



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 100

Submarine pipeline systems

07	01/2011	General review
06	10/2009	General review - lateral buckling assessment methodology
05	10/2008	General review
04	10/2007	Detailed engineering for new use of existing pipeline, subsea flanges
00	10/2002	First issue
Rev.	Date	Notes

Owner: EP/TDO/TEC

Managing entity: EP/TDO/TEC/PLR



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1. Scope

This General Specification is applicable to pre-project engineering, basic engineering, and construction engineering of the Submarine Pipeline Systems.

It can also be used for a re-qualification project as defined in Section 33.

The Submarine Pipeline System(s) are further on referred as the System(s) - see definition contained in Section 3.1.

2. Reference documents

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

Prime References

The Prime References are those of the reference documents which are addressing the entire scope of the System design.

Section 9 clarifies the conditions for the selection and use of the Prime References in conjunction with this General Specification.

All Prime References [ASME B31.4](#), [ASME B31.8](#), [DNV-OS-F101](#), [DNV-OS-F201](#), [ISO 13623](#), [ISO 16708](#), [API RP 2RD](#), and [API RP 1111](#) are identified with a **(PR)** mark-up in the following lists of the reference documents:

Standards

Reference	Title
API SPEC 6A	Specification for Wellhead and Christmas tree equipment
ASME B16.5	Steel pipe flanges and flanged fittings
ASME B16.20	Metallic Gaskets for Pipe Flanges
ASME B31.3	Process Piping-Includes Interpretation 21
ASME B31.4	(PR) Pipeline transportation systems for liquid hydrocarbons and other liquids
ASME B31.8	(PR) Gas transmission and distribution piping systems
ASME BPVC Section III	Boiler & Pressure Vessel Code - Rules for Construction of Nuclear Facility components
ASME BPVC Section VIII	Boiler & Pressure Vessel Code - Rules For Construction of Pressure Vessels
DNV-OS-F101	(PR) Offshore Standard - Submarine pipeline systems
DNV-OS-F201	(PR) Offshore Standard - Dynamic risers
ISO 13623	(PR) Petroleum and natural gas industries - pipeline transportation systems



Reference	Title
ISO 13628-1 to 11	Petroleum and Natural Gas Industries - Design and operation of subsea production systems - Part 1: General requirements and recommendation
ISO 16708	(PR) Petroleum and natural gas industries - pipelines transportation systems - reliability based state methods
NORSOK L-005	Compact flanged connections

Professional Documents

Reference	Title
API RP 2RD	(PR) Design of risers for floating production systems (FPSs) and Tension-Leg Platforms (TLPs)
API RP 1111	(PR) Design, construction, operation and maintenance of offshore hydrocarbon pipelines (limit state design)
DNV-RP-C203	Fatigue design of offshore steel structures
DNV-RP-F104	Mechanical pipeline couplings
DNV-RP-F105	Free spanning pipelines
DNV-RP-F107	Risk assessment of pipeline protection
DNV-RP-F109	On Bottom Stability Design of submarine pipelines
DNV-RP-F110	Global Buckling of Submarine Pipelines
DNV-RP-F111	Interference between Trawl Gear and Pipelines
DNV-RP-F203	Riser Interference
DNV-RP-F204	Riser fatigue
DNV-RP-F206	Riser Integrity Management
DNV-RP-J202	Design and Operation of CO ₂ Pipelines
ICPC - no. 3 - issue 7	Criteria to be Applied to Proposed Crossings Between Submarine Telecommunications Cables and Pipelines/Power Cables
InSpec JIP 1.1.4.140 / RP01	Recommended Practice for Insulation and Buoyancy Systems - rev 1 - July 2002
InSpec JIP 1.1.4.140 / SP01	Specification for Insulation and Buoyancy Materials - rev 3 - October 2002
PRCI PR-178-01132	Submarine Pipeline On-Bottom Stability - Volume 1 - Analysis and Design Guidelines



Regulations

Where Local (national, international) regulations and rules exist, their provisions and those of the standards and codes to which they refer shall have precedence over the prescriptions of this General Specification.

