

GENERAL SPECIFICATION

Field Operations

GS EP EXP 311

Plant integrity – Minimum inspection requirements

07	11/2019	Document digitalized - new version issued without any modification of the technical content (clarification on sampling inspection and generic RBI, section 4.1.5)
06	12/2018	Review inspection requirement for first in-service inspection, Storage Tanks, Structures, Lifting Equipment, Pipelines, Subsea Umbilicals and Manifolds. Add requirements for temporary repair on Piping
00	10/2009	Change of GS codification (old reference GS EP EXP 211) Classification societies' document references added
Rev.	Date	Purpose of the revision

Owning entity: DSO/IP/EXP	Managing entity: DSO/IP/EXP
Other Approving entity(ies):	

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 2 of 141

Contents

1. Scope	5
1.1 Objectives	5
1.2 Scope and application	5
2. Reference documents	6
3. Inspection principles	8
3.1 Inspection phases in projects and operations	8
3.2 National Legislation	10
3.3 Risk-Based Inspection	11
3.4 First In-Service Inspection	11
3.5 Floating Units classification	11
4. Pressure systems equipment	12
4.1 Pressure vessels	13
4.2 Heat exchangers	17
4.3 Steam boilers and fired heaters	20
4.4 Gas cylinders	23
4.5 Piping	27
4.6 Flexible hoses	30
4.7 Corrosion Monitoring	34
4.8 Pressure Safety Devices	34
4.9 Flares	37
5. Storage tanks	39
5.1 Storage Tanks (fixed roof and floating roof)	39
5.2 LNG cryogenic tanks	45
6. Well control and drilling equipment	48
7. Surface structures	49
7.1 General	49
7.2 Inspection Strategy	49
8. Subsea structures	51
8.1 General	51
8.2 Design review	51
8.3 Inspection strategy	51

9. Lifting equipment	53
9.1 Field of application	53
9.2 Inspection strategy	54
9.3 Drilling related lifting equipment	62
10. Helicopter refuelling stations and portable tanks	62
10.1 Helicopter refuelling stations - Pressure system inspection	63
10.2 Portable tanks	63
11. Marine terminal facilities	65
11.1 Jetties	65
11.2 Loading arms	67
11.3 Offloading buoys	69
11.4 Offloading hoses	73
12. Pipelines.....	76
12.1 General	76
12.2 Design review.....	76
12.3 Inspection strategy	77
13. Dynamic Riser Systems (deep offshore).....	92
13.1 Top tension risers.....	92
13.2 Riser towers	95
13.3 Steel catenary risers.....	98
13.4 Unbounded flexible risers and pipelines	101
14. Subsea umbilical systems (deep offshore).....	108
14.1 Dynamic umbilical sections	108
14.2 Static umbilical sections and distribution units.....	111
15. Manifolds and foundations (deep offshore).....	113
15.1 Design review.....	113
15.2 Inspection strategy	114
16. Xmas tree and well jumper (deep offshore)	116
16.1 Design review.....	116
16.2 Inspection strategy	117
17. Oil Offloading lines (deep offshore)	121
17.1 Design review.....	121
17.2 Inspection strategy	122
18. Mooring systems	124

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 4 of 141

18.1	Classification of Floating Units' mooring systems	124
18.2	Design review.....	124
18.3	Inspection strategy	125
19.	Floating Production and/or Storage Units	131
19.1	Classification Society requirements.....	135
19.2	Additional Company requirements.....	136
20.	Life Saving Appliances.....	136
20.1	National legislation and international regulation.....	136
20.2	Inspection strategy	136
20.3	Personnel and qualification	140
20.4	Reports and records.....	140
21.	Bibliography.....	141

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 5 of 141

1. Scope

1.1 Objectives

This General Specification provides the basis for defining the minimum inspection requirements necessary to assure the integrity of plant and structures.

It is the responsibility of each operational affiliate to determine and apply the optimum level of inspection to assure plant integrity and therefore these minimum requirements should be considered as a safety net with regard to integrity standards.

1.2 Scope and application

The scope of this document covers the following Plant and Structures:

- Pressure Systems (Pressure Vessels, Heat Exchangers, Steam Boilers, Fired heaters, Gas Cylinders, Piping, Flexible Hoses, Pressure Safety Devices and Flare Systems).
- Storage Tanks.
- Well Control and Drilling Equipment.
- Surface and Sub-Sea Structures.
- Lifting Equipment.
- Helicopter Refuelling Systems and Portable Tanks.
- Marine Terminal Facilities.
- Pipelines, Flowlines, Risers (including deep offshore facilities).
- Umbilical systems (deep offshore facilities).
- Manifolds, Xmas Tree, Well Jumpers (deep offshore facilities).
- Oil Offloading Lines (deep offshore facilities).
- Mooring Systems.
- Floating Production, Storage, Offloading Units.

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.

This General Specification is intended to be used:

- During the project phase: by the MIL (Maintenance and Inspection Leader) and the MIEC (Maintenance and Inspection Engineering Contractor),
- During the operations phase: by the Head of Inspection of the affiliate.

Any deviation from the minimum inspection requirements stipulated hereafter is cleared through a formal derogation request.

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 6 of 141

2. Reference documents

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

External Documents

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

Reference	Title
AN 14-2	Annex 14 to the Convention on International Civil Aviation. Aerodromes – Volume II – Heliports, Third edition, July 2009, International Civil Aviation Organization
API RP 21	In-service Inspection of Mooring Hardware for Floating Structures
API SPEC 8C	Drilling and Production Hoisting Equipment (PSL 1 and PSL 2)
API STD 620	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API STD 650	Welded Tanks for Oil Storage
API STD 653	Tank Inspection, Repair, Alteration and Reconstruction
CAP 437	Standards for Offshore Helicopter landing Area, 8 th edition, December 2016, Civil Aviation Authority
CODRES Division 2	Recommandations pour la Maintenance des Réservoirs de stockages cylindriques verticaux, édition 2009, SNCT
DNV-OS-E301	Offshore Standard. Position Mooring, October 2010, Det Norske Veritas
DNV-OS-E302	Offshore Standard. Offshore Mooring Chain, October 2008, Det Norske Veritas
DNV-RP-F206	Recommended Practices – Riser Integrity Management, April 2008, Det Norske Veritas
EEMUA Publication 159	Above ground flat bottomed storage tanks - A guide to inspection, maintenance and repair

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 7 of 141

EN 1968/A1	Transportable gas cylinders. Periodic inspection and testing of seamless carbon steel gas cylinders
EN 1802	Transportable gas cylinders. Periodic inspection and testing of seamless aluminium alloy gas cylinders
EN 1803	Transportable gas cylinders. Periodic inspection and testing of welded carbon steel gas cylinders
ISBN 978 0 85293 588 0	Guidelines for the management of Flexible Hose Assemblies, 2 nd edition, February 2011, Energy Institute
ISO 4309	Cranes - Wire ropes - Care and maintenance, inspection and discard
ISO 10855-3	Offshore containers and associated lifting sets. Part 3: Periodic inspection, examination and testing
ISO 11623	Gas cylinders. Composite construction. Periodic inspection and testing
NR 445	Rules for the Classification of Offshore Units, December 2016, Bureau Veritas
NR 467	Rules for the classification of steel ships, July 2018, Bureau Veritas
NR 493	Classification of Mooring Systems for permanent and Mobile Offshore Unit, December 2015, Bureau Veritas
NR 494	Rules for the Classification of Offshore Loading and Offloading Buoys, May 2006, Bureau Veritas
OCIMF 1995	Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the field, 1995, Oil Companies International Marine Forum
SOLAS III/20.4	Operational readiness, maintenance and inspections – Maintenance of falls
SOLAS III/20.8. MSC/Circ. 1328	SOLAS Chapter III Regulation 20.8 Servicing of inflatable liferafts, inflatable lifejackets, marine evacuation systems and maintenance and repair of inflated rescue boats
SOLAS III/20.11 MSC/Circ 1206	Measures to prevent accidents with lifeboats, SOLAS Chapter III Regulation 20

