



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS PLR 409

**Installation of submarine cables,
umbilicals and flexible pipes**

01	10/03	Change of Group name and logo
00	02/01	First issue
Rev.	Date	Notes



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1. Scope

This specification defines the minimum requirements for the installation of cables, umbilical and flexible pipes linking fixed or floating installations. Fixed installations are mainly subsea wellheads, manifolds or fixed platforms. Floating systems can typically be tension leg platforms, FPSOs or off-loading tankers.

1.1 Field of application

This specification is concerned with the laying of the current lengths of lines on site, end connections and special points.

The definition of cable, umbilical, flowline or riser also covers the flexible line or pipe itself and all top and bottom connection devices, anodes and associated equipment of the installation.

1.2 Exclusion

This specification does not cover bonded flexible pipe, off loading flexible pipe and composite compliant pipe.

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.

Where national regulations exist, their provisions and those of the standards and codes to which they refer shall apply, supplementing or amending the provisions of this document.

If there are no national regulations covering all or part of the subject of this document, the reference documents shall be strictly applied, as supplemented by the provisions of this document.

Only the main reference documents are mentioned; the CONTRACTOR shall be responsible for complying with all secondary reference documents dealing with the subject of this document.

Standards

Reference	Title
ANSI B 16.5	Pipe flanges and flanged fittings

Professional Documents

Reference	Title
Bureau Veritas NI364 DTO R00E	No-bonded flexible steel pipes used as flowlines
API specification 17J - ISO 13628-2.2	Flexible pipe systems for subsea and marine applications
API specification RP 2RD	Specification for design of risers for floating production systems and tension leg platform (draft)
API RP 1110	Recommended practice for the pressure testing of liquid petroleum pipelines
API specification 17D	Specification for subsea Wellhead and Christmas Tree Equipment

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

The provisions of this document shall be applied in the light of the supplementary documents supplied by the OWNER, including:

- Country specificity appendices
- Job specification
- Data sheets
- Articles and conditions; list of tasks
- Quality assurance provisions.

Reference	Title
GS GEO 202	Geophysical surveys for offshore pipeline installation
GS PLR 109	Fabrication and testing of submarine flexible pipe and risers

Reference	Title
GS PLR 407	Load-out of submarine cables, umbilical and flexible pipes
GS PLR 408	Transportation of submarine cables, umbilical and flexible pipes
GS STR 403	Acceptance of support vessel for offshore works
GS STR 481	Design and operation of ROV interfaces with subsea production system
GS STR 661	FPSO - Design requirements for the mooring and anchoring system

3. Terminology

The terminology and description of the system complies with the specification (API specification 17J - ISO 13628-2.2 flexible pipe systems for subsea and marine applications):

Flexible line General term for cable, umbilical or flexible pipe to be installed.

Current section Part of the cable, umbilical, flexible pipe, which rests on the sea bottom.

Riser Part of the line, flexible pipe or steel pipe, which connects the current section to the surface.

Dynamic umbilical Part of the cable or umbilical, which connects the current section to the surface.

Special Points

- **PLEM** (PipeLine End Manifold) A subsea equipment or manifold stipulated in this specification which is connected to one end of the flowline.
- **Suspension** A mechanical system which is used to suspend and connect the flexible riser at the riser head.
- **I tube guide** A steel protective envelope for the flexible riser, attached to the jacket and fixed by a suspension flange. Normally straight, and only used for the area requiring protection.
- **J tube guide** As I tube guide, but including a bend and a bottom bell mouth for pulling flexible pipe, used in all water depths.
- **Shore approach** Transitional area between the offshore and onshore sections of the flexible line.
- **Wellhead** Compact and complete unit of safety and production shut-off valves (topside or subsea units).
- **Subsea Station** Complete or partial units for the tie-in of one or more pipelines or flowlines (Subsea Manifold).
- **Tee** Device for connecting two or more lines together.