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
-/-	A treatise on the mathematical theory of elasticity, A. E. H. Love
OTC 5851	Forces on Sheltered Pipelines
-/-	SAFEBUCK JIP reports

Total General Specifications

Organisation and documentation systems to be put in place for the Design are separately covered in **GS EP PLR 002** and **GS EP PLR 001** respectively.

Reference	Title
GS EP COR 230	External laminated glass fibre/resin based coating for risers of sea line
GS EP COR 231	External elastomer based coating for risers of sea line
GS EP COR 250	Friction-reduction internal coatings for pipelines transporting non-corrosive gases
GS EP ECP 103	Process sizing criteria
GS EP EXP 101	Precommissioning and commissioning specification
GS EP EXP 103	Precommissioning and commissioning technical preparation
GS EP EXP 105	Precommissioning execution
GS EP EXP 311	Plant integrity - Minimum inspection requirements
GS EP GEO 701	Geotechnical data and foundation design considerations for subsea production systems and pipelines
GS EP PLR 001	Documentation requirements



Reference	Title
GS EP PLR 002	Organisation of the design works
GS EP PLR 102	Design of submarine pipelines as per API RP 1111 and ASME B31.4/31.8
GS EP PLR 103	Design of submarine pipelines as per DNV-OS-F101
GS EP PLR 105	Design of submarine pipelines as per ISO 13623
GS EP PLR 107	Design and construction of pipelines in swamp and marsh areas
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 for deepwater terminals
GS EP PLR 111	Submarine bundles
GS EP PLR 151	Design of steel catenary riser system
GS EP PLR 201	Fabrication of seamless pipes for pipelines (sweet service)
GS EP PLR 202	Fabrication of longitudinally submerged arc welded pipes for pipelines (sweet service)
GS EP PLR 211	Fabrication of seamless pipes for pipelines (mild, intermediate and severe sour service)
GS EP PLR 212	Fabrication of longitudinally submerged arc welded pipes for pipelines (mild, intermediate and severe sour service)
GS EP PLR 222	Carbon steel flanges and branch outlet fittings and forged components for pipelines (sweet service)
GS EP PLR 223	Carbon steel tees for pipelines (sweet service)
GS EP PLR 232	Carbon steel flanges and branch outlet fittings and forged components for pipelines (mild, intermediate and severe sour service)
GS EP PLR 233	Carbon steel tees for pipelines (mild, intermediate and severe sour service)
GS EP PLR 401	Installation of submarine pipelines
GS EP PLR 420	Site welding of carbon steel pipelines to API 1104 (sweet service)
GS EP PLR 421	Site welding of carbon steel pipelines to API 1104 (mild, intermediate and severe sour service)
GS EP PLR 501	Hydrostatic testing of pipelines
GS EP PLR 502	Precommissioning of gas pipelines
GS EP PVV 142	Valves
GS EP SAF 261	Emergency Shut-Down and Emergency De-Pressurisation (ESD & EDP)



Reference	Title
GS EP SAF 337	Passive Fire Protection: Basis of design
GS EP SPS 001	Design philosophy and requirements for Subsea Stations
GS EP SPS 002	Design of subsea structures
GS EP SPS 005	Subsea ball valves
GS EP STR 101	Design of offshore jacket and subsea structures
GS EP STR 201	Materials for offshore steel structures
GS EP STR 301	Fabrication of offshore steel structures
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures
GS EP STR 402	Anchorage for support vessel on an offshore site
GS EP STR 404	Marine aspects for load-out, transportation and installation of offshore structures

3. Definitions and abbreviations

3.1 Definitions

Design	Means the design of the System either of conceptual, pre-project, FEED, or detailed nature.
System	Means a submarine pipeline system comprised between one single entry point and one single delivery point; so that any other tied in pipeline shall be treated as another individual System . Refer also to Section 4.
Alternative(s)	Means any alternative(s) that can be proposed in the frame of the Design , and which have been clearly identified as open in the course of this General Specification. Refer to Section 9 for specific requirements.
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 System as specified by the Basis of Design (Refer to Section 8).
Component	Means any permanent or temporary component incorporated into the System(s) as necessary for its construction and operation. See list of components in Section 3.2.
General Specification	Means any Company DGEP General Specification part of the DGEP Referential, 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 be also referred to as job specification or particular project specification.
Company	Means Total SA.
Splash zone	Zone between the crest level of the 100 years 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.