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP COR 002	Corrosion control on production facilities: Field operations
GS EP COR 110	External cathodic protection of onshore structures
GS EP COR 501	Control of cathodic protection of submerged fixed structures
GS EP COR 502	Control by electrical measurements of cathodic protection of submerged pipelines
GS EP PLR 109	Design, fabrication and testing of submarine unbonded flexible pipes and risers
GS EP STR 002	Crane for fixed offshore installations
GS EP STR 003	Crane for floating offshore installations
GS EP STR 004	Riser/umbilical pulling rig, pulling and mooring winches
GS EP STR 005	Lifting appliances other than cranes and winches
GS EP STR 006	Requirements for the design, fabrication and testing of Overhead Travelling Cranes
GS EP STR 106	Assessment of existing fixed offshore platforms

3. Inspection principles

3.1 Inspection phases in projects and operations

{Rule 1:

All along this GS EP EXP 311, the minimum inspection requirements in order to assure the equipment integrity are detailed in tables where the different types of inspection activities are described and identified as a Rule (R) which shall be applied or a Guidance (G) as a recommendation.}

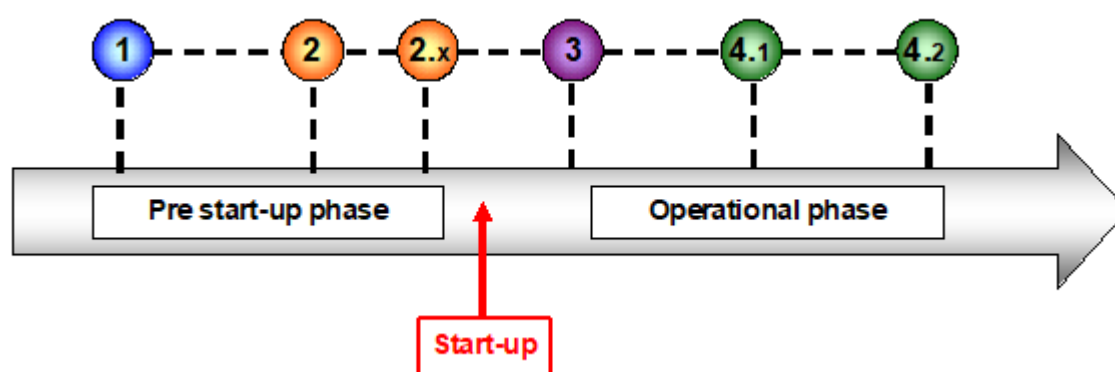
The different types of inspection are as follows:

- Construction Inspection.
- Installation, Commissioning & Baseline Inspection.
- First in-Service Inspection.

- Sub-sequent In-Service Inspections that can be split into:
 - Major (intrusive) inspection.
 - Intermediate (non-intrusive) inspection.

Complementary information on best practises for implementing these various inspections and interpreting their results are provided elsewhere in professional documents and Company Guides and Manuals.

Figure 1 represents the inspection phases during the equipment lifespan.



1	Construction Inspection	QA / QC records	Purpose: to ensure that new equipment is manufactured and tested in accordance with the COMPANY Specifications and Design Codes. This is achieved by implementing an adequate Quality Assurance and Control (QA / QC) programme during the construction phase.
2	Commissioning and Baseline Inspection	Reference condition	Purpose: to ensure that the equipment is in accordance with as-build drawings. It should be seen as a final check prior to start-up that all works are complete and that the plant is ready for operation. The result of this inspection is used as a reference for future in-service inspections. Do not confuse commissioning and baseline inspection with the first in-service inspection.
3	First in-service Inspection	Essential step in the inspection programme	Purpose: to ensure both the design and manufacture of the equipment are compatible with the actual operating conditions experienced and any corrosion prevention is effective.
4	Subsequent in-service Inspection (intermediate and major)	Planned inspections	Purpose: to ensure the equipment remains in a condition fit for service and can be safely operated until the next inspection date. Major inspections are visible in the Long-Term Plan of the asset as they have a significant impact on the business.
	Ad-hoc Inspection	Un-planned inspections	The Ad-hoc inspections will be carried out when specific event occurs. They can be planned when the opportunity arises like installation of new equipment, programmes shut-down. They can be triggered on unexpected event like defect observation, incident, environmental or 3 rd party damage.

Figure 1: Inspection phases and its explanations during the equipment lifespan

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 10 of 141

Lifetime extension:

{Rule 2:

When the design life of equipments and structures is about to expire, an engineering and fitness for service assessment shall be conducted to demonstrate the lifetime extension.}

Requirements during the Project phase

Inspection strategies to be implemented in operation are influenced by the SOR (Statement of Requirements) established during the Project phase.

In particular:

{Rule 3:

Specific maintainability and inspectability studies shall be carried out at each project phase.}

{Rule 4:

Basic Engineering phase: requirements for in-service monitoring activities shall be established for critical items.}

{Rule 5:

EPCC phase: Contractor shall design the monitoring systems to be installed according to the identified modes of failure, together with operating and maintenance recommendations from Manufacturers.}

{Rule 6:

MIEC (Maintenance and Inspection Engineering Contract) phase: MIL (Maintenance and inspection Leader) and MIEC Contractor shall:

- **Collect all relevant Technical Documents and drawings issued by EPCC Contractors and suppliers.**
- **Develop the Facility Inspection Plan according to this General Specification.**
- **Participate in the commissioning of the monitoring systems and collect the Technical Records.**
- **Perform the Baseline Inspection.**
- **Develop the strategy for the management of monitored data during the operational phase (data collection and transfer, trend analyses, assessment studies, definition of correctives measures).}**

3.2 National Legislation

In many countries national legislation may both dictate which items of plant are subject to statutory inspection and, the inspection programme which must be adhered to. In such cases the Head of Inspection-Corrosion **must** comply with these requirements to ensure the plant can operate within the law of the land.

In the case where there is a conflict between national legislation and this General Specification, the more stringent requirement is applicable.

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 11 of 141

In the case where national legislation falls short of these minimum Company inspection requirements, the Company's requirements are applicable.

3.3 Risk-Based Inspection

In order to focus inspection effort in the most efficient manner, a Risk-Based Inspection (RBI) approach may be elected by the Company for certain specific categories of plant and structures. Where an approved formal RBI approach is taken, its output replaces the minimum requirements specified in this General Specification.

{Rule 7:

Where an approved formal RBI approach is NOT applied then the minimum inspection requirements identified within this General Specification shall be adhered to.}

Attention is raised that an inspection plan designed according to RBI may be more stringent for some equipment and less for others depending on their criticality, than the requirements in this General Specification.

3.4 First In-Service Inspection

For Pressure Vessels, Heat Exchangers and Pipelines, First In-Service Inspection is not required provided RBI assessment is performed including the following verifications:

- Manufacturer and Quality Control Dossier has been completed during fabrication and maintained during operations. Any Non-Conformance is tracked and cleared in due time.
- Baseline Inspection and Intermediate Inspection are carried out in compliance with the Written Scheme of Examination. Any Integrity Notification is tracked and cleared in due time.
- Corrosion Control Program is implemented since start-up in compliance with the specifications.
- Corrosion Monitoring data and Inspection data are reviewed in order to confirm consistency with corrosion assumptions and assessment.

3.5 Floating Units classification

Floating Units are submitted to Classification Society's Rules and International Maritime Conventions which may both dictate which items of plant are subject to third party inspection for certification purposes and the inspection programme to be adhered to.

In such cases, it is the responsibility of the Head of Inspection-Corrosion to comply with these requirements and to maintain the certificates.

{Rule 8:

In case of conflict between Classification Society's Rules/International Maritime Conventions and this General Specification, it is the more stringent requirement that shall apply.}

The validity of certificates is subject to periodical surveys of structures, equipment and systems by the Classification Society:

- Annual survey.

- Intermediate survey.
- Renewal survey.
- Underwater survey.

The scope of any class survey depends upon the age and condition of the floating unit and associated equipment. The exact scope of class surveys is displayed in the Classification Society's Rules (e.g. for Floating Units classed with [NR 445](#)).