- **Subsea Construction flooring** Temporary or permanent structure to aid subsea work.
- **Burying** Installation of the pipeline in a trench and/or back-filled.
- **Free span or suspended part** Part of the pipeline, which does not rest on the sea bottom (part leaving the I tube riser to the sea bottom).
- **Support system** An artificial system used for stabilising line crossings and supporting free spans.
- **Anchoring** System used to stabilise the line and prevent longitudinal or lateral movements.

4. Engineering and procedures requirements

4.1 Flexible line route and laying

The feasibility of laying shall be checked against the theoretical route, basic data, planned methods and laying spread.

All additional investigations shall be carried out to ensure successful laying and safety of the installed line. Particular points such as boulders, wrecks, foreseeable out-of tolerances and free spans shall be investigated and dealt with at the engineering stage.

4.2 Installation engineering

This shall be performed in accordance with the Total specifications **GS PLR 109**.

Laying methods using free wheels or braked reels without motorised device are proscribed. Any laying or unreeling equipment shall be reversible i.e. must be able to pull back the flexible line.

The engineering design shall determine, in particular:

- Laying, adjustment and inspection parameters with their nominal values and their application tolerances to ensure flexible line integrity
- Special requirements and parameters applicable to particular operations and contingency procedures.

4.3 Procedures

Detailed procedures shall be established on the basis of the technical requirements, specification documents, and specified studies for all stages of installation. These procedures shall include unreeling plans, check lists and scale drawings. They shall be approved before the commencement of operations and/or mobilisation.

4.3.1 General procedures

These shall cover at least:

- Preparation of laying spread with specific equipment (DP/anchoring, ROV, survey means, diving, etc.)
- Inspection of laying spread on shore
- Plans for laying spread routes
- Inspection on site of laying facilities and equipment

- Transit and anchoring/positioning of laying spread
- Current laying and curve laying
- Procedure for topside connection
- Laying down, whether or not within target areas
- Pulling or traction start-up (I tube)
- Flexible line arrival and traction in I tube
- Positioning procedure
- Subsea operations procedures
- Test procedure: flooding, gauging/calibration, dewatering, testing.

4.3.2 Detailed procedures

These deal with special points, which may nevertheless be incorporated in the procedure documentation, namely:

- Installation of tees and subsea flooring
- Installation of messenger line
- Acoustic positioning
- Transportation and Installation of I/J tube
- Line burying
- Connections (risers, wellheads, subsea stations, PLEM, shore approach)
- Crossing.

4.3.3 Contingency procedures

These shall apply when the interruption of pipe laying operations becomes necessary for safety or feasibility reasons:

- Major repair to flexible line on lay barge
- Laying down and recovery (air or water filled pipe)
- Recovery of pipe upon damage after passage through tensioner or laying gutter
- Slowdown procedure (e.g. in case of wind gusts)
- Procedure for repairs after heavy damage (buckle).

These contingency procedures shall be supplemented by:

- Curves of response to waves of laying spread
- Laying spread movements and tensioner capacity curves shall determine safety limit conditions on site
- Evaluation of times required for making safe
- Leak detection and repair during line testing.

4.3.3.1 Inspection procedures

These shall cover as least:

- Inspection of equipment and spread prior to transportation and laying operations (hydraulic winch, rotary table, fastening, DP, anchoring system, ROV, hydraulic equipment, etc.)
- Inspection during laying operations (parameters, lines, spread, etc.)
- Inspection after contingency procedures (condition of line and spread)
- Route and laying survey
- Control of subsea work
- Control of line (geometry, strength, water tightness)
- Inspections related to the detailed procedures.

4.3.3.2 Procedures relating to other specifications

The procedures documentation must be consistent, exhaustive and readily available on site (Operation Manual). For this purpose the procedures below have been associated with the procedures documentation:

- Procedure for the acquisition and monitoring of weather and sea data
- Procedure for operating ROVs
- Welding procedures
- Cathodic protection procedures
- Procedures relating to the repair of flexible line
- Procedures relating to the testing of water treatment.

