Since 1961

SUPERLIT®

PIPE INDUSTRIES INC.

SUPERLIT GRP PIPES

MARINE INSTALLATION AND MAINTENANCE MANUAL

Contents

1. Premise

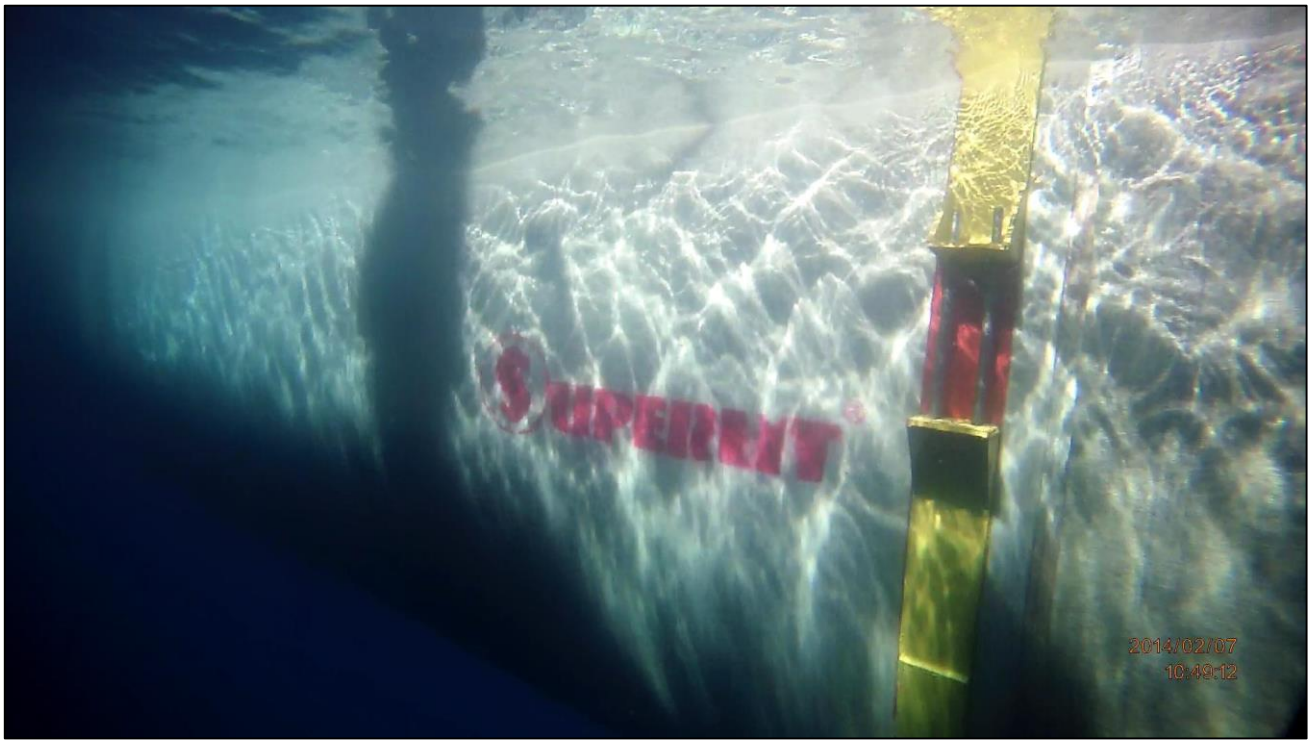
Marine pipelines, whether for power plants, desalination plants or waste water plants, are the critical parts of the projects because usually owners give the least priority at the start of the works and expedites when land works get closer to the finalization. It should not have been forgotten that without a cooling system or a discharge system of the plant, the plant itself has no value.

Present manual scope is to give to the owner some ideas and practical points on marine installation of large diameter Superlit GRP pipes.

We also aim to clarify a point which is generally misinterpreted by the owners; land installation and marine installation. While the marine contractor shall work in cooperation with the land contractor, there should be a tie-inn point which acts as a border between each other.

Unforeseen soil conditions or bottom configuration makes the marine installation works harder than land works. On top of these conditions, bad visibility due to the turbidity makes difficult the works of divers. And, even you have the best equipment, man power and experience, weather conditions decide if you can work or standby.

Following points will give you some ideas, starting from the engineering of the marine pipelines till the “As Built” preparation. It shall be taken note that each marine project has its own characteristics. It is not possible to copy and paste a section from a project to another one because, even in the same project, one meter chainage can be different from the following one.



2. Why to prefer Superlit GRP pipes for underwater applications

Superlit GRP pipes have proven its reliability by being one of the first 4000 ND marine installations without any problem.

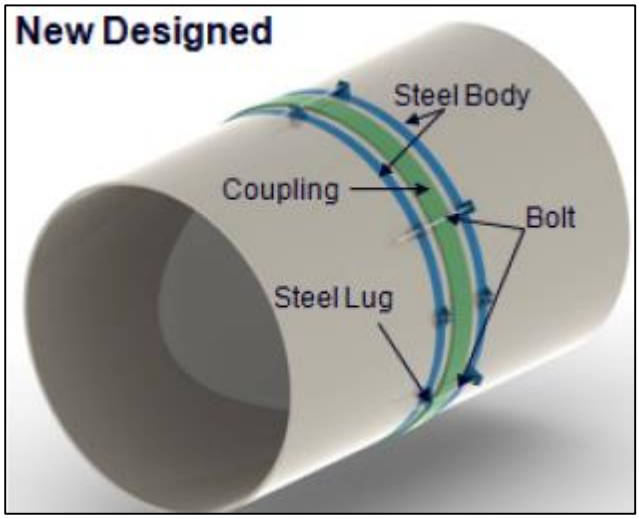
Apart the production quality, Superlit full face couplings and registered marine lugs put the product one step forward in the GRP market.

Integral full face gasket provides a better protection against leakage. This type of gasket does not dislodge or roll during marine installations; imagine the headache that the contractor will face to reinstall the gasket which is out of position during jointing of the pipe. Another benefit of this type of gasket is that it increases its efficiency in parallel to the increase of the internal pressure.

Another significant advantage of Superlit marine pipes is its registered **rotatable marine lugs** which presents a quicker and easier installation.

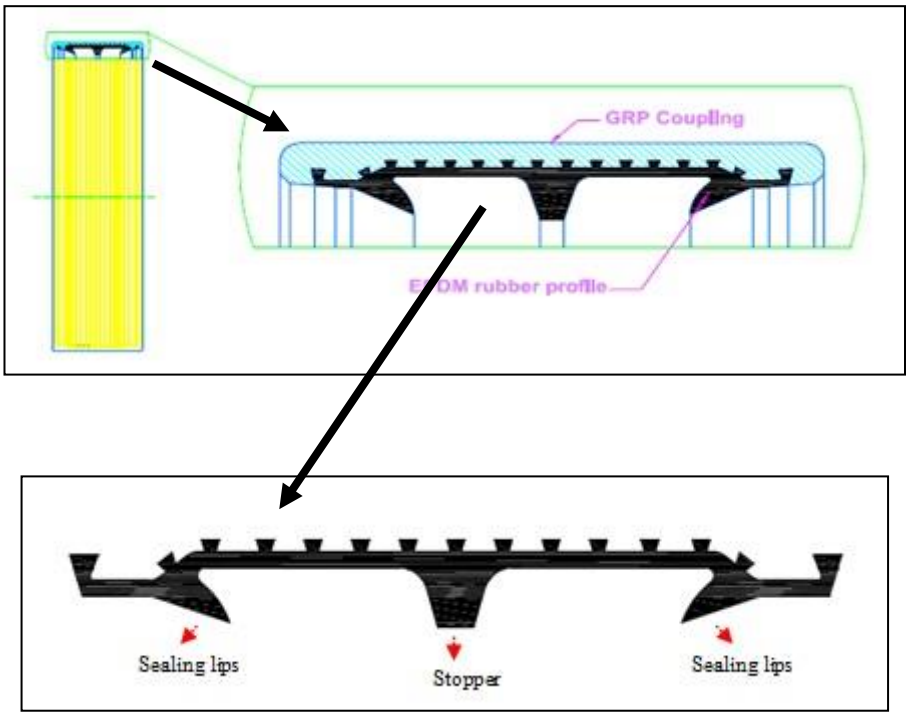
Traditional patch type of lugs requires the rotation of pipe in order to align the lugs for the rod insertion. While rotating a large diameter pipe on land requires a big effort, think about this hard operation when you are working at -50m or deeper depths with a limited visibility. It shall be also considered the limited underwater working time of divers which decreases as the depth increases.

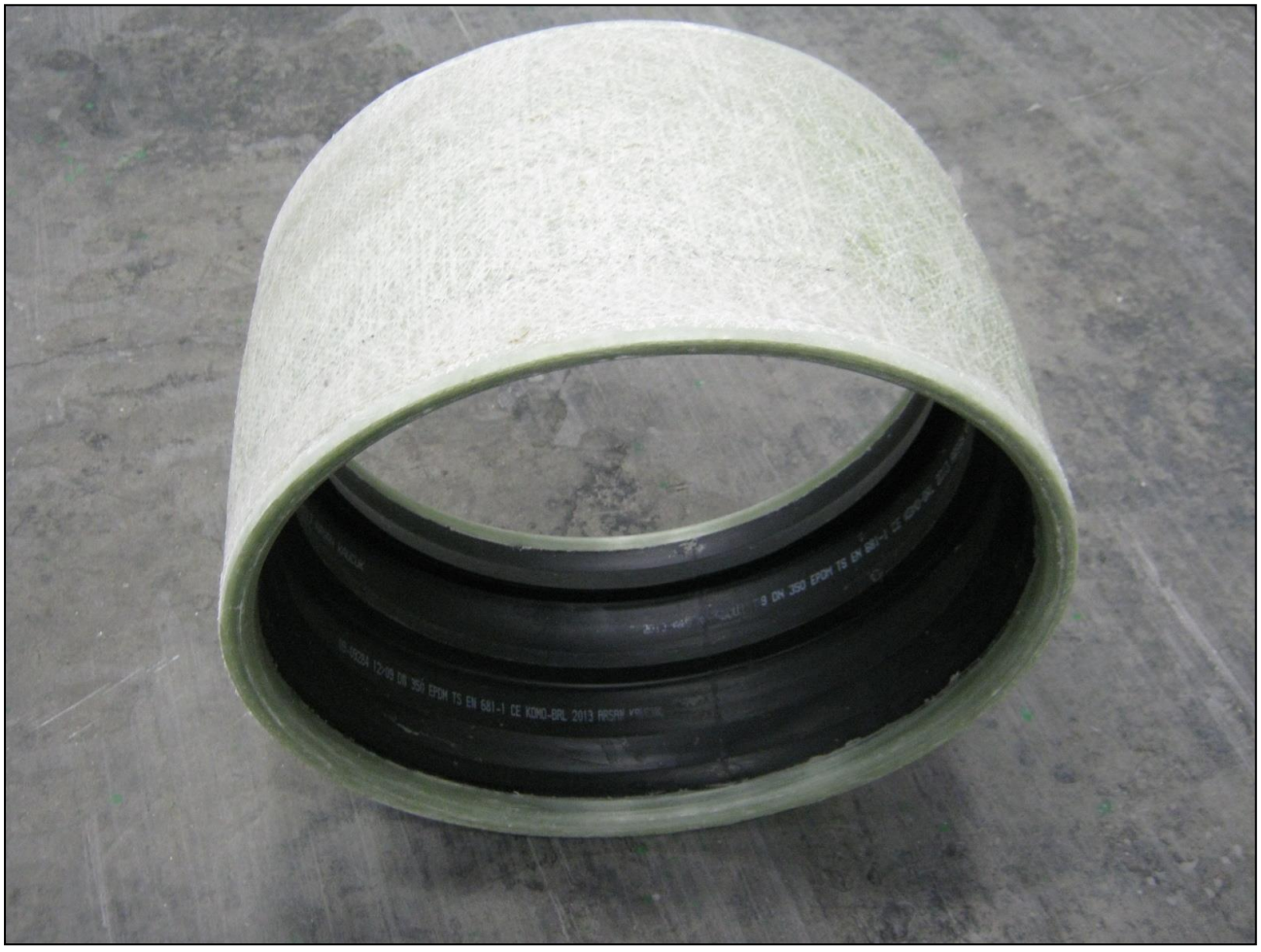
Superlit pipes will be at disposal of your facility all through the service life of it once its installation is realized as per design requirements.

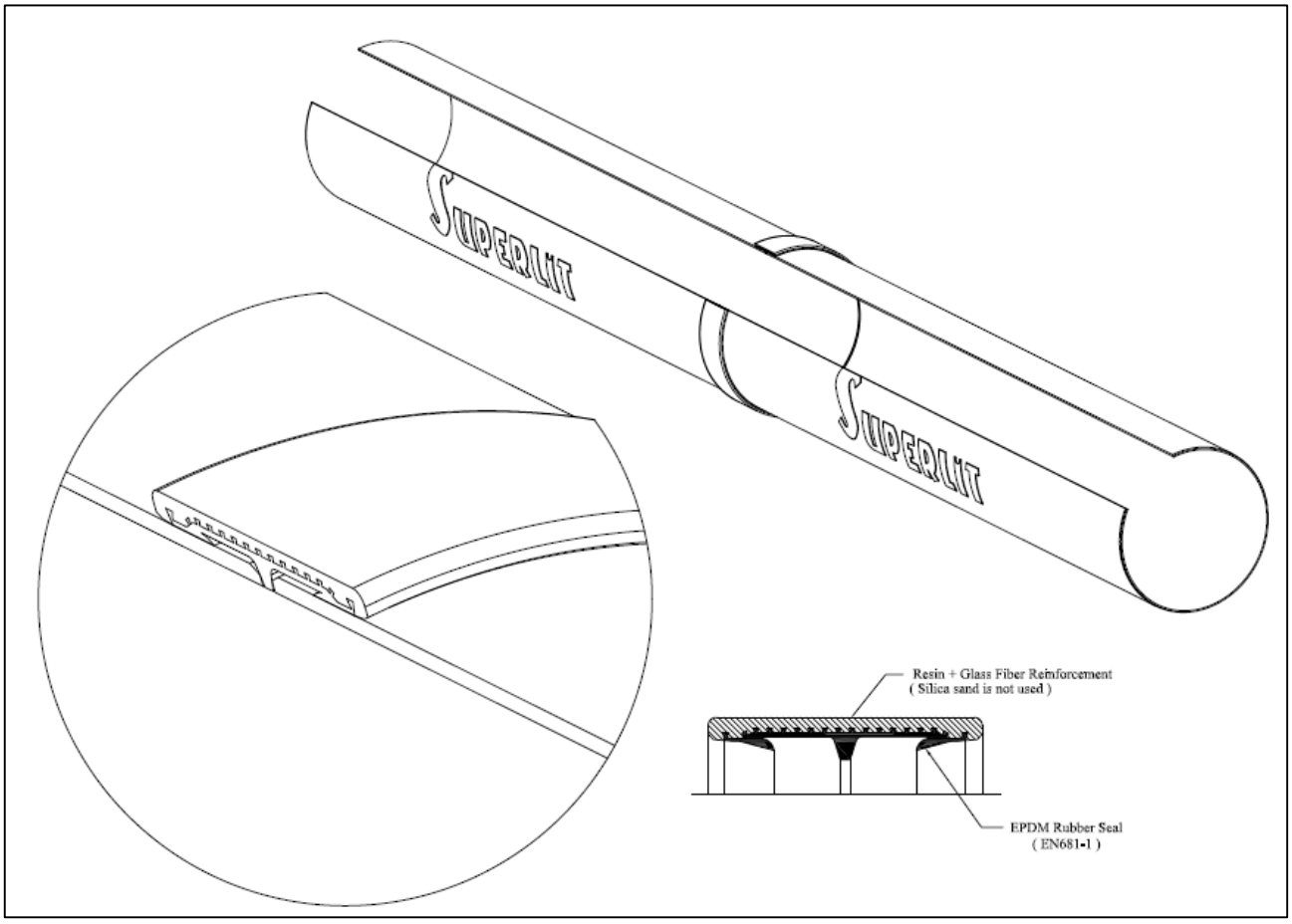


Rotatable marine lugs

Integral full face gasket



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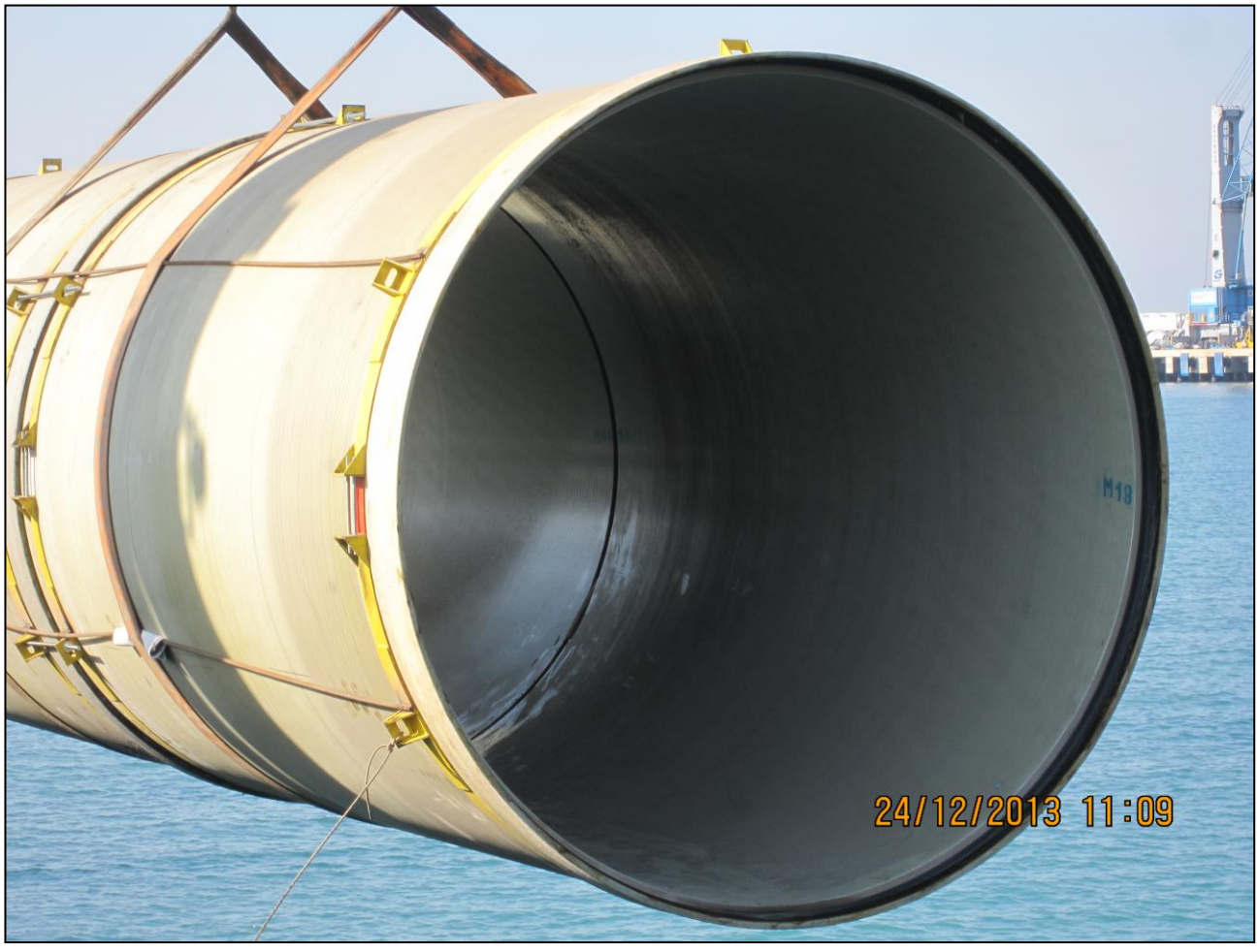
SUPERLIT
Resin + Glass Fiber Reinforcement
(Silica sand is not used)
EPDM Rubber Seal
(EN681-1)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3. Engineering approach

Design engineers in charge for the marine section of the project shall get the “design data” from the owner in order to decide or verify the pipe diameter, characteristics, dilution/recirculation study and the alignment.