{Rule 9:

The class periodical surveys shall be performed at the intervals laid down in Figure 2:

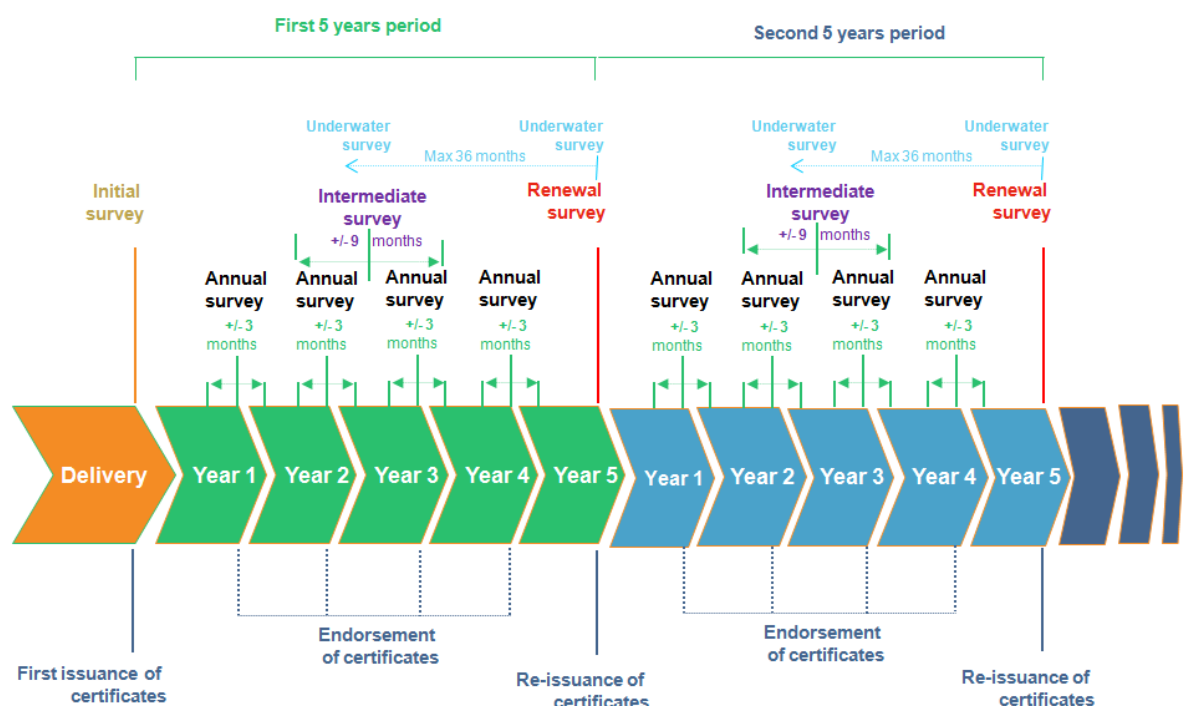


Figure 2: Class periodical surveys

A continuous survey system shall be implemented in order to allow the renewal survey to be spread over the 5 years cycle. Any given part or item under continuous survey shall be surveyed at least once during the 5 years cycle.}

{Rule 10:

Classification surveys are considered as "Third Party" Inspections and shall be included in the Company Inspection Plans.}

4. Pressure systems equipment

Pressure Systems Equipment is the collective term for all Pressure Vessels, Heat Exchangers, Steam Boilers, Fired heaters, Gas Cylinders and their associated Piping and fitting including Pressure Safety Valves.

4.1 Pressure vessels

4.1.1 General

For the purpose of this General Specification, Pressure Vessels mean Unfired Pressure Vessel. Process Tanks (excluding storage tanks on terminal facilities and structural tanks on Floating Units) are also considered in the scope of Pressure Vessels.

4.1.2 Design assessment

{Rule 11:

All pressure vessels shall be designed to allow internal inspection. Where physical entry is not possible due to the vessel size, 12" head-holes (as a minimum) should be fitted. Where vessels are large and complex (separators, columns, etc.) the provision of multiple manholes shall be considered, in particular where vessel internals render thorough internal inspection difficult.}

Using thermal insulation for personnel protection should be avoided and alternative means of protection such as guards and warning signs should be provided where safety permits. This will both allow inspection and avoid corrosion under insulation which is a major industry concern.

On systems requiring thermal insulation for process reasons, removable sections of insulation are designed and fitted to allow access to monitor internal corrosion. These sections should be specifically positioned at areas most at risk such as boots, other low points, dead legs, areas of high flow, etc.

4.1.3 Inspection strategy

The minimum inspection requirements to be applied to Pressure Vessels shall be in accordance with the **Table 4.1a**

Table 4.1a: Pressure vessel (general)

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of Pressure Vessels are the responsibility of Project. This section is therefore limited to modification and repairs of Pressure Vessels. Individual Quality Plans are prepared for each modification or repair. Any modification or repair is carried out in compliance with national legislation, international standards and/or Classification Society's Rules as applicable.			
Design Assessment	Before Start-up	R	As per section 4.1.2
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	
External General Visual Inspection and Photography		R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 14 of 141

Wall Thickness Measurements to verify nominal values and consistency with as-built drawings		R	Buried vessels: WT to be measured from the inside
Preparation of Vessel Inspection Drawings with inspection points.		R	
Internal General Visual Inspection and Photography	With Comm. Team	R	
Operational Phase			
First In-Service Inspection (exemption as per § 3.4)			
Detailed External Inspection of shell, nozzles, piping and trim, supports, foundations, associated access platforms and structures	Not > 2 years	R	
Wall Thickness Measurements (where internal corrosion is identified as a possible mode of failure) at key points on Shell and Nozzles	Not > 2 years	R	
Detailed Internal Inspection prior to any cleaning including the assessment and analysis of debris		R	Exceptions as per section 4.1.4
Detailed Internal Inspection after any cleaning		R	
Surface NDT of internal seam welds and shell attachment welds		R	
Holiday detection of internal linings		R	
Removal of selected sections of insulation to identify Under Insulation Corrosion or Stress Corrosion Cracking Ad-hoc NDT when practicable		R	Only when operating conditions can trigger these damages
Where vessels are internally clad, Dye Penetrant on cladding seam and nozzle welds		R	
Subsequent In-Service Inspection (Intermediate)			
Detailed External Inspection of Shell, nozzles, piping and trim, supports, foundations, associated access platforms and structures	Not > 2 years	R	
Subsequent In-Service Inspection (Major)			

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 15 of 141

As per First In-Service Inspection	Not > 4 years	R	
Ad-Hoc			
Scope to be determined by specific event	As required	N/A	
Inspection Reviews			
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, plant upsets, extreme environmental events, etc.			
Where unexpected inspection results are reported which could affect other plant			

It is the basis for preparing specific Written Schemes of Examination (WSE) for each individual Pressure Vessel.

Internal inspection requires clearly the shutdown, isolation and depressurisation of the Pressure Vessel. This task requires detailed planning, preparation of isolation and spading procedures and the purchase of gaskets. Although this is normally performed by production and maintenance/facilities engineering personnel, it is driven by the Inspection-Corrosion entity.

Vessel internals are removed as necessary to facilitate internal inspection. Again this needs careful planning and preparation. For complex separators and columns this may involve many days of effort. It may also require the replacement of internal components like filter cartridges.

Subsequent major or internal inspections are performed off-line both before and after any cleaning. The tasks to be carried out are the same as the ones during the first in-service inspection but frequency is different, as per **Table 4.1a**.

4.1.4 Exceptions

{Rule 12:

Where detailed internal inspection of Pressure Vessels is considered impossible or impractical or detrimental to safety or detrimental to the integrity of the vessel (some cryogenic equipment for example), their integrity shall be proven by other means such as comprehensive NDT or pressure testing. Moreover, assistance and feedback from the Vendor is taken into account to design the inspection strategy.}

{Rule 13:

Where Pressure Vessels are buried such as LNG Bullets, Cathodic Protection (CP) levels shall be monitored at a maximum frequency of three monthly. Internal inspections are performed as per non-buried vessels except that ultrasonic techniques are deployed internally to identify external corrosion.}

Acoustic Emission (AE) can be used as an alternative to internal inspection.

Pressure vessels covered by Classification Society's Rules (e.g. compressed air bottles) are subject to internal inspection or pressure test at max 5 years intervals in presence of the Class Surveyor.

4.1.5 Sampling inspection or generic RBI

Sampling inspection or generic RBI inspection can apply to for those vessels which contain:

- Non production water.
- Compressed air.
- Inert gas.
- Lube/synthetic oil.
- Non flammable heating/cooling fluids.
- Diesel oil.
- Or oil field chemicals.

These vessels do not have the complexity of process or utility vessels and are normally 'standard or off the shelf items' generally not designed to meet the specific requirements of a particular asset or oil Company. By principle, they are designed in the same way and are operated in similar condition. For inspection planning and management, such vessels are grouped according to the effluent they are subjected to.

