



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS PLR 111

Submarine bundles

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1. Scope

The purpose of this General Specification is to specify the minimum requirements for the design, fabrication and installation of a submarine bundles system, as defined in Section 3.

This General Specification shall be read in conjunction with the **GS PLR 100**.

2. Reference documents

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

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS PLR 100	Submarine pipeline systems

3. Subsea bundle systems

A subsea bundle represents a wide variety of structural arrangement of lines which, in addition to one or several in-field or export transportation pipelines, may comprises:

- water injection flowline(s),
 - gas lift flowline(s),
 - service fluid line(s) such as chemicals injection, kill-choke,
 - electrical power cable(s),
 - hydraulic control line(s)
 - electrical control line(s),
 - optical fiber control line(s),
 - composite cable(s) with any combination of the above power and control functions,
- as necessary for the intended offshore development.

Most typical structural arrangements are schematically presented in the following figure:

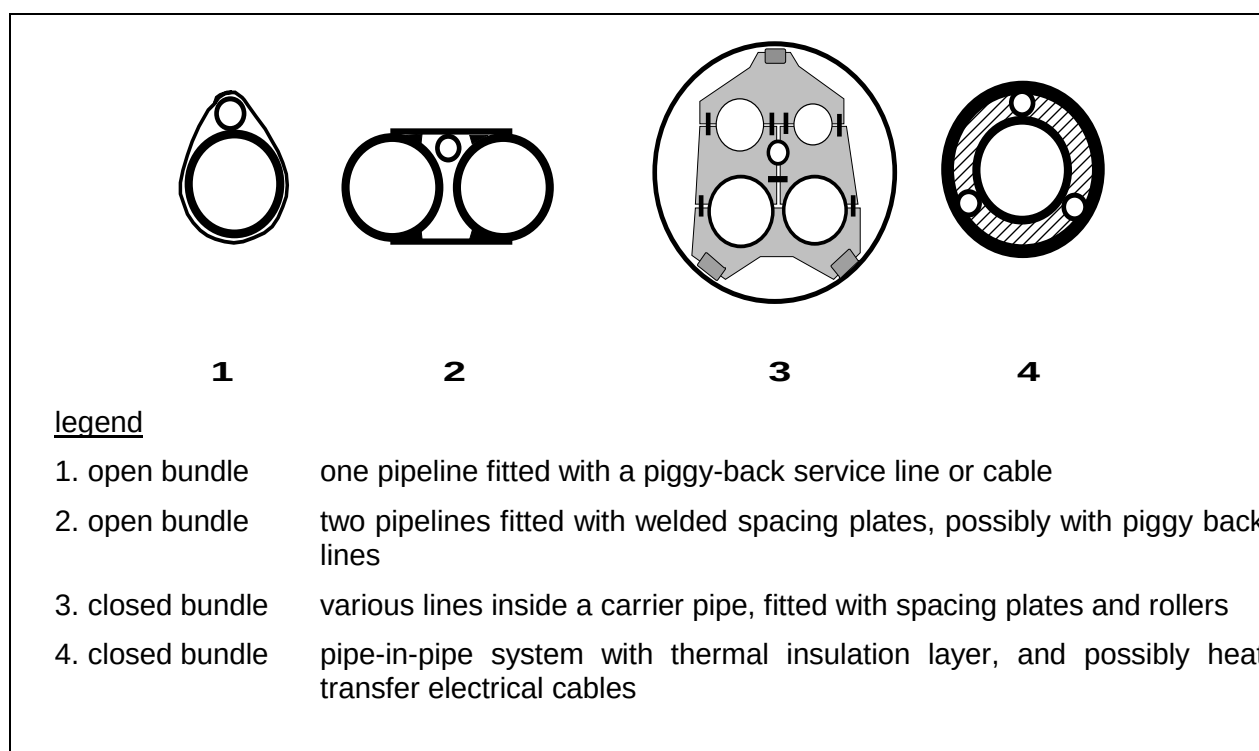


Fig. 1 - Typical subsea bundle systems

4. Objectives

Subsea bundle system based field development schemes shall be investigated whenever the following issues are essential for the field development:

- very high degree of quality control during the fabrication and assembly phase
- consequent reduction in the laying corridor and consequent reduction of laying operations

- consequent reduction in the subsea operations duration
- enhanced security against physical damages from external agents
- reduced environmental impact and risk
- controlled environment inside carrier pipe
- enhanced field abandonment process

As a consequence, the above objectives shall serve as a basis for the functional requirements of the subsea bundle system.