During the Environmental Impact studies, a detailed marine survey [(1)] should also have been realized and this report, containing the Hydrographical (Bathymetric), Oceanographic and Geophysical Surveys, shall be delivered to the designer. The report shall include:

- Bathymetric survey
- Side Scan Sonar runs
- High-resolution seismic reflection profiling
- Surface sediment sampling and grain size analysis - Boreholes
- Physical sea water data and meteo-marine data
- Verification of present water/sediment quality
- Video inspection

Oceanographic conditions shall specifically give information on the waves and currents, including long term meteorological tables.

After receiving the above input data and survey report, the designer starts to verify the project which has been submitted to the Authorities for the approval purposes. This verification is followed by optimization of the design and finally issue of the construction drawings.

Designer also prepares the material specification, related Bill of Quantity and Method Statement which will enable the owner to issue the tender documents.

In some cases, before the tender for installation, owner requires pre-qualification of the subcontractor and this pre-qualification document shall be prepared solely according to the project requirements.

It shall be noted that some of the tender procedures (i.e. Fidic Red Book) are very hard to adopt for marine works because in some cases, you have to take immediate decisions in case of project deviations and these procedures limit this kind of approach.

Designer starts the works:

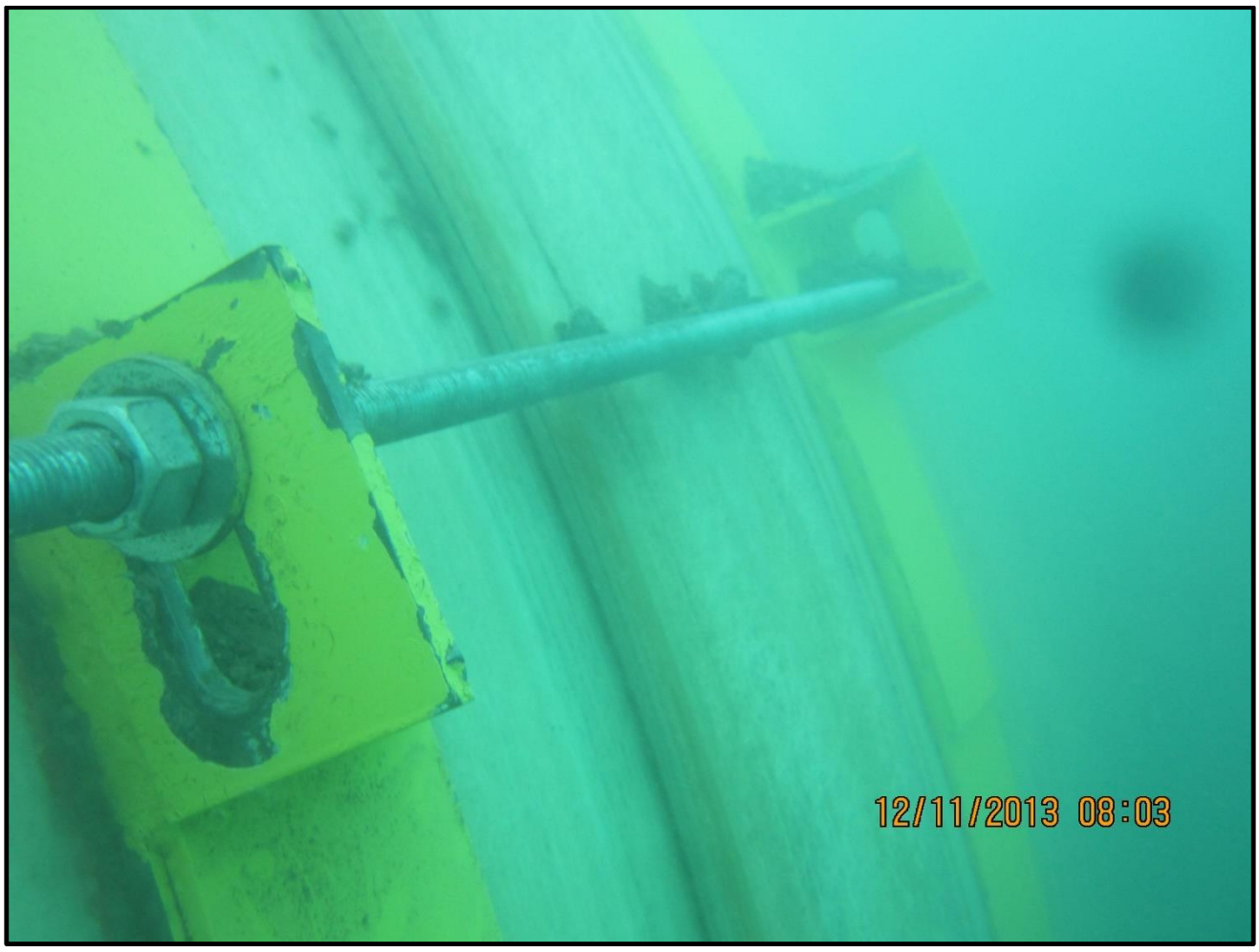
1- Evaluating the survey report in order to verify the alignment conditions and eventually relocate the line for a more economical solution if it does not create a recirculation and dilution problem. If required, designer shall cooperate with the surveyor for some additional runs if he feels opportune to relocate the alignment of the pipe.
2- Environmental Impact Assessment report shall contain the dilution calculation and designer shall check the line hydraulics, considering all the head losses at the diffuser ports and offshore intake head grids.

[1] As per the regulations, all the marine hydrographic and oceanographic surveys shall be executed as per the format of Department of Navigation, Hydrography and Oceanography and the report shall be submitted for the examination of the department (valid for Turkey).

3- Recirculation study report (for power plants). It is very critical to avoid the discharged thermal water entering to the intake system. This shall be verified by models considering the worst meteo-marine conditions.

For the deep sea outfalls, local regulations [(2)] shall be respected.

After the above verifications, designer starts the executive design of the line. He decides the bedding, haunching, backfilling and final armouring layer materials and heights at various lengths. He takes the necessary precautions for the safety of the line against external interventions.



Depending on the length of the lines, various sections are prepared for the shore approach area, for all through the length, for the diffuser and intake structures.

Designer considers tie-in points and settlement risk areas and eventually specifies special elements for these areas.

[2] For Turkey, pls. refer to “Waste Water Treatment/Deep Sea Outfall Project Approval Circular, dated 04/03/2014, with the number 53177711-010.06.02-2746”

After the above studies, a tender dossier is prepared for the subcontracting of the works, consisting:

- Prequalification document [3]
- Method statement
- Bill of quantity
- Particular conditions for the works
- Material specifications
- Marine survey

It shall be specified in the tender documents that marine contractor shall submit his own method statement because it may not be the same as the one designer specifies.

After the collection of documents of the bidders, designer only evaluates the technical part of the documents and shall not absolutely involve in the economic part of the project. This means that designer verifies the bidder documents from technical point of views and scores each bidder.

Finally, after the decision on the marine contractor, designer and marine contractor engineer shall meet and finalize the particular conditions.

The next chapters will explain how a marine contractor shall prepare himself during and after the tender.

[3] In order to enable participation of qualified contractors and avoid awarding the project to the cheapest bidder which may not have any big diameter experience, it is always recommended to issue prequalification procedure.

4. Tender stage – marine contractor approach

After the prequalification of the marine contractor, the marine contractor shall evaluate the tender dossier precisely, and if he feels opportune, following interventions can be made:

- Site visit
- Clarification requests
- Meeting with designer in the presence of the owner
- Further bathymetric study
- Discussions with the local fishermen who knows the area better than any indication in the literatures
- Meeting with coast guard to verify if there is any restriction for marine works
- Get some information about the local manpower, local industrial market, local accommodation and living conditions for the personnel

As soon as the subcontractor gets clear ideas about the construction yard and about the design, he shall start to fill the Bill of Quantity and prepare his own method statement. In his dossier, he shall submit:

- Method statement
- Priced Bill of Quantity
- Company certificates
- CVs of the key personal
- Organization
- Time schedules, payment milestones and handover dates
- Health, safety and environmental management plan, including hazard and waste management
- QA/QC plan

It is recommended that the awarded marine contractor, following the signature of the agreement, shall execute a pre-construction survey in order to verify the data submitted by the owner, and if needed, justify his revision requests on the design.

5. Pre-construction survey

During the design stage, the owner should have a survey study which provides the overall condition of the construction limits.

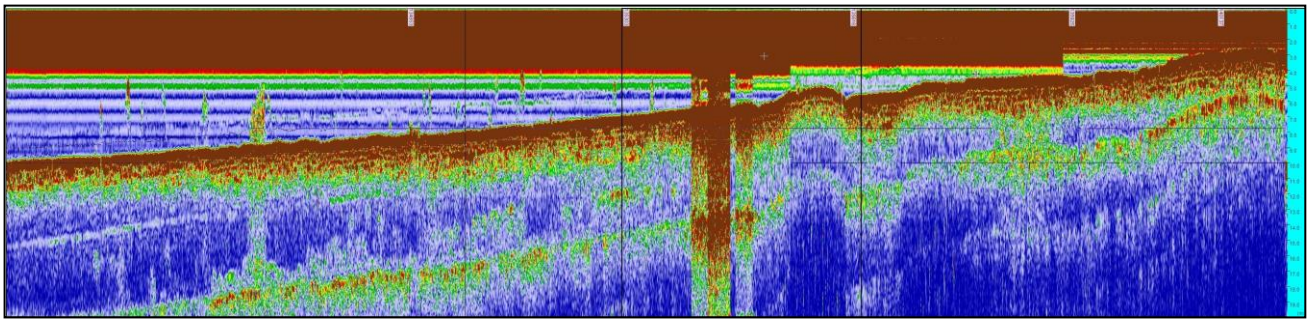
Nevertheless, the owner does not guarantee the completeness of the survey in view of the needs of detailed information needed by the Contractor.

Therefore, it is recommended to the Contractor to perform, at own care and cost, a pre-construction survey as necessary to confirm and implement the supplied data.

The pre-construction survey shall be directed to:

- Confirm the bathymetric data for the navigation of the vessels and barges in the area and for the evaluation of the access for marine operations
- Evaluate exactly the nature of the different ground layers to assess the methods of excavation. This can be made with trial excavations along the PL routes
- Individuate the area for any planned loading facility (temporary jetty) and obtain the data for its installation
- Perform a topographic survey in the land areas to be occupied either by the works or by temporary facilities

A report on the site investigations – whichever they will be – shall be submitted “for information” to the owner



6. Safety standards

Contractor shall follow strictly all the National and international Safety Standards, the safety standards applied in the site and all the standards he will include in the HSSE Manual [4].

Any proposed safety standard shall be equal or more severe than the corresponding local and/or international standard.

In particular, all navigation and diving regulations and standards shall be strictly followed.

The Contractor shall have at site a full time, qualified, Safety Supervisor and any diving operation shall be coordinated under the safety aspect by and experienced Diving Supervisor with qualification for safety control.

The Contractor shall provide on site a local meteo station and shall be in contact on hourly basis with the nearest meteorological office, in order to get in real time the information about any significant change in the weather conditions.

[4] HSSE Manual – Health, Safety, Security and Environmental Manual

7. Marine equipment, vessels and crews

Contractor shall ensure for all the duration of works, all marine equipment, vessels, barges and any marine craft, including the main equipment on board (such as cranes, davits, motors etc.) used during the works is correctly classified, that the relevant Certificates have been renewed as necessary and are valid and that all the fleet is in good working conditions.

Contractor shall be fully responsible for the qualification and capability of the crew and operators, and for the proper operation, care and maintenance of all marine equipment and vessels provided for the performance of the works.

If any breakdown or long time repair of any marine equipment occur, contractor shall be responsible at own care and cost for a prompt and timely replacement of such equipment or for any modification.

The following equipment can be a summary of required equipment for a proper marine installation:

- Transportation barge: in order to avoid time requirement of positioning the installation barge if also used for transportation, a barge which is used for transportation purposes is preferable
- Flat or excavation barge: it can be a crane barge or barge with pumps and other equipment destined for trenching. It is preferable to have this barge draft as short as possible in order to have it as close as possible to shore and working in low depths.
- Jack-up Barge: it will provide a safer installation during bad weather conditions. Jack-up barges can lift themselves on the legs in order to avoid the wave effects on the barge [(5)].
- Pipe Installation barge: in case a jack-up barge is not available, a stable barge with sufficient deck and on board equipment shall be available. This barge can be equipped with legs even if not sufficient to lift itself but just to sit on the bottom.
- Sea-horse or hydraulic jointing clamps: will be preferable equipment for pipe jointing. In case a sea-horse is used, the pipe alignment and elevation shall be controlled acting on the legs and on the clamps of the horse itself. It shall have its positioning system for a precise jointing. If a hydraulic clamp shall be used, its design shall be specifically done for the outside diameter of the pipe and the part which will be direct contact with pipe shall be rubber coated.
- Tug Boats: required to move the barges
- Divers Boats: shall contain all necessary diving equipment for a safe dive
- Service Boats

All the equipment that will be used in the project shall be precisely listed with sufficient information about their size and/or capacity and particularly it has to be indicated if the equipment is owned or hired.

[5] It shall be noted that even if the barge is not effected by the weather conditions, the pipe during lowering and jointing may be effected due to the swells (dead waves) or under water currents created by offshore storms

The contractor shall have available all the documents, licenses, classification documents and all other necessary documents in case the owner asks them.

It is recommended that the contractor shall also provide a man power histogram and qualifications of all skilled employees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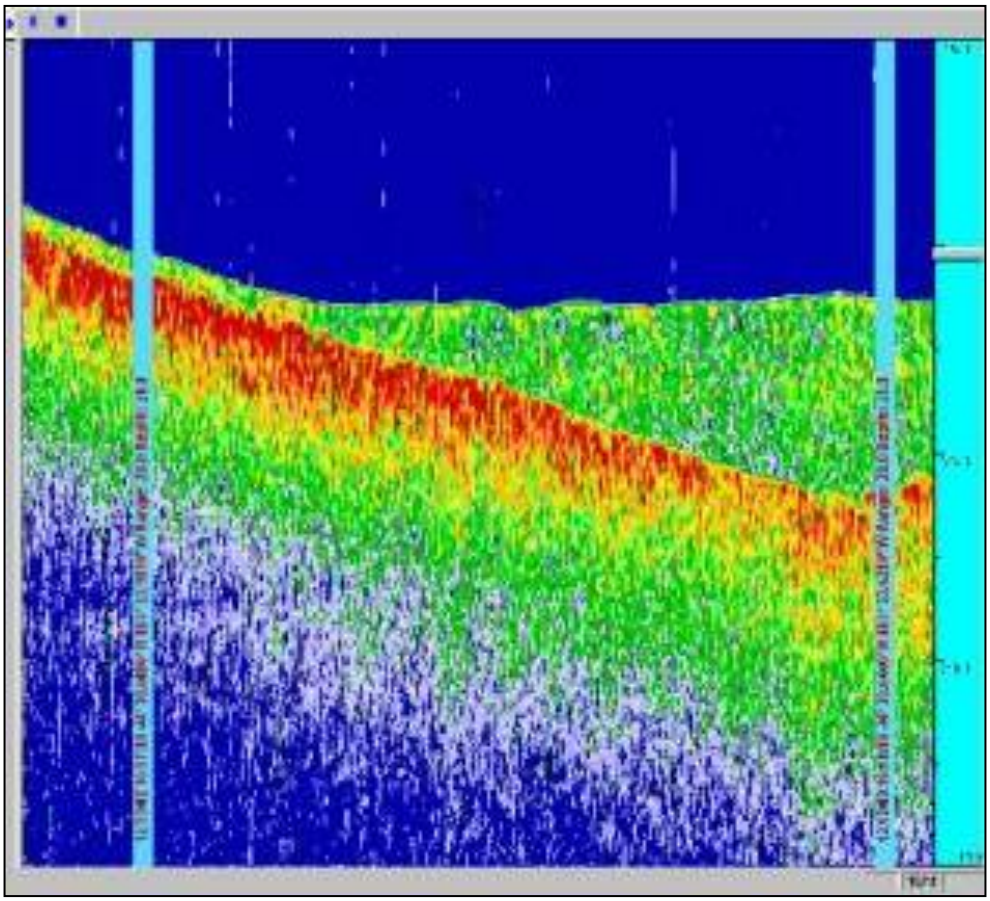
8. Survey/measurement to be conducted by the marine contractor

During the execution of the works, the owner will have his own site supervision but before the delivery of any finished section of the project, the contractor shall make his survey for a precise measurement.