An inspection strategy shall be selected for each group among two options:

- either **Generic Risk-Based Inspection** supported by a generic RBI assessment for the vessels group (the representative vessel being the one with the highest factor Volume x Maximum Operating Pressure)
- or **Sampling inspection** as per **Table 4.1b** supported by a generic WSE for the vessels group

Table 4.1b: Sample inspection

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
First In-Service Inspection			
ALL Vessels: GVI to identify external threats	Not >2 years	R	
33% of vessels: wall thickness checks on low spots and main inlet / outlet nozzles to determine internal threats		R	
Subsequent Major Inspections			
ALL Vessels: GVI	Not >4 years	R	Subsequent inspections alternate to other 33% of vessels

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 17 of 141

Another 33% of vessels: wall thickness checks on low spots and main inlet/ outlet nozzles		R
Ad Hoc		
Scope to be determined by specific event	As required	

4.2 Heat exchangers

4.2.1 General

Heat exchangers are generally designed according to Pressure Vessel codes and sometimes complemented by an additional standard such as TEMA (Tubular Exchanger Manufacturers Association).

4.2.2 Inspection strategy

In addition to the general requirements of **Table 4.1**, Heat exchangers are subject to requirements as specified in **Table 4.2 (a-e)** depending on their individual design. It is stressed that these requirements shall be in addition to and NOT as an alternative to the general requirements of **Table 4.1**.

Table 4.2 (a-e): ADDITIONAL requirements to Table 4.1
Table 4.2.a - Heat Exchangers - Fixed Tube sheet

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
First In-Service and Subsequent Major Inspections (exemption for First In-Service Inspection as per § 3.4)			
Internal inspection of tubes: - first, at tube ends by borescope / fiberscope - where corrosion or fretting is observed, Eddy Current or Internal Rotating Inspection System (IRIS) inspection of complete tubes	First in-service Not >2 years, Subsequent Not > 4 years	R	This requires the shutdown, isolation, depressurisation of the exchange and removal of channel end. Special cleaning may be required and this is performed by the inspection Vendor to avoid dispute.
External inspection of tubes, impingement and baffle plates and internal shell		R	Removal of shell inlet and outlet piping
Check for: - cracking at tube sheet - cracking and fretting at baffle plates		R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 18 of 141

Leak test for exchanger tubes		R	
Leak test of gasket on gas part		G	
Ad Hoc			
Following poor thermal efficiency or leakage	As required		

Table 4.2.b - Heat Exchangers - Removable Bundle

Table 4.2.3 Heat Exchangers - Removable Bundle			
Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
First In-Service and Subsequent Major Inspections (exemption for First In-Service Inspection as per § 3.4)			
Internal inspection of tubes: - first, at tube ends by borescope / fiberscope - where corrosion or fretting is observed, Eddy Current or Internal Rotating Inspection System (IRIS) inspection of complete tubes	First in-service Not >2 years, Subsequent Not > 4 years	R	
External inspection of bundle and baffle plates Internal inspection of shell		R	Withdrawal of tube bundle from shell
Check for: - cracking at tube sheet - cracking and fretting at baffle plates		R	
Leak test for exchanger tubes		R	
Leak test of gasket on gas part		G	
Ad Hoc			
Following poor thermal efficiency or leakage	As required		

Table 4.2.c - Heat Exchangers - Air Coolers

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
---------------------------------	------	------------------	----------

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 19 of 141

First In-Service and Subsequent Major Inspections (exemption for First In-Service Inspection as per § 3.4)

Internal inspection of tubes and header boxes:

- first, at tube ends by borescope / fiberscope
- where corrosion or fretting is observed, Eddy Current or Internal Rotating Inspection System (IRIS) inspection of complete tubes

First in-service
Not >2 years,
Subsequent
Not > 4 years

R

Remove header plugs (10%)
Special cleaning may be required
and this is performed by the
inspection Vendor to avoid
dispute

Ad Hoc

Following poor thermal efficiency or leakage

As required

Table 4.2.d - Heat Exchangers - Plate Type

Table 2.12 – Heat Exchangers – Plate Type			
Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
First In-Service and Subsequent Major Inspections (exemption for First In-Service Inspection as per § 3.4)			
All plates are fully dismantled and thoroughly cleaned to allow detailed close visual inspection of the plates for pitting.	First in-service Not > 2 years, Subsequent Not > 4 years	R	Great care is needed to ensure the plates are correctly replaced and re-tightened. Exception as per section 4.2.3.
Draw bolts are inspected for elongation by checking the overall length and using thread gauges. They are also ckd for possible cracking.		R	
Ad Hoc			
Following poor thermal efficiency or leakage	As required		

Table 4.2.e - Heat Exchangers - Cryogenic

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
First In-Service and Subsequent Major Inspections (exemption for First In-Service Inspection as per § 3.4)			
Inspection programmes for specialist heat exchangers are prepared in conjunction with the Manufacturer's instructions	First in-service Not > 2 years, Subsequent Not > 4 years	R	
Ad Hoc			
Following poor thermal efficiency or leakage	As required		

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 20 of 141

What make exchangers unique from Pressure Vessels are their tubes or their plates. Depending on their structures, inspection tasks can be different for each type of heat exchanger.

Where corrosion is noted, Ad Hoc inspection has to be performed according to **Table 4.2**.

In addition to external corrosion, exchanger tubes may be susceptible to fatigue cracking at tube sheets and impingement baffles, and fretting at baffle plates.

4.2.3 Exceptions

On those plate exchangers

- Which are not possible to dismantle.
- Or where dismantling/retightening may be detrimental to the integrity of the exchanger.
- Or where effluents on both sides are in the list of section **4.1.5**.

Inspection may be performed by a combination of borescope / fiberscope inspection, external inspection and pressure test in accordance with Vendor's instructions.

4.3 Steam boilers and fired heaters

4.3.1 General

Steam Boilers generally fall into two categories, Fire Tube or Water Tube. The majority of the Steam Boilers in use in the Oil and Gas Industry are Fire Tube where the heat source or fire is contained within the boiler tubes and the outer boiler shell is a pressure vessel. For the purpose of this General Specification Glycol regenerators are considered as Fire Tube Boilers (**Table 4.3.a**).

Large Water Tube Boilers are generally used for power generation but small "package" water tube boilers can also be found in the Oil and Gas Industry. Water tube boilers are normally gas or oil fired and the internal walls are lined with refractory brick (**Table 4.3.b**).

Fired heaters are normally used as part of oil or condensate stabilisation plant or glycol re-boiling. Their design is similar to a water tube boiler where heat is applied to the outer skin of the tubes and the process fluid is contained within the tubes.

Boilers and heaters can be dangerous! There have probably been more accidents relating to boilers than to any other single item of plant within a Pressure System. For this reason the inspection of boilers is heavily regulated in the majority of countries.

Because of this heavy regulation there is limited value in performing formal criticality assessment of Steam Boilers. However the criticality process should be run to identify the likely modes of failure and therefore the optimum inspection techniques. Frequencies of inspection are almost always determined by national legislation and Classification Society Rules as applicable.

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 21 of 141

4.3.2 Inspection strategy

In addition to the general inspection requirements of **Table 4.1**, Steam Boilers and Fired Heaters are subject to requirements as specified in **Table 4.3 (a-b)** depending on their individual design. It is stressed that these requirements shall be in addition to and NOT as an alternative to the general inspection requirements of **Table 4.1**

Table 4.3 (a-b): Additional requirements to Table 4.1
Table 4.3.a - Steam Boilers - Fire Tube

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Inspection review			
Check for inspection requirements as per national legislation and Classification Society's Rules as applicable.			
Continuous monitoring			
Feed water chemistry: oxygen content, pH	Daily	R	
Fuel gas composition	As Required	R	
Example of Classification Society's survey (according to BV Rules)			
Internal examination and functional test	Not > 30 months	R	NR 467, Ch 2, Sec 1.4.5
Additional Company Inspection			
First In-Service and Subsequent Major Inspections			
Detailed internal and external examination of the furnace chamber to identify overheating, deformation and cracking	Not > 18 Months from commissioning and Not > 36 Months thereafter	R	Exceptions as per paragraph 4.3.3
External visual examination of boiler tubes for blisters and other deformation together with wall thickness measurements		R	
Visual examination of stay tubes for elongation, buckling and deformation		R	
Partial removal of insulation to check for Corrosion Under Insulation		R	
Internal examination of exhaust/flue box structure and tubes		R	
Pressure Safety Valves: overhaul and inspection		R	
Subsequent In-Service Inspection (Intermediate)			
Detailed External Inspection of Shell, nozzles, piping and trim, supports, furnace, flue, foundations, associated access platforms and structures	Not > 18 Months	R	Including a 36 monthly partial removal of thermal insulation

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 22 of 141

Ad Hoc

Following problems with the control of BFW and fuel gas supply

As Required

Table 4.3.b - Steam Boilers - Water Tube Boilers, Fired Heaters and Reboilers
Inspection review

Check for inspection requirements as per national legislation and Classification Society's Rules as applicable.

