

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 100

Submarine pipeline systems

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1. Scope

This General Specification is applicable to Submarine Pipeline Systems. Onshore Pipeline Systems, including river crossings, are covered by [GS EP PLR 104](#).

The elements of the Submarine Pipeline System covered by this General Specification are detailed in Section 4.2. This includes pipelines, spools and risers. In-line structures, dynamic risers and umbilicals are partly covered. Components integral to these elements are also considered.

The general principles of this document are applicable to all pipe technologies listed in Section 4.1. However, specific aspects of design focus on elements built of rigid steel pipe technologies described in Section 4.1.1. For elements built using other pipe technologies, reference is made to the appropriate General Specification (see Section 4.1.2).

This specification applies to systems conveying the following fluids: multiphase production effluent, crude oil, stabilised oil, commercial oil, raw gas, treated gas, CO₂, condensates (stabilised or not), injection water, treated water, methanol or glycol.

This General Specification is applicable in all project phases, including re-qualification and life extension.

Planning and documentation of the design of the Pipeline System is covered in [GS EP PLR 001](#).

2. Reference documents

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

Section 6.1 clarifies the conditions for the selection and use of the Prime References (**PR**) in conjunction with this General Specification.

All Prime References [ASME B31.4](#), [ASME B31.8](#), [DNVGL-ST-F101](#), [DNVGL-ST-F201](#), [ISO 13623](#), [API STD 2RD](#), and [API RP 1111](#) are identified with a (**PR**) mark-up in the following lists of External Documents.

Amendments to ASME/API, DNV and ISO are presented in Appendix 1, Appendix 2 and Appendix 3, respectively.

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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
2010-9414, 12TB6X5-10	Report DNV, Collberg, L. 2010 "Guideline on Design of Pipeline Systems with Over Pressure Protection System"
API RP 1111	(PR) Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)
API SPEC 17D	Specification for Subsea Wellhead and Christmas Tree Equipment
API STD 2RD	(PR) Dynamic Risers for Floating Production Systems
ASME B31.4	(PR) Pipeline Transportation Systems for Liquids and Slurries
ASME B31.8	(PR) Gas Transmission and Distribution Piping Systems
ASME BPVC Section VIII Div 2	ASME Boiler and Pressure Vessel Code (BPVC), Section VIII- Rules for Construction of Pressure Vessels - Division 2: Alternative Rules
DNV-2011-3167	Guideline for Design and Construction of Lined and Clad Pipelines
DNVGL-ST-F101	(PR) Submarine Pipeline Systems
DNVGL-ST-F201	(PR) Dynamic Risers
DNVGL-RP-C203	Fatigue design of offshore steel structures
DNVGL-RP-C205	Environmental Conditions and Environmental Loads
DNVGL-RP-F104	Design and Operation of Carbon Dioxide Pipelines
DNVGL-RP-F105	Free Spanning Pipelines
DNVGL-RP-F107	Risk Assessment of Pipeline Protection
DNVGL-RP-F109	On-Bottom Stability Design of Submarine Pipelines

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Reference	Title
DNVGL-RP-F110	Global Buckling of Submarine Pipelines Structural Design due to High Temperature/High Pressure
DNVGL-RP-F111	Interference between Trawl Gear and Pipelines
DNVGL-RP-F112	Design of Duplex Stainless Steel Subsea Equipment exposed to Cathodic Protection
DNVGL-RP-F113	Pipeline Subsea Repair
ICPC Recommendation No. 3	Criteria to be Applied to Proposed Crossings Between Submarine Telecommunications Cables and Pipelines/Power Cables (Issue 9A)
ISO 13623	(PR) Petroleum and natural gas industries - Pipeline transportation systems
ISO 13628 (Parts 1 to 11)	Petroleum and natural gas industries - Design and operation of subsea production systems - Parts 1 to 11
ISO 19901-2	Petroleum and natural gas industries - Specific requirements for offshores structures - Part 2: Seismic design procedures and criteria
ISO 21329	Petroleum and natural gas industries - Pipeline transportation systems - Test procedures for mechanical connectors
ISO/TS 12747	Petroleum and natural gas industries - Pipeline transportation systems - Recommended practice for pipeline life extension
MSS SP-44	Steel Pipeline Flanges
NORSOK L-005	Compact flanged connections
NORSOK U-009	Life extension for subsea systems
NORSOK Y-002	Life extension for transportation systems
OMAE2003-37376	Benefit of partly displacement controlled condition in sagbend
OTC 10711	Buckle arrestors for deepwater pipelines
PR 10-1161-SR04	SLARP JIP Slug Loading and Response - Design Guidelines

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Reference	Title
PRCI PR-178-01132	Submarine Pipeline On-Bottom Stability - Volume 1 - Analysis and Design Guidelines
SAFEBUCK JIP Phase III	SAFEBUCK JIP Phase III reports