After execution of each section of the project, contractor will inspect the area or pipe both for design measurement and work quality. All the measurements shall be recorded and shall be available to the owners' inspection in case a verification is required.

For such kind of scope, the contractor shall have at least:

- Nautical charts (digital or printed)
- Side Scan Sonar
- Topographic instruments (laser beam distance meter, etc.)
- DGPS or a GPS with a reliable software
- Recordable echosounder, with narrow beam high and low frequency transducer
- tide gauge (also known as mareograph) for measuring the change in sea level
- Navigation software
- Underwater camera with high definition record capability and if possible can be watched on board or even on land through a secure network connection

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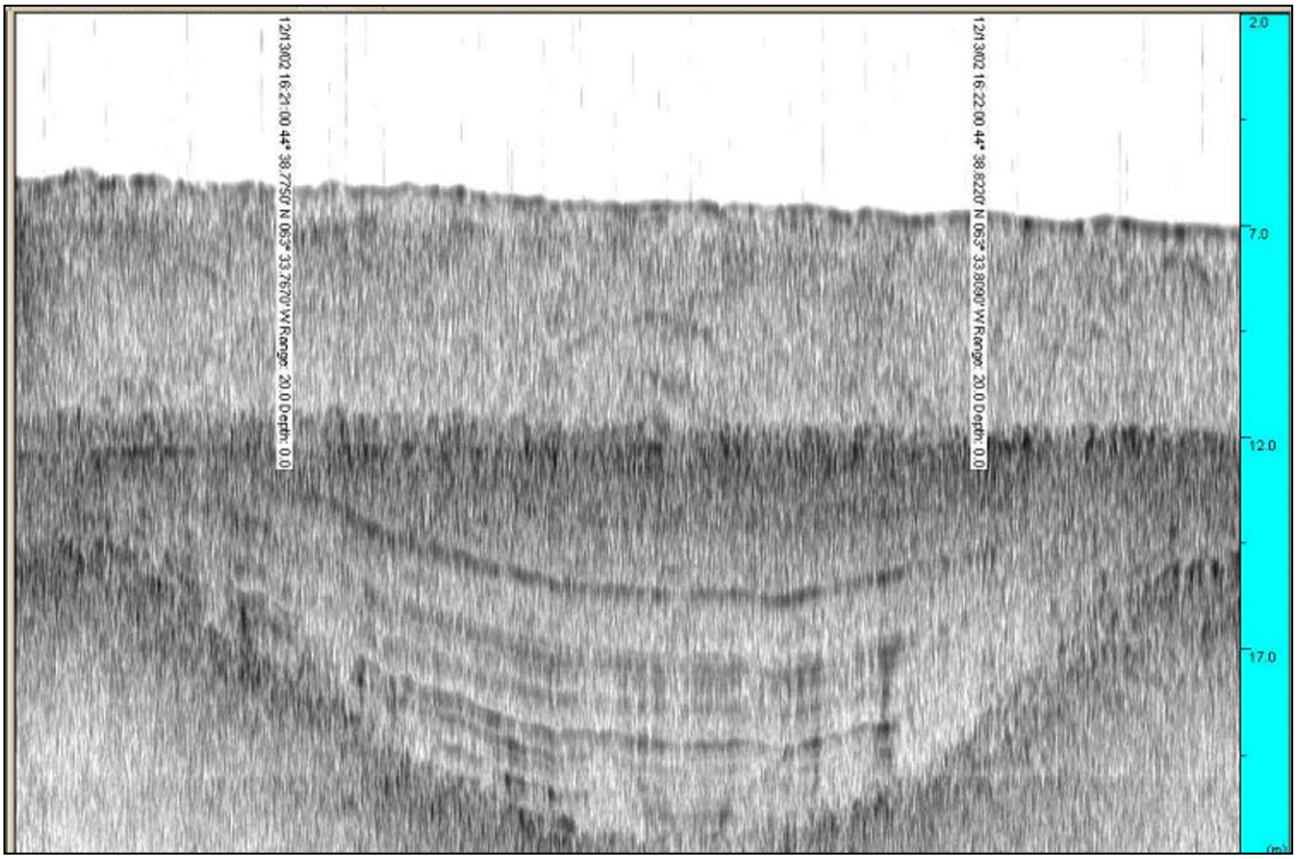

12/13/02 16:21:00 44° 38.7750' N 063° 33.7670' W Range: 20.0 Depth: 0.0
12/13/02 16:22:00 44° 38.8220' N 063° 33.8090' W Range: 20.0 Depth: 0.0
2.0
7.0
12.0
17.0

9. Transportation, unloading and storage of pipes

9.1. Transportation of pipes and fittings

While transporting, moving, loading & unloading pipes and fittings at jobsite, maximum care should be exercised to avoid any structural damage. The following points should be considered during these operations:

- Identify proper lifting points and methods.
- Identify proper moving methods and vehicles.
- Visually control each moved item for damages or cracks.
- Compare and control total quantity of moved or transported items with the order quantity.
- Report any damage or a missing item.

Note: Damaged goods should not be used unless inspected and repaired by Superlit personnel.

9.2. Loading and unloading of pipes

Loading and unloading operations are critical issues, therefore, techniques which will be used during these operations should be determined based on site conditions.

While loading or unloading and placing pipes on the ground, prevent any impact with rigid objects to avoid structural damage.

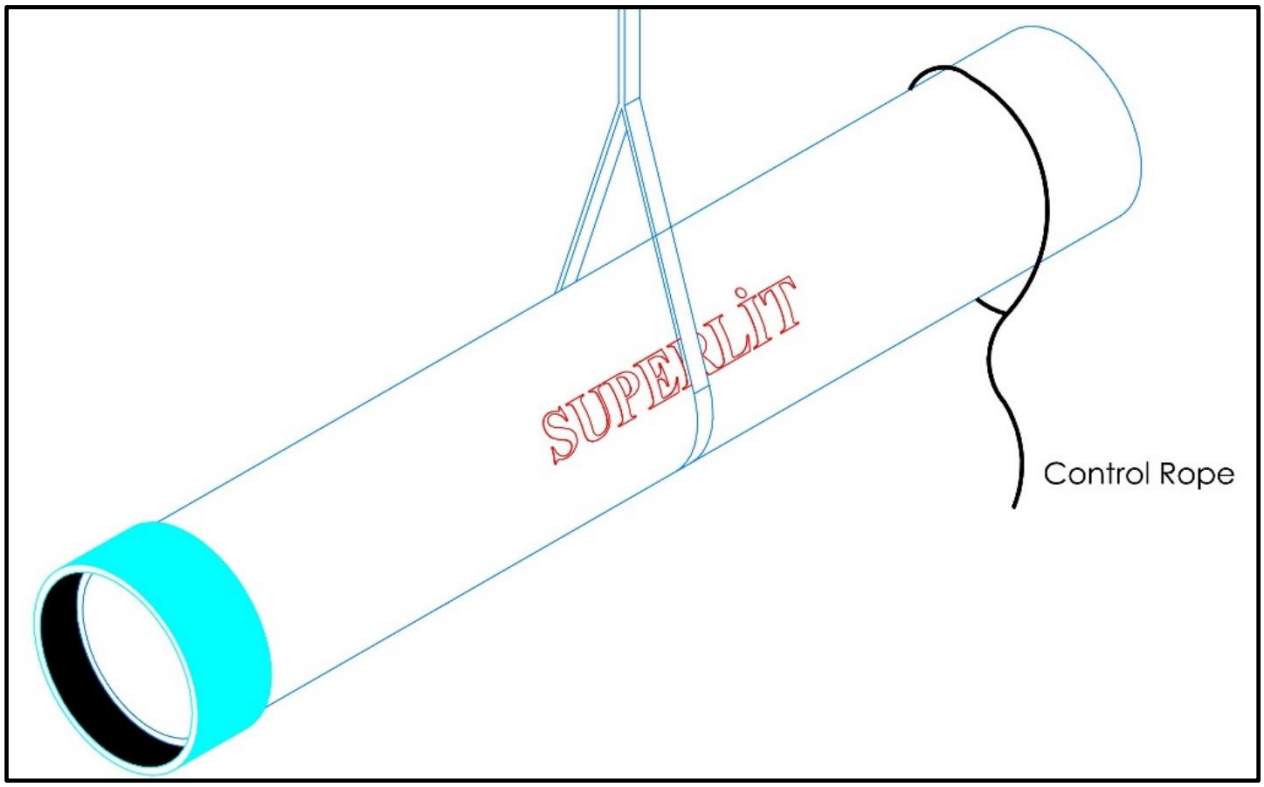
Loading and unloading of pipes with DN ≥ 300mm should be exercised with an appropriate loading equipment or machine. Based on pipe diameters, lengths and weights, as well as jobsite conditions, crane-lifting strap method or forklift can be used for these operations.

Loading and unloading with crane and lifting strap: Pipes can be lifted either with one or two lifting straps, however, for an easier balancing control while lifting, two lifting straps usage is recommended. With one lifting strap, the strap should be fastened at pipe's center of gravity.

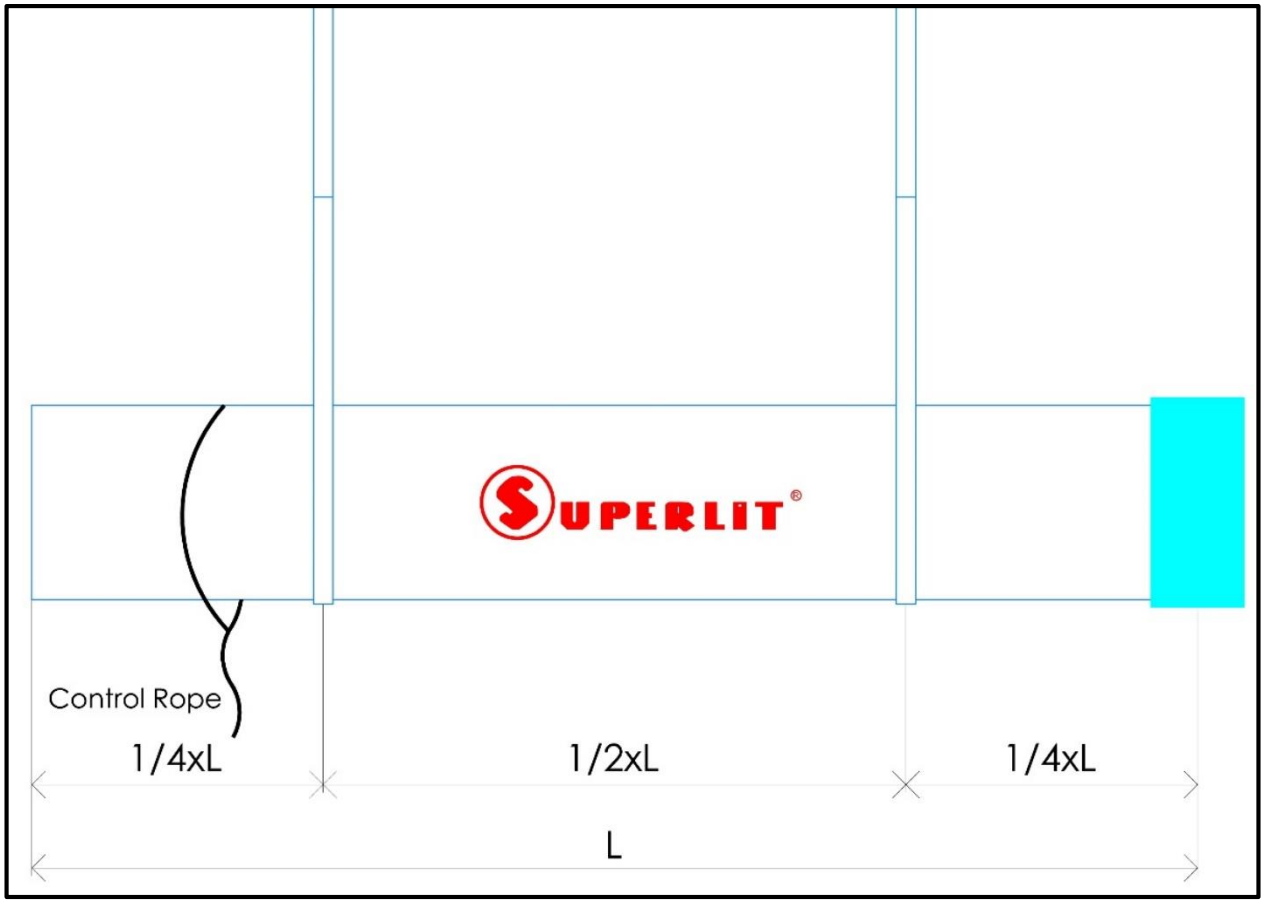
With two lifting straps, fastening points should as per the below illustration. Both methods should be exercised very carefully, fastening points should be controlled and secured.

To prevent any possible accidents, ensure that there is nobody under the pipe while lifting.

Guide ropes tied around the pipe can also be used to have manual control over the pipe while it is in the air, this method is strongly advised particularly in high winds. Pipe direction control with guide ropes should be performed at a distance, should not be done from underneath the pipe.



One lifting strap method (with a guide rope)



Two lifting straps method (with a guide rope)

9.3. Loading and unloading with forklift

This method is generally used for factory loadings or for wagon loadings of railway transportation. However, since there is generally no need for a forklift at infrastructure jobsites, unloading at jobsites is performed with crane-lifting strap method.

Ensure that forklift is operated by a licensed forklift operator. Pipes should be placed on wooden cradles, and forklift should lift the pipe with the cradle as shown on below picture.

9.4. Loading and unloading of couplings and fittings

Superlit GRP pipes are generally delivered with a coupling installed on one end. If there is a special requirement or if additional couplings are required, couplings can be delivered separately as bundles.

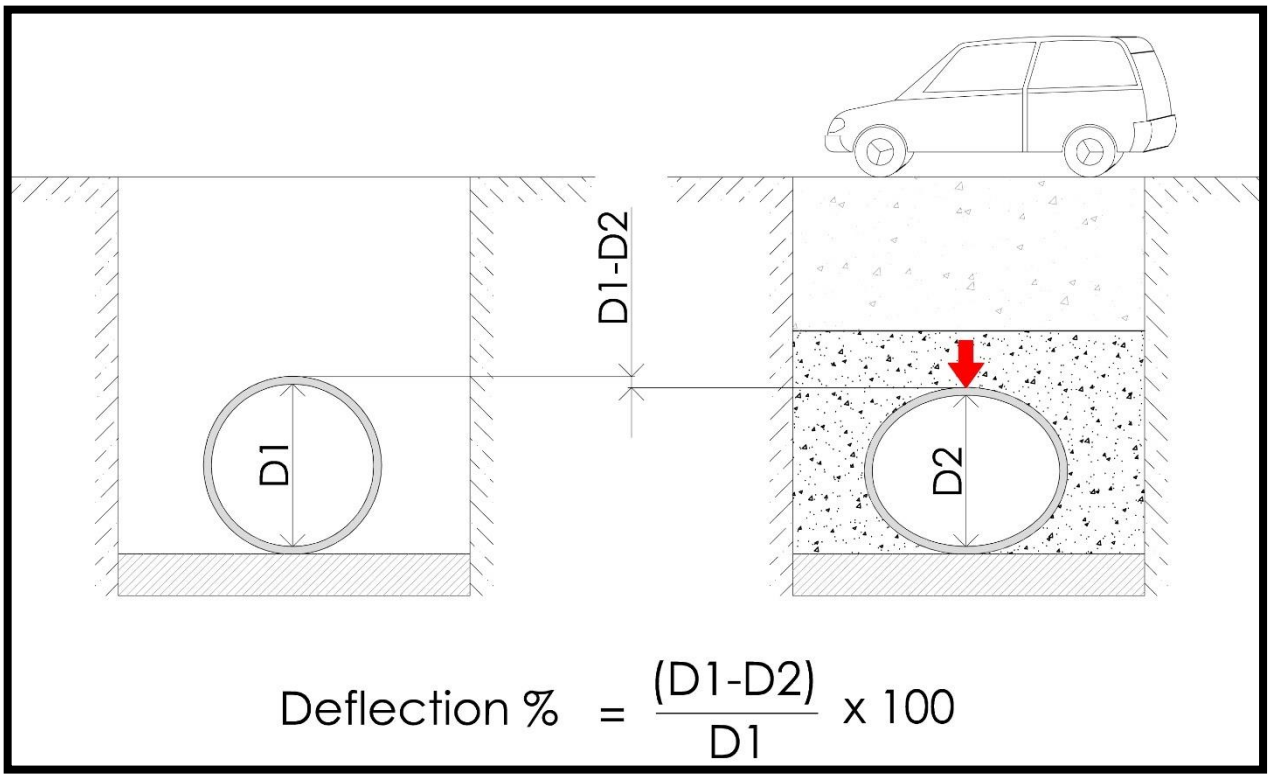
Regardless of its dimensions, every fitting should be carried and unloaded with maximum care. In case fittings are delivered plain (without external packaging), determination of lifting points and unloading techniques are critical issues. For unloading of fittings with packaging, pipe unloading methods can be used.

