



Exploration & Production

GENERAL SPECIFICATION

PIPELINES - RISERS

GS PLR 401

Installation of submarine pipelines
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1. Scope

This specification - which shall be read in conjunction with the **GS PLR 100** - defines the minimum technical requirements with respect to the installation of submarine pipelines.

Pipeline installation in swamp areas, J-lay pipeline installation, and towing out of bundles are not covered by the present General Specification.

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
ISO 13628	Petroleum and Natural gas industries - Design and operation of Subsea Production Systems
DNV OS F101	Offshore standard - Submarine Pipeline System

Professional Documents

Reference	Title
API SPEC 17J	Specification for unbonded flexible pipe

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 201	Supply of sacrificial anodes
GS COR 420	External field joint coatings of pipelines
GS GEO 201	Offshore geophysical survey
GS PLR 100	Submarine pipeline systems
GS PLR 109	Design of submarine flexible pipe and risers
GS PLR 403	Installation of onshore pipelines
GS PLR 404	Installation of steel pipelines by horizontal directional drilling
GS PLR 406	Packaging and transportation of line pipes
GS PLR 410	Concrete coating of pipelines
GS PLR 420	Site welding of carbon steel pipelines to API 1104 (sweet effluent)
GS PLR 421	Site welding of carbon steel pipelines to API 1104 (sour effluent)
GS PLR 501	Hydrostatic testing of submarine pipelines
GS PLR 502	Precommissioning of submarine gas pipelines
GS STR 402	Anchorage for a support vessel on an offshore site
GS STR 461	Diving specification

3. Definitions and abbreviations

The definitions stipulated in the **GS PLR 100** shall apply, but with the present General Specification, the following definition is modified:

the WORKS means the surveys, site preparation works, installation works, and reinstatement works, as a whole.

In addition, the following abbreviations are used in the present General Specification:

ROV	Remote Operated Vehicle
OBSROV	Observation ROV
WOROV	Work ROV
ROT	Remote Operated Tool

4. Safety and environment

4.1 Safety

At all times throughout the WORKS, all precautions necessary to actually prevent any accident in any location of his activities shall be taken and as a minimum, the Project Requirements shall be strictly fulfilled.



4.2 Environment

Special cares shall be taken on possible environment impacts.

A dedicated study shall be carried out to define the impacts of the proposed pipelines on the surroundings and in particular on the landfall, if applicable.

CONTRACTOR shall also evaluate and document any potential impacts of the construction works regarding noise, venting, sea current, possible spillage, disposals, smells, electrical/radio interference, positioning beacons, geodetic points, lights, etc. on the local populations and existing constructions, flora and fauna, shore profile etc.

Local relevant Authorities or agencies will be listed and consulted as requested by the Project Requirements.

If deemed necessary, any alternatives consistent with the Project Requirements can be proposed.

4.3 Site reinstatement

All non necessary installation aids shall have been removed before hydrostatic testing.

However, temporary positioning, protective and guiding devices shall not be retrieved until satisfactory completion of the installation and precommissioning works.

In addition, the WORKS shall culminate with the full reinstatement of the work sites as per above 4.2. Especially, all active subsea temporary components shall be removed.

5. Regulations

5.1 International Maritime Regulations

The WORKS shall be executed in compliance to the good practices edited by local and international Maritime Regulations.

5.2 Local Authorities

The WORKS shall be executed in full compliance with the acquired authorisations and permits from the local governing Authorities.

6. Construction Engineering

6.1 General

CONTRACTOR shall prepare - as necessary for the Project and according to the Reference Documents - the detailed engineering documentation which shall be permanently updated with due consideration of the most recent and accurate site and environmental design data as well as on the basis of the intended installation spread characteristics.

Special consideration shall be brought on the pipeline stress analysis, as outlined in further § 6.4.

All of these documents shall have been approved by COMPANY before the commencement of operations and/or mobilisation.

6.2 Calculation notes

The following calculation notes shall be prepared, as a minimum:

- Lay analysis
- Abandonment/Recovery of empty line
- Abandonment/Recovery of flooded line
- Maximum gouging length
- Maximum sea states during laying operations
- Pulling forces during shore approaches (if any)
- Sea bottom shifting analysis
- Fatigue analysis during operation
- Evaluation of the residual stress, stain, out of roundness, out of straightness and metallurgical characteristics and evaluation on detail engineering results.

6.3 Procedures

The following procedures notes shall be prepared, as a minimum:

- Storage, handling, transportation and marking of the materials (see § 7.5 and 8.2)
- Laying route preparation, including pre-surveys, freespan assessment, seabed preparation, existing facilities inventory, etc. (see § 9)
- Installation works as per section 10, including:
 - Station keeping and monitoring (see § 7.4)
 - Weather forecasting (see § 7.5)
 - Laying direction (see §10.2)
 - Pipeline standard assembly and laying (see § 6.5,10.3)
 - Pipe inspection, internal cleaning, and repairs (see §10.3.2 to 10.3.4)
 - Detection of buckles, associated contingency and repair methods (see §6.7, 10.3.7, 10.12)
 - Surface and subsea connections diver assisted or diverless, mechanical or hyperbaric welding (see §10.4)
 - Freespan reduction works (see § 10.5)
 - Corrosion protection of field joint (see §10.6)
 - Special procedures (see § 6.6)
 - Contingency Plan (see § 6.7, 10.12)
 - Offshore terminations, including subsea and surface works, installation of risers and appurtenances, etc., and intermediate subsea tie-ins (see §10.7)
 - Onshore terminations, including onshore preparation works, pipeline pulling, etc. (see § 10.8)
 - Crossings (see §10.9)

- Mechanical protection such as trenching, backfilling, covering, etc.(see §10.10)
- Pipeline hydrotesting and pre-commissioning (see §10.11)
- Final and contingency surveys (see §10.12)
- Site reinstatement works (see § 4.3)

6.4 Pipeline Characteristics Monitoring System

The detailed global and local stress and strain analysis results shall serve to set up an operational schedule of the monitored lay-barge parameters and this schedule shall be as simple as possible in order to reflect immediately any likely or confirmed shift of the monitored data towards unsafe areas.