4.3.4 Planning

The following schedule shall be prepared:

- Detailed schedule for the project (loading, laying and inspections, reporting)
- Estimated dates for precommissioning
- Work progress as a percentage in accordance with the approved formula (contract)
- Key dates as specified in the contractual document.

5. Installation spreads

All operations shall be carried out using the appropriate equipment and spread in compliance with the basic data and in respect of above engineering methods and procedures. Acceptance shall be based on specification **GS STR 403**.

5.1 Description

A description of all resources and auxiliary equipment, their characteristics and performance data, shall be included in the procedures.

Such descriptions shall include in particular:

5.1.1 Overall characteristics

- Dimensions, strength of decks, layout arrangement and equipment of installation spreads
- Anchoring and/or dynamic positioning system including control units, monitoring and emergency equipment
- Operating, capacity and supply system of power sources
- Accommodation and allocation of working space
- Internal and external means of communication
- Helicopter deck
- Acquisition and processing of weather and sea data
- Diving units
- Safety scheme and equipment
- Medical facilities
- Surface and subsea positioning systems, including ROVs.

5.1.2 Description and performance

Performance shall be described for:

- Hydraulic equipment for flexible line unreeling, control system, continuous recording of speed, capacity, response times, regulation range
- Laying gutters and lifting beam
- Equipment related to underwater inspection and operations
- Constant tension winches for towing and pulling: equipment, control system, power capacity, continuous recording of tension is required
- Positioning with drift and positioning tolerances. Inspection procedures shall be proposed for the mobilization acceptance of laying spread before commencement of operations and shall include anchoring and/or dynamic positioning stresses and test values
- Positioning equipment and ROV
- Testing and detection equipment.

5.1.3 Personnel

- List of all personnel with qualifications and their allocation to installation spread and workstations
- CVs of management personnel and specialists.

5.2 Seaworthiness of installation spread

The particular information below shall be included in the description of the equipment:

- Maximum drift force of the surface vessel during dynamic positioning or on its anchors in the course of operations and when subject to onsite weather and sea conditions
- Stability conditions and safety margins.

5.3 References and tests for the installation spread

The description of the laying spread shall include previous references and records of operations.

6. Movements and station keeping

6.1 Positioning by anchors

Approach to existing installations and anchoring on a field shall be performed in strict conformity with specification **GS STR 661** and is subject to COMPANY's permission and specially by nigh.

Location of anchors must always be monitored with a ± 10 m accuracy.

In case of crossing, the minimum vertical clearance of the mooring line must be 10 m when the line is set and greater than half of the water depth when the line is in the process of being deployed.

A mooring line shall never be located at distance less than 10 meters from a fixed installation.

Distance between anchors and any fixed underwater installation must always be more than 200 meter and distance from an anchor to a crossing point must be greater than 400 meters.

6.2 Dynamic positioning

At least two different navigation systems must be in service during all phases of operation.

6.3 Tolerance and accuracy

The system used shall comply with the following tolerances:

- The location of the line on seabed shall be known with a accuracy better than 5 m.
- The tolerance in the relative spacing known between two or more parallel line shall be ± 2 m (4 m).

7. Laying operations

7.1 Preparation

The flexible line shall rest on the line up stations on supports designed to maintain the integrity of the external sheath and on the outlet gutter for laying.

7.1.1 Butting of strings

Line up stations shall include all means for aligning and butting connections together.

Care and precautions must be taken during assembly to ensure that no foreign bodies are left inside the line. If a testing device exists, the connection shall be tested before laying. Certificates shall be established.

7.1.2 Identification

Identification as specified in the specification **GS PLR 109** shall be checked and recorded during laying.

During flexible line repairs, any changes to the marking shall be recorded under the original procedure.

7.2 Initial pulling

Pulling or pushing operation in the I/J tubes or for connections shall be fully controlled using equipment whose capacities do not exceed the mechanical characteristics of the flexible line. Pulling shall be continuously checked by ROV or diver.