5. Serviceability

With respect to service life consideration, the following design principles shall be fulfilled :

- each line and each component shall have the design lifetime which is specified for the project and therefore,
- the assembly of each line and component shall not result in any reduction in the design lifetime of the bundle system
- the transportation and installation of the bundle system shall not result in any reduction of the design lifetime of the bundle system

In addition, the assembly of each line and component, as well as the transportation and installation of the bundle system shall not result in any downgrading of the specified performances of each of the lines.

Given the very different nature of the lines and components which are making a subsea bundle system, the order of priority of the following functional requirements shall be clearly assessed:

- normal operation
- incidental situations
- access for inspection, maintenance, repair

6. Initial response

Design, fabrication and operation risks shall be assessed as early as possible in order to identify potential problem areas associated with technical, budget and programme elements.

An extensive review of the Reference Documents shall be performed at the commencement of the design, involving not only the Prime References (see **GS PLR 100**) but also the other ones, as soon as critical components such as thermal insulation materials are involved.

Conceptual level studies shall aim at delivering a robust and cost saving scheme in order to avoid a re-engineering at the detailed design stage.

Technological gaps shall be carefully identified so as to allow sufficient time to resolve these matters.

Sufficient time shall be allowed when a limit state design is pursued since improperly defined limit states are generally leading to an overconservative design of the bundle as a whole.

Contingencies shall be elaborated as necessary since of these risks.

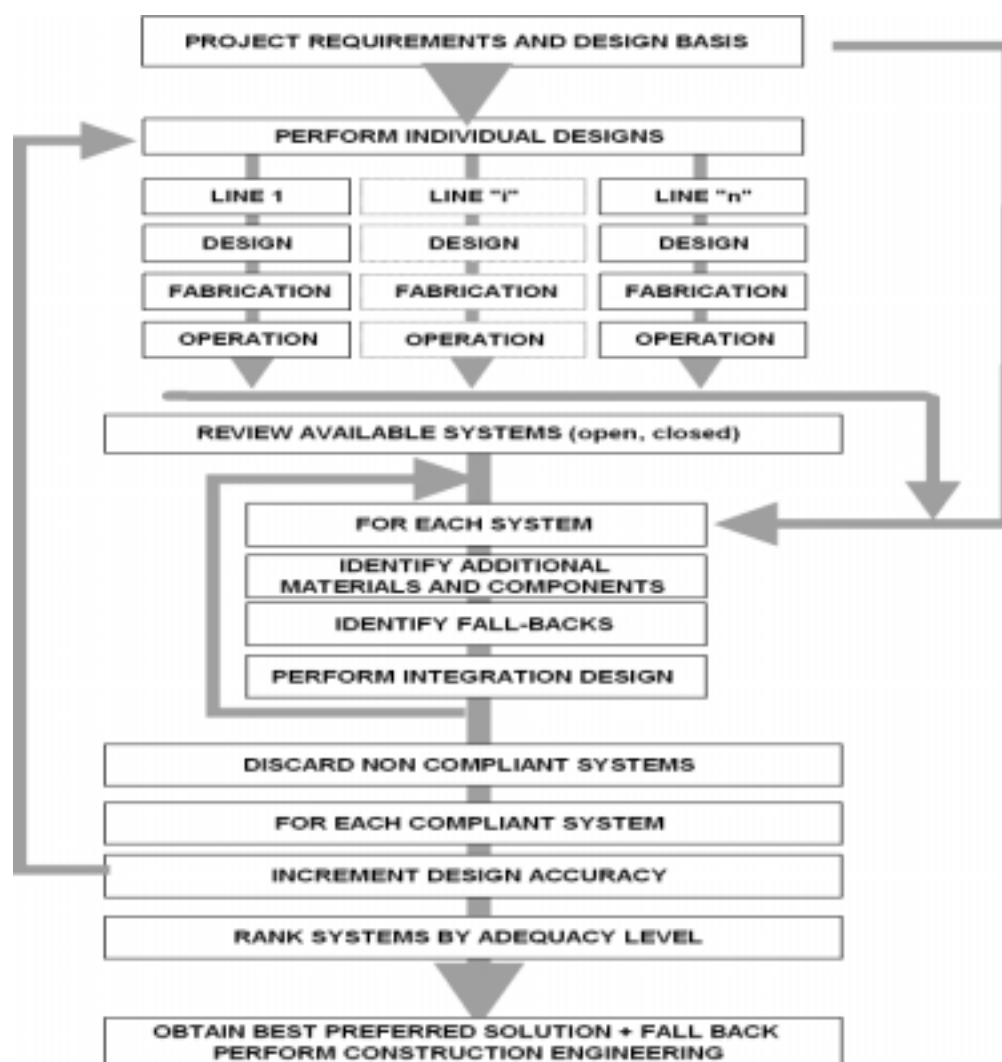
New or little-proven technology shall only be envisioned when only a reasonable degree of testing is necessary prior to use and on such an occurrence, the designer's experience (see [GS PLR 100](#)) may be essential.