3.2 Abbreviations

ALARP	As Low As Reasonably Possible
APR	Applicable Prime Reference(s)
BL	Battery Limit
CBA	Cost Benefit Analysis
D	Outer Diameter
DCS	Distributed Control System
DP	Design Pressure
E	Young's modulus
EAF	Effective Axial Force
ESDV	Emergency Shut Down Valve
FPU	Floating Production Unit
HAT	Highest Astronomical Tide
HAZID	Hazard Identification
HIPPS	High Integrity Pressure Protection System
ICAF	Implied Costs of Averting a Fatality
ID	Internal Diameter
ILT	In-Line Tee
IR&M	Inspection, Repair, & Maintenance
IRPA	Individual Risk Per Annum
LAT	Lowest Astronomical Tide
LRFD	Load Resistance Factor Design
MOP	Maximum Operating Pressure
MATIS	Modular Advanced Tie-In System
MoU	Memorandum of Understanding
MPI	Magnetic Particle Inspection
OD	Outer Diameter

OCTG	Oil Country Tubular Goods
PFP	Passive Fire Protection
PLEM	Pipeline End Manifold
PLET	Pipeline End Termination
PLL	Potential Loss of Life
PPS	Particular Project Specification
PSS	Pressure Safety System
QRA	Quantified Risk Analysis
ROV/ROT	Remote Operated Vehicle/Tool
SCADA	Supervisory Control And Data Acquisition
SLOR	Single Line Offset Riser
SMYS	Specified Minimum Yield Stress
SOR	Statement Of Requirements
SRA	Structural Reliability Analysis
SSIV	Subsea Safety Isolation Valve
UHB/LB	Up Heaval Buckling and/or Lateral Buckling
VIV	Vortex Induced Vibration
WSD	Working Stress Design
WT	Wall Thickness

4. The System

4.1 Scope

The System shall consist of a submarine pipeline with a single entry point and a single delivery point. Any other tied-in pipeline shall be considered as an individual System which also has a single entry and single delivery point.

Appendix 1 provides an overview of the main typical System configurations in the frame of this General Specification.

Design of river crossings is not addressed by **GS EP PLR 100**.

Design of pipelines in swamp and marsh areas is specifically addressed by **GS EP PLR 107**.

Specific design of safety systems such as High Integrity Pressure Protection System (HIPPS), Distributed Control System (DCS), and Supervisory Control And Data Acquisition (SCADA) is not covered by **GS EP PLR 100**.

4.2 Conveyed fluids

Conveyed fluids shall only be either: crude oil, stabilised oil, commercial oil, rough gas, treated gas, condensate (stabilised or not), injection water, treated water, methanol, or glycol. Where



conveyed fluids are overwhelmingly CO₂, recommended practice [DNV-RP-J202](#) shall be applied and used in conjunction with the APR.

4.3 Main assemblies

The System shall be primarily composed of steel pipe (see Section 26) or of non-bonded flexible pipe or any combination thereof.

Steel pipe segments shall be formed by girth weld assembly of individual pipes. Joining of individual pipes by:

- Special mechanical couplings ("Zaplock" or similar) shall be treated as a critical Alternative
- Flanges or threads shall be treated as fully prohibited (use of new or second-hand OCTG tubings).

Combination of steel pipe and flexible pipe segments shall be limited to pipeline-riser interfaces and branches to subsea host facilities

Flexible pipe segments shall be:

- Designed in compliance with the [GS EP PLR 109](#)
- Continuous unless there is a change in the cross-section design (i.e. a riser to pipeline transition) or if the whole length cannot be fabricated or transported in a single continuous segment.

For corrosion resistant alloy metals other than steel incorporated into or fully making the tubulars of the System the limitations outlined in Section 26 shall be observed.

4.4 Bundles

Bundles shall be designed in compliance with the [GS EP PLR 111](#) and the individual pipelines being part of a bundle shall be individually designed in compliance with this General Specification.

Other lines entering the structure of a bundle shall be individually designed in compliance with the relevant Company General Specifications.

4.5 Mid-water lines

Mid-water lines are those which are not bearing onto the seabed such as those lines in use to convey fluids or power between floating supports.