In the view of the installation works, a dedicated pipelaying software package - as far as possible the same as the one permanently allocated for the selected laying vessel - shall be provided onboard the laying vessel.

The operational schedule and the monitoring system shall be fully described in the Construction Manual and referred as "The Pipeline Characteristics Monitoring System", aim of which being to ensure that normal and contingency installation works are conducted in a safe manner given the parameters of the Project.

More precisely, this system shall be designed so as to provide instantaneous direct or indirect access to pipeline buckling and collapse safety margin, pipeline as-laid versus initial routing gap, static and dynamic deflections, fatigue, etc.

The schedule of laying parameters shall reflect four distinct areas, which shall consist of:

- A first area, inside which laying operation can be normally conducted (safe area) or resumed (if interrupted)
- A second area, inside which the normal laying operation shall be stopped
- A third area, inside which the pipeline shall be abandoned
- A fourth area, inside which damage of pipeline is confirmed or highly suspected.

As a minimum, the following parameters shall be recorded in a continuous way and made available to COMPANY:

- Pipe tension, tensioning devices setting and dead band
- Out of roundness and straightness (in case of plastic deformation)
- Water depth
- Continuous view (video) of the last itemised roller where the pipe is resting on before going off the stinger
- Loads at the pipeline supports
- Barge draft
- Barge trim
- Current velocity and direction at or near the location of the laybarge
- Significant wave height, period and direction
- Wind speed and direction

- Co-ordinates of the following locations:
 - The barge ramp rollers relative to the deck level and the stern of the barge
 - The stinger hitch relative to the deck level and the stern of the barge
 - The stinger rollers relative to the stinger hitch and the axes of the stinger.

The calculation shall be prepared by a COMPANY recognised software as per **GS PLR 100** §7.4 requirements.

6.5 General laying procedure

This procedure shall describe the different operations necessary for assembling the pipelines (single jointing or double jointing) and refer to detailed procedures for each specific operations and in particular:

- Inspection and possible repair of pipe coatings
- Bevelling
- Lining-up
- Welding
- Inspections and possible welding repairs
- Field joint coatings
- Tagging, marking, numbering.

This procedure shall demonstrate that the pipelines configuration (geometry of welding ramp-stinger-unsupported pipeline section) is such as to keep the pipeline stresses within allowable values as per the Stress Monitoring System principles and requirements (see § 6.5).

The lay-barge mooring system shall be assessed with regard to the various morphological and bathymetric conditions and the necessary tension for safe pipe laying.

The assessment shall include in particular:

- Tension in mooring lines and general anchor pattern
- Anchor types
- Sequence of anchor relocation and mooring in congested problem areas
- Barge position and heading
- Lay-barge maximum movement as a function of bow and stern mooring lines characteristics
- Horizontal translation and lay-barge correct alignment in relation to laying route axis in case of dynamic forces acting against the unsupported pipeline section and on the same lay-barge (tri-dimensional mathematical model).

6.6 Particular laying procedures

In the case of uneven situations which may occur in the course of normal laying phases, dedicated procedures shall be developed, with due consideration on the necessitated techniques and equipment.

For these cases, offshore control system of pipeline touchdown point on the bottom shall be available, in order to carry out laying operations complying with the final conditions (target areas, tolerances for pipeline location) provided for in the design.

If the situation is not perceived in advance, new procedures shall be developed and/or designed and approved, aiming at reducing the induced loss of time.

Special laying procedures shall treat initiation, laydown, pipeline crossings, installation of tee, sled in line, piggy back lines, and shall refer to the standard laying procedure.

The procedure shall therefore describe:

- Method of high accuracy lay barge positioning
- Underwater inspection immediately preceding pipe laying
- Underwater inspection to constantly check the pipeline at the touchdown point
- The variation of pipeline tension simultaneously with lay-barge lateral displacement
- Anchor pattern and mooring lines tension.

6.7 Contingency procedures

Procedures describing in detail which action is to be taken in the event of major equipment failures, adverse weather, sea conditions and accidents shall be prepared.

Topics, which specifically need to be addressed, are:

- Mooring system
- Tensioning system
- Abandonment/recovery system
- Stinger
- Assessment of suspected pipeline damages
- Care of proven damages on pipelines, including:
 - Abandonment/recovery head suitable for flooding/dewatering and pigging
 - Accurate abandonment/recovery head localisation means
 - Detailed reporting system on accidental event.

Specific procedures for buckle treatment shall reflect the following three typical cases:

- Dry buckle - Pipe can pass through tensioner
- Dry buckle - Pipe cannot pass through tensioner
- Wet buckle.

6.8 Anchoring procedures

Anchoring devices shall be clearly identified on the list of spare parts, which mainly include:

- Anchors Weight/type
- Steel wires Diameter - Safe Working Load



- Pennant Buoy Weight/type - Floating capacity
- Shackles Weight/type - Safe Working Load

During construction, all anchoring obstructions within 500 m of the anchor pattern of the lay vessel shall be located.

Anchors shall be placed within a maximum range of 15 m around the target locations.

Anchor catenary to be maintained shall ensure a minimum vertical clearance of 10 m directly above any on-bottom facilities.

Anchor wires shall not be dragged across any existing pipelines.

Anchor handling vessels carrying the anchor on deck shall be used.

Any alternative anchor handling procedures may be proposed, providing they are fully acceptable on safety and efficiency basis.

All existing pipelines likely to be within 500 m of the extremities of lay barge anchor pattern shall be located by survey vessel and "as surveyed" charts drawn.

These charts shall be used for reference when running anchors near or over these pipelines.

Drawings of proposed anchors showing dimensions, weights in air and water, method of anchor wire connection, size of pennant wire shackles and buoys shall be supplied in the Construction Manual.

The accuracy of the laying of the pipeline system shall be monitored to ensure it is laid in the correct position.

The lay-barge will be equipped with the positioning systems approved by COMPANY.

A chart showing the position of the lay-barge throughout the lay shall be updated as necessary during the installation works and made available on the installation vessel.

The chart shall be generated on-line and be used for monitoring the accuracy of the lay.

Both theoretical and as-laid touchdown point locations shall be plotted on the same chart.