7. Design roadmap

The following design roadmap is supplementing the one that is specified in the [GS PLR 100](#).

Outgoing and incoming connections between the bundle design roadmap and the [GS PLR 100](#) design roadmap shall be adequately identified and resolved in order to derive a fully consistent design process.

From the very beginning of the design and along with it, the need of fall back solutions shall be carefully investigated and the fall back solutions shall be identified at a sufficient level of design together with their respective availability windows in the frame of the allocated time for the CONTRACT.



8. Selection of the bundle system

As far as the type of bundle system such as summarised in previous section 3 is not strained by the CONTRACT, then the following table shall serve as a guidance in the view of the selection of the bundle system.

The figures represent the ranking system by decreasing order of precedence, hence the lower the figure, the higher the efficiency of the system with respect to the functional requirement.

Recommend 	Single pipe & piggybacks	Dual pipeline open bundle	Multi-pipe bundle	Pipe-in-pipe
To improve 				
Thermal management	3 (a)	3 (a)	1	2 (b)
Ground occupation	3	2	1	3
Installation (e)	2	3	1	4 (c)
Access for IM&R (d)	1	1	3	2
Access for future tie-backs	1	1	2	2

Notes:

- (a) on contemplating single pipe with piggy back lines or dual open bundles, it may be of interest to consider the case of pipe-in-pipes.
- (b) a pair of individual pipe-in-pipes for a production loop is generally less efficient than a composite bundle but in several instances and especially for long tie-backs, this may not be the case.
- (c) the installation of a pipe-in-pipe may seriously entail this system since of largely interacting thermal and installation design requirements.
- (d) means external access for externally operated IM&R tools; loss of external access is deemed to significantly entails the benefits from closed bundle systems.
- (e) installation by means of towing-out method shall be preferred when dual or multi-line systems are contemplated.

9. Combined thermal and mechanical design

The following issues shall be addressed when assessing the impact of the range of the operating temperature and pressure:

- the decrease of thermal and mechanical properties of the thermal insulation materials at increasing temperatures and particularly as soon as they exceed 70°C shall be completely assessed
- the heat transfer process shall be completely assessed, having in mind that even gaps in thermal insulation of less than 5 mm can have a considerable detrimental effect on insulation thermal performance, hence on the global design
- all the mechanical interactions between the components, since of the functional and environmental loads shall be carefully identified and evaluated.

10. Active heating

When active heating such as from:

- electric cables,
- hot water lines,
- phase change materials,
- and any combination thereof,

is essential to the design, the specific design steps shall be performed:

- local and global performances of the active heating system along the intended service life
- overall availability and reliability of the active heating system,
- subsequent impact on the operational philosophy
- local and global impact on the design, fabrication, assembly, installation, site acceptance test, of the bundle
- available monitoring and inspection means for the active heating system.

11. Reliability

The need and the location of "weak link" in the bundle shall be investigated in order to optimise the replacement works, safely, technically and economically wise.

Only engineered "weak links" shall be used.

The need for sectional isolation from water ingress point of view shall be carefully investigated, taking into account for the best compromise between:

- the amount of sections
- the loss of performance of the wet section
- the capability to operate the entire bundle under partial water ingress
- the repair philosophy.