In any case, center of gravity and balanced distribution of mass factors should always be taken into account while lifting, loading and unloading of fittings.

9.5. Storage of pipes at job site

- The storage area should be flat, leveled and clear of objects such as rocks, stones, sharp edges, etc.
- Pipes can be stored in piles to minimize the storage area within the allowed limits.
- While storing the pipes as piles, wooden cradles should be placed between pipe levels. The first level pipes should be supported with wooden wedges to prevent sliding.
- It is recommended to store pipes on flat timbers to facilitate placement and removal of lifting slings around the pipe, as well as easy handling of pipes with a forklift.
- Flat timbers should be placed at a distance of ¼ of pipe length from each pipe end.
- If couplings are delivered as bundles, couplings should be stored at horizontal position to prevent radial deflection.
- The storage ground should be resistant to heavy loads and should not be exposed to strong winds.
- Maximum piling height is around 2,5 meters. It is not recommended to store pipes as piles for diameters bigger than DN 1200 mm.

Change of pipe's round form to oval form as a result of vertical loads is defined as "vertical deflection" and calculated as follows:



Vertical deflection

Maximum allowed vertical deflection should not exceed below values while storing the pipes as piles (stacks).

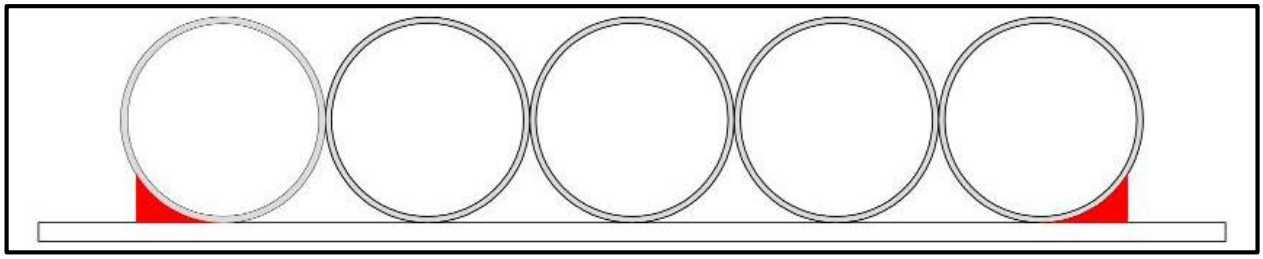
Stiffness Class (SN)	Maximum Deflection (% diameter)
2500	2.5
5000	2.0
10000	1.5

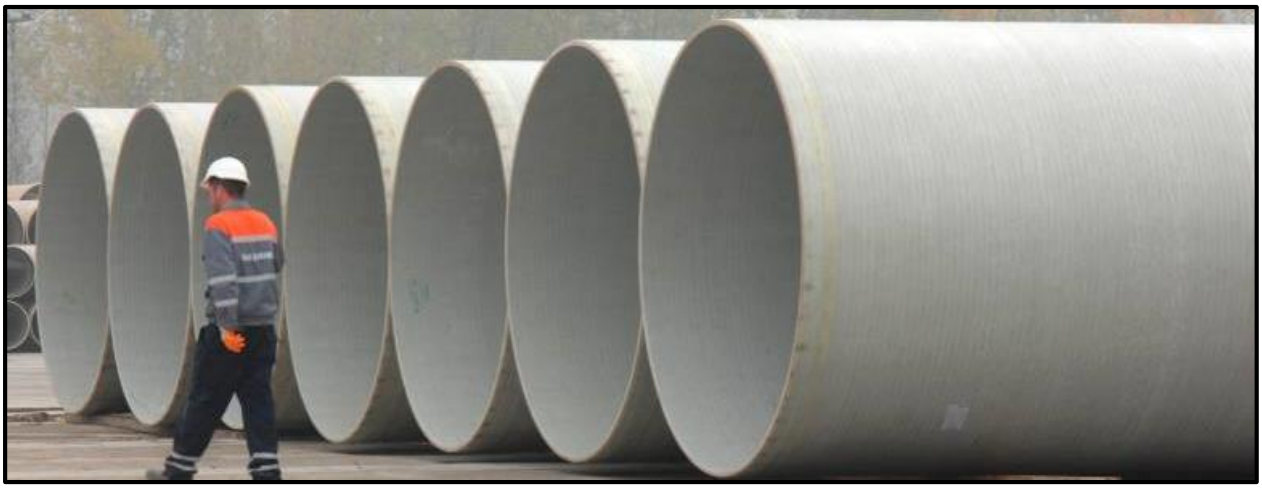
Maximum vertical deflection

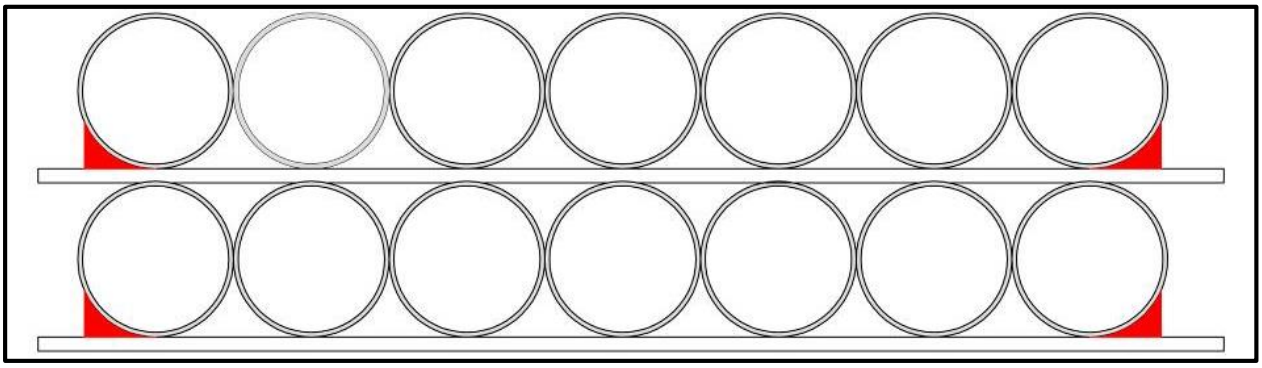
Another way to describe storage height is to express the number of stacking layers.

Diameter DN (mm)	Maximum number of stacking layers	
	SN 2500	SN 5000 & 10000
200 – 450	4	5
500 – 700	3	4
700 – 900	2	3
1000 – 1200	2	2
> 1500	1	1

Maximum number of stacking layers







9.6. Unloading, handling and storage of nested pipes

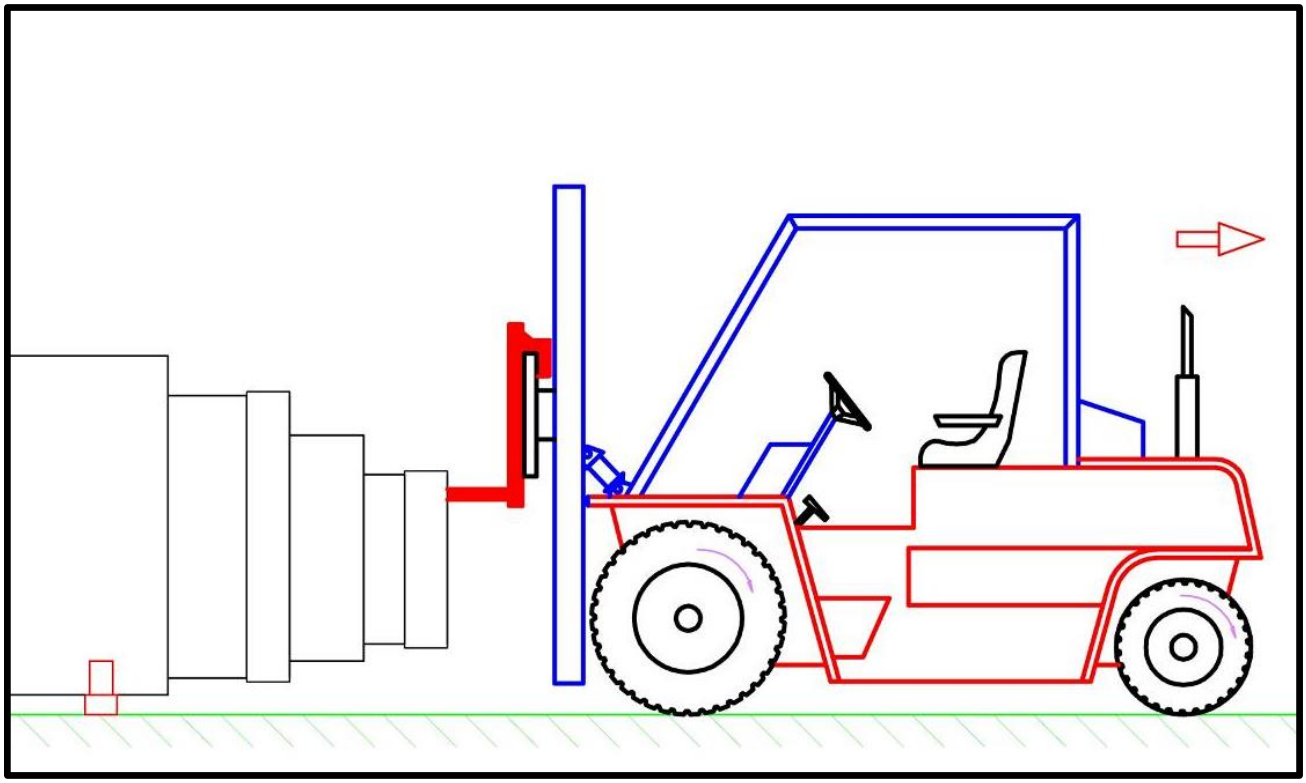
Pipes which will be shipped to far destinations can be shipped as nested (smaller diameter pipe placed inside bigger diameter pipe) to reduce transportation costs. These pipes are packed in a special way and may require case specific procedures for unloading, handling, storing and transporting.

General recommendations are as follows:

- Always use 2 lifting slings while lifting nested pipes. Since the weight of nested pipes will be much higher than the weight of a single pipe, ensure that lifting slings are strong enough to handle the total load.
  Consult Superlit for lifting points and lifting method for nested pipes.
- Storing pipes as nested is a preferred application in many cases due to less storage cost and space. However, do not store nested pipe bundles as stacks and always store nested pipes as a single level.
- To prevent movement of inner pipes while transporting, special packaging techniques are used for nested pipes. Do not release original packaging of nested pipes until installation.
- Before de-nesting inner pipes, be sure to remove all packaging such as steel strips, wooden wedges, sand bags etc. without damaging the pipes.
- The most common technique used for de-nesting pipes is using a forklift with a padded boom fixed on one of its forks. The padded boom installed on the fork is generally a steel tube covered with plastic.
  Before de-nesting the pipes, be sure that the forklift capacity is sufficient for this operation.

De-nesting operation can be described as follows: Forklift operator places the boom inside the most inner pipe without touching the pipe walls, then starts lifting the boom very slowly. The boom lifts the pipe slightly until the lifted pipe becomes completely loose inside the outer pipe.

By driving forklift backwards, lifted pipe is taken out of the bundle. After each de-nesting, pipes should be visually controlled for damages. To keep the pipe bundle stable, it is recommended to perform de-nesting operation at a de-nesting station. If weight, length of the pipes or the unloading equipment capacity do not allow above described de-nesting operation, please consult Superlit Project Design and Site Support Department for special de-nesting procedures.



De-nesting with a forklift

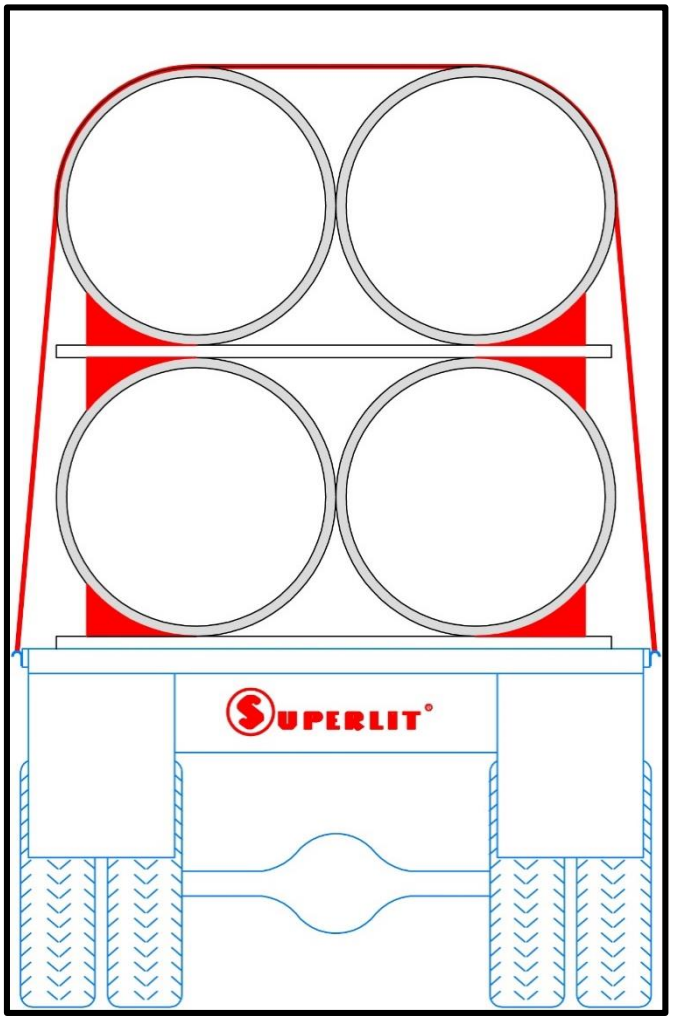
9.7. Handling of lubricants

Lubricants used for pipe and coupling installation should always be stored in their original packaging. During transportation, make sure that the original packages are mounted tightly and not subject to any damage or leakage.

9.8. Transportation of pipes

Transportation vehicle should never be loaded over capacity while transporting pipes. To prevent any structural damage due to the movement and vibration during transportation, pipes should be separated from each other. To keep the stability and to prevent movement, pipes should be tightly packaged and supported with wooden wedges.

Maximum loading height for pipes is 2,5m. Pipe bundles should be fastened on the vehicle with pliable straps or ropes over the support points. If steel strips or chains are used for fastening, place fabric pads between the strips / chains and the pipe to prevent abrasion. Maximum deflection values during loading and transportation should not exceed the values given on the above table.



Pipes loaded on truck

10. Mobilization

Mobilization includes all the activities of preparation for the works (insurances and permits are included), set up of the Contract Management in a suitable office and of the Site Management, preparation and delivery of Quality Control Manual, of HSE Manuals, preparation and follow-up of material purchases, establishing a work program setting up of site offices and storage areas, preparation of equipment and personnel schedule and of their mobilization.

Following the preparatory activities, the marine contractor shall present to the owner a site mobilization plan and execute it according to the contractual programs.

The storage area shall be also provided during mobilization.

There should be sufficient number of office and storage containers.

The site shall be equipped with lighting and water supply. The Contractor shall provide a container with washing facilities and lockers for the workers and chemical toilet/s or an easily reachable service room in town. The fencing of the area shall be provided.

11. Trenching

The marine contractor shall decide the most efficient trenching equipment during the tender study. The equipment choice depends on the volume of dredging, soil characteristics and availability of the equipment.

11.1. Types of dredgers

Basically, following equipment are used for marine trenching:

Mechanical dredgers

- The bucket ladder dredge
- Grab or Clamshell dredger
- Hydraulic cranes (Backhoe and front shovel)

Hydraulic dredgers

- Plain suction dredger
- Cutter suction dredger
- Trailing Suction Hopper Dredger
- The bucket wheel dredger

The choice of the equipment depends on the material to be dredged (sandy, soft soil, clay or rock), depth of the excavation and working capability on the weather and wave conditions.

The following table can act as a guide for the choice of the equipment

	Suction Dredger	Cutter Dredger	Trailer Dredger	Hopper Dredger	Bucket Dredger	Grab Dredger	Backhoe Dredger
Sandy bottom	X	X	X	X	X	X	X
Clay bottom		X	X		X	X	X
Hard bottom		X			X		X
Accuracy		X			X		X
Dredging depth - max	70	25	100	50	30	> 100	20

The direction of the excavation (from land to sea or vice versa) shall be planned after examining the soil conditions in order to coordinate at best the operations and to minimize the excavation times.

The Contractor shall provide to excavate the trench in any type of ground ensuring the stability of the trench slopes and shall provide the correct maintenance of the bottom and bedding level until the installation of the pipes and backfill.

The designer may decide to have excavation supported by sheet piles at the shore approaches. If this method is used, then installation of pipe within sheet piles may be executed with land-based equipment with divers' assistance.