Weld and joint numbers should be annotated on the chart.

At sections where the positioning of the pipeline is critical, the charts shall be generated at a larger scale.

6.9 Dynamic positioning procedures

Vessel using dynamic positioning system shall comply with [DNV OS F101](#) - Section 9 C500.

6.10 Construction Manual

The construction engineering documents necessary to achieve the WORKS in accordance with the Project Requirements shall be prepared and collected in a Construction Manual, which shall contain as a minimum the detail procedures and design documents as per § 6.1 and especially the "Pipeline Characteristic Monitoring System", as per § 6.4.

6.11 Mobilisation Manual

The Mobilisation Manual shall include the following documents:

- The detailed installation spread characteristics (including onshore means, if required), with their applicable QA/QC procedures and the inspection and testing results thereof
- The named personnel with their CV, qualifications, etc.
- The detailed list of components, spare parts, consumables, etc., including Vendors' data, specifications and calibration certificates, etc.
- The description and user's manual of the pipelaying software(s) onboard the laying vessel(s).

The spreads required for the project shall be mobilised according to the Mobilisation Manual.

The pipelay spreads, spool pieces installation and tie-ins spreads, diving spread, gravel dumping spread and pipeline crossings construction spread shall be required to undergo a survey as part of their mobilisation.

If so requested by the project, access to or dismantling of items and parts to be inspected shall be given or done.

If a COMPANY survey reveals that equipment is not in acceptable condition, the necessary repairs or replacements shall be carried out as per the Project Requirements.

The repairs and the replacements will also be subject to a survey.

7. Installation spread and facilities

7.1 General

The installation spread shall be furnished fully in compliance with the technical specifications in order to complete the work efficiently within the time as indicated on the master construction schedule.

The installation spread comprises the following means and their associated personnel, as adequately for the needs of the Project:

- The laying vessel, with the necessitated equipment
- The supply vessels for the line pipe and other equipment to be installed by the laying vessel
- The diving support means, either onboard the laying vessel and/or onboard a dedicated support vessel
- The associated support vessels and their equipment as necessary for survey, subsea repair, towing, anchor handling, etc.
- The associated support vessels as necessary for trenching, backfilling, etc.
- The associated onshore means, such as pre-assembly yard, pulling systems, etc.
- The means and equipment associated to contingency repair works.

All of the equipment shall be in good and serviceable condition and in ready status to perform the work as per the Project Requirements and specifications, with no lost time and with full spread operability throughout the duration of the installation works.



As part of the Contingency Plan, it shall be demonstrated that provisions have been made to locate and obtain spare parts of major equipment should the original major equipment be damaged.

Pipelay vessel and its equipment, as well as any other vessels and equipment proposed for the site works shall be suited to handle the Pipeline System under the routing and environmental conditions of the Project, and taking also into account the presence of any other site works in the concerned area.

A dedicated survey vessel shall assist the pipelaying spread during the complete operation.

All survey and positioning activities shall comply as a minimum with **GS GEO 201**.

7.2 Diving spread

Diving teams and suitable diving equipment able to perform regular underwater inspection of the stinger and/or subsea construction works on the pipeline not limited to repairs may have to be mobilised.

It is to be noted that in some countries diving operations are not recommended.

Diving methods and means shall strictly reflect **GS STR 461** requirements, including full compliance with international and local diving regulations.

Inspection and as necessary tests and checking of the diving system shall be conducted by a reputed independent surveying agency.

It is to be noted that the duration of a full survey for a saturation diving system may take more than 72 hours.

All subsea operations shall be monitored from the surface using colour video camera and recorded on VHS video tapes.

A sufficient number of divers to perform efficiently the works at sea shall be provided.

7.3 ROV spread

At least one OBSROV shall be available at all time during the works at sea.

Depending on the nature of the subsea works, additional WOROVS and OBSROVs may also be required by the Project.

OBSROV(s) shall be used to check laying and connection operations, in particular at the beginning of these operations and at the end of the installation or under any circumstances (riser clamps, spot check of sea lines, anodes, flanges, etc.).

They shall be suitably equipped with colour records on videotapes -VHS standard- (with comments and video titles as necessary).

WOROV(s) spread shall be mobilised during the installation phase in order to ensure specific subsea works such as -but not limited to- diverless tie-ins, removal of debris, site reinstatement, etc.

Any WOROVS to be mobilised in the frame of the Project shall comply as a minimum with **ISO 13628** requirements.

7.4 Station keeping and positioning system

A dedicated positioning system suitable for the performance of the work shall be installed.

It shall be approved by COMPANY and in particular the following requirements shall be covered:

- All vessels working in the frame of the Project shall use the same positioning systems
- The selected systems shall provide a continuous position compatible with the required positioning tolerances imposed by the choice of the pipeline route and anchor locations
- The systems shall have a 100 % redundancy or standby to allow for breakdown
- The systems shall provide the following information:
 - Position relative to the chosen grid reference system
 - Geographical position
 - Visual display and record of planned and actual pipeline route and actual track
 - Visual display and record of other positioned fixed structures
 - Offsets from antenna position.

During installation within congested areas or during start up and laydown, a local positioning system of greater accuracy may be required, such as acoustic transponder systems. ROVs may be used to monitor the touchdown point.

7.5 Weather forecast and metocean condition

Approved equipment shall be provided to continuously monitor the environmental data during laying operations including: wind speed and direction, current speed and direction, air and sea temperatures, wave heights near the barge.

An accurate weather prediction system (2 days forecast as a minimum) shall be continuously available in order to enable safe contingency measures such as standbys, temporary abandonment and recoveries.

Links between these systems and The Pipeline Stress Monitoring System shall preferably be available for decision making purposes during the pipelay works.

8. Material

8.1 Care of material

Packaging, storage, handling and transportation of the line pipes and associated materials for the purposes of the Project shall be performed according to **GS PLR 406** requirements.

In addition:

- Any permanent and temporary storage areas, facilities and means for the Project shall be fully documented and permanently accessible
- Any damaged item shall be repaired, or replaced if repair is not allowed or not possible
- A list of the damaged items, indicating the reinstatement method performed, shall be maintained.