The overall design shall result from a life-cycle technical and economical assessment.

12. Components

Enough time and resources shall be allowed for the identification of the available components and of their respective design, fabrication, inspection and assembly procedures.

Design and qualifying procedures of special components (such as sleeve pipe welds) as sleeve pipe joint details shall be carefully and timely elaborated.

Discrimination process between prefabricated (forged, machined) fittings or plastically strained and welded fittings shall be carefully and timely performed.

The risks involved in deciding to put lots of different components into a bundle shall be carefully assessed.



13. Corrosion protection

The incorporated components shall be fully compatible each other.

Any components that cannot be reached once integrated in the bundle system shall be designed accordingly.

Issues from accidental wetting as well as for wetting by design (wet bundles) shall be taken into account.

Partial pressure built-up since of of gases in between the various components may not only result in corrosion issues but also in mechanical ones.

Therefore, these effects and their consequences shall be carefully assessed and either purging valves or adsorbant systems shall be implemented as necessary to avoid any detrimental effects since of permeation.

Potential effects of electrical cables on the cathodic protection of the pipeline shall be investigated and compensated as necessary, either by adjustments on cathodic potentials and/or by an adequate electrical insulation of the electric cables.

14. Installation

When conventional pipelaying method is used together with an open bundle system, the impact of the site assembly works on the whole installation process and schedule shall be carefully analysed.

At an unacceptable level of impact, a closed bundle system shall be investigated since of its relevancy for bottom or near -bottom tow installation method.

The bottom tow or near-bottom tow route shall be carefully assessed and the obstacles shall be identified in advance so as to identify the required crossing methods, or any alternative route as soon as at least one crossing is not feasible.

The assessment of the towing route shall consider the minimum achievable radius of curvature along the towing route and until the targeted as-laid route is obtained.

Termination heads at either ends of the bundle shall be designed so as to facilitate together the towing and the end connections.

Only recoverable and re-usable additional temporary buoyancy aids shall be used when permanent buoyancy cannot be ensured without impairing the overall design and economy of the bundle.

If the bundle is to be laid inside an open trench or a back-filled trench, as a consequence of applicable rules and regulations, the impact of the subsea trenching and back-filling works shall be evaluated and taken into account in the design of the bundle system and the selection of the work means.

When addressing the installation of open type bundles, the risks from a rotation of the bundle in the course of the pipelaying process (either by a laybarge or by towing out) shall be carefully evaluated and countermeasures shall be engineered, as necessary.

15. Tie-ins

It is outlined here that the lead-times for tie-in spools are rather long, so that the geometry of the tie-in spools for bundles shall be constrained as early as possible at the design stage, and in an attempt to minimise their lengths since of installation issues.

The result of a minimisation exercise is likely to be a highly stressed spool which may not suit the bundle project, where the laydown point may vary considerably from the intended design, and hence result in a tie-in spool unable to carry the stresses.

Spool designs must therefore include a reasonable laydown contingency at conceptual design stage.

Deflect-to-connect method shall only be used when the interface loads and residual displacements at the tie-in location are acceptable for the host system as well as for the bundle.

The advantages and drawbacks of simultaneous connection of the individual lines by means of built-in bulkheads and associated receptacles in the host facility shall be timely and carefully investigated in order not to compromise the design of these receptacles.

When the pipelines and the other lines making the bundle are to be tied-in to a riser, the following **minimum** issues shall be investigated in order to contribute to the global optimisation of the riser and bundle system:

- specific requirements for the bundle and for the riser, separately
- added value against drawbacks from identical design of riser and bundle
- accessibility at the on-bottom interface between riser and bundle
- feasibility of continuous laying of bundle and riser installation

One of the most critical riser issues that is currently and widely recognised is the access for gaslift at the foot of the riser, since of flow assurance design requirement.

Other potential critical issues are:

- corrosion management
- riser and bundle footprint
- congested areas
- compatibility of the interfaced materials
- electrical continuity in the case of electrical power or control lines
- efficiency of thermal management at tie-in point
- soil-bundle-riser interface management
- retrieval/reconnection capability
- etc.

Most of these issues are also potentially relevant for a bundle tie-in to a subsea facility.