The trench profile shall be respected as reference for the trenching levels. It shall be noted that the trench level shall be equal to the pipe bottom level minus the height of the bedding.

The contractor shall ensure the stability of the trench slopes to guarantee the safety of the divers working in the trench. The sides of the trench may collapse if not cut to the proper slope or stabilized. The collapse or material sliding may move the pipes which are not stabilized yet.

In any case, usually there is no prescription for the trench slopes because to achieve the design slope in the sea is not easy like land excavation. The sides of the trench shall follow the natural angle and, in case of instability, the angle shall be decreased or the trench sides shall be terraced to prevent any caving-in. This means that when you reach the specified trench bottom width, the slopes shall be in such that will not slide and fill back the excavated area.

The contractor decides, depending on his equipment and available manpower, how to execute trenching and installation. Usually, his one team excavates while pipe installation

continues approximately 100m backwords. Working in parallel becomes a hard operation if there is the risk of turbidity which will reduce the visibility for diving operations.

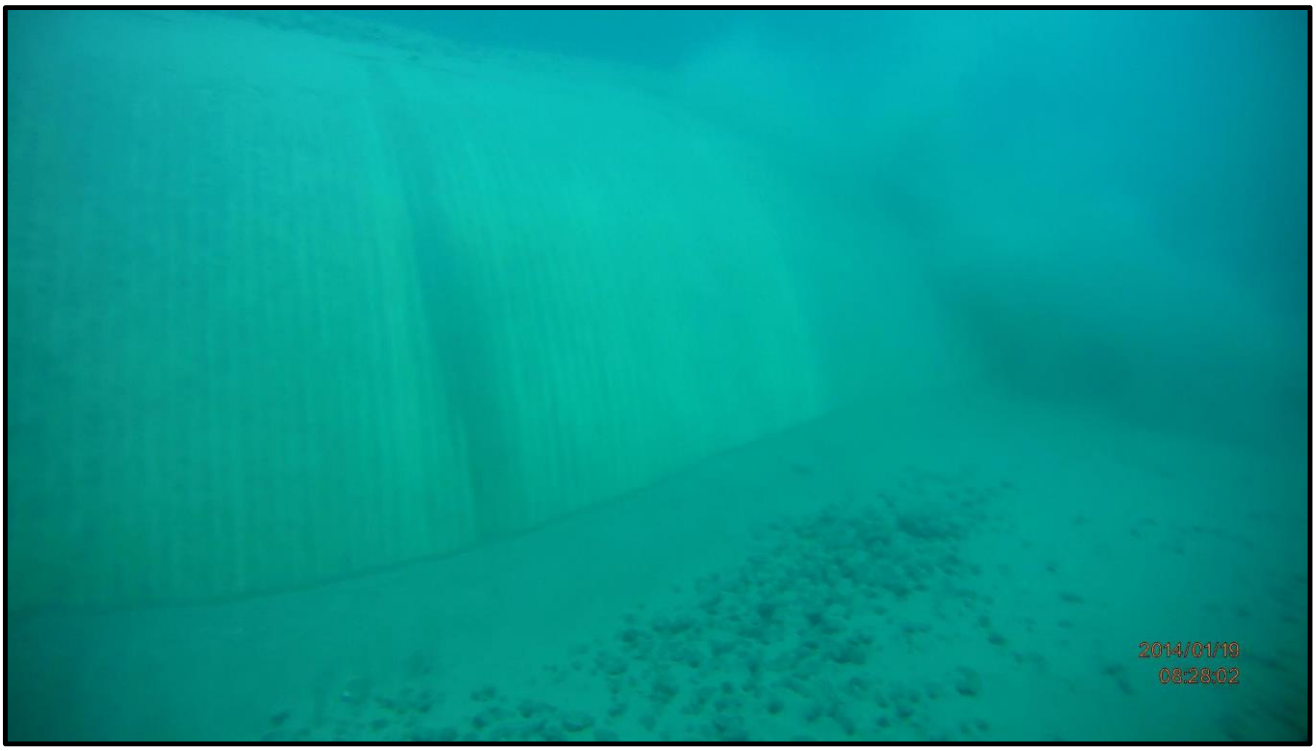
11.2. Control and correction of the excavated trench

At the end of any section of excavated trench, or before installing the bedding if following immediately the excavation, the trench bottom shall be surveyed in order to evaluate the high points or areas exceeding the allowed tolerances.

In case of any bottom configuration that results unacceptable for excess of high points, it shall be provided to flatten such areas before installing the bedding. It shall be filled with sand bags or with other means in case of over-excavation.

11.3. Disposal of excavated material

The excavated material is suitable to be used as backfill, it can be accumulated at the side of the trench or in any nearby area in the quantity necessary for the final backfill.



All excess material which cannot be used for final backfill shall be removed from site and disposed according to the instructions of the Environmental and Maritime Authorities. These kind of locations where excess excavated material can be dumped are mostly the deepest locations of the involved sea; therefore, it may require a considerable transportation distance which can be an extra cost if did not considered during the project initial design.

During the transportation of this excess material, transportation barges shall be chosen carefully in order not to cause any leakage of material which may cause interim turbidity.

The contractor shall evaluate the quantity of excess material and get the basic information about its utilization or disposal and about the possible disposal areas.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11.4. Trench width

Trench width should be wide enough to place fittings and connection parts, and to allow a convenient working space for field teams for compaction.

For standard installations, minimum trench width is advised as follows:

DN < 600, Trench width = DN + (2 x 300mm)

DN < 1000, Trench width = DN + (2 x 400mm)

DN ≥ 1000, Trench width = DN + (2 x 450mm)

If there are unstable, lose or soft soil conditions, based on the pipe stiffness and trench depth, trench width can be increased.

11.5. Multiple pipe installation in a single trench

During installation of multiple pipes in a single trench, distance between any of the 2 pipes is determined with the formula (r1+ r2) / 2 whereas r1: radius of the first pipe and r2: radius of the second pipe.

Complying with the formula, Superlit recommends below values for the distance of pipes in the same trench:

Diameter (mm)	Minimum distance between pipes (mm)
200 – 600 mm	300 mm
700 – 1200 mm	600 mm
1300 – 2000 mm	1000 mm
2100- 3000mm	1500 mm
3000 mm and above	2000 mm

11.6. Turbidity

If there is high content of fine sediments or organic particles in the excavated area, turbidity will occur during excavation.

In order to minimize the turbidity at sea, excavation materials shall be transferred to the dumping area that is allowed by the Authorities. In this way, dispersion of the excavation materials with flow will be kept at minimum level.

Silt curtains or barriers can be used during the excavation. Silt curtains are vertical barriers positioned within excavated area to keep the fine materials that are mixed to the water during dredging.

After the approval of the excavation, marine contractor proceeds with bedding.

12. Bedding (and level supporting)

Bedding is required to establish a soft pipe support. The bedding shall be minimum 50 mm thick and shall provide the pipe with a uniform and continuous support over its entire length.

Bedding or levelling supports shall create the conditions of lateral stability of the pipes during the haunching and backfilling.

The present information about the materials to be used in the installation and covering of the pipes is indicative only. The type of material may be changed according to the local conditions.

Imported material shall be used for bedding. Bedding material shall be granular material to be selected as type SC1[6] or SC2[7] or crushed rock, in sizes 20-50 mm. The material shall be obtained from hard rock, excluding local sandstone or mudstone, and be crushed uniformly.

The material shall have adequate fluidity in order to fill the voids occurred during excavation.

The material shall not contain organic material. The reason of specifying the granulometry of the material is to permit an easier intervention by water jet pumps without washing out the material.

The same material shall be used for the haunching and for the backfill up to certain distance (generally 30-50 cm minimum thickness) on top of the pipe.

The Contractor shall supply samples for the approval.

The bedding shall be laid by buckets or tremie in controlled quantities on the bottom. The Contractor shall provide a suitable equipment for the distribution of the material and for the following flattening and removal of excess material. If possible, the bedding shall be flattened with a frame, moved along the alignment.

The vertical profile of the pipeline can be achieved by using “supports”. Supports can be the same granular material mounds formed like saddles or traditional sand bags or big bags which can also be filled underwater. If it is decided to fill them underwater, the pipe shall be kept suspended till the bag is filled with water/sand mixture which is pumped from the barge through the filling hose. In this case, the big bags are pre-fixed to the pipe on 3-4 positions along the pipe.

After the vertical elevation is fixed by the filled bags, the gaps between the bags shall be filled with the bedding material. After that the pipe can be released, and following haunching can be proceeded.

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[6] Soil stiffness category SC1: Crushed rock containing less than 15 % of sand. (maximum %25 passing through 9.5 mm sieve and maximum 5% passing through No.200 sieve)

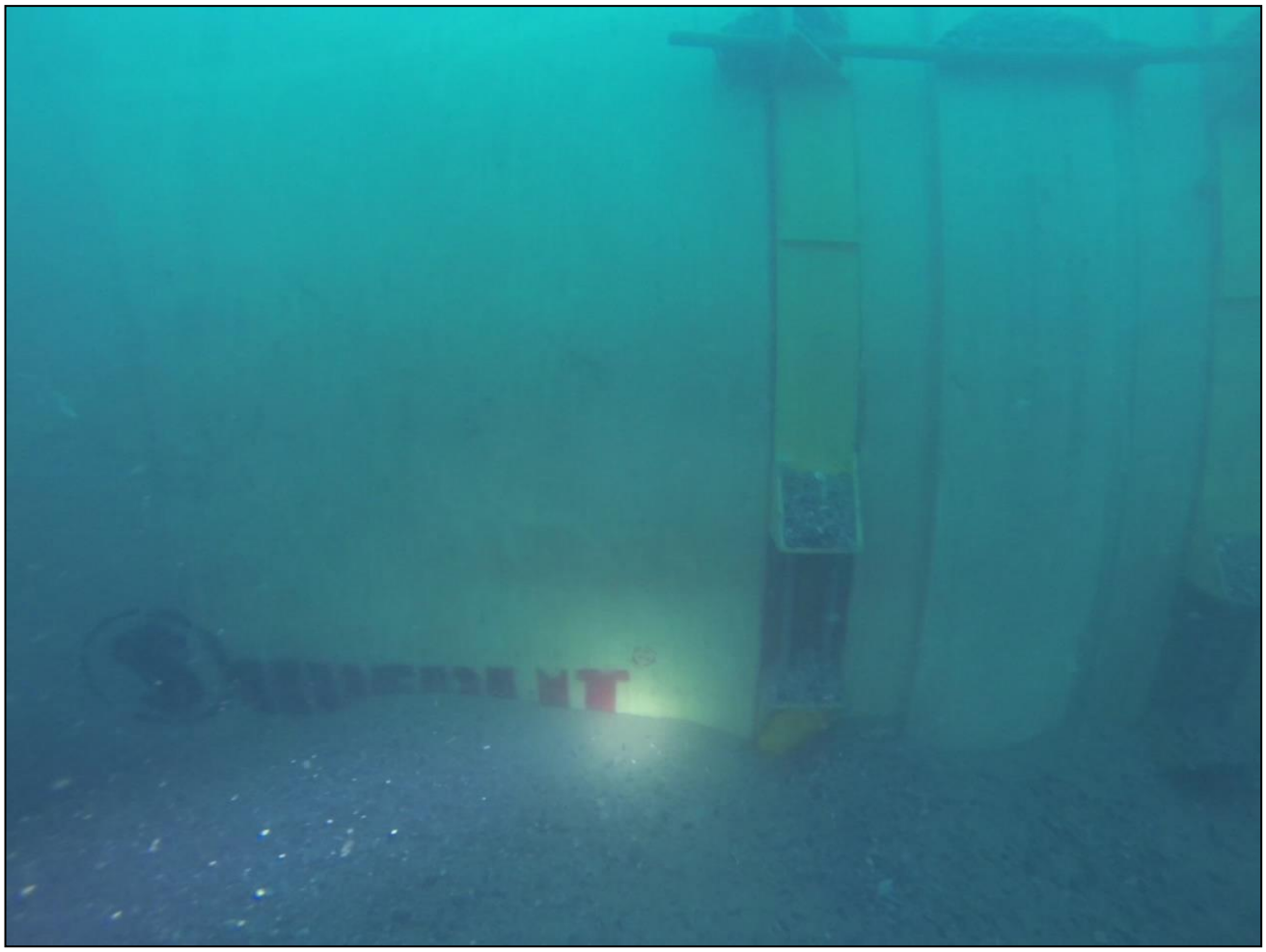
[7] Soil stiffness category SC2: Clean, coarse-grained soils (SW, SP, GW, GP and similar soil with maximum 12 % passing No 200 sieve)

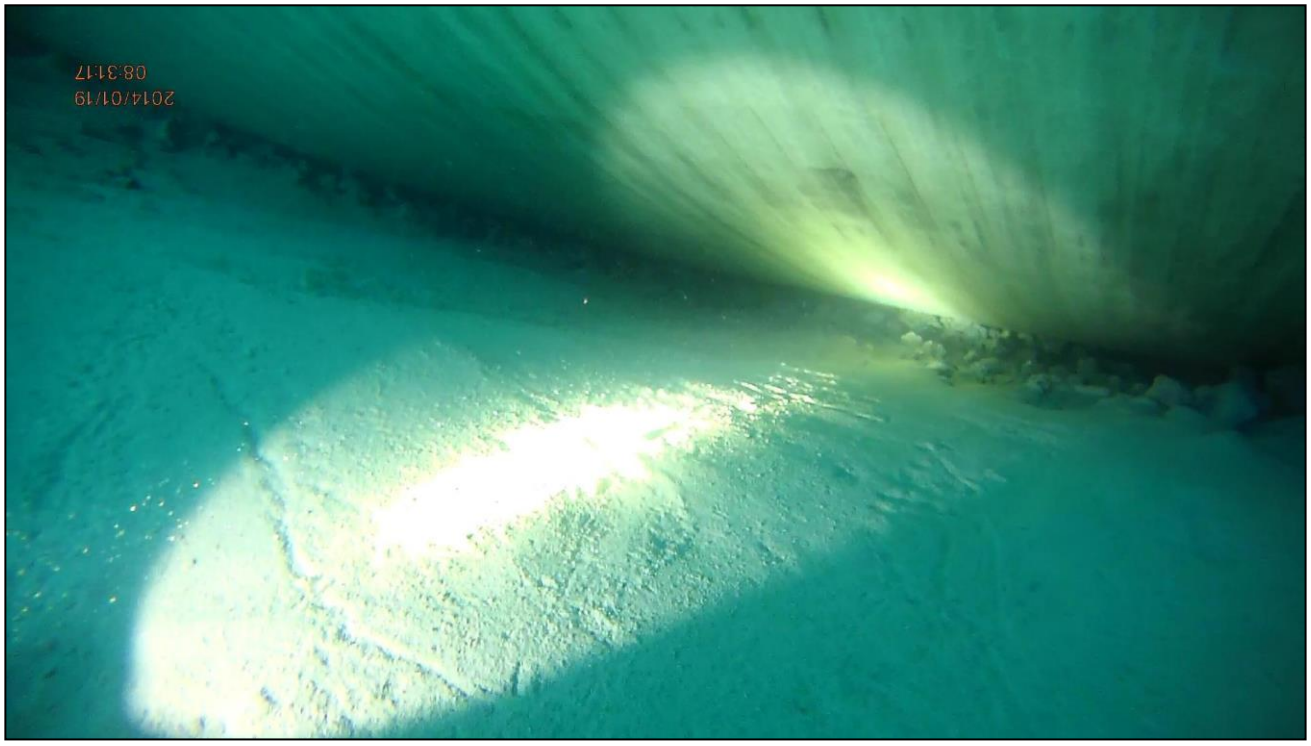
Tolerances in the longitudinal and transverse profile of the bedding shall be verified according to the design values.

Spacing for couplings and for tightening the marine lugs shall be considered for any type of bedding or supporting.

The bedding surface shall be controlled by visual means for acceptable configuration. Before the installation of the pipes, all areas out of tolerance shall be corrected.

If the material at the bottom after the trench is adequate and provides similar bedding capability as indicated above, the installation of the bedding layer may be avoided.

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13. Pipe handling and transportation to the installation position

All pipes, couplings and fittings are legibly marked at least including the following information. Yellow marking is preferred for underwater applications.

- Manufacturer's name or trade mark
- Manufacturing date and number
- Nominal diameter in mm
- Nominal pressure in bar
- Nominal stiffness in N/m2
- Pipe length
- Manufacturer's inspection mark
- Bend angle in degree, or nominal diameter of Tee Branch in (mm)

Pipes shall be stored on a flat surface and protected against mechanical damage. Each pipe is also marked from inside to indicate pipe number and direction of land/sea in order to individuate the pipe during internal survey.

Pipes shall be delivered to the Contractor in the storage area. The storage area and its access roads shall be within the responsibility of the owner.

All pipe handling and lifting shall be made with the use of plastic or canvas slings which should be new and with sufficient length to avoid any contact of the hooks to the pipe. For single 12-15 m sections, a 6 m spreader beam with 2 slings will be sufficient. No steel rope or hooks can be used for lifting.

Transportation of pipes within the yard area shall be made with flat-bed cars and the pipe shall be supported with saddles.

When it is brought to somewhere close to the temporary jetty [8] realized by the contractor, the pipe shall be taken from the truck with the same lifting method.

Depending on the design basis, 2 or up to 3 pipes can be pre-jointed on the assembly area and then can be loaded to the transportation barge or single pipes can be loaded on order to realize eventual long strings on the barge.

If it is decided to install long strings, jointing of pipes can be also realized, as an alternative, by hand lamination (only on the land assembly area). This method gives an advantage of storing long strings on land.