8.2 Marking of materials

This paragraph does not address tagging during pipelaying operations.

The marking of all materials, the materials traceability procedure and the maintenance of proper records of the materials records shall be accessible at any time.

All line pipe, fittings and other materials shall be thoroughly inspected and made good and the list of the found damages, inclusive of the corrective or remedial measures shall be prepared and available.

9. Laying route preparation

9.1 Laying corridors

When laying a pipeline, due consideration shall be given to the presence of any existing facilities:

- A stand alone (section of) pipeline refers to such a route section where there do not exist any facilities
- A congested area represents such a section of pipeline route where there exist any facilities or where restricted access is requested in the view of a facility to be installed in the future.

Given the above, laying of the pipeline must be done within a corridor which shall fulfil the following requirements:

- A stand alone pipeline shall be within a 30 m wide corridor (± 15 m on either sides)
- Within congested areas, the corridor shall not exceed 10 m (± 5 m on either sides) and
- A minimum separation of 5 m between the nearest existing facility shall be obtained
- It is outlined here that these requirements are also applicable for any special point on the pipeline route, such as tie-in templates, manifolds, etc.

9.2 Pre-survey

Before the commencement of pipe laying works, a pre-laying survey of the pipeline system installation corridor shall be conducted according to the applicable reference documents.

The reference to be used shall be the same as the one specified for the pipelaying works (same KP 0).

Detailed seabed characteristics shall be surveyed to allow adjustment of installation equipment, if necessary.

The pipeline pre-laying survey shall be performed using an echo sounder, a side scan sonar and a magnetometer.

The pre-survey shall also aim at collecting freespan information, which shall be used to specify the requested freespan reduction works (see § 9.3).

Pre-survey results shall consist of specific maps and drawings enhanced with comprehensive dedicated markings reflecting the main findings.

9.3 Freespan assessment

From the pre-survey results, a freespan assessment task shall be performed in order to derive the necessitated freespan reduction works.

For this purpose, a spreadsheet shall be implemented, showing out the Project's reference of the pipeline and for each change in its cross-sectional specification:

- The steel pipe OD or ID, whatever the constant value, in mm
- The steel pipe WT, in mm
- The steel grade in MPa
- The corrosion coating WT, in mm
- The concrete coating WT, in mm
- The maximum span length under hydrotest condition, in m
- The maximum span length under operating condition, in m.

When processing freespan assessment, it shall be demonstrated whether or not the pipe will deflect and gain any intermediate supports under in-service conditions and the location of these supports as well as their suitability as permanent supports (integrity, susceptibility to scour, etc.) shall be fully assessed from the pre-survey results.

The location of freespan reduction supports, as well as the required pipeline lift-up height shall then be specified so as to optimise the in-service stress/strain behaviour of the pipeline.

9.4 Seabed preparation

The construction route shall be cleared of any debris and obstructions assessed as hazards, in order to facilitate the proper and safe installation of the pipelines and dog-legs.

Such debris and obstructions shall be cleared and disposed in the respect of § 4.2 requirements.

Adequate provision for keeping the route clear of all waste materials and refuse as the works proceed shall be made accordingly.

For high temperature pipeline, where upheaval buckling phenomena are anticipated, special attention will be paid to the possible future preparation of the pipeline route.

Pre-sweeping and other subsea works to limit pipeline free spanning shall be evaluated.

9.5 Existing facilities

The proposed installation procedures must be designed not to damage any existing facilities (fixed or floating structure as well as submarine facilities such as pipelines, cables, templates, manifolds, etc.).

The exact location of each of the above facilities shall be verified so as to ensure that they will remain safe at any time during the site preparation and the installation works.

Intention to work near any one of the existing facilities shall be subject to a specific advanced notification.

Loads shall not be applied on the platform or jacket structures.

Installation of mooring lines above existing an subsea facility shall comply with Section 5 of the **GS STR 402**.

10. Installation works

10.1 General

This section provides the minimum requirements to be fulfilled during the preparation, site preparation and installation phases for normal and contingency conditions.

10.2 Laying direction

Unless otherwise stated by the Project Requirements, lay direction together with reason for selected options shall be proposed and duly documented in the Construction Manual; as a guideline, the lay direction shall minimise any possible interferences/clash with other activities.

10.3 Pipeline standard assembly and laying

10.3.1 General

Installation of the pipelines shall conform strictly with all applicable laws and regulations. The installation works shall also be performed in compliance with the applicable specifications and also in compliance with the following guidelines:

- Stress in the pipelines shall be controlled during the lowering, laying and repairing to prevent yielding, buckling or weakening of the pipe
- During the laying operations, equipment which will ensure the pipelines adequate protection from external forces which might cause buckling, weakening or overstressing of the pipe shall be provided as necessary
- All equipment used in handling and cradling coated pipe shall be of a type which will not damage the coating
- Pipe shall be handled in a manner to prevent damage to the pipe walls and bevels. In lining up the pipe, care will be taken so that pounding with a sledge hammer will not be necessary
- Damaged pipe ends will have to be re-bevelled before welding
- When laying operations are interrupted and abandonment of pipe is decided, the open end of the laid pipe shall be securely closed and shall not be opened until laying is resumed
- Any pipe end lowered in the water shall have watertight caps, installed with provisions for flooding and dewatering
- In case of accidental water ingress any sections, incriminated sections shall be swabbed or pigged in a satisfactory manner before that section is tied into the line, according to the dedicated procedure
- Special care shall be taken to ensure that the electrical bond from the anode bracelet to the pipe is not damaged during the handling and installation of these pipes.

10.3.2 Pipe inspection and repairs

According to the Project Requirements and before bringing a pipe to the assembly line, internal and external inspection shall be carried out on each pipe, and the observed unacceptable defects shall be reported.

