead the reviews with the attendance of the Vendors as required and Company representatives.

Contractor shall review the overall OMP as well as the deliverable list during the miscellaneous project phases.

During the life of equipment in operation, the OEM shall review on request of the Company the Obsolescence Management Plan and the Obsolescence Monitoring Plan. The Company may request to have this review conducted on a time cycle three years.



During this “plan review” all topics listed in the Obsolescence Management Plan with all the related deliverables shall be reviewed, stated and their advancement shall be reported in the updated Obsolescence Management Plan and the Obsolescence Monitoring Plan and outlined in a dedicated review report to the Company or Company representative.

Contractor shall perform internal active checks at frequent intervals. The maximum obsolescence plan review period shall be every year.

During this “plan review” all topics listed in the Obsolescence Management Plan with all the related deliverables shall be reviewed, stated and their advancement recorded in a minute of meeting.

Maintenance operations	When	Maint. type	Comments
Obsolescence management plan			
Constitution of obsolescence dossier	Before Start up		Based on GS EP TEC 007
Review of obsolescence dossier	3 years	PS	

Table 40 : Minimum maintenance requirements for obsolescence management



Bibliography

EN 13306	Maintenance — Maintenance terminology
IEC 62443	Security for industrial process control network and system security
SOLAS II-2/14	Construction – fire protection, fire detection and fire extinction - Operational readiness and maintenance
NF C 71-830	Eclairage de sécurité
GS EP SPS 019	Subsea production control system
GS EP INS 110	Instrumentation for package units
GS EP PVV 142	Valves
GS EP MEC 300	Vibration control philosophy
GS EP EXP 207	Installation description structure.
GS EP SAF 312	Guidelines for selecting and installing fire and gas detection systems
GS EP SAF 321	Fire pump stations and fire water mains