[8] The scope of a temporary jetty is for loading and unloading materials and equipment. The location shall be preferably chosen in a protected area and close as much as to the installation area. At the end of the works, the area used for jetty shall be left as its first condition, unless requested differently

Single pipes or longer strings shall be loaded to the transportation barge with a long spreader beam with at least 2 holding strings per each pipe and when it is loaded on the barge, pipe shall be supported by wedges in order to avoid damages on it.

The section can be eventually pre-assembled on barge or pontoon in any length which can be handled by the marine equipment.

Depending on the capability of the marine vessels of the contractor, the transportation can be executed by a transportation barge or by the installation barge.

If the installation barge will be used also for transportation, time losses during the position shall also be considered. This is particularly important if there are parallel lines to be constructed because position of the barge and sitting of the barge legs can endanger the installed pipes.

Any operation for lifting or lowering long sections shall be made with the use of spreader beams or using well-coordinated separate lifting/lowering equipment.

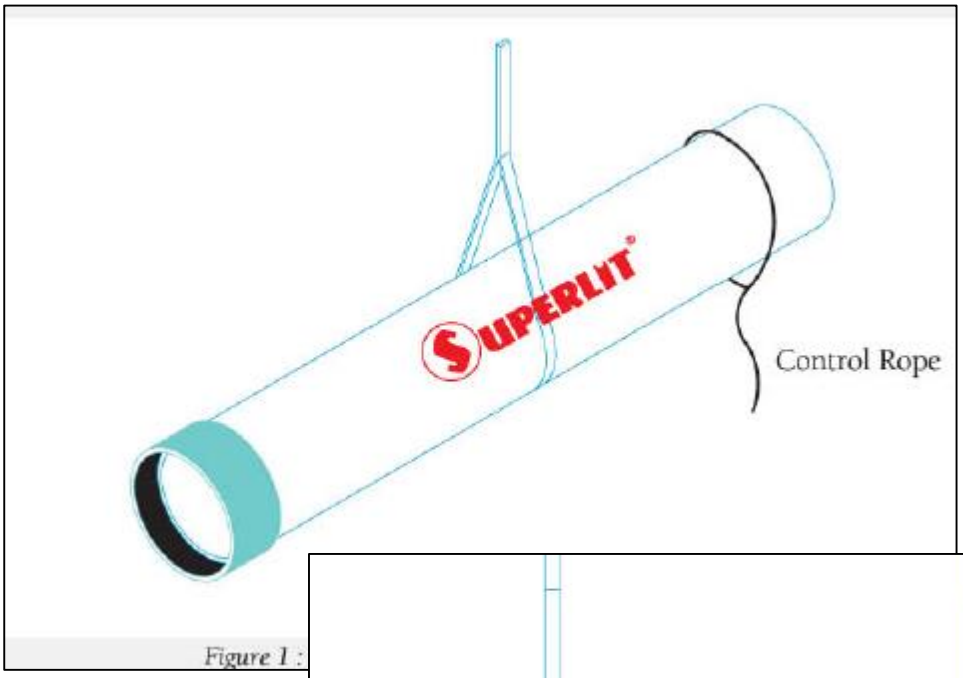

Figure 1 :

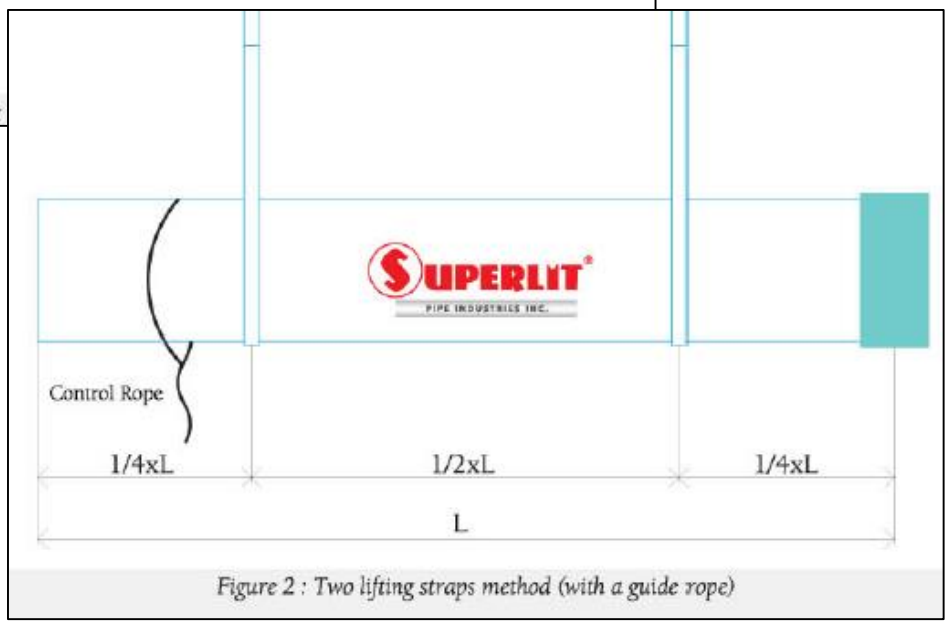

Figure 2 : Two lifting straps method (with a guide rope)


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14. Lowering and jointing operation

After the location confirmation of the installation barge, the preassembled sections or single pipes can be lowered to the bottom.

The lowering of the pipes depends on the installation method; if the installation will be done by the assistance of a seahorse, the lowering shall be done with it. If the pipe connection will be done by hydraulic clamps or by the assistance of cranes or frames on barge, then the pipe can be lowered by spreader beams.

The contractor shall control, during the lowering, the levels and the orientation of the pipe, and shall take care of regulating the length of the suspension slings for an easy underwater coupling.

If no seahorse is available, the most and safe method of lowering could be with separate davits or winches from the barge side; in any case, other systems are acceptable.

Before inserting a pipe or string in a coupling, the position of the gaskets shall be checked, to avoid misplacement during the jointing, and the inside of the coupling shall be cleaned from debris, sand or dirt. Similarly, the axial alignment shall be accurately maintained.

Stoppers shall be used to ensure the correct gap between the pipe ends when inserting the pipe into the coupling. At lowering, the position of the marine lugs shall be maintained and any rotation shall be avoided.

The pipe can be jointed underwater with a hydraulic clamp, with a seahorse or any specific equipment that the contractor proposes.

In some projects, marine lugs are used for the jointing operation; this method is not suggested and shall be avoided as much as possible. The risks are the bolts or marine lug clamp can be damaged or the lug may slip off the pipe. In any case, the main scope of marine lugs is to keep the pipe strings in its installed position till its haunching and backfilling is completed.

The hydraulic clamp or any underwater jointing equipment shall be lowered with the pipe end or be already sitting on the preceding string ready for the coupling.

The pipe string shall be kept suspended in a close position to the installed pipe to ensure the proper alignment. The positioning shall be carefully regulated by the suspension equipment and controlled by the divers.

Once the new section is in position near the coupling and correctly aligned, the clamp of the hydraulic clamp or any other pulling device shall be attached to the string and it shall be pulled into the coupling.

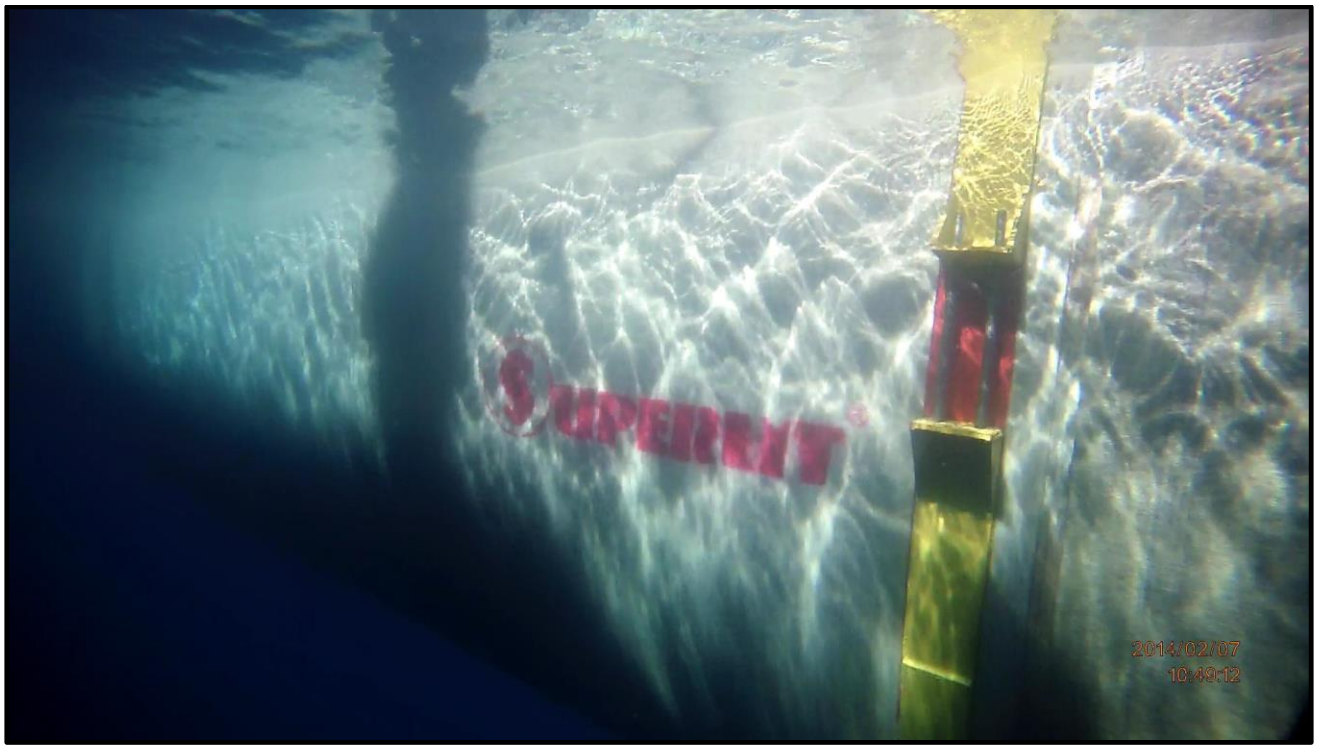
The bedding under the incoming pipe coupling shall have sufficient space in order to provide free string movement.

During lowering and underwater operations, the contractor shall consider the lateral forces which may displace the pipe.

After insertion, the bags or supporting levels shall be checked before removing the lifting elements. When the pipe sits free on the bottom, bedding gaps between the bags or supports shall be filled immediately, eventually with the assistance of water jets.

At the end of the operation, the marine lug bolts can be fixed. A hydraulic wrench with torque limit shall be used to tighten correctly the bolts. The bolts can be left a little loose in order to permit long term angular movement (within the coupling allowable limit) of the pipe due to eventual settlements.

During the installation, the weather conditions may change suddenly which will require the emergency protection of the pipes. In the installation sequence, final backfill can be realized on the 3rd or 4th preceding pipe; meaning the last installed 2 pipes are in exposed conditions and may be subject to external forces.



The marine contractor shall provide in due time his emergency procedure in order to secure the pipe. The pipes can be protected with the anchor concrete blocks(9) lowered to the bottom, placed in a sufficient distance away from the pipe and protect the pipe with a sling connected to the marine lugs.

[9] Blocks to be dimensioned as per the submerged weight of the pipe/pipes to be protected. Blocks shall be always available on the barge for a quick intervention.

It shall also be kept in mind that, during the installation interruptions, pipe ends shall be temporally closed with lids in order to protect the pipe from the entrance bottom material. This lid shall be a light type for a quick handling of the diver.

Bends and fittings shall be installed separately with the same procedures. In case of tees, the maximum section can be formed with the tee itself and one 2m element on each side. The verticality of the tees shall be properly controlled during and after the installation.

Any span longer than 1 m (actual value depends on the diameter of the pipe) which can be visually detected under the pipe shall be corrected by inserting bedding. Any horizontal or vertical misalignment shall be corrected with the proper means and brought within the given tolerances.

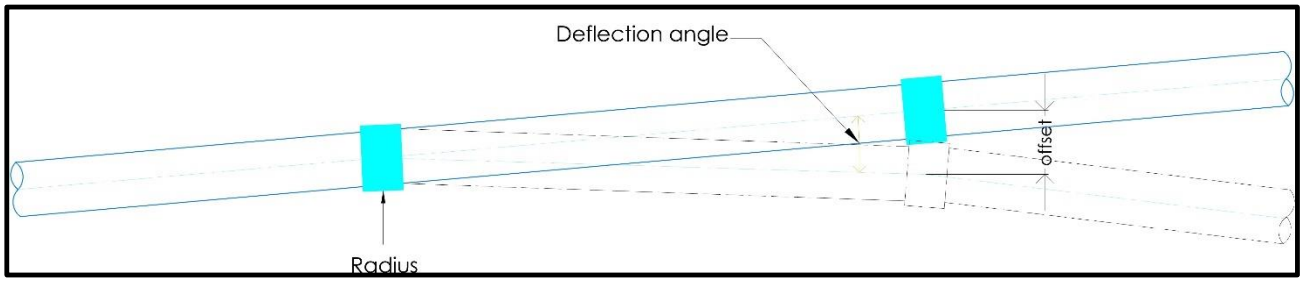
14.1. Angular deflection

Superlit GRP couplings are manufactured with full face EPDM gaskets. When compared with similar couplings, Superlit GRP couplings guarantee a complete leak tightness. The biggest advantage of these couplings is their suitability for angular deflection. Especially for longer pipelines, it is possible to rotate the pipeline with angular deflections from the couplings, without any necessity for additional elbows. Below are the maximum allowable maximum deflection values.

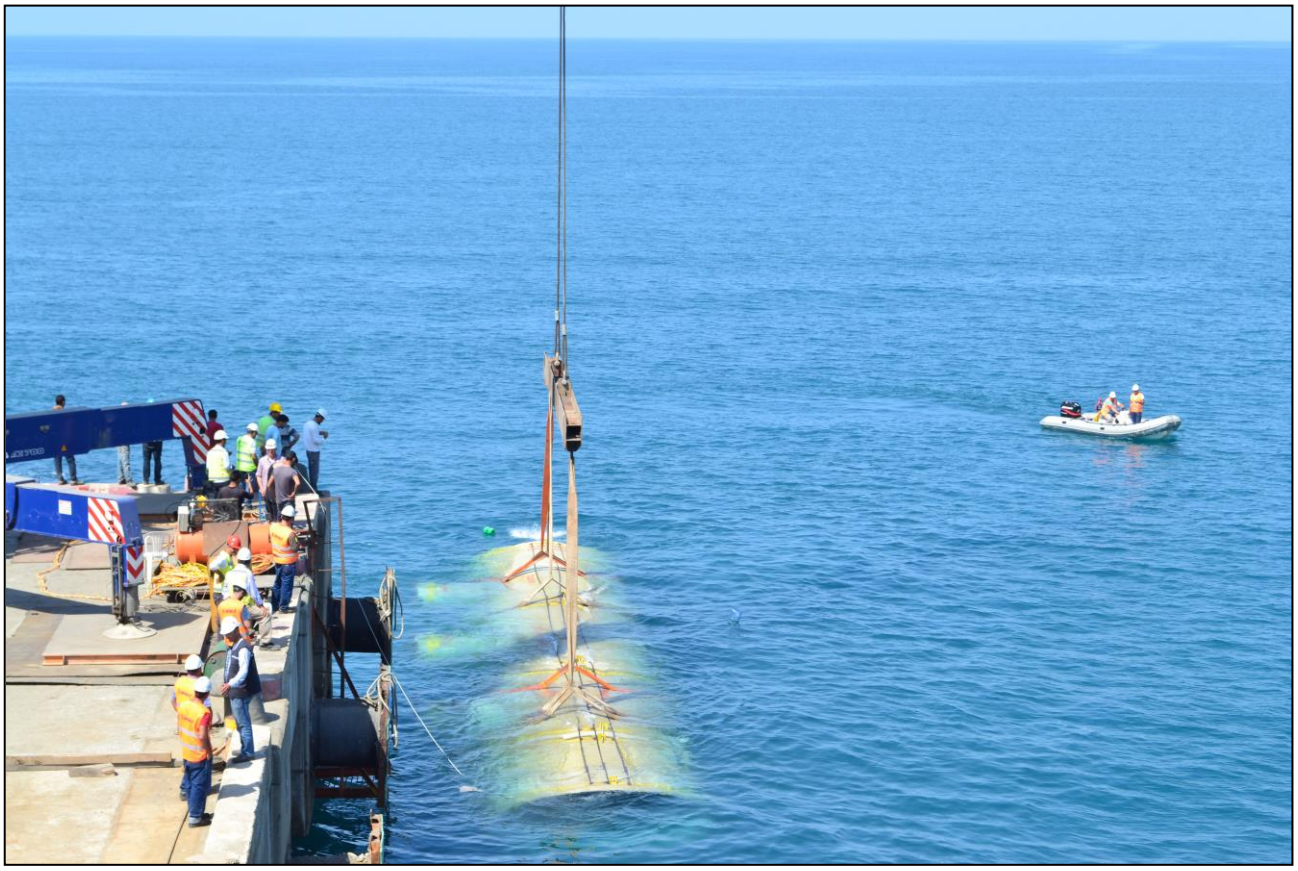
Diameter (mm)	Angular deflection (degrees)
200 - 350	3
400 – 500	3
600 – 900	2
1000 – 1800	1
> 1800	0.5