Each line pipe presenting any defects beyond the specified limits shall be returned to shore, otherwise repairs shall be processed according to the following requirements:

- Defects in the corrosion coating and in the concrete coating shall be repaired
- Localised repairs can be allowed only if less than 20% of the coated area is damaged, otherwise the pipe shall be rejected
- Hairline circumferential concrete cracks can in certain conditions not be considered as coating defect
- Pipe bevelled ends shall be visually examined and corrected where necessary
- Anodes must be firmly attached on the pipe and if an anode bracelet is loose or a connection cable is found disconnected, the pipe shall be returned to shore
- Repairs to the concrete coating should be made with materials of equivalent strength and weight to that of the original coating
- Concrete defects on pipe joints may be manually repaired onto the barge providing defects surface area does not exceed specified thresholds as specified in **GS PLR 410**.
- Such defects can be repaired either by concrete, polyurethane filler foam or marine mastic application. In case of concrete application minimum curing time is of 5 days
- A "returned pipe record" shall be completed for each pipe returned from the marine spread to shore.

10.3.3 Pipe internal cleaning

All necessary precautions to keep the inside of the pipes free from dirt, waste and other foreign matters shall be taken.

Before welding, each single length of pipe shall be visually inspected and cleaned inside (internal coating, if any, must not be damaged during the cleaning) using appropriate tools such as brushes, swabs, etc., as per Project's procedures.

10.3.4 Tagging

The sequential tagging of pipeline joints shall be done at the line up station and touched up after the pipe has passed through the tensioning device.

- Suitable quick curing marine paint shall be used
- Characters shall be visible and identifiable by ROV (typically 400 mm height x 50 mm wide)
- Each pipe length shall be tagged on the concrete coating (or on the corrosion coating, if not a concrete coated pipeline) at the 10 o'clock and 2 o'clock positions and as close as possible to the weld.

Proper recording and maintenance in the pipe joint identification marks and numbers and of the sequence as-laid in position shall be done.

10.3.5 Field welding

All welding operations and NDT inspection shall be carried out in accordance with the Project Requirements.

Protection of personnel and X-ray prevention shall be implemented according to Project Requirements in terms of safety at works.

Weld repairs after the last tensionner shall be fully substantiated by calculation notes and associated procedures, otherwise they are not allowed.

During the process of welding, repairs of weld defects on the stinger of the barge are not allowed to be carried out and more especially as field joint coating is to be pull out and reinstalled.

10.3.6 Station keeping and positioning

Whatever the involved works at sea, proper monitoring/controlling of the work vessel station keeping or displacement shall be permanently conducted and reported.

Uneven or failure hereof shall be fully documented and contingency procedures shall be applied, however upon firm Project approval/request to doing so.

10.3.7 Buckle detector

A buckle detection system shall be operational throughout pipeline installation shall be provided. The gauging plate shall be in accordance with **GS PLR 100**.

The detector shall be pulled through the line at a sufficient distance behind the lay vessel to be certain that the pipe is without buckles or other deformities after being laid on the sea bottom.

In addition, a load cell shall be installed on the pulling cable of the buckle detector.

This unit shall be a complete recording with an immediate alarm system: should a buckle or deformation be detected, its repair shall be proceeded immediately in accordance with the Project's procedures.

10.4 Connections

10.4.1 Surface welded connections

Similar surface welding equipment, procedures and specification as those dedicated to line up on board a conventional lay barge shall be used. However, it shall be outlined that there is no over length of the two pipes, so that the following procedure is required:

- Lift up one end of the pipe
- Add sufficient pipe joint to get the required over length
- Move the barge
- Lift up the other end
- Cut and clamp both ends into axial alignment
- Weld spool piece to bridge the gap



- Inspect the welds
- Lower the pipeline back to the seabed in a series of steps while the barge moves progressively sideways.

10.4.2 Diver assisted connections

The suitability of the diving spread and means shall be checked in the respect of the type of connection - either of flanged or mechanical connector types - to be performed and this check shall especially focus on the operability of the tools as well as on the safety of the subsea works.

10.4.3 Diverless connections

When diverless mechanical tie-ins are anticipated - mainly as a consequence of water depths out of operational diving ranges - the operational means and procedures shall fulfil [ISO 13628](#) requirements, especially for the WROV/ROT operational requirements.

10.4.4 Hyperbaric works

Three main items have to be cleared up within the Construction Manual:

- Diving and subsea intervention equipment including, as applicable, ROV, diving spread, operational and contingencies procedures, safety procedures
- Pipe sections mechanical alignment - H frame - clamps
- Welding procedure detailing the welding selected and approved process as per [GS PLR 420](#) or [GS PLR 421](#), as applicable.

The welding procedure shall comply with the applicable reference documents for sweet service or sour service, as applicable.

10.5 Freespan reduction

During the pipelaying phase, any new freespans shall be subject to the assessment method presented in previous § 9.3.

Temporary free spanning must not induce fatigue concern.

Then, freespan reduction supports shall:

- Be of either inflatable grout bags or any approved alternative devices.
- Be installed at the assessed locations and shall achieve the required lift-up values.
- Be installed as soon as practicable after laying and always before it is waterfilled for the hydrostatic test.

Bags containing either cement plus sand or sand alone are **prohibited**.

The type of grout bags, cement sand ratio, etc., and all grouting shall fulfil Project requirements.

The bearing width of the grout bags across the pipeline should be at least three times the outside diameter of the pipeline.

Grout bag support shall embed the pipeline over at least one half of the outside pipe diameter.

Settlement as well as scouring of the supporting bags in soft seabed shall be accounted for.

10.6 Corrosion protection

10.6.1 Anodes

Anodes features and installation shall comply with the **GS COR 201** and all other applicable reference documents.

Care shall be taken to the dimensions of the anode, which could be damaged during their passage on the rollers of the stinger or in the tensioners.

The method of connection of the anode onto the pipe shall be done as tabulated below and this connection shall be protected by relevant anti corrosion coating.

Welding of anode pad is always preferred, but in some case, the brazing by electrical discharge method could be authorised if the conditions of the following table are fulfilled:

Laying method	Concrete coating	Position of electrical connection	Pipe grade	Electrical discharge pin brazing
S-lay	No	Pipe or coating mill	< X60	Authorised
			≥ X60	On double plate
	Yes	On board before tensioning	All	Unauthorised
		On board after tensioning	< X60	Note 2
			≥ X60	Note 2 + on double plate
		On piggy back method	< X60	Authorised
			≥ X60	On double plate
		J-lay	On board before tensioning	All
On board after tensioning	< X60		Note 2	
	≥ X60		Note 2 + on double plate	
Reel-lay		On board before tensioning	All	Unauthorised
		On board after tensioning	< X60	Note 2
			> X60	Note 2 + on double plate

Note 1: For all other laying and/or other electrical connection methods, double plate is required with the associated requirements indicated in the note 2 hereunder.