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 102	Design of cathodic protection of submarine pipelines by galvanic anodes according to ISO 15589-2
GS EP COR 210	Monolithic insulating joints
GS EP COR 226	Materials for thermal insulation of pipeline, piping and subsea components
GS EP COR 227	Multi-Layer Glass Syntactic PP coating for wet thermal insulation of subsea pipes
GS EP COR 233	Risers coatings
GS EP COR 250	Friction-reduction internal coatings for pipelines transporting non-corrosive gases
GS EP ECP 103	Process Design Criteria
GS EP ECP 105	Process and Flow Assurance Deliverables to be Prepared by Contractor During Engineering Phases
GS EP ENV 001	Environmental Requirements for Projects Design and E&P activities
GS EP EXP 101	Pre-commissioning and Commissioning specification
GS EP EXP 103	Pre-commissioning and Commissioning engineering and preparation
GS EP EXP 105	Pre-commissioning Execution

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Reference	Title
GS EP EXP 311	Plant integrity - Minimum inspection requirements
GS EP GEO 101	Offshore Geotechnical Survey
GS EP GEO 201	Offshore Geophysical Site Investigation
GS EP GEO 202	ROV Survey Work for the Installation and/or the Inspection of Offshore Structures and Flowlines
GS EP GEO 601	Seismic Hazard Assessment for Offshore Structures
GS EP GEO 701	Geotechnical Design Considerations for Soil-Pipeline Interaction
GS EP GEO 702	Requirements for design and installation of skirted foundations and suction anchors
GS EP PLR 001	Documentation requirements
GS EP PLR 104	Onshore pipeline systems
GS EP PLR 109	Design, fabrication and testing of submarine unbonded flexible pipes and risers
GS EP PLR 110	Design, fabrication and testing of submarine bonded flexible pipes
GS EP PLR 151	Design of steel catenary riser systems
GS EP PLR 152	Hybrid Riser Systems
GS EP PLR 160	Design, fabrication and testing of Subsea Umbilicals
GS EP PLR 205	Carbon steel, pipe manufacturing for pipeline applications according to API SPEC 5L and DNVGL-ST-F101
GS EP PLR 207	CRA Clad or Lined Steel Pipe manufacturing for pipeline applications
GS EP PLR 208	Duplex and Super-Duplex Stainless Steel Pipe Manufacturing for Pipeline Applications
GS EP PLR 226	Fabrication of hot bends for pipelines

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Reference	Title
GS EP PLR 227	Carbon Steel Flanges, Branch Outlet Fittings and Forged Components for Pipelines
GS EP PLR 228	Carbon steel tees for pipelines
GS EP PLR 244	Fabrication of Duplex & Super-Duplex Stainless Steel Seamless Hot Bend for Pipeline
GS EP PLR 401	Installation of submarine pipelines
GS EP PLR 405	In-Service Welding and Hot-Tapping
GS EP PLR 410	Concrete Coating for Pipelines
GS EP PLR 425	Site welding of carbon steel pipelines (sweet and sour service, onshore and offshore) according to API STD 1104
GS EP PLR 426	Site welding of carbon steel and CRA pipelines (sweet and sour service, onshore and offshore) according to DNVGL-ST-F101
GS EP PLR 501	Hydrostatic testing of pipelines
GS EP PLR 502	Pre-commissioning of pipelines
GS EP PVV 154	Ball Valves according to API SPEC 6D or API SPEC 6A
GS EP SAF 041	Technological Risk Assessment Methodology
GS EP SAF 261	Emergency Shutdown and Emergency Depressurisation (ESD & EDP)
GS EP SAF 337	Passive Fire Protection: basis of design
GS EP SPS 001	Subsea Production Systems General Design Requirements
GS EP SPS 002	Design of Subsea Stations
GS EP SPS 004	Subsea Valves
GS EP SPS 006	Service Valves in Subsea Stations
GS EP SPS 007	Subsea Connection Systems

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Reference	Title
GS EP SPS 008	Thermal Insulation of Subsea Stations
GS EP SPS 009	Corrosion Protection of Subsea Stations
GS EP SPS 024	Subsea Valve Manual Actuators
GS EP SPS 025	Subsea Valve Actuators
GS EP SPS 029	Metallic Materials for Subsea Production Facilities
GS EP SPS 034	Well Jumper Design
GS EP SPS 038	Subsea Structures design & fabrication
GS EP STR 101	Design of offshore jacket and subsea structures
GS EP STR 402	Anchorage for support vessel on an offshore site

3. Definitions and abbreviations

3.1 Definitions

For the purpose of this General Specification, the following terms and definitions apply:

Design Means the design of **the Pipeline System** either of conceptual, pre-project, FEED, basic engineering, detailed engineering or construction nature.

Pipeline System Means a submarine line extending between one single entry point and one single delivery point; so that any other tied-in line shall be treated as another individual **Pipeline System**. Refer also to section 4.

Third Party Means a Certifying Authority, or a Classification Authority, or an independent Company in charge of any independent design review, appraisal, or analysis.

Battery Limits Means the extremities of **the Pipeline System** as specified by the Basis of Design (Refer to section 4.3).

Pipeline Component Means any permanent or temporary component incorporated into **the Pipeline System(s)** as necessary for its construction and operation. See list of components in section 12.

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General Specification Means any Company General Specification part of the E&P Technical Standards, of mandatory application on any new project.

Particular Specification Any particular specification based on Project requirements and on instructions, for the performance of the works. May also be referred to as job specification, or particular project specification or PPS.