Steel bosses are prohibited, only the use of Chinese fingers, long nylon bosses or suitable clamps shall be allowed. Bosses and clamps shall be retrieved after completion and agreement on the configuration.

Equipment for pulling flexible line through the I/J tube shall be in accordance with the allowable curvature radius, the a lifting beam shall have it marked cable, or using acoustic beacons. Equipment shall have full safety control on the opening.

In the final configuration, the flexible line shall rest on the sea bottom without free span, the touch point location shall be in tolerance and the horizontal profile shall be recorded.

7.3 Laying

All laying operations shall be performed with complete control and continuous recording:

- Tension (including during the pulling and laying phases)
- Angle from the laying gutter
- Continuous visual monitoring of the touch point in order to correct any loops or crossover.

Continuous laying shall take place only if all the above parameters are within the tolerance range. In addition the following conditions shall apply:

- In the soft clay soil and without visibility, procedures and methods shall be adapted with the use of acoustic and sonar
- Flexible line shall be installed within the defined corridor with its axis along the theoretical route
- Flexible line shall rest on the sea bottom under the conditions defined by the procedures, without humps or loops or excessive mechanical stress
- Under no circumstances may the flexible line be in contact with any adjacent lines; no crossings or overlaps shall be tolerated unless otherwise specified
- The residual tension on the sea bottom shall be low as possible, and shall not cause free spans. It shall be strictly limited to 0.5 t

- When all useful information concerning the nature of the sea bottom and the presence of any obstructions (boulders, wrecks, subsea lines, etc.) have been checked, the locations of these obstacles and necessary detours shall be determined
- If the laying procedure requires water filling, the water treatment is compulsory and shall be submitted for approval
- While laying is in progress, any check considered useful must be made (subsea inspection, calibrating pig, etc.) whenever incidents may compromise line integrity.

7.4 Laying corridor, laying tolerance

7.4.1 Laying of the line alone

The laying corridor is restricted to 30 m width (-15; +15), the theoretical route being the centreline.

7.4.2 Obstructed/restricted area or existing lines

The laying corridor is restricted to 10 m, centred on the theoretical route. The space between two theoretical routes is restricted from 5 to 15 m.

7.4.3 Particular points

At start and arrival points, tolerances may be modified according to on site conditions.

7.5 Tie-ins

Approach operations or operations in the vicinity of structure(s), and flexible line connections shall be performed in strict compliance with site regulations.

Shifting, alignment or lightening for line recovery shall be fully monitored (acoustic, marked cables, horizontal and vertical metrology).

Lightening devices, cables and fittings temporarily installed on the line shall be recovered; this shall also apply to current laying and pulling.

7.6 Remedial works

7.6.1 Support systems installation

Support systems shall normally be installed prior to the flexible line laying operations and based on the following investigations:

- Quantified results of inspection during or after flexible line laying
- Comparative analysis of admissible free spans
- Operation limits as specified in the procedures
- Methods and special procedures for the installation of approved support systems.

The following structures and methods may be applied depending on the nature of the bottom: sand, clay or rock:

- Grouted mattress
- Steel structures fitted to the flexible line

- Burying/de-rocking, jetting to prevent friction, or replacing a support system
- Anchoring of the flexible line.

Note: The use of sand bags or sand plus cement is prohibited.

The flexible line shall leave along the specified heading and length in excess shall be laid in area 100 m away from the structure or subsea connection.

In the case of sets of flexible lines, the suspended parts shall not touch or cross one another and clearance may be specified and restrictors fitted.

7.6.2 Pipe burying, back-filling

Pipe burying or back-filling is required in specific conditions (geographical areas, diameter, insulation, etc.).

The flexible line shall be buried in a trench where erosion may occur or in heavily trawled areas.

The flexible line shall be backfilled in areas of known instability and prone to scouring or heavily trawled areas.

7.7 Other subsea works

Subsea works, particularly those performed by divers, shall be governed by strict application of the regulations and shall be subject to the provisions of specification [GS STR 481](#).