Note 2: Pin brazing by electrical discharge could be authorised if the supplier demonstrates that the anode does not move onto the pipe when the anode goes through the stinger.

Note 3: In case of internal coating, the double plate method shall be always required.

10.6.2 Field joints

Field joints shall be coated on the line up of the barge in sequence of the last fillet bead welds accepted.

Any coating material (anti corrosion primer, marine resistant mastic, synthetic resin, shrinkable sleeves or other mean) applied onto the pipeline must be done only as per Project's procedure and in agreement with the applicable reference documents for anti corrosion coatings.

The following parameters shall be checked according to the relevant procedures:

- Appearance
- Adhesion

- Electrical porosity
- Cathodic disbondment
- Thickness
- Tensile Impact Strength
- Final holiday detector inspection before pulling out the line up.

10.7 Offshore terminations

10.7.1 Spools

Unless deemed impossible, spools shall be pre-assembled and tested and inspected in onshore construction yards prior to be shipped to sites on cargo barge.

10.7.2 Tie ins and spool connections

Pipeline to offshore termination tie-in systems acceptable systems are:

- Surface welded connection
- Hyperbaric welded connection
- Diver assisted mechanical connection
- Diverless mechanical connection.

10.8 Onshore terminations

10.8.1 General

Onshore termination shall comply with **GS PLR 403** and/or **GS PLR 404**, as applicable.

Onshore termination may consist either of:

- Access to a natural beach landfall
- Access to an existing structure such as dock, pontoon or wharf.

Natural beach landfall can be performed according to one of the following methods:

- Pipeline onshore preassembly, then on-bottom (negative buoyancy), off-bottom (trimmed buoyancy) or near surface (positive buoyancy) towing-out
- Pipeline onshore preassembly and lay barge pulling (controlled tension method)
- Pipeline lay barge assembly (standard) and beach pulling.

In the case of natural beach landfall, special care shall be given to environmental requirements.

Any other onshore civil works at the landfall, such as access roads, working areas, transport of equipment, crane facilities, mobilisation and demobilisation aspects shall also be performed in compliance with Project requirements.

10.8.2 Additional buoyancy

Whenever additional temporary buoyancy is used, the buoyancy means shall be recovered upon completion of the laying works, unless otherwise stated by Project requirements or dictated by fully documented specific reasons.



10.8.3 Pipeline pulling

The pulling winch shall be preferably located on the laying vessel, in order to ensure a more efficient tension control.

Except for very light pipes, it is usually recommended to pull the pipe during the rising tide, when the pipe is submerged, but the prevailing broadside current during pulling should not exceeds 0.5 knots.

10.8.4 Barge equipment

The lay-barge must be fully equipped as in conventional laying except that the stinger may be shorter or sometimes no stinger is required for this type operation. Buoyancy tanks may replace the stinger in shallow water.

The barge must be carefully positioned since the pulling cable must be laid accurately in the pulling axis.

10.8.5 Shore equipment

The main shore equipment is the pulling winch and its associated equipment.

In order to retain the highest pulling capacity for the end of operation, since the pipe will then be entirely laid and part of it not be submerged, it is recommended to use either capstan winches or linear winches with the winding drum separate from the winch.

The pulling force can be also increased with tackles.

Onshore pulling facilities and equipment shall be considered as temporary ones and therefore subject to environmental and site reinstatement requirements set out in the present document.

10.8.6 Pipe trenching in shore approach

Trenching depth shall have been fully defined according to the local conditions, as per the applicable design requirements specified in the particular project specification and the trenching monitoring system shall be provided and shall remain active until the completion of the works.

If the riser is already in place on the platform, so that the battery limits of the installation works consist of the installation of the spoolpiece and its connection to the riser bottom end, otherwise, the battery limits are the installation of the riser and its supports onto the structure.

It is outlined here that the prefabrication and erection of the spoolpiece alone or the spoolpiece and the riser together shall be performed according to the as-built situation of the receiving offshore structure and with the applicable reference documents.

10.9 Crossings

Crossings of existing lines shall have been engineered according to the particular project specification. In the course of the preparation of the detailed procedures and in the course of the installation works, any changes of the design and/or location of any crossings shall be fully documented and submitted to Project's approval.

Concerning the characteristics of the crossings, any discrepancy found during the laying works shall be reported and evaluated in terms of the constructional consequences (technical, time schedule, risks and safety).

The crossings shall be designed in accordance with **GS PLR 100** requirements.

10.10 Mechanical protection

Pipeline mechanical protection shall not be performed on a section prior to freespan reduction and intermediate hydrotesting.

Amongst the various methods, the following ones shall preferably be contemplated:

- Trenching
- Dredging
- Artificial backfilling, in conjunction with trenching or dredging
- Natural backfilling, in conjunction with trenching
- Artificial covering.

Whatever the applied method, the following requirements shall be addressed during the execution of the works:

- Pulling parameters shall remain within design ranges so as not to compromise the integrity of the pipeline and its coatings as well as the design parameters of the protection
- Reversibility/back-up procedures of the operation shall be ensured, as required
- Implications of the loss of access on the protected length of pipeline shall be taken into account for the selection of the post-lay inspection and pre-commissioning activities.

10.10.1 Trenching

The trenching depth and profile shall be regulated within the prescribed limits to ensure the pipeline is not over stressed during the trenching itself or during its operation period.

Loads imposed on the pipeline during trenching shall be monitored.

Calculation note shall be made in order to evaluate the extra loads imposed when pipeline is flooded.

Care shall be taken to:

- Maintain an even profile and to avoid damage to the coating
- Control the dredged profile to reduce the potential for pipeline spanning
- Avoid premature natural backfilling prior to the laying operation.