Company Total E&P

Splash zone Zone between the crest level of the 100-year wave, superimposed on the maximum surge height, plus the normal Mean High Water Springs (MHWS), and 3 m below the Lowest Astronomical Tide (LAT) or the annual swell, whichever is the greater.

Spools Pipe sections that connect a FLET, a PLET, an ILT, an in-line WYE or a PLEM to another structure.

Riser base spools Pipe sections that connect the bottom assembly of a riser to the adjacent structure (FLET, PLET, PLEM, SSIV module or PLEM).

Clad Pipe Carbon steel pipe with metallurgically bonded CRA layer.

Lined Pipe Carbon steel pipe with mechanically bonded CRA liner.

3.2 Abbreviations

3D 3 dimensions; or bend which radius is 3 x OD

5D bend which radius is 5 x OD

AC Alternating Current

ALARP As Low As Reasonably Possible

APR Applicable Prime Reference(s)

BL Battery Limit

CRA Corrosion Resistant Alloy

CTZ Current Transfer Zone

DEH Direct Electrical Heating

E Young's modulus

EDP Emergency Depressurisation

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EPRS	Emergency Pipeline Repair System
ETH	Electrical Trace Heating
ESD	Emergency Shutdown
ESDV	Emergency Shutdown Valve
FEA	Finite Element Analysis
FLET	Flowline End Termination
FPSO	Floating Production Storage and Offloading vessel
HAT	Highest Astronomical Tide
HFW	High Frequency Welding
HIPPS	High Integrity Pressure Protection System
ID	Internal Diameter
ILT	In-Line Tee
IMR	Inspection, Maintenance, Repair
LAT	Lowest Astronomical Tide
LB	Lateral Buckling
LRFD	Load Resistance Factor Design
MOP	Maximum Operating Pressure
MoU	Memorandum of Understanding
MPFM	Multi-phase Flow Metre
ND	Nominal Diameter
OD	Outer Diameter
OCTG	Oil Country Tubular Goods
OOS	Out of Straightness
P&ID	Process and Instrumentation Diagram

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PFP	Passive Fire Protection
PIP	Pipe in Pipe
PLEM	Pipeline End Manifold
PLET	Pipeline End Termination
PPS	Particular Project Specification
PR	Prime reference
ROV/ROT	Remote Operated Vehicle/Tool
SCM	Subsea Control Module
SMYS	Specified Minimum Yield Stress
SOR	Statement Of Requirements
SRA	Structural Reliability Analysis
SSIV	Subsea Safety Isolation Valve
SURF	Subsea Umbilicals Risers Flowlines
UHB	Upheaval Buckling
VIV	Vortex Induced Vibration
WSD	Working Stress Design
WT	Wall Thickness

4. Pipeline System

4.1 Pipe Technologies

The following types of pipe technology or combinations thereof can be considered for the elements of the Pipeline System, subject to the limitations listed below.

Non-metallic pipes (other than those listed in Section 4.1.2) are not include in the scope of this General Specification.

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4.1.1 Rigid Steel Pipe Technologies

This includes the following types of pipe, subject to material selection limitations (see Section 6.3):

- Carbon steel rigid pipes
- Solid Corrosion Resistant Alloys pipes
- Carbon steel rigid pipe with mechanically lined CRA liner
- Carbon steel rigid pipe with metallurgically clad CRA layer.

These can be used either as:

- Single pipe system
- Part of a Pipe-in-Pipe system
- Part of a bundle of the piggybacked type
- Part of bundle with a carrier pipe.

Rigid steel pipe joints shall be joined by welding as per requirements in Section 13 and joining of individual pipes by flanges or threads is prohibited.

Joining of individual pipes by special mechanical couplings (such as “Zaplock” or similar) shall be subject to a derogation request.

4.1.2 Non-Rigid Pipe Technologies

This includes the following types of pipe:

- Unbonded flexible pipes
- Bonded flexible pipes.

Bonded flexible pipes shall be permitted only for mid-water lines as defined in Section 4.2.

Design of Pipeline System Elements containing unbonded flexible pipes shall comply with [GS EP PLR 109](#).

Design of Pipeline System Elements containing bonded flexible pipes shall comply with [GS EP PLR 110](#).

4.2 Pipeline System Elements

The following elements are considered as part of the Pipeline System and are covered by the requirements of this General Specification:

- Pipelines with terminations either subsea or at landfall points
- Spool and jumper
- Risers supported on fixed offshore structures

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- Risers supported on floating structures
- In-line subsea structures installed integrally with the pipeline, e.g. FLETs, PLETs, ILTs, SSIV, etc.
- Subsea umbilicals
- Mid-water lines: these are sections which are not borne by the seabed, such as lines used to convey fluids or power between floating supports, or to offload oil from a floating unit to an offloading terminal, or between a platform and a floating unit.

In addition to the general requirements within this General Specification, the followings shall be applied:

- Where applicable, jumpers satisfy the requirements of **GS EP SPS 034**.
- The design of risers supported on floating structures complies with a Prime Reference addressing dynamic risers and with **GS EP PLR 109**, **GS EP PLR 151** or **GS EP PLR 152**, depending on the pipe technology and riser configuration selected.
- The design of subsea umbilicals complies with the requirements of **GS EP PLR 160**.
- The design of mid-water lines complies with a Prime Reference addressing dynamic risers and with **GS EP PLR 109**, **GS EP PLR 110** or **GS EP PLR 151**, depending on the pipe technology selected.