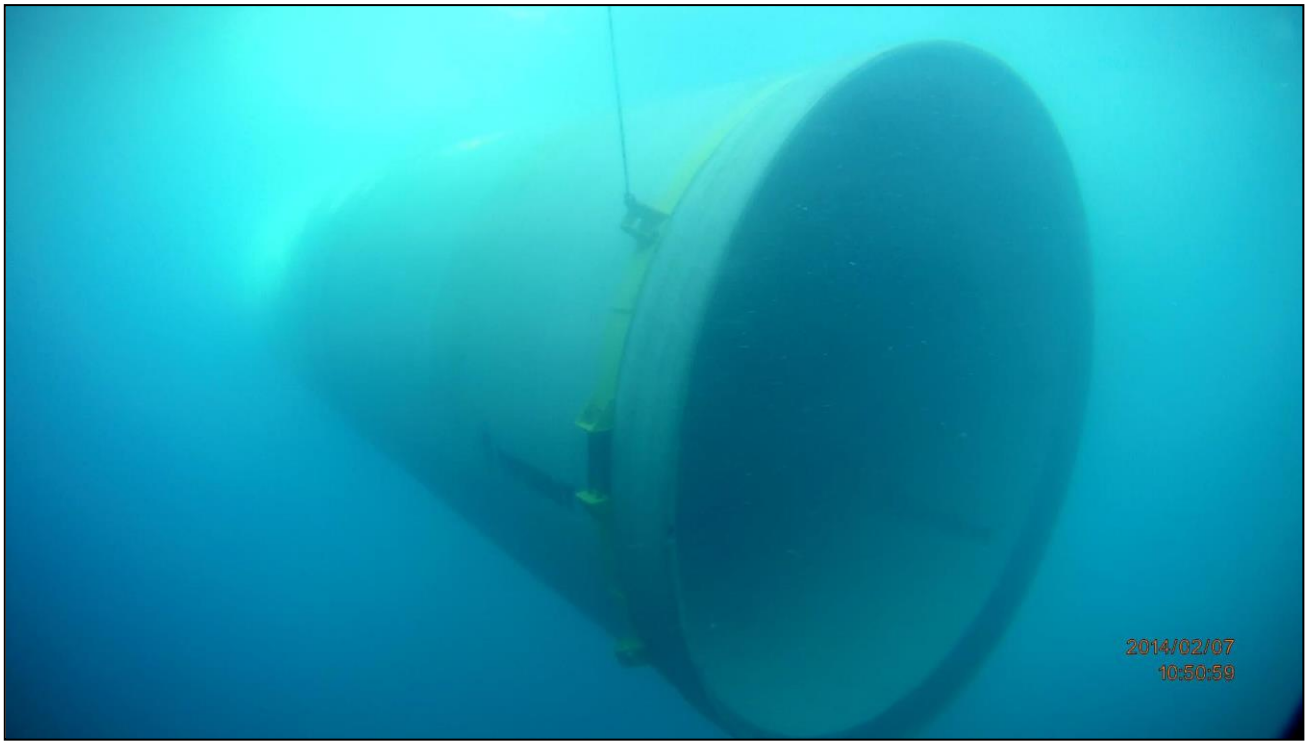
Allowable angular deflection values

Before applying an angular deflection, pipe should be installed to the pipeline at a straight position, then angular deflection should be performed.



Angular deflection





Marine Lugs

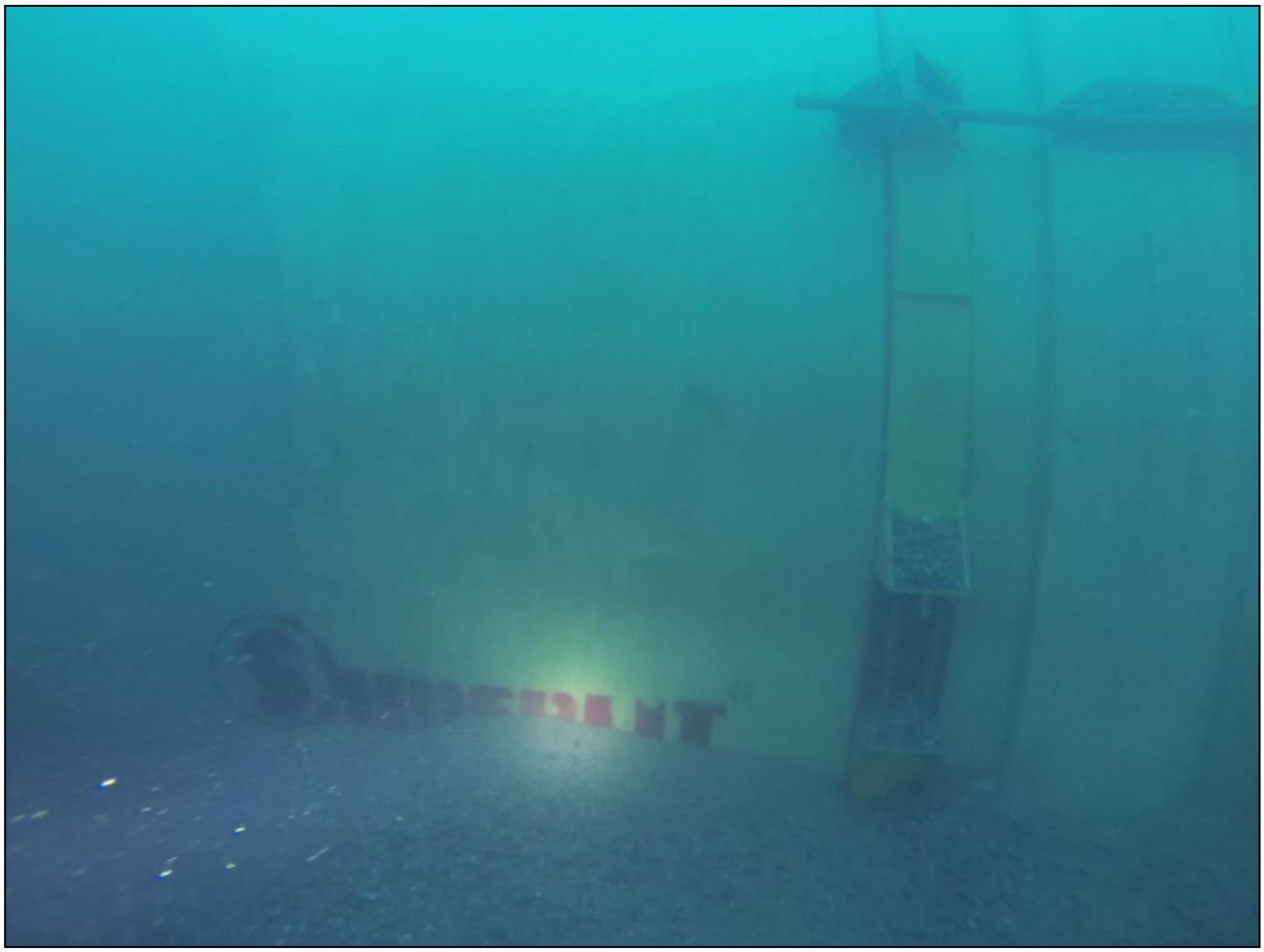
15. Haunching

Haunching means backfilling of the pipe up to 30-50 cm minimum thickness on top of the pipe.

After the spans occurred during bedding is corrected, and the levels and alignment verified, the haunching operation may be started.

Sufficient material shall be filled around the pipe sides by a tremie. Such material shall be distributed evenly and then “pushed” with a water jet or with other equipment under the pipe to provide a supporting layer. The operation shall be executed without displacing pipes in any direction.

After a 500 mm level above the bedding is reached, following 400 – 600 mm layers can be added until the level reaches 2/3 of the pipe diameter.



Each layer shall be controlled and the material evenly distributed in order to reach a good, natural compaction, and preventing any pipe movement. It shall be avoided to execute the haunching all at once for parallel lines.

After the level is more or less reaches to the top of the pipe, material can be dumped, ensuring a minimum 30-50 cm cover.

The same material specified for bedding shall be used for the haunching.

It is recommended not to use the excavated material for haunching, unless it meets the specification for bedding material.

16. Backfilling / Scour protection

After the haunching is completed, the line shall be protected against wave and current effects, against external impacts and against scour.

Due to the underwater currents or wave hits in the surf zone, haunching may wash out the pipe could remain exposed. Therefore, as specified by the designer, the haunching shall be protected in order to keep it in its position.

Depending on the depth and wave effects:

- a geotextile cover acting as a filter layer and on top of the geotextile, suitable excavated material
- a geotextile cover acting as a filter layer and on top of the geotextile, a layer of articulated concrete mattresses or gabions and final backfill suitable excavated material
- a geotextile cover acting as a filter layer and on top of the geotextile, a layer of articulated concrete mattresses or gabions and then backfill with suitable excavated material and final protection with armour stone or gabions

Where;

Geotextile: non-woven type, permeable to water, 400 to 600 g/m2

Articulated concrete mattresses (ACBM): square blocks connected with plastic mesh or ropes, produced from Sulphate resistant Portland cement

Gabion: baskets made of double twisted steel wire and filled with stones to create a mass protection

Armour stone or Rip-rap: The sizes depend on local conditions and are generally in the range of 100 – 500 kg each

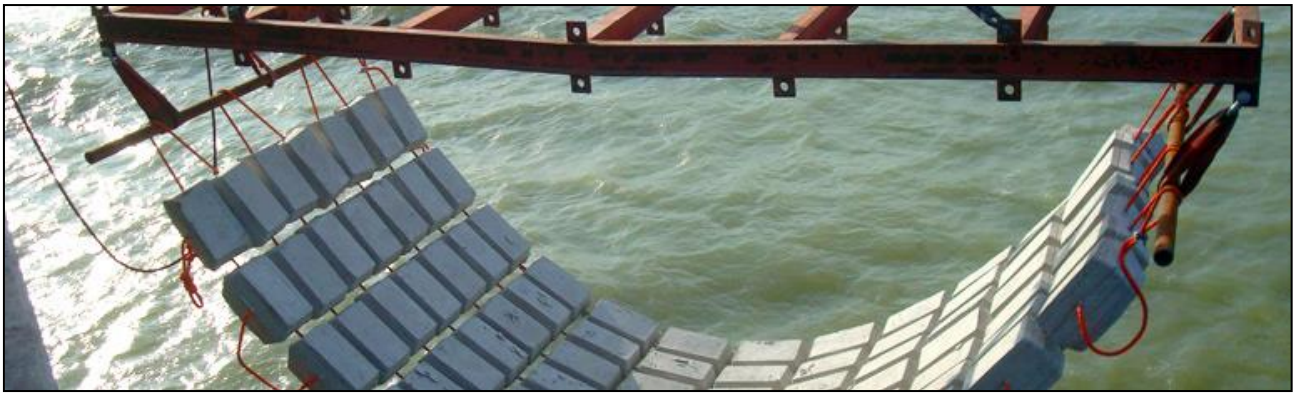
The pipe shall always be backfilled unless it is decided to keep it exposed under a certain depth of water where under water currents are not expected to be effective and where marine traffic is not heavy.

Therefore, the designer decides during the stability calculations the height and weight of final backfill. It is extremely important to consider the scour protection in order not to lose the haunching in a short time.

The trench depth can also be reduced as the depth increases. In any case, it is suggested to keep at least half of the pipe in the trench and protect and stabilize the pipe with ACBMs or gabions.

Gabions

Geotextile



Articulated concrete mattresses (ACBM)

17. Connection to the rigid structures

On land or in marine, the pipe may require a connection to a rigid structure.

This rigid structure could be pump or discharge chamber on land or an intake structure or a diffuser in marine.

If the connection will be realized on land, a puddle pipe shall be embedded to the structure. Outside of this pipe shall contain ribs as much as the design requires and also sealing material [10] in order to avoid water leakage.

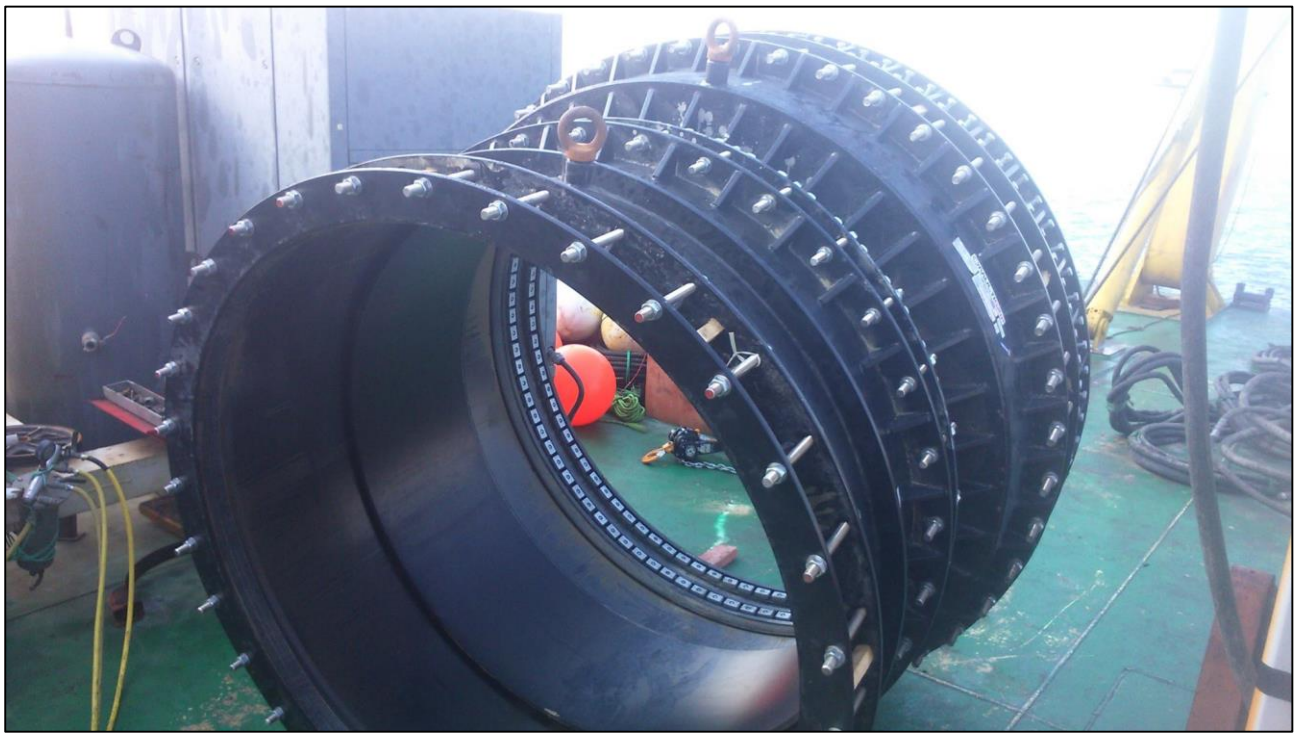
After the pipe exits from the chamber or any kind of rigid structure, it is recommended to use spool pieces or compression coupling or expansion joints.

If there is a risk of settlement in the structure or in the nearby area, use spool pipes or compression couplings may be sufficient to avoid eventual damages that can happen to the pipe.

If there is an axial movement is expected on the line, an expansion joint which allows both axial and lateral movement shall be used.

Compression couplings and flanges of expansion joints shall be protected against corrosion. Depending on the choice of the designer, the metal parts can be coated by plastic base coatings, can be protected by sacrificial anodes or stainless steel material can be used.

[10] Sealing material shall be any kind of material that increases its volume when gets in contact with water



Compression Coupling

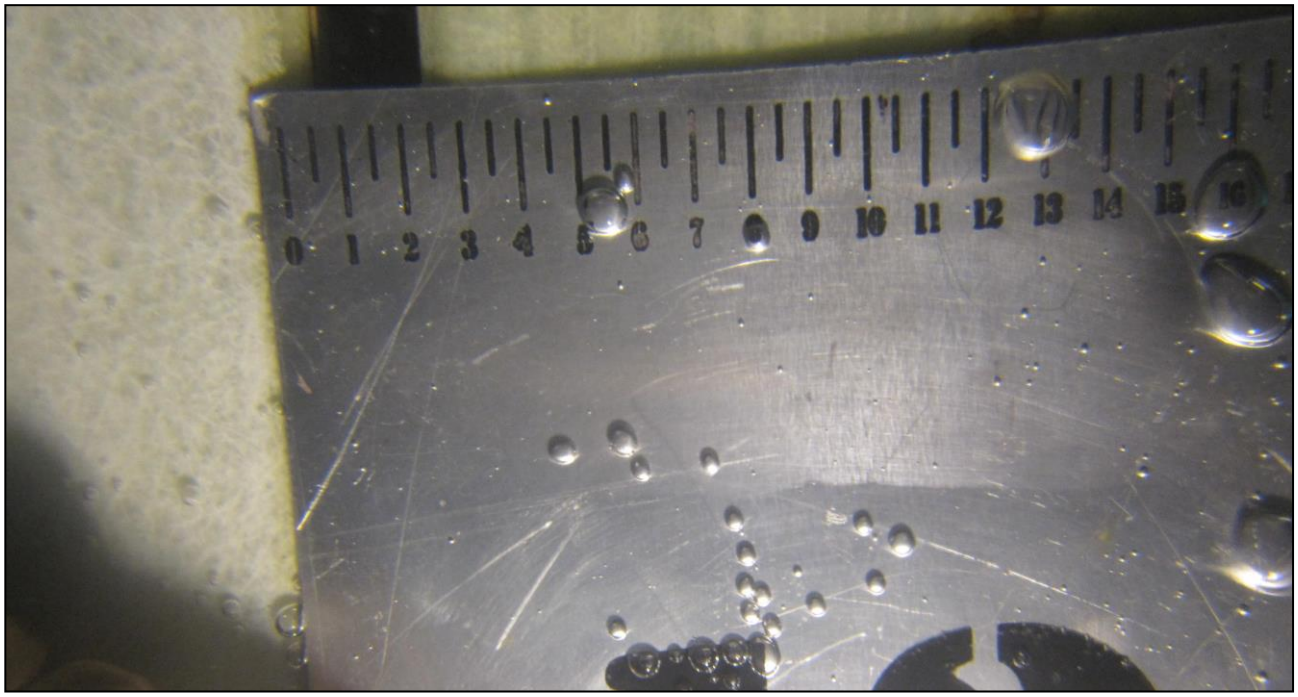
Flexible Joint

18. Installation tolerances

The installation tolerances given hereafter are just informative, it shall be decided by the designer, depending on the diameter, length, bottom conditions and depth.