10.10.2 Protection and pipeline coverage

Selected material shall be placed in a controlled manner to achieve a smooth profile and to avoid damage to the pipeline and its coatings.

Whenever requested by the local regulations on dumping at sea, local statutory authorities shall be consulted before any material are placed for such purposes.

Two following materials covering techniques can be used:

- Mattresses pipelines coverage for particular points such as: crossing, isolation valves, or dog leg spool expansions
- Gravel or rocks dumping for straight isolated sections of pipeline.

Alternative methods can also be presented for Project's evaluation.

Mattresses

Shape, size and flexibility of mattresses to enable accurate placement.

The possible requirement to remove mattresses at some future date shall be considered.

Gravel dumping

Pipeline protection will consist of dumping appropriate rocky materials onto the pipeline.

Design considerations for stone placement shall include the following:

- Stability of placed material
- Sinking of placed material into the seabed, particularly where the grain size of the material exceeds that of the underlying seabed, and built up to protective gravel/rock cover in progressively graded layers, if necessary
- Possible impact damage to pipe from falling rock during dumping
- Upheaval buckling of pipe line within the gravel when in operations
- Dispersion of gravel or rock material during placement operation, which may be reduced by the use of a fall pipe dumping trunk, connected on surface onto the gravel carrier vessel
- Cross-section of final gravel embankment and number of needed dumping passes.

10.11 Pipeline pre-commissioning

To the extent of the Project Requirements, a step by step description of proposed methods and equipment for Pipeline flooding, cleaning, gauging, and hydrostatic testing, shall be implemented in full compliance with with **GS PLR 501** and **GS PLR 502**.

10.12 Scheduled stand-by and abandonment

Based either:

- On Pipeline Characteristics Monitoring System and weather/sea-states prediction system together, showing out the occurrence of a predictable unsafe situation
- On any unpredicted works in the same area, with expected risks and safety issues
- Or as normally scheduled in the construction plan.

it may be necessary to interrupt the works at sea and possibly to abandon the pipeline or equipment currently installed.

This scheduled interruption of the works shall be prepared and run so as to avoid overstressing of the pipeline or equipment during the stand by period.

Abandonment shall be prepared so as to avoid overstressing of the pipeline or the abandoned equipment and the pipeline end or the equipment shall be accurately located by using buoy marks and locating devices (pingers, etc.), as necessary for further safe and efficient recovery of the abandoned facilities.

10.13 Contingency

A detailed report on any accident or damage occurred during operations shall be prepared.

In case of contingency abandonment, an abandonment/recovery head shall be equipped for localisation and easy recovery.

Requirements stated in § 10.12 shall be fulfilled.

Damage like buckles, collapses, etc. on the laid pipeline shall be repaired according to the contingency procedures.

Prior to any repair, a detailed underwater inspection and survey procedure to assess the extent of the damage and where the pipeline is to be cut shall be implemented.

10.14 Final and contingency surveys

Recording and mapping of all necessary data required to determine the as-laid and as-built position of the pipeline and associated appurtenances shall be obtained and gathered for the preparation of as-built drawings of the completed pipeline and appurtenances, as specified in the Construction Manual.

All surveys will be made in accordance with particular specifications concerning:

- Positioning of vessels
- Pipelay survey
- Mooring and anchoring.

A ROV survey shall be performed on the pipe already laid on the bottom to assess position, configuration, and status. This inspection procedure shall be detailed in the Construction Manual.

Such a survey shall be performed before free span corrections and flooding over the entire pipeline length.

The partial ROV survey shall be resumed at the completion of the free span rectification campaign on each incriminated area.

A certain number of additional surveys may be deemed necessary during Construction on special occurrences (for example: buckle detector stuck, incident during laying, loss of anchor, etc.).

Typical procedures covering all possible occurrences shall be submitted in the Construction Manual.

11. Additional requirements for flexible pipe, cable and umbilical installation

11.1 General

In this section, the generic term "**pipe**" means a flexible pipe, a cable or an umbilical.

11.2 Engineering

The following calculation notes shall be prepared, when applicable:

- Deck layout arrangement and strength
- Laying gutter dimension
- Lifting beam and installation aids capacity



- Riser hand over to Floating Support and/or platform
- I or J-tube pulling
- Ancillary equipment installation
- Arch Installation.

The following contingency procedures shall be produced:

- Pipe repair on lay barge
- End fitting/termination assembly on lay barge
- Recovery of pipe upon damage following passage through tensioner or laying gutter
- Curves of response to waves of laying spread.

11.3 Pipe Characteristics Monitoring System

Minimum Bending Radius and damaging pull loads both in straight line and during bending shall also be used to establish the operational schedule required in section 6.2.

The following procedures shall be generated, when applicable:

- Unreeling and reeling operation
- Installation of messenger line
- Pulling in I/J tube
- Connections (riser topside, wellheads, PLEM, shore approach)
- Buoyancy modules installation
- Arch installation
- Gas release valves opening/closure during installation
- Dedicated measures taken to ensure that damage of the external sheath is avoided.
- External sheath water tightness control.

11.4 Laying equipment

Laying methods using free wheels or braked reels without motorised device are not permitted. Redundant safety features shall be integrated so as to prevent free unreeling of the reel during laying.

All laying and unreeling equipment shall be reversible and shall be able to pull back on board the pipe.

Description and performance in terms of response time and control system of the hydraulic equipment for pipe unreeling shall be provided.

All equipment in contact with the pipe shall be engineered so as to prevent damage of the external sheath (e.g. Tensioner pad material, deck supports material)

Description of laying gutter and lifting beam shall be presented.

11.5 Laying operation

Through out installation, dedicated measures shall be taken to ensure that damage of the external sheath will be avoided.

Identification

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

Pulling

- Bellmouth entrance shall be continuously monitored by ROV
- Equipment shall have full safety control on opening devices
- Only Chinese fingers and fit for purpose designed clamps on pipe shall be used to transfer the pulling loads to the pipe.

Laying

- In addition to the requirements from section 6.2, the pipe angle at the laying gutter exit shall be continuously controlled and recorded
- Pipe length in excess shall be laid 100 m away from the termination structure or the subsea connection
- The bottom residual tension shall be as low as possible and should not cause free spans. It shall be strictly limited to a third of the damaging pull load calculated for the bent pipe.