4.3 Battery Limits and Interfaces

Battery limits define either a change in the applicable General Specification, e.g. PLR, SPS or PVV, or the extent of the section designed within a specified scope of work or work package.

Battery limits at either end of the Pipeline System (and within the Pipeline System where applicable) shall be specified in the Particular Project Specifications produced before the start of the Detailed Design.

These Project Particular Specifications shall also define the interface at each battery limit.

Battery limits shall not be located at tie-in welds.

The design of an interface shall not impair the safety or the functional requirements of the interfaced sections or facilities.

Analysis methods used to assess the conditions at or near interface locations shall encompass as much as necessary of the Pipeline System and of the interfaced facility to obtain a representative and reliable response of the section assessed.

By default, at the interface between the riser and the topsides facilities, the battery limit is located on the pipeline side of the connection to the Emergency Shut Down Valve (ESDV).

Code breaks may or may not coincide with Battery Limits. Details on how the location of code breaks is selected are presented in Section 5.3.

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4.4 Tie-ins

Tie-ins may be made using the following sealing devices: surface welds, hyperbaric welds, flanges, mechanical couplings, and subsea connectors (clamp-connector and collet-connector).

The selection of the possible tie-in methods shall be based on a life-cycle tie-in assessment study, addressing the safety and the economic issues, before the Basic Engineering, as per the following principles:

- Benefits and disadvantages of each proposed method are compared.
- Benefits and disadvantages of using the same tie-in methods as used in adjacent fields (standardization philosophy) are evaluated where applicable.
- Logistic issues (such as local content, time-schedule duration for intervention spread, additional safety concerns related with the intervention, etc.) are thoroughly addressed.

Tie-ins shall be designed:

- To not reduce the level of safety, reliability and efficiency of the Pipeline System or the host facilities.
- In compliance with the interface requirements set in section 5 and section 8.21.

At each end of the Pipeline System, or just before the inlet of an ancillary assembly (e.g. subsea manifold), there shall not be more than 3 (three) subsea connections of non-welded type in order to minimise the overall risk of leaking.

Non-welded tie-ins shall remain accessible to ROVs or divers for inspection or intervention.

All mechanical or thermal external protections shall be retrievable subsea.

5. Functional Requirements

5.1 Pipeline System

All the Elements of the Pipeline System shall be designed:

- To provide strength performance to avoid incidents leading to accidents and pollution throughout the service period.
- To provide safety integrity against failure throughout the service period, in order to perform its intended purpose and protect Company assets and obligations.
- To meet the Basis of Design (BOD) for their intended purpose.
- To be fabricated to minimise lifecycle costs.
- And qualified to for the service conditions expected during manufacture, transport, installation, pre-commissioning and the operating life.
- To convey the required fluids, maintaining all flow assurance and thermal management requirements, as identified in the Basis of Design. This extends to all components of the

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Pipeline System and includes provision of insulation for cold spots (doghouses for connectors, bulkheads, etc.), as applicable over and above pipework insulation.

- To allow all activities involved in pre-commissioning (such as pigging, testing, de-watering or drying) as per **GS EP PLR 502**.
- To allow for maintaining all aspects of performance, accessibility and maintainability over the specified design life accounting for the physical composition of transported fluids and entrained solids and how these may change over the life of field.
- To resist degradation from corrosion, erosion, wear, fatigue and interactions thereof.
- With corrosion control/protection to avoid corrosion-initiated failures, both internally and externally.
- Reduce as much as possible pressure drops along the Pipeline System. In particular, number of elbows, roughness, etc. are to be minimized.
- To be fully compatible with all other systems and their interference requirements, as well as field layout interfaces.
- To allow for required Inspection, Monitoring, Maintenance and Repairs.
- To allow for repairs to be performed in-place during the whole design life of the system where feasible.
- To ensure that at all stages of the installation and operation of subsea equipment, the sequence of operations are reversible.
- To ensure that mechanical strength of the all Elements of the Pipeline System are ensured at all stages, including, construction, transportation, installation and in-place.

All the equipments shall be designed:

- So that equipment and interface are standardised whenever possible.
- With due consideration to ease and speed the installation, operation and (where possible) use of standard tools.
- With the objective of achieving safe handling and operation through all stages of assembly and testing, transportation, installation, commissioning, operation and removal.

Field proven equipment and techniques shall be considered.

Before being proposed, newly developed technologies providing improved performance without compromising safety shall be supported by a detailed qualification and testing program subjected to Company review and approval.

The qualification schedule for new developed technologies shall not adversely affect the overall project schedule.

The ability to retrieve and/or replace critical components shall be documented.

Thermal performance shall be fully documented for Company approval.

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Additional requirements for some types of Pipeline System are detailed in the following sub-sections.

5.1.1 Production Pipeline Systems

Production Pipeline Systems shall comply with the following requirements:

- Avoid complex elevation profiles which may lead to flow assurance issues (i.e. slugging) where possible.