Continuous monitoring

Feed water chemistry: oxygen content, pH

Daily

R

Fuel gas composition

As Required

R

Example of Classification Society's survey (according to BV Rules)

Internal examination and functional test

Not > 30 months

R

[NR 467](#), Ch 2, Sec 1.4.5

Additional Company Inspection
First In-Service and Subsequent Major Inspections

Thermographic survey of outer shell to identify any damage to the refractory lining

Not > 18 Months from commissioning and Not > 36 Months thereafter

R

Detailed External and Internal examination of steam drums

R

Exceptions as per paragraph 4.3.3

External visual examination of boiler tubes for blisters and other deformities

Not > 18 Months from commissioning and Not > 36 Months thereafter

R

Pressure test of steam coil

G

Internal examination of exhaust/flue box structure and tubes

R

Overall measurement of Fired heater and Reboiler tube bundle lengths to identify creep

R

Ultrasonic Wall Thickness measurement of Fired heater and Reboiler tubes

R

Pressure Safety Valves: overhaul and inspection

R

Subsequent In-Service Inspection (Intermediate)

Detailed External Inspection of Shell, nozzles, piping and trim, supports, furnace, flue, foundations, associated access platforms and structures

Not > 18 Months

R

Ad Hoc

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 23 of 141

Following problems with the control of BFW and fuel gas supply	As Required	
--	-------------	--

It should be noted that steam boilers may be started-up long before the actual Oil and Gas Plant to provide steam for well clean-up or other utility services.

The date of first in-service inspection will therefore be 18 months from the initial commissioning of the boiler.

Pressure Safety Valves (PSV's) are integral to the safety of steam boilers. Again it is likely that their inspection and overhaul is subject to national legislation and Classification Society Rules.

Unless directed by more stringent legislation, Steam Boiler PSV's are subject to overhaul and inspection in coincidence with Major inspections to the Boiler.

4.3.3 Exceptions

Boilers covered by Classification Society's Rules shall be subject to internal inspection at max 2.5 years intervals in presence of the Class Surveyor.

4.4 Gas cylinders

4.4.1 General

Gas cylinders are generally small, enclosed metal vessels used to store and transport compressed gases or gas liquefied under pressure. They are mainly used in the Oil and Gas Industry for storage of inerting and purging gas, testing gases, cutting, heating and welding gas.

Gas cylinders may also be used as part of fixed fire fighting appliances and for the storage of air in breathing apparatus.

Sample cylinders are also included within the scope of gas cylinders. They are used for the collection and transportation of various fluids and gases prior to laboratory analysis.

Air cylinders for diving breathing apparatus and portable fire extinguishers are not covered by this General Specification.

{Rule 14:

Due to the large variety of usage, gas cylinder are managed by several actors within and outside an affiliate: in all case the responsibility for the integrity and for the examination of all gas cylinders shall be formally agreed and recorded within each affiliate.}

4.4.2 Rented gas cylinders

In the majority of cases gas cylinders used in the Oil and Gas Industry are rented from the Gas Supply Company. In this case it is the responsibility of the Gas Supply Company to inspect the Gas Cylinders they fill and supply and thus to assure their integrity.

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 24 of 141

Where gas cylinders are rented it is the responsibility of the Company to ensure that the supplies Vendors are performing their inspection duties. This is controlled by the Supply Contracts and Purchase Orders by Company audit and by certification of incoming cylinders.

4.4.3 Company-owned cylinders

For Company-owned cylinders, the Inspection entity is accountable for their inspection and integrity.

The initial task is the setting-up of a register of all Company owned cylinders and the safe storage of their original certification. Gas cylinders are either registered by Serial Number or alternatively by allocated Tag Numbers.

The followings are recorded as a minimum: Manufacturer name and mark, original serial number and any other identification number, fabrication specification, maximum working pressure and original test pressure, tare weight, dates and details of any damage, date of initial manufacture, date of initial and subsequent inspection and nature of the contained gas.

4.4.4 Inspection Strategy

The minimum acceptable inspection requirements to be applied to Company-owned Gas Cylinders shall be in accordance with the **Table 4.4**.

Table 4.4 : Company-owned gas cylinders

Table 4.4 : Company-owned gas cylinders			
Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of Gas Cylinders is the responsibility of Project. Gas Cylinders are never modified or repaired.			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	According to section 4.4.3
Wall Thickness Measurements to verify nominal values and consistency with as-built drawings	Before Start-up	R	
Preparation of Written Scheme of Examination according to EN 1968/A1 , EN 1802 , EN 1803 , ISO 11623 or equivalent		R	Including inspection drawing and insp. points
Operational Phase			
Sample cylinders			

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 25 of 141

External visual Inspection of shell, threaded connections and fittings	Prior to Filling	R	
Detailed Internal and external Inspection prior to any cleaning including the assessment and analysis of debris	Not > 3 years	R	As per section 4.4.4
Detailed Internal and external Inspection after any cleaning		R	
Wall Thickness Measurements (where internal corrosion is identified as a possible mode of failure)		R	
Thread Inspection using GO/NO GO Gauges		R	
Hydro Testing for 2 minutes < 130 litres capacity and 10 minutes > 130 litres capacity		R	
Gas cylinders			
External visual Inspection of shell, threaded connections and fittings	Prior to Filling and Not > 1 year	R	
Detailed Internal and external Inspection prior to any cleaning including the assessment and analysis of debris	Not > 5 years for Corrosive Service or Permanent Liquefied Gas and Breathing Air Cyl. Not > 10 years for Non Corrosive Service	R	As per section 4.4.4 Exemption conditions in section 4.4.5
Detailed Internal and external Inspection after any cleaning		R	
Wall Thickness Measurements (where internal corrosion is identified as a possible mode of failure)		R	
Thread Inspection using GO/NO GO Gauges		R	
Tare Weight Test			
Hydro Testing for 2 minutes < 130 litres capacity and 10 minutes > 130 litres capacity	Not > 5 years for Corrosive Service or Permanent Liquefied Gas and Breathing Air Cyl.	R	
Hydro Testing for 2 minutes < 130 litres capacity and 10 minutes > 130 litres capacity	Not > 10 years for Non Corrosive Service	R	
Ad-Hoc			
Scope to be determined by specific event	As required		

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 26 of 141

Inspection Reviews			
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, etc.			
Where unexpected inspection results are reported which could affect other plant			

Three categories of inspection are performed on gas cylinders:

- General visual examination at filling (the main objective is to detect any damage or corrosion on shell, threaded connections and fittings).
- Thorough examination (detailed internal and external inspection).
- Hydro testing (hydraulic pressure test), except for acetylene cylinders

{Rule 15:

Thorough examination and hydraulic pressure test shall be performed in accordance with EN 1968/A1, EN 1803, ISO 11623 as relevant (or equivalent), by a qualified competent Contractor and audited by the Inspection Entity.}

{Rule 16:

The survey and maintenance of fire-extinguishing equipment and systems on board Floating Units shall be checked by Service suppliers approved by the Classification Society.}

4.4.5 Exemption for fixed fire-fighting systems

Gas cylinders that are used for fire fighting purposes may be exempted from 5 yearly Thorough examinations providing that they are subject to full external examinations every year. Subject to satisfactory annual external examinations and satisfactory drying facilities audit (CO₂ cylinders), the frequency of thorough examination and Pressure test may be extended to 20 years.

{Rule 17:

Gas cylinders used for fixed fire fighting purposes on board Floating Units shall be submitted to periodical tests by approved service suppliers at intervals not exceeding 10 years.

At the 10-year inspection, at least 10% of the total number provided should be subject to an internal inspection and hydraulic pressure test.

If one or more cylinders fail, a total of 50% of the onboard cylinders are to be tested.

If further cylinders fail, all cylinders are to be tested.}

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 27 of 141

4.5 Piping

4.5.1 General

For the purpose of this General Specification, Piping means all pipes, fittings, valves, supports but **excluding** Pipelines and Risers.