8. Surveys

All inspection shall be performed in compliance with the Total specification [GS GEO 202](#).

9. Testing and commissioning

Flexible line shall be accepted by performing the operations:

- Prerequisite
- Pigging and gauging
- Hydrostatic testing.

9.1 Prerequisite

The flexible pipe flooding operations, water testing, etc. shall be performed using general provisions stated in the specifications [API RP 1110](#).

The Maximum Test Pressure (MTP), testing procedures and test equipment shall be specified in the procedures.

A list of the produces necessary for all type of treatment, including contingency solutions, shall be drawn up before commencement of operations.

9.2 Pigging, cleaning and gauging

9.2.1 Flexible line pigging

The line shall be cleaned by flushing water treatment (approximately four times the flexible pipe volume).



Additional products (anti-corrosion and corrosion inhibitor) shall be injected and adjusted during the cleaning by circulating water operation.

- Pigs with polyurethane washers and plastic gel are allowed
- Pigs shall be fitted with new sets of bi-directional sealing washers
- The method consisting in pushing several pigs is allowed, provided that care is taken to observe the spacing between pigs and not to interrupt fluid injection.

9.2.2 Flexible line gauging

The line shall be gauged by passing a pig fitted with a plate that can be deformed with a diameter of not less than 95% of the nominal inside diameter. This plate shall have a maximum wall thickness of 10 mm, with an edge of 3 mm.

The pig shall be pushed by treated water at a rate of between 0.5 and 1.5 m/second. Depending on the equipment used, a backpressure must be maintained downstream in order to control the rate of progress.

For particular cases, the laying specification may request the use of an instrumented pig (acoustic device-calliper) either as a standard procedure or as a contingency procedure.

If the pig becomes jammed in the line, it must be recovered and all remedial work must be carried out to make the line good, including the repetition of new line gauging operations.

The pressure/volume parameters at line inlet and outlet shall be recorded in such a way that if the deformable plate is damaged the probable causes can be analysed. It may then be necessary to pass an instrumented gauge and perform all necessary operations to achieve pipe conformity.

Passage of a gauge shall give rise to a certificate signed by all parties involved, with all photographs of the condition of the pig and gauging plate, the pig trap being designed to avoid any damage which might prejudice investigation of its condition.

Hydrostatic testing may be performed only after formal acceptance of the pig's condition or after inspection by instrumented pig.

9.3 Hydrostatic testing

The purpose of the tests is to check the line seal tightness and strength. Before performing this test, a test for air in the line shall be carried out to check the percentage (must be lower than 0.5% for a smooth bore and 1% for rough bore).

If part of the installation has already been tested, the test documents of that part shall be checked.

General hydrostatic tests of the complete installation may be necessary to validate pre-commissioning of the line (depending on the interface equipment).

9.3.1 Test pressure

Unless otherwise specified in the job specification, the Site Acceptance Test Pressure (SATP) shall be at least 1.25 times the Design Pressure (Maximum) DP and at most shall **not** be above 90% of the Factory Test Pressure (FATP).

9.3.2 Pressurization

Pressurization shall be increased in a controlled way, using a pressure gauge controlled by a dead-weight tester (stamp date not older than six months) and recording the volume injected.

The rate of pressurization shall not exceed 3 bars/minute.

As pressure rises from 90% to 100% of the SATP, the pressure shall be checked every bar using the dead-weight tester.

9.3.3 Stabilization period

A minimum of 6 hours shall be maintained between the end of pressurization and the beginning of testing. Temperature stabilization is considered to have been reached when the pressure variation does not exceed 30 mbar/hour.

If pressure/temperature measurements¹ are not stable, and in particular for pressure drop, the pressure shall be increased to the test pressure and the exact volume of water added shall be recorded.

The pressure shall be recorded continuously, and checked each hour using the dead-weight tester, with indication of water temperature (10 metres above sea bottom).