5.1.2 Electrically Heated Pipeline Systems

All electrically heated Pipeline Systems shall comply with the following requirements:

- The heating system is to be powered and monitored via a single dynamic power umbilical.
- The electrical system is to be instrumented such that faults in the system can be detected.
- In-line structures are to be heated through.

5.1.2.1 Heated Pipeline Systems - ETH PIP

Pipeline Systems with Electrical Trace Heating PIP shall comply with the following requirements:

- The temperature is monitored with fibre optic cable laid along the inner pipe.
- The Pipeline System inclusive of heating and monitoring systems is repairable during installation campaign between water stops.
- The system has the following minimum redundancy level:
 - 4 x 100% for the electrical heating system by considering the designing scenario from the PPS (preservation and/or cold restart or warm-up): this means 4-off independent set of electrical cables / lines sized for 100% design conditions for all sub-systems (junction boxes, topside terminations, umbilical and UTA, flying leads, distribution boxes, connections from UTA, ILT and FLET, etc.).
 - 100% for fibre optic temperature monitoring system.

5.1.2.2 Heated pipelines – DEH

Pipeline Systems with Direct Electrical Heating shall comply with the following requirements:

- At each electrical connection, i.e. each end of the pipeline, banks of anode are installed along the section of pipeline to ensure that the current is distributed between pipe and seawater such that the system is in equilibrium.
- The current transfer zone section between the termination plate and pipeline end is not heated and is chemically inhibited during shutdown.
- The CTZ is maintained above the seabed throughout the project design life.

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- The Pipeline System inclusive of heating and monitoring system is repairable, with provision available on the cable termination plate (and other DEH components welded onto the pipeline) for retrofitting of the piggy back cable in case of repair/recovery.

5.1.3 Brownfield Pipeline Systems

Pipeline Systems in brownfields shall comply with the following requirements:

- Tie-ins to existing systems do not compromise the operability of the existing field, including ability to flush, preserve, pig and all IMR activities.
- Design of new Pipeline Systems minimises impact on existing assets.
- Spool design is compliant with existing facilities (loads, material selection, CP, fatigue limitation, displacement, etc.) and no mitigation measures are implemented on existing structures.
- Demonstrate with relevant studies that integrity of existing structures is not affected by the modifications due to brownfield.

5.2 Pipeline

5.2.1 Dry Gas Export Pipelines

Dry gas export pipelines shall be internal coated, unless the following requirements can be ensured otherwise:

- Minimize the corrosion/deposits during storage and therefore the amount of corrosion products in the pipeline.
- Improve the performance of the dewatering/drying process.
- Limit the quantity of debris left in the pipeline in operation, which impact intelligent pig run, may damage the in-line valves and interfere with Operations.

5.3 Risers

For static risers attached to platform, the following specific functional requirements shall be applied, in addition to those listed in Section 5.1:

- The riser design allows connection / disconnection to the riser base and topside spool piece.

For dynamic risers, reference shall be made to [GS EP PLR 109](#), [GS EP PLR 151](#) and [GS EP PLR 152](#).

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5.4 Spools and Jumpers

The following specific functional requirements shall be satisfied, in addition to those listed in Section 5.1:

- Accommodate the flowline expansion, the displacements and settlements of the adjacent structures and the misalignment tolerances
- Allow connection / disconnection to the adjacent structures
- Allow an easy lifting in air and in water
- Clashing with surrounding structures (including during installation and testing phases) is not allowed
- Spools are retrievable
- Optimize layout to limit risks associated with installation and retrieval sequences to an ALARP level
- Define flow assurance thermal management requirements for the spool.

For jumpers, in addition to functional requirements listed in Section 5.1, reference shall be made to **GS EP SPS 034**.

5.5 In-line Structures

For in-line structures, the following specific functional requirements shall be satisfied, in addition to those listed in Section 5.1:

- In-line structures are designed with a mudmat or a foundation fixed with regards to the seabed and a guiding system, with the objective of allowing smooth and controlled pipeline axial displacements and preventing rotation and lateral displacements.
- All in-line structures are fitted with a longitudinal displacement monitoring device (refer to section 8.11) allowing measurement of current displacement / position at the time of a survey and record of extreme displacements.
- For end structures, allow initiation or abandonment of the pipeline.
- For in-line structures, allow in-line installation with the pipeline.
- Allow connection / disconnection to the spool or jumper.
- Accommodate pipeline expansion / axial movement.
- Comply with all SPS requirements (**GS EP SPS 001, GS EP SPS 002, GS EP SPS 009, GS EP SPS 038**).
- Integrate, support and protect the valves.
- Integrate, support and protect chemical injections, control and instrumentation functionality when required.
- Be as compact and light as possible not to affect pipeline integrity during installation.
- Provide connection to pig launcher / receiver when necessary for pigging operations.