4.5.2 Design assessment

4.5.2.1 Access

Piping requires extensive monitoring and therefore should be installed at ground level. Where this is not possible due to equipment layout, access platforms should be installed.

4.5.2.2 Investigation of welds

Selective internal corrosion of weld roots is a recognised problem in both hydrocarbon and water injection lines. Although this should be designed out by avoiding excessive velocities, balanced weld root metallurgy and effective chemical treatment, it remains a serious potential area of risk and as such is included in the inspection programme.

4.5.2.3 Insulation design

Thermal insulation should be specified only if strictly required for process purpose. Insulation for personnel protection should be avoided and alternative means of protection such as guards and warning signs should be provided. This allows both inspection and avoids corrosion under insulation which is a major industry concern.

On insulated piping systems which are susceptible to internal corrosion, there will be a need to routinely remove sections of insulation to facilitate inspection. In such cases, it is needed to incorporate removable sections of insulation into the initial design. These sections should be specifically positioned at areas most at risk such as boots, other low points, dead legs, areas of high flow, etc.

Where removal insulation sections are installed, to ensure such designs do not pose an additional risk to the piping integrity by allowing water ingress and subsequently Corrosion Under Insulation.

4.5.2.4 Piping supports

Piping supports often receive little design attention in relation to allowing water ingress especially where insulated or fitted with PFP. Commissioning inspection has to carefully address this matter.

4.5.2.5 Vibration review

Small bore pipework are locations where fatigue cracking is currently experienced, especially when they are fitted with heavy instrumentation equipment and located close to machinery. Piping where flow rate is high are critical as well.

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 28 of 141

It is strongly recommended that a vibration survey is carried out by a specialised Contractor during Commissioning in order to identify those small bore connections where resonance can take place and to implement preventative solutions at the early stage.

4.5.2.6 Temporary repairs

Definitions:

Repairs made to piping systems in order to restore sufficient integrity to continue safe operation until permanent repair is conducted. Typical temporary repairs are based on welded sleeve, welded patch, bolted clamp or composite wrap repair systems.

General requirements:

{Rule 18:

Temporary repairs shall be subject to all the following requirements:

- Design and implement in accordance with the relevant standard and supported by a specific engineering assessment (including defect assessment and calculation note).
- Ensure registration in a temporary repair register.
- Perform periodic inspection (the first inspection interval does not exceed 6 months).
- Conduct a risk assessment in order to define the appropriate strategy for inspection, maintenance and repair (depending on the type of original defect, repair technique and the design life (short or long term) of the repair system).
- Schedule and execute the permanent repair when required.}

4.5.3 Inspection Strategy

The minimum inspection requirements to be applied to Piping shall be in accordance with the **Table 4.5**.

Table 4.5 : Piping systems

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of piping systems is the responsibility of Project. This section is therefore limited to modification and repairs of piping systems. Individual Quality Plans is prepared for each modification or repair.			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 29 of 141

Wall Thickness Measurements to verify nominal values and consistency with as-built drawings		R	
Preparation of piping isometric inspection drawings with inspection points.		R	
Preparation of Written Schemes of Examination (WSE)		R	
Buried piping: witness Cathodic Protection baseline survey together with commissioning of impressed current transformer rectifiers		R	
Carry out a design review as per paragraph 4.5.2		G	
Operational Phase			
First In-Service Inspection			
Selective Internal Inspection of choke valves and adjacent downstream piping	As Required	G	Specific inspection programme should be prepared
Detailed External Inspection of piping, fittings, valves, supports, foundations and associated structures	Not > 2 years	R	Look for evidence of coating or insulation breakdown
Wall Thickness Measurements (where internal corrosion or erosion is identified as a possible mode of failure) at key points		R	
Surface NDE of Small Bore piping welds where vibration is observed		R	
Removal of selected sections of insulation to identify Corrosion Under Insulation or Stress Corrosion Cracking Ad-hoc NDE when practicable		R	Systematic inspection ports or windows are NOT recommended
Cathodic Protection (CP) survey of complete piping system, where applicable		R	
Subsequent In-Service Inspection (Intermediate)			
General External Inspection of piping, fittings, valves, supports, foundations and associated structures	Not > 2 years	R	
Subsequent In-Service Inspection (Major)			
As per First In-Service Inspection	Not > 4 years	R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 30 of 141

Internal and external examination of in-line Flame Arrestors (where fitted)			
Ad-Hoc			
Scope to be determined by specific event	As required	N/A	
Inspection Reviews			
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, plant upsets, extreme environmental events, etc.			
Where unexpected inspection results are reported which could affect other plant			

4.6 Flexible hoses

4.6.1 Field of application

For the purpose of this General Specification, Flexible Hoses mean hoses assemblies such as rubber type reinforced with textile and wire, thermoplastic type, stainless steel braided, used for the following services:

- Hydrocarbon process and utilities, chemicals transfer.
- Bulk loading (methanol, diesel oil, water, etc.).
- Sampling.
- Hydraulic fluid.

This section does not apply to the following hoses:

- Flexible Risers and Flexible Jumpers.
- Oil Offloading Lines.
- Offloading Floating Hoses, Submarine Hoses.
- Breathing Apparatus hoses.
- Fire fighting hoses.
- Jet Fuel hoses.
- Instrument hoses.

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 31 of 141

Flexible hoses which are part of machine package (cranes, pumps, compressors, generators, etc.) are not covered by this General Specification provided that they have management programs developed by the manufacturer.

ISBN 978 0 85293 588 0 may be used as a reference for general recommendations related to design, supply, storage, handling, installation and commissioning of flexible hoses.

4.6.2 Supply and storage

{Rule 19:

Any new flexible hose shall be delivered with its certificate of conformance and pressure test certificate.}

The hose certificate should include the following as a minimum:

- Manufacturer's name.
- Manufacturer's hose batch number.
- Date of manufacture.
- Nominal size (diameter, length).
- Materials.
- Design Pressure / Design Temperature.
- Test pressure.
- Service.

These data should be marked on the hose end-fittings.

Storage of flexible hoses requires precautions according to Manufacturer recommendations, including recommendation for maximum storage life. Rubber type or thermoplastic type flexible hoses require protection from direct sunlight.

4.6.3 Installation

{Rule 20:

Any new flexible hose shall be submitted to the following verifications prior to first utilisation:

- Identification and registration.
- Conformance of hose certificate and marking.
- Adequacy of operating conditions against design conditions.
- Examination in order to check the condition of hose body and end-fittings.
- Verification of proper installation in order to make sure there is no over-bending, torsion, axial extension or compression.
- Verification of electrical and earth continuity if applicable.}

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 32 of 141

4.6.4 Inspection strategy

Inspection strategy applicable to flexible hoses is based on prescriptive requirements for periodic visual inspection and systematic replacement at pre-defined frequencies.

Minimum requirements shall be in accordance with the **Table 4.6.b**

Table 4.6.b - Flexible Hoses

Table 4.6.5 - Flexible Hoses			
Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Although the purchase of the initial Flexible Hoses is the responsibility of Project, the replacement flexible hoses requires to be purchased by the affiliate. It is therefore the responsibility of the Head of Inspection & Corrosion to provide inspection and Quality Control Support Services to the Procurement Entity for the replacement purchase of any Flexible Hose. Individual Quality Plans is prepared for each Purchase Order. Repair or modification of flexible hoses is not permitted.			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	
Check for proper installation (over-bending, torsion, axial extension, axial compression not permitted)		R	
Check for electrical continuity if applicable		R	
Operational Phase			
Detailed visual inspection of flexible hoses over the full length, including hose body, end-fittings, supports and associated accessories. Verification of: - Proper installation: over-bending, torsion, axial extension and axial compression are not permitted. - Condition of hose body (outer cover or braid, etc.): detection of bulge, crack, cut, kink, abrasion, corrosion, dents, broken braid wires. - Condition of end fittings: detection of mechanical damage or corrosion. - Electrical continuity when applicable.	Not > 1 year (Class C) Not > 2 years (Class B) Not > 3 years (Class A)	R	

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 33 of 141

Replacement of flexible hoses	Not > 6 years (Class C) Not > 8 years (Class B) Not > 10 years (Class A)	R	Replacement frequency may be extended on conditions defined in section 4.6.5
Ad-Hoc			
Scope to be determined by specific event	As required	N/A	
Inspection Reviews			
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, plant upsets, extreme environmental events, etc.			
Where unexpected inspection results are reported which could affect other plant			

Frequencies for inspection and replacement are defined considering the following flexible hoses classification:

Table 4.6.a - Flexible hose classification

Service Conditions	Flexible Hose Class
Utilities ≤ 600# (non flammable fluids)	A
Utilities > 600# (non flammable fluids) Hydrocarbon / Chemicals ≤ 600#	B
Hydrocarbon / Chemicals > 600# Bulk loading hoses (methanol, diesel oil) Sampling hoses	C

4.6.5 Conditions for flexible hoses life extension

The replacement frequencies in **Table 4.6.b** may be extended on condition that:

- A qualification programme formally validated by relevant technology experts (Piping Valves Vessels, Pipelines, Risers) has been successfully completed.
- A dedicated inspection plan has been developed and is duly implemented.