Currently, there are no professional documents, standards, codes, or Company General Specifications directly addressing these highly dynamic systems; therefore, relevant information shall be obtained from:

- [GS EP PLR 109](#) for unbonded flexible lines
- [GS EP PLR 110](#) for bonded flexible lines
- Or [GS EP PLR 151](#) for steel lines.

Until such documents are available, the design requirements and analysis methods utilised shall be derived from those of the Prime References which are addressing dynamic risers.

4.6 Other components

In addition to steel line pipes, the following components are incorporated to form a complete submarine pipeline system:

- Aerial and subsea valves of any type
- Anodes (bracelets, bulks)
- Blind flanges
- Bulkheads (temporary or permanent)
- External concrete weight coating
- External corrosion coating
- External thermal insulation coating
- Flanged connectors (swivel or not)
- Flexible joints
- Installation aids (temporary or permanent)
- Insulating joints
- Internal cladding, lining or coating (corrosion, flow drag reduction)
- Mechanical connectors
- Rigid or flexible jumpers and spools
- Mechanical protectors (temporary or permanent)
- Monitoring devices (temporary or permanent)
- Pig traps
- Piggy back straps
- Pipeline end manifolds (PLEM) and terminations (PLET), in-line tee (ILT)
- Riser clamps (fixed or guided)
- ROV/ROT aids (temporary or permanent)
- Slug catchers
- Stabilising mattresses (anti-scour)
- Mechanical protection devices
- Stress joints, tapered joints
- Supports (temporary or permanent)
- Tapping, tees, and wyes
- VIV suppression devices.

Subsea pipeline systems incorporate subsea components which are most often covered by the [ISO 13628 - parts 1 to 11](#) and as such:

- Design principles shall comply with [GS EP SPS 001](#) requirements when the System is interfaced with any subsea production systems
- Compliance with these references shall also be considered for components that are incorporated into the System (i.e. in-line subsea valves, subsea connector hubs).

5. Battery Limits and interfaces

5.1 Scope

The Battery Limits (BLs) of the System shall consist of the tie-in point to the host facilities at either ends of the pipeline and these tie-in points shall be treated as Interfaces in compliance with Section 5.2.

By default, the BL is located on the pipeline side of the connection to the Emergency Shut Down Valve (ESDV).

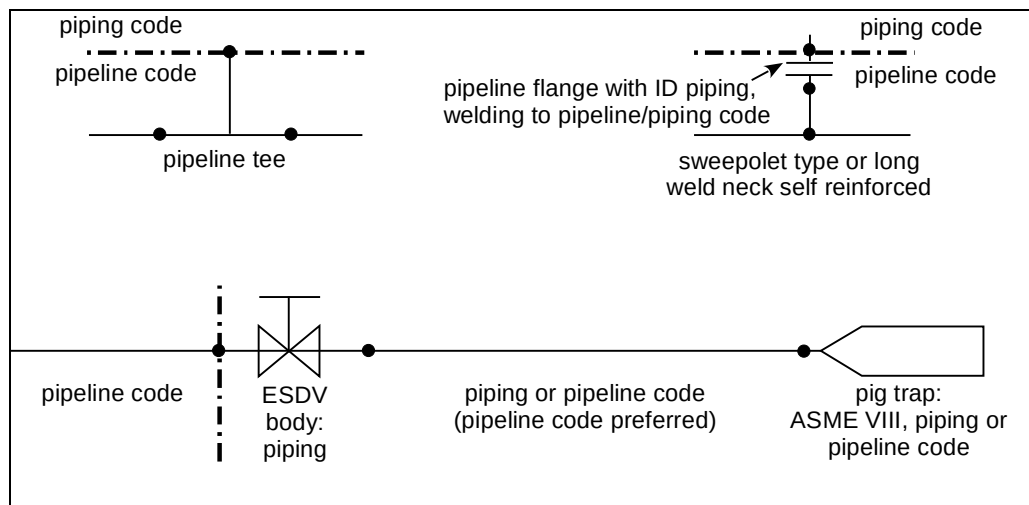


Figure 1 - Typical Battery Limits for topside

In addition:

- The branch between the ESDV and the pig launcher or receiver shall be preferably part of the System
- Depending on the APR, slug catchers and pig traps can be either treated under a pressure vessel Prime Reference, a piping Prime Reference, or a pipeline Prime Reference
- ESDV tie-in method is defined in **GS EP SAF 261**
- Piping code shall be understood as **ASME B31.3**
- In case of a welded tie-in, the battery limit shall be located in the forged branch; i.e. the branch inside diameter and wall thickness shall meet piping code requirements. This option shall be detailed in a Particular Project Specification (PPS)
- Main lines inside subsea structures - such as subsea manifolds, Flowlines and Pipeline End Terminations (FLETs and PLETs), In-Line Tees (ILTs), Pipeline End Manifolds (PLEMs) - shall comply with the System's selected APR, and in conformity with **GS EP SPS 002**.

5.2 Major requirements

Interfaces shall be identified at the commencement of the Design and then thoroughly resolved in a timely manner.

Analysis methods shall encompass as much as necessary of the System and of the interfaced facility to obtain a representative and reliable model for both involved parties.

Main interfaces are at the BL of the System.

Additional interfaces shall be created wherever there is a significant disruption in the design requirements, especially at design code break points such as pipeline/piping, pipeline/riser, offshore/onshore.

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



The envelopes of the acceptable design parameters of the interfaced systems, sub-systems, components shall be part of the Basis of Design (see Section 8).

The interaction analysis shall be fully documented with an outline of the safety margins with respect to the APRs of both interfaced systems.

6. Organisation of the Design

The organisation of the Design shall as a minimum conform to the [GS EP PLR 002](#).

7. Deliverables

The documentation to be produced in the frame of the Design shall as a minimum comply with the [GS EP PLR 001](#).

The main input and output design data shall be reported in a follow-up datasheet - refer to [GS EP PLR 001](#).

8. Basis of Design

The format and the organisation of the design data shall comply with the requirements and principles stated in Appendix 2 and in the [GS EP PLR 001](#).

The available design data shall be sufficient and consistent for the Design with the respective uncertainty levels of the data consistent for the required level of accuracy in the Design.

Additional working hypotheses shall be implemented and approved before any application. As such, interpolation and extrapolation methods addressing the use of the design data shall be treated as Alternatives.

9. Applicable Prime Reference (APR)

If the APR is not defined in the Scope of Requirements / Design Basis, the Design shall start with the recommendation for the APR, which shall result from a sound comparison study of the various relevant Prime References. This is outlined in Section 11.7 Design roadmap.

[DNV-OS-F101](#) is the recommended APR for Systems including parts in water depths deeper than 150 m.

When [ASME B31.8](#) is the APR for the production lines, [ASME B31.4](#) shall be the APR for water injection rigid pipelines.

When the complexity of the System requires more than one APR, then any potential conflict shall be identified and resolved at the earliest stage of the Design, to achieve compliance with the project goals.

Partial use of other Prime References is allowed when the APR is silent on specific matters and potential inconsistencies as of these uses shall be timely resolved.

Prime References amendments are detailed in [GS EP PLR 102](#), [GS EP PLR 103](#) or [GS EP PLR 105](#), as appropriate, and shall be used in conjunction with the present General Specification. Inconsistencies shall be sorted out before entering the design process.

If the System is an extension to an existing network which has been designed under a Prime Reference that does not exist anymore or that has undergone modifications, the selection



process for the APR shall aim at an As Low As Reasonably Practicable (ALARP) set of modifications on the interfaced facilities. Under these circumstances, the consequences of using a different Prime Reference shall be fully understood by all the involved parties.

10. Alternatives

The use of **Alternatives** is only possible whenever specifically identified as such in the course of this General Specification.

Alternatives do not concern the requirements from the Regulations in force whenever these documents are contradicting this General Specification.

Alternatives shall:

- Be proposed as soon as a requirement from this General Specification cannot be fulfilled either for safety, technical, or economical reasons.
- Be supported by sound documentation that shall:
 - Reflect their adequacy with respect to the Contract, and especially with the set of functional requirements (Refer to Section 11.2)
 - Clearly establish their benefits and drawbacks as compared to the corresponding base cases of this General Specification
 - Be worked out on the basis of measurable elements.
- Be fully approved by Company before entering the design process.

11. Design requirements and principles

11.1 Scope

This section outlines the design principles which shall be used for the Design and based on which the Design Plan shall be implemented as per the **GS EP PLR 002**.