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- Allow transfers of loads to the soil.
- Have a sufficient net weight in water.
- Have a sufficient bearing capacity to be parallel to the seabed and remain above the mudline.
- Minimize dead-legs and demonstrate by CFD that no hydrate formation is possible.
- All fittings (in particular hydraulic, electrical, optical stab coupler parts, male or female) are protected from particle contamination or damage during storage, testing, transportation, installation, operation. Subsea protector are installable and removable subsea. Electrical and optical cabling are routed, secured and protected by use of cable trays.
- Where possible, the FLETs/ILTs are modularized in such a way that components vital to integrity and efficient performance can be disconnected, replaced and tested either as part of a module or as individual components to avoid structure retrieval. Possible replacement of connection segments that could be damaged during installation, pre-commissioning or operation is to be maximized.
- Whenever FLETs/ILTs are fitted with foldable mudmats, means for locking down the mudmat wings are to be provided. The locking system may be automatic or ROV activated. However, it is to be fitted with an ROV operated unlock system and means to fold and secure the mudmat wings.

6. Design Code

6.1 Applicable Prime Reference (APR)

The Applicable Prime Reference should be specified in the SOR / Design Basis.

If the APR is not specified in the SOR / Design Basis, the Design shall begin with a detailed comparison, specific to the Pipeline System considered, of all the relevant Prime References.

From the findings of this comparison, the APR shall be recommended for Company approval.

Where possible, the same APR shall be selected for all the elements of the Pipeline System, including pipeline, risers and spools.

When the complexity of the Pipeline System requires more than one APR, any potential conflict shall be identified and resolved with Company approval at the earliest stages of the Design.

Details on the location of code breaks are presented in Section 5.3.

Partial use of other PR(s) is allowed when the APR is silent on specific matters and upon approval from Company. Any potential conflict between PR(s) or between PR(s) and this General Specification (including amendments to PRs in the Appendices) shall be identified and resolved with Company approval at the earliest stages of the Design.

If the Pipeline System is an extension to an existing network which has been designed under a PR that no longer exists or that has undergone modifications, the selection process for the APR

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shall aim at an As Low As Reasonably Practicable (ALARP) set of modifications on the interfaced facilities and be documented highlighting the consequences of using a different APR. Requalification of the existing network, if required, to be addressed as per section 17.

[DNVGL-ST-F101](#) is the recommended APR for Pipeline System rigid pipeline sections with parts in water depths over 150 m.

[DNVGL-ST-F101](#) shall be the APR for Pipeline Systems made of spiral welded pipes.

When [ASME B31.8](#) is the APR for the gas or multiphase production lines, [ASME B31.4](#) shall be the APR for rigid pipelines transporting liquid hydrocarbons or other liquids.

Amendments to the PR(s) are detailed in Appendix 2, Appendix 3 and Appendix 4. These amendments shall be used in conjunction with the present General Specification.

Material and Construction Specifications and Prime References shall be consistent with the selected Design APR.

6.2 Design Format

Where allowed by the APR, the design may follow a Working Stress Design approach, a Load Resistance Factor Design approach or a Structural Reliability Analysis approach.

The choice between WSD and LRFD shall be supported by a comparison study done at the earliest phases of the Design and be subject to Company approval.

The use of a SRA approach shall comply with the requirements of [DNVGL-ST-F101](#) (Section 2.3.5 in December 2017 Edition) and shall be subject to Company approval.

Material and construction specifications shall be consistent with the selected design methodology.

6.3 Code Breaks

Code breaks may be required within or at the ends of the Pipeline System due to the range of applicability of the APR or the General Specification.

The selection and application of the code breaks shall take the following into account:

- The code break is not located within a tie-in weld (as illustrated in Figure 2).
- When a transition piece is required at the code break location as illustrated in Figure 2, it satisfies the requirements of both APRs.
- The requirements of [GS EP SPS 007](#) on the code break location between pipeline and SPS elements is adopted.
- The girth weld adjacent to the code break satisfies the fatigue requirements of both APRs considering the load case matrix provided by pipeline engineering.

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- Main lines within in-line subsea structures (installed integrally with the pipeline) - such as FLETs, PLETs, ILTs, SSIV – comply with the APR for the pipeline.
- All aspects of subsea structures not installed integrally with the pipeline are addressed by **GS EP SPS 002**.
- For branched connections, lines with an ND lower than 6" are designed to the piping code (see Figure 1 (c)).
- Fittings with a ND between 2 and 6" are designed with a Piping Prime Reference.
- Fittings with a ND of 6" or higher, can be designed either with the Pipeline System APR, or with a Piping Prime Reference.
- When a Piping Prime Reference is selected for the fitting, the branch wall thickness complies with both piping code requirements and Pipeline System APR requirements.