4.7 Corrosion Monitoring

It is the responsibility of the Head of Inspection-Corrosion to ensure that corrosion monitoring activities are implemented according to **GS EP COR 002**.

S/He ensures also that:

- Corrosion monitoring readings and subsequent analysis are performed by either the Inspection-Corrosion entity or the Laboratory/Treatment entity.
- The results of all corrosion monitoring are put together with all other inspection results to produce an overall consolidated assessment of corrosion and recommend changes as necessary to any treatment procedures.

4.8 Pressure Safety Devices

4.8.1 General

For the purpose of this General Specification, Pressure Safety Devices mean Pressure Safety Valves (PSVs) and Bursting Discs. The term PSV includes Pressure Safety Valves, Thermal Safety Valves, Safety Relief Valves and Vacuum Breakers. Spill valves and relief valves integral to machine package and located on hydraulic systems will be maintained along with their associated equipment under the responsibility of Maintenance entity.

4.8.2 Design reviews

PSVs need to be overhauled on regular basis. Duplicate PSV with locked open isolation valves should therefore be installed on equipment that cannot be shutdown in normal production mode. This could be particularly important where PSV's inspection intervals do not fit associated equipment major inspection ones.

4.8.3 Inspection Strategy

The minimum inspection requirements to assure the safe operation of such devices shall be in accordance with the **Table 4.7**.

Table 4.7: Pressure Safety Devices

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of Pressure Safety Devices are the responsibility of Project. This section is therefore limited to modification and repairs of Pressure Safety Devices. Individual Quality Plans are prepared for each modification or repair.			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 35 of 141

General external visual inspection		R	
Internal visual inspection and witness of function test	With Comm. Team	R	
Operational Phase			
First In-Service Inspection (General PSVs)			
General External Inspection	Not > 2 years	R	Exceptions as per sections 4.8.4
Witness Pre Overhaul Test (pre-pop test)		R	
Internal Visual Inspection	Not > 2 years	R	
Witness Final Function Test		R	
Subsequent In-Service Inspection (General PSVs)			
As per First In-Service Inspection	Previous interval plus 1 year up to a max. of 5 years	R	Exceptions as per sections 4.8.4
First and Subsequent In-Service Inspection (Bursting Discs)			
General external inspection	Not > 5 years	R	Date of Bursting Disc inspection may be extended based upon Manufacturer's recommendations for the specific service.
Internal visual inspection		R	
Ad-Hoc			
Scope to be determined by specific event	As required	N/A	
Inspection Reviews			
Damage assessment for replacement of bursting disc	Not > 10 years	R	
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, plant upsets, extreme environmental events, etc.			
Where unexpected inspection results are reported which could affect other plant			

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 36 of 141

The minimum requirements specified in **Table 4.7**, together with national legislation and their service history are the basis for the formulation of a WSE for each PSV.

{Rule 21:

Prior to dismantling, PSV's shall be subject to a pre-pop test to determine how they would have performed in-service. The results of the pre-pop are recorded in the PSV overhaul report.

A satisfactory test is one where the PSV lifts within +10% and -10% of set pressure. Since the pre-pop results will be used to partly determine the date of next inspection, care is required whilst handling the PSV to ensure the condition at pre-pop remains representative of how it would have performed in-service.

If heavy fouling is observed when the PSV is removed, no pre-pop test is needed. In this case the pre-pop is automatically determined to be unacceptable. The nature of the fouling has to be investigated and measures taken to prevent future occurrences. Following the pre-pop test, each PSV is to be dismantled and overhauled. Any damage to the valve body or any of its components is brought to the attention of the Inspection-Corrosion entity. All consumable part is replaced and non-consumable parts replaced as necessary. A satisfactory PSV is one where the overall condition is good and no non-consumable spares are needed.

PSV's are reassembled, calibrated and function tested in the presence of the Inspection-Corrosion entity. The PSV overhaul report is prepared by the Valve Technician and signed off by the Inspection-Corrosion Entity.

Unless a formal RBI Approach has been adopted, the date of next inspection is determined by the current interval modified by +/- one year depending of the observed condition and performance of the PSV during overhaul.

When a PSV is found to be in a generally satisfactory condition, did not require non-consumable spares and performed satisfactorily during pre-pop, its date of next inspection is increased by one year up to a maximum ceiling value of five years where permitted by national legislation.

When a PSV is found to be in a generally poor condition, or required the replacement of non-consumable spares, or was found to be out with +10% and -10% of set pressure during pre-pop, its date of next inspection is reduced by one year down to a minimum of one year.

When the condition of a PSV or its performance is found to be borderline, its overall interval of inspection remain the same.}

In situ testing of PSV's such as Trevitest or equivalent can be considered subject to the competence of the Contractor and their testing procedures. Adoption of such a strategy should be approved by Field Operations.

4.8.4 Exceptions for PSDs

4.8.4.1 PSDs on Boilers and Fired Heaters

Refer to **section 4.3** and **Tables 4.3a** and **4.3b**.

General Specification		GS EP EXP 311
Plant integrity – Minimum inspection requirements		
Rev.: 07	Effective date: 11/2019	Page: 37 of 141

4.8.4.2 PSDs on systems covered by the Classification Society's Rules

On board Floating Units, Pressure Safety Devices belonging to classed systems in machinery spaces and storage area shall be subject to internal inspection and/or pressure test every 5 years.

The Class Surveyor has to be informed prior to overhaul and calibration of classed Pressure Safety Devices.

4.8.4.3 "Small" PSVs

Small PSVs are PSVs with inlet diameter less than 1" or equal to 1".

The following maintenance and inspection strategy can be selected for small PSVs:

- PSV to be scrapped and to be replaced by brand new one at fixed interval.
- Interval is 5 years when operating conditions are clean and non-corrosive (low severity).
- Interval is 4 years when fouling and/or corrosion may occur (medium severity).
- Interval is 3 years max when fouling and/or corrosion is expected (high severity).
- Pre-pop test, dismantling and overhaul are not required.

This strategy should be preferred in order to optimize stock management (avoid proliferation of small items) and maintenance tasks (like for like replacement, no dismantling, no reassembling).

4.9 Flares

4.9.1 General

Flare systems comprise of piping, pressure vessels, support structures, ignition systems and finally flare tips. Since the majority of these components are included within other sections of this General Specification, this section only focus on the inspection requirements for flare tips and its surrounding piping and structure.

4.9.2 Design review

The repair and eventual change-out of flare tips is almost inevitable over the life of the field. Flare tips should therefore be designed to be replaced. The operation and test of flare tip replacement handling equipment should therefore be tested as part of the flare pre-commissioning works. Since this involves various items of lifting and structural equipment, the Head of Inspection-Corrosion entity should pay special attention to this activity.

4.9.3 Inspection strategy

Flare tips may be either atmospheric or sonic type. For either type the inspection strategy and frequency are the same. The minimum inspection requirements to assure the safe operation of Flare Tips and their associated components shall be in accordance with the **Table 4.8**.