Strength testing shall not be started until all the above requirements have been met.

9.3.4 Hydrostatic test acceptance

The tests shall be carried out for 24 hours without interruption.

The test shall be accepted only if:

- The allowable pressure drop at the end of the 24 hours testing period is:
 - Less than 1 bar when the test pressure is lower than 100 bars
 - Less than 1% of the test pressure when this is higher than 100 bars.

If the pressure drop after 24 hours is higher, the test shall be extended for a further 24 hours, after restoring the nominal test value, and with the volume of the water reinjected accurately recorded.

The instruments and equipment required for measuring pressure, flow rate, volume and temperature shall meet the following criteria:

- Accuracy is fixed at $\pm 0.1\%$ of the maximum value of the operating ranges
- The calibration certificate is less than three months old, the equipment has not been used since and this is in accordance with the applicable regulations
- Their readings and operating ranges shall be fixed in the same way as for the pressure measuring equipment, and lie between:

$$\frac{\text{test pressure}}{3} \text{ and } \frac{3 \text{ times test pressure}}{2}$$

The nature of the tests and their recordings shall conform to these requirements and be readable.

¹ A temperature log might be required at both ends

9.3.5 Leak detection

Where the pressure drop recorded is caused by a leak in the line, whatever its origin, all materials and equipment required to locate the leak (products, ROV, hydrophone, fluorescent meter, tracer) shall be made available. Any defects detected shall be made good after detection as specified in the procedures. After this, the test shall be performed again subject to the same requirements and the same acceptance values as in the chapter above.

9.3.6 Specific methods

A special procedure shall be provided for checking tightness of special points (tees, tie-ins) separately from the main line tests.

This test shall be carried out before the main line tests and in all circumstances before demobilization of the spread.

9.3.7 Depressurisation

This may only be performed after the COMPANY has accepted the test documents.

The line shall be decompressed progressively at a maximum rate of 2 bar/mm. Values shall be recorded.

Unless otherwise specified, the inhibited fluid shall be left in the line at the pressure, which may be requested in the job specification (in theory 5 bar).

9.3.8 Dewatering

Dewatering and water treatment may be requested.

The gas drying method for dewatering the line may be requested.

9.3.9 Documents/Reports

A preliminary report shall be submitted on site (this is part of the technical preliminary report).

This shall include at least:

- Copies of the pressure log/temperature log/volumes recorded
- The test sheet as an appendix
- Reports of incidents and/or repairs
- Brief progress report
- Calibration acceptance certificate
- Quantity injected and analysis of volume
- Diagram and isometrics of the line tested

The original and final documents shall be treated as part of the technical documentation upon completion of the work.

10. Repair of flexible pipe

Depending on the dimensions and location of the damage along the line, the COMPANY and the CONTRACTOR shall decide after due consideration:

- Not to repair
- To repair
- To cut a string and to repair with supplementary connection
- To replace all the line.

The provision, execution and acceptance of the repair shall be subject to all requirements of this specification.

11. Technical documentation

11.1 General requirements

In addition to the preliminary report provided on the site, the technical documentation for the installation shall be submitted two months after the certified statement of work completion on site.

11.2 Minimum contents

This documentation shall include at least the contents as listed below:

1. Purpose
2. General
3. Laying spread and equipment
4. General and job specification
5. Performance of laying, reporting
6. Inspection and survey reports
7. Pre-commissioning (Site Acceptance test)
8. Time schedule and analysis of operations
9. Sea weather conditions report
10. Certificates

Appendix 1 - Topographic surveys

Appendix 2 - Documents

Appendix 3 - Subsea works

Appendix 4 - Video report/Photographs

Appendix 5 - Report of laying campaign

Appendix 6 - Loading, transport, unloading

In any case, the COMPANY shall receive documentation including all the originals, in particular the test certificate, transparencies, negatives, logs and recordings from test surveys and inspection, photographs and video tapes.

All documentation shall be signed by the parties involved, otherwise it shall not be valid.