11.2 Functional requirements

As a minimum, the following main functional requirements shall be addressed:

- Flow assurance and thermal management
- Mechanical strength (assembly, laying, in-place stability)
- Inspection Monitoring, Maintenance and Repair (IMM&R)
- Retrieval/Replacement ability of critical components.

11.3 Criticality assessment

The criticality of the System shall be assessed and the findings shall be ranked by measurable impact to the Design.

The criticality may involve specific conditions such as but not limited to:

- Stringent Local Regulations
- Severe flow assurance and/or thermal management requirements

- Severe flowing condition (high pressure and high temperature, souring, etc.)
- Severe and/or poorly assessed environmental conditions
- Very constricted area
- Stringent interface condition, especially with a host facility owned by others
- Simultaneous site works and field operations
- Need of non fully industrially proven technology
- Time history of an existing System, under new qualification process.

11.4 Risk assessment

The risks shall be assessed in measurable terms - such as from QRA - and given the following order of precedence: human, environmental, industrial.

The risks shall be evaluated at an early phase in the Design process and shall be re-evaluated during the course of the Design and at every occurrence of a significant change in the design conditions. Risk mitigation measures shall be implemented as necessary.

At the end of the Design it shall be demonstrated that both the safety, environmental and functional requirements have been successfully fulfilled.

11.5 Design Format

The Working Stress Design (WSD) and the Load Resistance Factor Design (LRFD) are the most currently used design formats, but the Structural Reliability Analysis (SRA) method may also be applied as an Alternative to the LRFD.

The selection of the design format shall be made according to the following principles:

- At a conceptual level, it should not be necessary to involve the LRFD format
- The choice between WSD and LRFD shall be supported by a comparison study that shall be done at the earliest phases of the Design
- Calibrated factors are provided by LRFD based Prime References, but Alternatives can be proposed based on designer's experience (refer to Section 11.6)
- The SRA may be applied as an alternative to the LRFD; the use of SRA method shall follow the conditions stipulated in [DNV-OS-F101](#) Section 2 C500.

The Company General Specifications that address the linepipe and fittings are consistent with the Prime References based on a WSD format. Potential conflict of the Company General Specification with the Prime Reference based on a LRFD format shall be carefully investigated before any further step.

11.6 Designer's experience

Designer's experience shall be treated as an Alternative.

Designer's experience can be of essence in areas such as but not limited to:

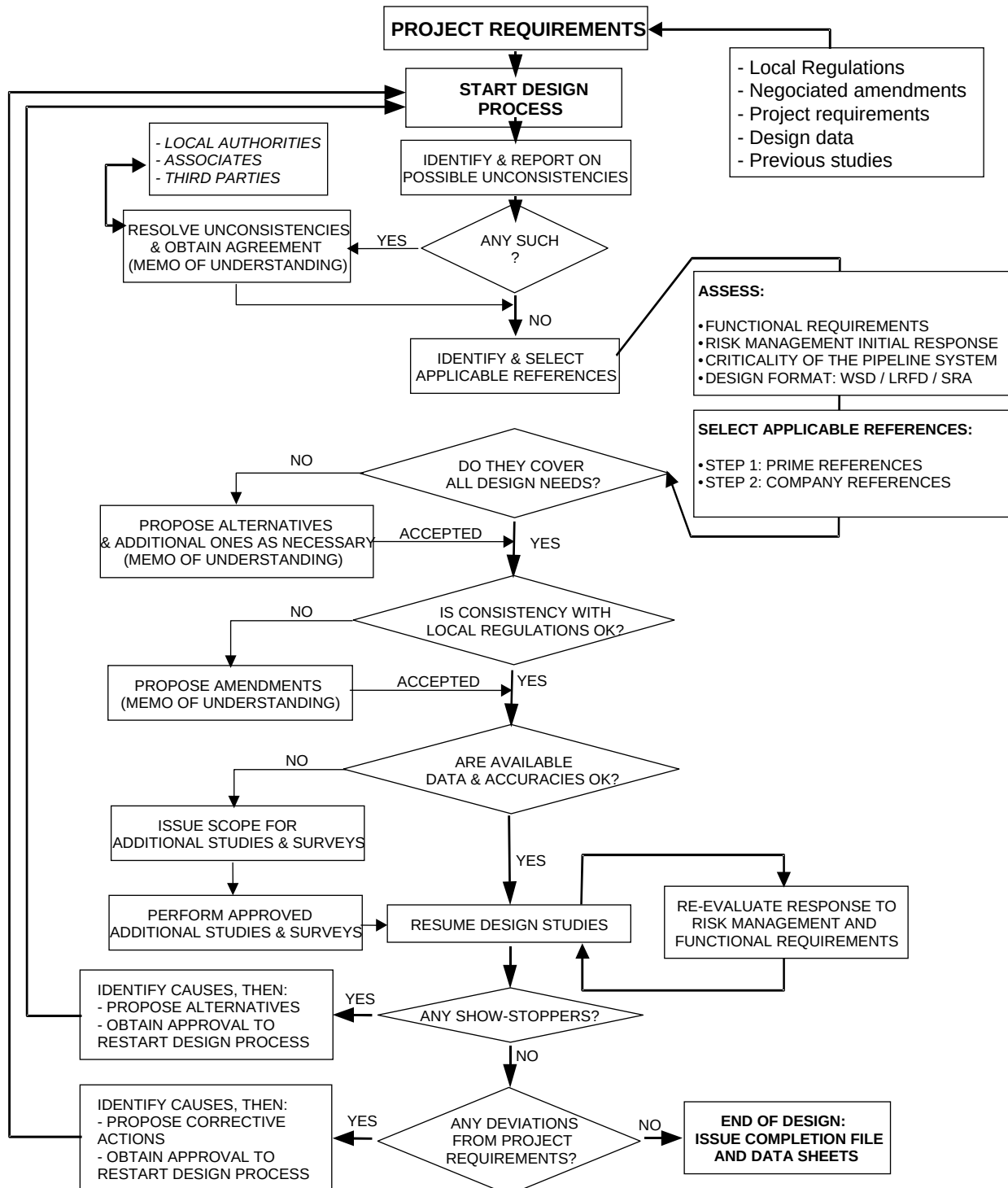
- Concepts
- Refined analysis or qualification methods



- Materials, components or sub-systems either of temporary or permanent nature
- Installation methods
- Inspection, monitoring, maintenance, repair methods, etc.

11.7 Design roadmap

The following design roadmap shall serve as a general guidance for the preparation of the Design Plan.



12. Flow assurance and thermal management

The flow assurance and thermal management design shall address the following issues, as applicable:

- The hydrate and/or paraffin formation prevention methods to be used during shutdown phases as well as during normal in-service conditions
- Any transients that would result from normal and abnormal operations, as well as from a sudden loss of containment (leak)
- Inhibition or insulation requirements to prevent wax or hydrate deposition
- The effect of flow conditions on the efficiency of corrosion inhibitors, liquid catchment and slug control requirements
- The System entry/delivery pressure and temperature envelopes
- The flow velocity
- The need for intelligent pigging.

Pipe burial shall not be considered in the calculation for the design of the insulation system, if any.

The Design shall include an assessment of the following potential effects:

- Cross-sectional design changes driven by installation and/or in-place constraints
- Routing issues in terms of the bathymetrical profile, such as local low/high points, overall slope, and roughness of profile
- Elevation layout of dynamic risers and bottom spools
- Minimum and maximum acceptable velocities given the nature and properties of the conveyed fluids
- Flow improvement from drag reduction internal coating.

A final hydraulic and thermal analysis shall be performed in view of delivering:

- Accurate flowing conditions, with local effects such as liquid hold-up, hydrate and/or wax formation conditions, cooling effects, cool-down and warm-up times
- Accurate stress, strain and displacements along the System and especially at the interfaces with other facilities.

This analysis shall also demonstrate the adequacy in respect of the Functional Requirements.

Default values:

The following default values can be used for flow assurance studies at the early study levels and/or in the lack of any further requirements:

- The minimum velocity for an oil pipeline shall not be less than 1 m/s
- The maximum velocity for a gas pipeline shall not exceed 15 m/s
- Drag reduction internal coating: a bulk roughness of 15 micrometers shall be used for flow calculations (actual values should be well below this roughness but some allowance has