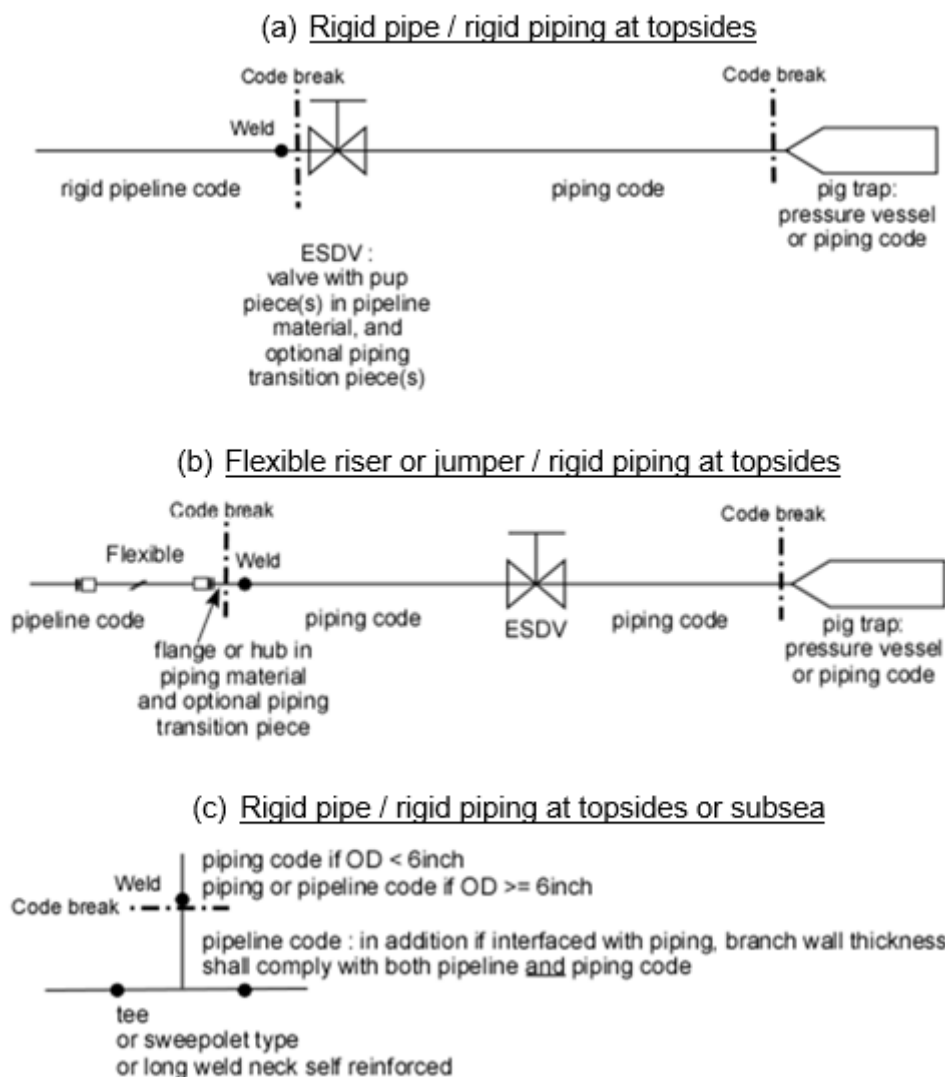
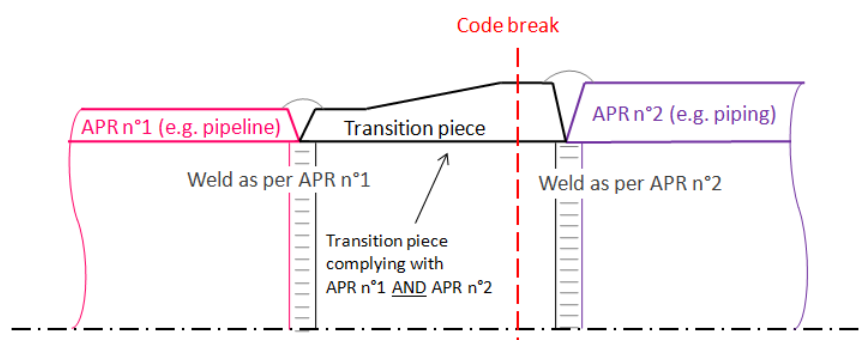
The code break between the Pipeline System and the structures not installed integrally with pipeline shall be defined in the PPS, taking into account the wall thickness transition arrangement.

All code break locations shall be clearly detailed in the Design Basis for Company approval.

Code break locations are shown in Figure 1.

Depending on the APR, slug catchers can be either treated under a pressure vessel Prime Reference, a piping Prime Reference, or a pipeline Prime Reference.

At all locations along the Pipeline System, Material, Construction and Design Specifications and Prime References shall be consistent, regardless of where code break locations are placed.

Figure 1 - Code Break Locations

Figure 2 - Typical Code Break with a transition piece


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7. Basis of Design

The Basis of Design shall present all the input data used in the design of the Pipeline System.

Additional working assumptions identified during the design process shall be added to the Basis of Design and approved by Company before use.

As a minimum, data on the following aspects shall be presented in the Basis of Design:

- Pipeline diameters
- Fluids conveyed
- Corrosion and material selection
- Process and flow assurance data
- Field operations data
- Geophysical data
- Existing and future facilities data
- Geotechnical data
- Seismic and geohazard data
- Metocean data
- Interface data
- Third party interaction data.

Further details on the data required are presented in the following sections.

The format and the organisation of the design data shall comply with the requirements and principles stated in **GS EP PLR 001**.

7.1 Pipeline Diameter

The pipeline diameter shall be specified for each Pipeline System as either a constant internal diameter or a constant outer diameter.

The selection of a constant ID or a constant OD system shall involve a life-cycle technical and economic assessment addressing, as a minimum, the following issues:

- Availability of linepipe of non-standard outer diameter if constant ID is considered taking into account the construction phase but also potential future repairs.
- Pigging operations when the Pipeline System has a constant OD and includes sections with different IDs. This includes the passage of the pigs through the Pipeline System and their effectiveness in performing the required tasks (i.e. cleaning, gauging, inspection or operational pigging) in accordance with the relevant specification.