Table 4.8: Flares

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 38 of 141

Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of Flares are the responsibility of Project. This section is therefore limited to modification and repairs of Flares. Individual Quality Plans are prepared for each modification or repair			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	
External General Visual Inspection and Photography	With Comm. Team	R	
Witness commissioning and function test of flare tip change-out handling equipment		R	
Preparation of Vessel Inspection Drawings with inspection points	Before Start-up	R	
Operational Phase			
First In-Service Inspection			
Detailed External Visual of support structure, floor grating, ladders and handrails.	Prior to any inspection	R	
Internal and external examination of in-line Flame Arrestors (where fitted) and cleaning	Within 2 years	R	
Thorough visual examination of flare tip including measurement of any damage or distortion noted		R	Done during plant shutdowns
Surface NDT of flare tip welds and major support structure welds		R	
Visual inspection of refractory tiles where applicable		R	
Visual inspection associated pilot and ignition equipment		R	
Subsequent In-Service Inspection (Intermediate)			
Remote Visual Inspection using binoculars or telescopic equipment	Not > yearly	R	Helicopter can be used if access is insufficient to confirm defects

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 39 of 141

Subsequent In-Service Inspection (Major)			
As per First In-Service Inspection	Not > 4 years	R	
Ad-Hoc			
Scope to be determined by specific event	As required	N/A	
Inspection Reviews			
Following a significant change in the operating parameters or the environment			
Following abnormal incidents such as damage, leaks, plant upsets, major plant blow-downs, extreme environmental events, etc.			
Where unexpected inspection results are reported which could affect other plant			

For “Cold” flares which do not continuously burn, detailed thorough inspections are only performed where a problem has been identified during in-service inspections.

Great care is taken to assure any access structure including gratings and handrails are safe and suitable for use prior to performing the actual tip inspection. These preliminary structural inspections may be performed by specialist abseiling teams.

Once access to the flare tip is considered safe, it is thoroughly inspected both visually and by supplementary NDT. This includes any equipment associated with flare tip handling. In situ repairs of lifting/handling points may be required PRIOR to the removal of the tip.

5. Storage tanks

For the purpose of this General Specification, Storage Tanks include Fixed Roof Tanks, Floating Roof Tanks and Cryogenic Tanks for storage function on onshore terminal facilities, designed and built in accordance with [API STD 620](#), [API STD 650](#) or equivalent.

Structural Tanks on Floating Units are not in the scope of this section; they are covered by **chapter 19**.

Inspection specifications applicable to LNG Cryogenic Tanks are given in **section 5.2**.

5.1 Storage Tanks (fixed roof and floating roof)

The inspection strategy applicable to storage tanks (fixed roof and floating roof) is based on the following periodic tasks:

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 40 of 141

- Routine in-service surveillance.
- Intermediate External Inspection
- Major Internal Inspection.

and shall be in accordance with **Table 5.1**
Table 5.1 : Storage Tanks (fixed or floating roof)

Table 6.1: Storage Tanks (fixed or floating roof)			
Inspection Type/Integrity Tasks	When	Rule or Guidance	Comments
Pre Start-up Phase			
Construction Inspection			
Manufacture and hence QA of Tanks are the responsibility of Project. This section is therefore limited to modification and repairs of Tanks. Individual Quality Plans are prepared for each modification or repair.			
Commissioning/Baseline Inspection			
Verification of Technical Records and Registration in Plant Inventory	Before Start-up	R	
External General Visual Inspection and Photography		R	
GVI and compliance verification of retention pond		R	
Preparation of Tank Inspection drawings with inspection points reported on shell, floor and roof	Before Start-up	R	
Wall Thickness Measurements of walls and floor to verify nominal values and consistency with as-built drawings	With Commissioning Team	R	
Confirm operation of atmospheric vents, flame arrestors and vacuum breakers		R	
Internal General Visual Inspection and Photography		R	
Tank foundation and tank settlement measurement. Shell plumbness (verticality). Shell roundness		R	
Witness Cathodic Protection baseline survey together with commissioning of impressed current transformer rectifiers or sacrificial anodes		R	
Operational Phase			

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 41 of 141

Routine in-service surveillance

As per check-list defined in a dedicated guide, with particular attention to the following:
Confirm operation and absence of debris for atmospheric vents, flame arrestors and vacuum breakers
Confirm operation and absence of debris for roof drains

R

To be performed by
Production or Maintenance

Continuous monitoring

Impressed current CP system: measure and analyse transformer / rectifier output (U/ I trend)

Not > 2 weekly

R

Intermediate External Inspection

Visual: as per check-list in [API STD 653](#) (Appendix C), [CODRES Division 2](#) or [EEMUA Publication 159](#)
As part of this check-list, check general condition of:

Not > 4,5 years

R

- Access to tanks (platforms, stairs, ladders, handrails, etc.)
- Tank foundation, bottom annular ring to foundation support, settlement
- Tank shoe plates, bottom annular plates, shell to floor weld, bolting
- Shell plates
- Shell appurtenances, Manholes, Nozzles, Piping
- Tank Roof plates
- Roof appurtenances, roof drains, roof seal
- For floating roof:
 - check absence of liquid in buoyancy spaces,
 - check level of floating roof (uneven level)
- Confirm operation and absence of debris for roof drains
- Confirm operation and absence of debris for atmospheric vents, flame arrestors and vacuum breakers
- Earth connections
- Retention pond
- Etc.

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 42 of 141

<u>Wall thickness measurements on Shell</u> <u>Vertical lines from bottom to top of shell:</u> 4 vertical lines if tank $\varnothing \leq 20\text{m}$ 8 vertical lines if $20\text{m} < \varnothing \leq 36\text{m}$ 1 vertical line every 15m if $\varnothing > 36\text{m}$ (5 UT spots on each plate)	Not > 4,5 years	R	May be performed by rope-access or robotics (crawler, drone)
<u>Wall thickness measurements on Roof (for fixed roof tanks):</u> Lines from edge to center of roof 4 lines if tank $\varnothing \leq 20\text{m}$ 8 lines if $20\text{m} < \varnothing \leq 36\text{m}$ 1 line every 15m if $\varnothing > 36\text{m}$ (1 UT spot every meter)	Not > 4,5 years	R	May be performed by rope-access or robotics (crawler, drone)
<u>Wall thickness measurements (UT scan on areas):</u> 100% of nozzles and manhole on first course - bottom annular plates (on areas of possible concern)	Not > 4,5 years		May be performed by manual or automated UT system (or RT for small bore nozzles)
Tank foundation: Shell settlement measurement in accordance with API STD 653 (appendix B)	Not > 4,5 years	R	
Shell plumbness (verticality) and shell roundness	Not > 4,5 years	R	To be performed during first in-service inspection. Then, to be performed only in case of concern (settlement measurement not satisfactory, deformation on shell, etc.)
Acoustic Emission Acoustic Emission (AE) of tank floor to detect and locate any active corrosion, crack or leakage	Not > 9 years	G	AE may be part of the deferral conditions as per section 5.1.3.1
Major Internal Inspection			
External visual: as per Intermediate External Inspection	Base Case: Not > 10 years	R	

Plant integrity – Minimum inspection requirements

Rev.: 07

Effective date: 11/2019

Page: 43 of 141

Internal visual: as per check-list in API STD 653 (appendix C) or CODRES Division 2 or EEMUA Publication 159 As part of this check-list, check general condition of: • Access to tanks • Tank floor • Shell • Shell appurtenances, Manholes, Nozzles, Piping • Draining pipes • Tank roof including buoyancy spaces • Roof appurtenances, drains, etc.	Alternate Case: Not > 12 years subject to deferral conditions as per section 5.1.3.1	R	
Tank floor inspection: • Wall thickness measurement with MFL floor scan or equivalent for 100% of floor plates • Wall thickness UT scanning on areas of concern including the floor plates near the shell (50mm from the shell over the full circumference), draining wells/sumps and draining pipes. • Check for cracking on 100% of shell to floor weld (ACFM or equivalent) • Check for cracking on suspected floor plates welds such as bulges areas and plates under legs (ACFM or vacuum box or MPI/DPI) • Assess depletion of sacrificial anodes • Check internal coating by Holiday test (as applicable)	Base Case: Not > 10 years Alternate Case: Not > 12 years subject to deferral conditions as per section 5.1.3.1	R	
Tank floor settlement measurement Edge settlement measurement, Bottom depressions or bulges in accordance with API STD 653 (Appendix B)		R	
Overhaul of vacuum breakers, flame arrestors Overhaul of fire-fighting system, water drainage system Overhaul of roof seals (shell plumbness and roundness to be performed before roof seal replacement)		R	

Checklists for visual inspection (external and internal) are defined referring to the following codes: [API STD 653](#) (Appendix C) or [CODRES Division 2](#) or [EEMUA Publication 159](#).

5.1.1 Routine in-service surveillance

Routine in-service surveillance is under the responsibility of Operators.