Tie-in between two flexible pipes

- Tie-in between two flexible pipes end fittings shall be made by the means of a welded connection. Use of grayloc and subsequent nitrogen testing is not permitted
- During over-boarding of the tie-in connection, a section of pipe may not be supported any more by the laying gutter
- As a result, dedicated measures shall be engineered and taken to ensure that the pipe allowable limits in terms of bending radius and damaging loads are not exceeded.

11.6 Remedial works

As per section 10.5, bags containing sand plus cement or sand alone shall not be used.

11.7 Testing and Pre-commissioning

Flexible pipe hydrotesting shall satisfy the **GS PLR 501** requirements.

Flexible line pigging

- Pigs with polyurethane washers and plastic gel are allowed
- Pigs shall be fitted with new sets of bi-directional sealing washers
- The line shall be cleaned by flushing water (approximately four times the flexible pipe volume). Additional products (corrosion inhibitors, oxygen scavenger and bactericide) shall be injected and adjusted during the cleaning by circulating water operation.



Flexible pipe hydrostatic testing

- The air content shall not exceed 0.2% of the calculated capacity of the pipeline section under test for a smooth bore and 0.5% for a rough bore
- The test pressure shall satisfy the **GS PLR 501** and **API SPEC 17J** requirements whichever is the more onerous.

Flexible pipe depressurisation

- Depressurisation will be regulated to ensure a moderate and constant reduction pressure at a rate not exceeding 2 bar/min
- Values shall be recorded.

Flexible Pipe expansion/reduction

- During the hydrostatic test, measurement of the flexible pipe displacement shall be carried out
- Remedial action shall be undertaken if displacement is not in-line with the predictions from the calculation as per the **GS PLR 109** requirements.

12. Additional requirements for rigid pipe reeling installation

12.1 General

As a general requirement, pipe layer using reeling technique shall satisfy as a minimum all the requirements specified in the **DnV OS F101**.

12.2 Laybarge requirements

Functional trials of all the pipelaying equipment (straightner, tensioning device, aligner etc) shall be performed at the beginning of the mobilisation phase.

They shall demonstrate that these equipment settings ensure that, when installed, the pipe will meet the requirements specified in the detail design engineering and in **GS PLR 100** - as a minimum in terms of:

- Out of roundness
- Residual stress and strain
- Out of straightness
- Mechanical property of the parent material and of the weld.

In particular, the effect of straightening a pipe from a section reeled on the drum or a section from the top of the reel shall be addressed.

If required, the straightening device shall be operated with a combination of settings to cover the whole pipeline route.

For deep water application, pipeline ovality following the straightening operation shall be continuously measured, recorded and compared with the data used in the design.

This tool shall be engineered so as to monitor the pipeline ovality even when thick coating is applied on the pipe.



If the measurement is in excess of the design data, pipelay shall be stopped and the sections of pipe shall be removed.

Pipeline rotation shall be measured during pipelay for cases where in-line structures (tee – manifold) are installed.

Specific procedures shall be developed so as to ensure that structure installation tolerances are met.

Previous experience has shown that once the structure is on the sea bed, laying of the remaining pipe does affect the orientation of the structure.

As a result, the installation method shall be generated to capture this issue.

The installation vessel shall have on board hydraulic equipment which can recalibrate the reeled pipeline end to its nominal out of roundness value if required before tie in the reeled pipe.

Such operation shall be qualified and tested in order to make sure that the mechanical and geometrical characteristics of pipeline end are still within the design criteria.

12.3 Pipeline material requirements

A qualification program shall be carried out if demonstration of successful previous installation experiences of pipelines with same metallurgical and geometrical characteristics in a similar application (WD, etc) can not be produced.

The program shall include but not be limited to pipe bending and straightening in a test rig replicating the vessel main equipment.

Detailed justification shall be provided to demonstrate that the test rig and procedure adequately replicate the whole reeling process; alternatively, full scale tests shall be performed.

In addition, qualification program shall be conducted for reeling of pipeline with changes in stiffness (for e.g. due to a thick field joint coating).

Similarly reeling of pipe in pipe shall be qualified through a test program demonstrating the fitness for purpose of the reeled pipe in pipe.

For dynamic application (for instance for deep offshore riser application) if the fatigue appears to be a critical parameter in the design a full scale fatigue testing programme on the welded pipes after a simulation of the full reeling-unreeling cycle shall be performed.

Number of the welds to be tested, mean stress and stress range values, high-low values, etc., shall be defined with respect to the detail design dossier, parameters of installation and relevant code.

13. Scheduling

The detailed schedule of the WORKS shall be prepared according to Project key dates and requirements.

This schedule shall define all equipment requirements and anticipated equipment movements on a calendar time scale.

Computer aided systems of industrially proven types combining scheduling and reporting functionality shall be preferably used.

Mobilisation plans shall be carefully studied and organised in order to comply with the general schedule and the commencement date of the WORKS shall be consistent with the beginning of the selected laying season.

As a minimum the following milestones shall be incorporated, typical delivery dates being indicated for information only:

To be provided for Project's review and approval	Notices
Works to be performed near existing facilities	ASAP during the construction engineering phase
Anchor handling, station keeping procedures	
Laying corridors	
Permits and Certificates Applications	
Engineering dossier	2 months before mobilisation for the works
Site supply of linepipe and fittings	1 month before any transportation phases (earth, sea)
Construction Manual	1 month before mobilisation for the works
Mobilisation Manual	
Pre-survey report	

14. Completion file

All As-built information shall be supplied in a traceable form and collected in an as-built dossier which shall be supported by all necessary data records including as a minimum:

- Pre-survey records and maps
- NDT weld records on line up
- Pipelaying survey records, including video records, still photos, etc.
- Anchor positioning reports
- Pipe and weld progress records, including stand-by, contingencies, etc.
- Progress records and description of the special works
- Weather conditions during the installation works
- Stress control/stinger control reports
- Consumables daily consumption and balance sheets of line pipe, fittings and components
- Daily status of personnel and installation means.