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The recommendation of constant ID or constant OD shall be presented for Company approval at pre-project stage and documented in the SOR.

7.2 Fluids conveyed

This shall detail the conveyed fluid type and composition including in particular CO₂ and H₂S.

7.3 Corrosion and Material Selection

The material selection shall be specified according to the relevant Company specifications under the responsibility of the corrosion engineer in Headquarters Corrosion Entity.

In particular, the following shall be gathered into the Basis of Design:

- The corrosion and erosion allowances
- The service condition (sour severity 0, 1, 2 or 3)
- The material selection along the Pipeline System
- The inspection requirements

7.4 Process and Flow Assurance Data

7.4.1 General

7.4.1.1 Pressure Interfaces

When more than one APR is used for the Pipeline System, when the Pipeline System interfaces with sections designed with other Prime References or with superseded revisions of the APR, a Memorandum of Understanding (MoU) detailing how the different pressures are defined and interfaced to achieve a consistent design approach shall be produced for Company approval.

The approved MoU shall be part of the Basis of Design.

7.4.1.2 Pressure Reference Level

All pressure values shall be referenced to a defined reference level (which may be different from the Pipeline System inlet) and consistently used in the project.

Use of either absolute or gauge pressure units is acceptable, provided the method used throughout the Design is clearly identified.

7.4.2 Process / Flow Assurance Data

As a minimum, the following Process / Flow Assurance data shall be presented in the Basis of Design:

- Definition of all modes and conditions of operation, including but not limited to, normal operating, turndown, slugging, packing, pigging, start-up, shut-down, restart, preservation

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sequence, depressurisation, cooling/heating of trapped liquid, etc. including the identification of the pressure source for each scenario.

- Design pressure and, when [DNVGL-ST-F101](#) is the APR, incidental pressure.
- Minimum and maximum design temperatures.
- Minimum and maximum contents densities.
- The design pressure, temperature and contents density profiles as follows:
 - Design temperature profile & associated pressure and contents density profiles
 - Design (or incidental when [DNVGL-ST-F101](#) is the APR) pressure profile & associated temperature and contents density profiles.
- Steady state pressure, temperature and contents density profiles for all relevant operating conditions, including but not limited to maximum and normal operating.
- Transient pressure, temperature and contents density profiles for all relevant transient conditions, including but not limited to, shutdown (short and long), preservation, hot oiling or dead oil circulation, cooldown and restart.
- Definition of slugging conditions along Pipeline System.
- Pipeline System preservation strategy.
- Constraints on pipeline bathymetry associated to flow assurance, e.g. avoidance of low points.
- Thermal performance requirements:
 - U-value to maintain minimum arrival temperature
 - Cool down times to allow preservation of the Pipeline System.
- Pipeline heating requirements.
- Need for riser activation system.
- P&ID and PFD for any in-line subsea structure and topsides.

Transient profiles shall capture the steepest temperature transients.

The transient steps shall be such that an intermediate transient can be interpolated between two consecutive transients with reasonable accuracy. A minimum of seven (7) transients is required for each transient phase.

Thermal performance requirements shall include the required averaged values but also the values at specific locations which require insulation such as but not limited to structures (FLET & ILT), spools or where cold spots or water condensation are not allowed.

Reference is made to [GS EP ECP 105](#) for details on how the above parameters are defined and determined.

The requirements of [GS EP ECP 105](#) on the flow assurance deliverables shall also be satisfied.

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7.5 Field Operations

As a minimum, the following Field Operations data shall be presented in the Basis of Design:

- Pigging philosophy, including need for operational pigging
- Operating cycles expected during the design life of the Pipeline System.

Unless otherwise stated in the PPS, the operating cycles in Table 1 shall be presented for Company approval.

Table 1 - Operating Cycles (in absence of detailed data)

Type of Pipeline	Number of Cycles	Cycle Conditions
Production and service	Twelve (12) full shutdown cycles per year over the entire design life	Range between normal operating temperature and pressure and ambient seabed temperature and atmospheric pressure at topsides reference elevation.
Water injection	Fifty-two (52) full shutdown cycles per year over the entire design life	Range between normal operating temperature and pressure and ambient seabed temperature and atmospheric pressure at topsides reference elevation.
Gas export and Gas injection	One (1) full shutdown cycle over the entire design life	Range between normal operating temperature and pressure and ambient seabed temperature and atmospheric pressure at topsides reference elevation.
	Fifty-two (52) partial shutdown cycles per year over the entire design life	Starting from normal operating temperature and pressure, pressure variation of 0.25 x MOP and no change in temperature.

7.6 Geophysical Data

A geophysical survey performed in accordance with **GS EP GEO 201** shall be available no later than the start of FEED or Basic engineering studies and the survey reports be cross-referenced in the Basis of Design.

When a shore-pulling method is envisioned the site surveys shall also cover the onshore areas concerned.

The bathymetric profile of the Pipeline System shall be specified and consistently defined relative to the selected reference elevation, with positive values above reference elevation.