	ON LONGITUDINAL PROFILE	ON TRANSVERSE PROFILE	ON ALIGNMENT
TRENCH LEVEL	In any type of ground, at spot, no limit for levels lower than theoretical	Maximum ± 10cm difference between the elevation of the trench bottom at the sides	No instruction
	In any other type of ground, maximum +10cm		Trench slopes: No instruction. The sides of the trench shall nevertheless follow the natural angle and, in case of instability, the angle shall be decreased or the trench sides shall be terraced to prevent any caving-in.
BEDDING LEVEL	Every 50 m on each pipe axis: +0 / - 50mm	Maximum ± 10cm difference between the elevation of the bedding, with no higher point at centre	
	At spot: ± 10cm		
PIPE LEVEL	Maximum angular deviation at each joint ± 0,3°	Pipe elevations at any cross section shall be within ± 10cm, provided that the prescriptions for longitudinal elevations are respected	Planimetric profile: maximum angular deviation at each joint ± 0,3°
	Maximum axial misalignment every 12m ± 6,5cm		Planimetric profile: maximum axial misalignment every 12m ± 6,5cm
	Any level measured at the joint, progressing from land to sea, shall be ≤ of the one of any preceding point (slope to be completely		Pipe spacing: tolerance on distance of the pipe wall for the parallel pipes: ± 10cm, provided that the angular

	horizontal or sub-horizontal)		deviation limits are respected
	Maximum tolerance in any point of the profile ± 10cm, provided that all other conditions are respected.		Fixed or end points: ± 50 cm, provided all other conditions are respected



19. Pipeline Signalization

The position of the pipelines shall be signalized with beacons [11] and buoys [12]

In general, beacons and buoys that are supplied according to IALA [13] standards (and notified to the Department of Navigation, Hydrography and Oceanography or the General Management of Coastal Safety and Salvage Administration) are sufficient to prevent damages to the pipelines from small crafts and fishing boats.

The buoys and the land beacons shall be equipped with light and radar reflector, visibility ~5 NM, with rechargeable batteries and solar panels in order to avoid the periodical change of batteries.

[11] It is a structure on land which indicates the start of marine pipeline. It has lights for a night visibility (small lighthouse for pipelines). It is a light pole with a directional or blinking light, according to the prescriptions.
[12] It is a floating object that is anchored by blocks to the sea bottom to warn the navigators and especially fishermen about the pipeline
[13] International Association of Marine Aids to Navigation and Lighthouse Authorities

20. Testing and Commissioning

Marine pipelines, together with its diffusers and intake heads, are open pipe lines with working pressure at very low values.

As it is not a closed system, it will not be possible to pressurize the line and then perform the test. Even the offshore ends of the pipe have been blinded, it will be not easy because the compaction of the backfill will be finalized in long term (self-compaction or auto compaction in long term).

As there is the risk of settlement after the final backfill, again it will be not applicable to perform the test on exposed pipe.

On the other hand, when the line is tested after the backfill even with the test water is dyed, to determine a leakage in water will not be easy (not to say “impossible”).

Therefore, instead of a hydraulic test of the entire line, it is recommended to check the couplings internally for the gasket positioning and to avoid counter slopes during the installation.

If internal check of the line results without any problematic and/or risky joint, the line commissioning can be released.

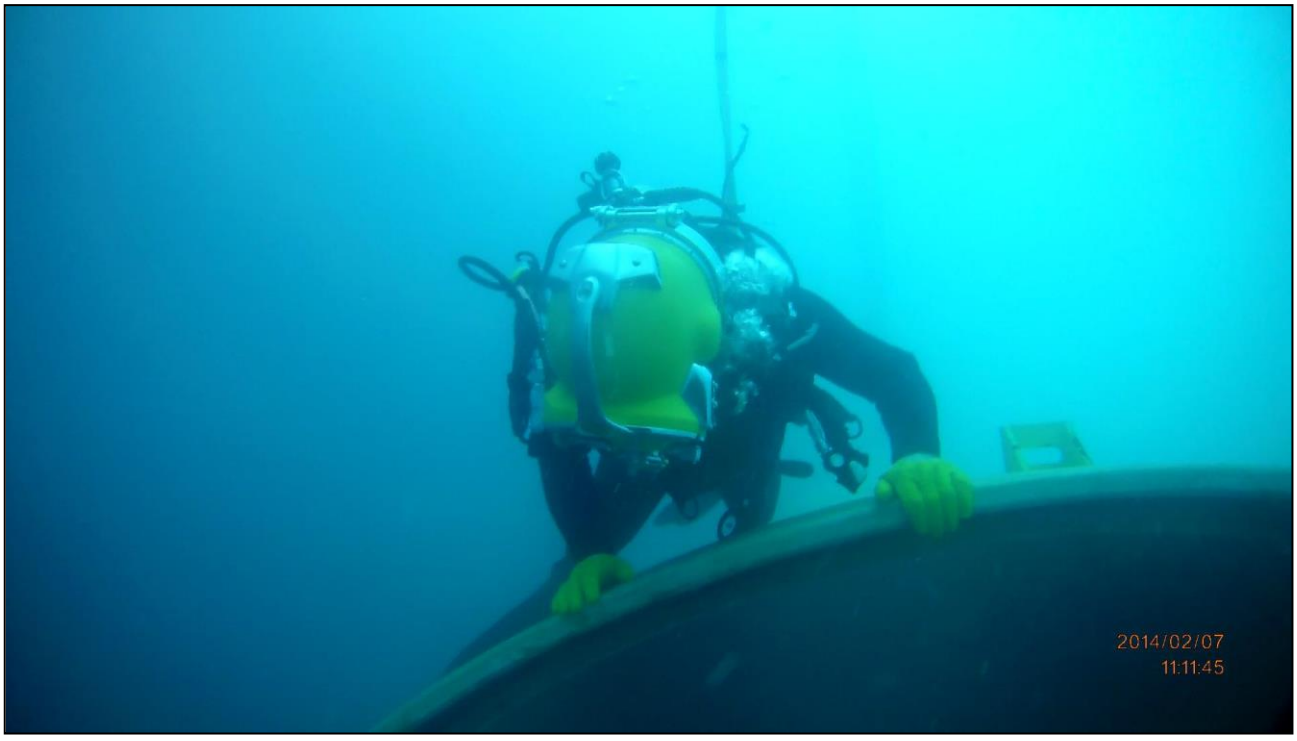
21. Inspection and test plan for the installation works

During the installation works, owner shall inspect the works with an inspection and test plan which shall also be delivered to the marine contractor.

This plan shall be prepared specifically for the project but the following scheme can be a guide for the works.

The inspection team of the owner shall be completely independent from the marine contractor and shall have his own equipment for the measurements.

All the measurements shall be recorded and if there are deviations from the design criteria, the supervision team shall inform the owner and owner shall issue a notice to the marine contractor. It is always recommended that supervision/diving team of the owner not to get any direct contact with the contractor.



CONTROL POINT	DEFINITION OF INSPECTION	CONTROL AREA	FREQUENCY	METHOD	CRITERIA TO BE CHECKED	ACCEPTANCE CRITERIA - TOLERANCE
INSTALLATION OF PIPELINE (General)	Installation Method Statement and Risk Assessment	Construction area	Always on site	–	MS to be prepared and approved	–
LAND SECTION EXCAVATION	Level, trench width and depth measurement	Land section trench	Always on site	topographic measurement	Design documents	At spot, no limit for levels lower than theoretical, in any other type of ground maximum +10 cm, on transverse profile: maximum ± 10 cm difference between the elevation of the trench bottom at the sides
MARINE EXCAVATION	Level, trench width and depth measurement	Marine section trench	Always on site	Echosounder, electronic depth gauge	Design documents	At spot, no limit for levels lower than theoretical, in any other type of ground maximum +10 cm, on transverse profile: maximum ± 10 cm difference between the elevation of the trench bottom at the sides
BEDDING, HAUNCHING AND BACK FILLING	Size of crushed material, pollution control and suitability of excavated material	On site	at random, every batch of material	visual inspection/sieve analysis/chemical analysis for excavated material	Technical Specifications	size of crushed material between 20 - 50 mm

CONTROL POINT	DEFINITION OF INSPECTION	CONTROL AREA	FREQUENCY	METHOD	CRITERIA TO BE CHECKED	ACCEPTANCE CRITERIA - TOLERANCE
PIPELINES INSTALLATION	Bedding, haunching and backfilling heights	Trench	at every pipe segment	On land: topographic measurement Offshore: Echosounder, electronic depth gauge	Installation Technical Specifications	Refer to the installation tolerances at section 14 of this document
	Support level control	Trench	at every pipe segment			
	Pipe Installation	Along the pipeline	at every pipe segment			
	Pipe Spacing	Along the pipeline	at every 100 meters			
	Backfilling Material	Along the pipeline	at every installation segment	visual inspection		
	Riprap filling Material	Along the pipeline	at every pipe segment	visual inspection		
CHLORINATION PIPES INSTALLATION	Installation control	along the chlorination pipe line	at every pipe segment	visual inspection	Installation Technical Specifications	
FINAL INSPECTION	Visual inspection	construction area	100%	visual verification	drawings	tecnical specification-drawings
	- Check of final documentation - Control of “As Built” survey - Verification and approval of “As Built” report	_	_	_	ITP	_

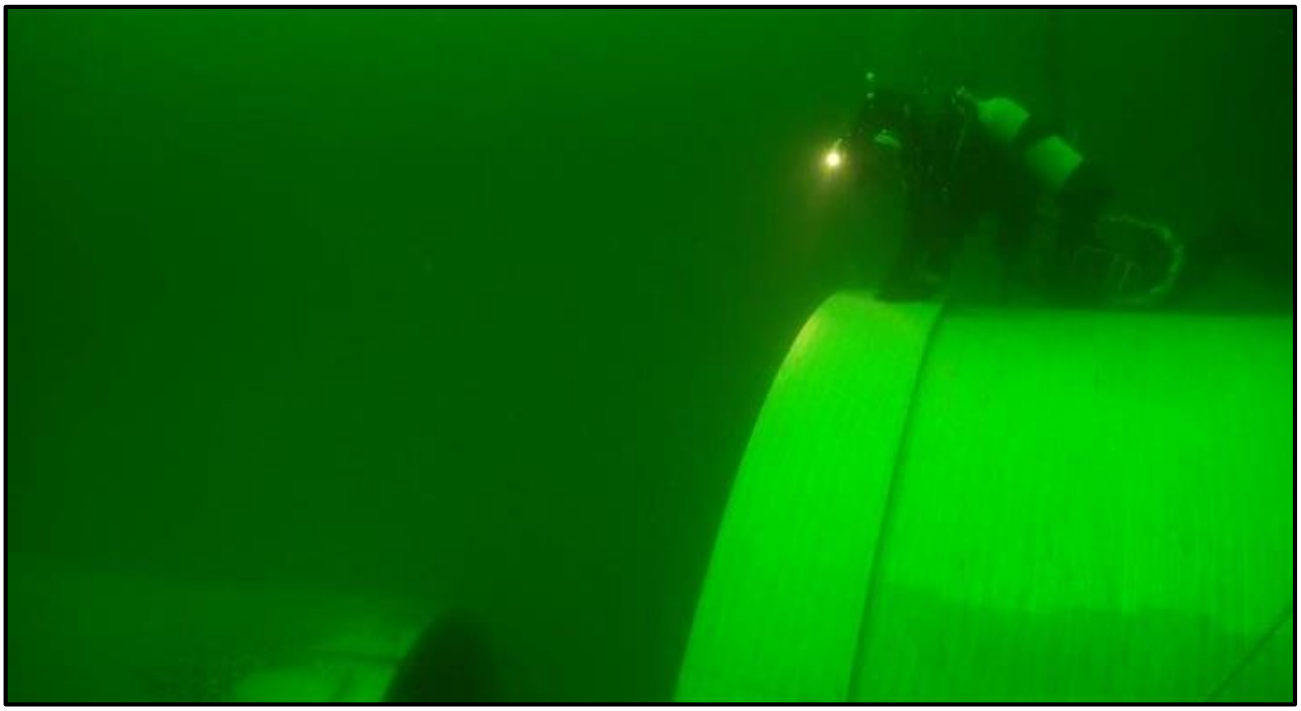
22. “As Built” Report

The Contractor shall provide an “as Built” report including all relevant data, levels, coordinates, quantities of materials, and any particular information which may be used for the future maintenance or to locate any structure belonging to the pipelines.

Contractor shall supply, with the “as Built” reports, all the visual documentation (drawings, photos and videos) which will illustrate all phases of the works.

After the submittal of the report, it will be controlled for the completeness and correctness of the information.

It shall also include the precise geographical coordinates to be transmitted to the Department of Navigation, Hydrography and Oceanography and to the General Management of Coastal Safety and Salvage Administration for the indication in the Nautical Charts.



23. General Safety Procedures

Valid also for land based applications

23.1. Pre installation stage

- All site personnel should complete technical and safety trainings regarding jobsite activities including loading, unloading, storing and installation before accessing to the jobsite.
- “Jobsite Safety Procedures” booklet should be prepared and distributed to all jobsite personnel. Warning labels and plates should be placed at appropriate places at jobsite.
- During safety trainings, prior accidents and experiences should be presented by pictures and videos, undesired outcomes of the accidents should be emphasized. It is vital to persuade and convince job site personnel for the importance of jobsite safety to be able to enforce and apply the procedures strictly.
- A safety supervisor should be assigned. Responsibilities, duties and authority of the safety supervisor should be clearly identified and declared to all job site personnel.
- Safety equipment such as helmets, safety shoes, safety gloves, etc. should be provided and consigned to each site personnel with a signed receipt declaration.
- Site personnel should strictly be controlled in terms of utilization of the safety equipment.
- Safety equipment supplied should be quality certified by independent accredited agencies.
- Periodic maintenance and controls on safety equipment should be performed. Old, torn out or non-functional equipment should be replaced.
- Personnel who does not obey and apply Jobsite Safety Procedures should immediately be discharged from the jobsite area and pre-determined penalties should be exercised.

23.2. Installation stage

- Safety supervisor should strictly control whether or not installation activities are performed as described during installation trainings. If there is a case which needs application of a non-standard installation procedures, such a procedure should only be applied under the permission and supervision of the Safety Supervisor.
- Installation equipment should be free of damage and defects, and should be completely functional.
- Machines and vehicles such as excavator, bulldozer, grader, etc should only be operated by certified and licensed operators without any exception.
- Make sure that communication system among jobsite personnel is clear, correct, uninterrupted and not subject to misunderstanding or misinterpretation. (For instance, communication of a worker inside the trench, with the crane operator lowering a pipe into the trench)

23.3. Entering into a pipeline for land sections of the project

While entering into a pipeline for control or repair purposes on empty pipes for land based applications, below items should be taken into consideration:

- Entrance into a pipeline should only be done with Safety Supervisor's permission. Safety Supervisor should evaluate all potential risks before permitting entrance. Personnel having health problems and personnel who are not willing should not be allowed to enter into a pipeline.
- If there is a necessity to perform gas and oxygen level tests, such tests should be performed by authorized and certified personnel.
- If the oxygen level inside the pipeline is not sufficient, entering personnel should be equipped with oxygen tubes.
- Personnel entering into a pipeline should be equipped with safety equipment and should always have a spare lighting.
- Communication between entering team and outside team should be clear and uninterrupted. For any reason if communication is lost, inside team should immediately get out of the pipeline.

23.4. During repairs at job site

- Safety procedures exercised during installation should also be applied while removing a pipe or a fitting from an installed pipeline.
- Repairing works should be performed at a repairing station. Boundaries of the repairing station should be clearly marked.
- Any person other than authorized repair personnel should not enter to the repair station.
- Repairing equipment should be functional, in good condition, clean and clear of defects.
- Safety Supervisor should continuously inspect utilization of safety equipment during repairing.
- Repair station environment should be clear of any possible fire risks.
- Repair station should be equipped with fire extinguishers.

If the repair should be performed inside the pipeline;

- Repairing personnel entering into the pipeline should wear isolated work suits and gas masks. If the oxygen level is not sufficient, personnel should be equipped with oxygen tubes. Sufficient ventilation should be supplied to remove the dust from the pipeline.
- If the repair inside the pipe should be done at 2m height or more, suitable scaffolding should be provided.

23.5. Storage of chemicals and raw materials

- Chemicals and raw materials which will be used for repairs should be stored in a closed and locked storage room.
- Storage room should have natural ventilation and should not be subject to high temperatures.

- Storage room should be isolated from outer side conditions such as humidity, rain, snow, etc.
- All chemicals and raw materials should be stored at their original packages.
- Storage room should be equipped with fire extinguishers.

24. Maintenance and monitoring manual

After the commissioning of the pipelines, the designer or the contractor shall prepare maintenance and monitoring manual which shall be a part of “As Built” documents.

It shall be taken note that this set of document must be always kept in a hand position for an easy access in case of need.

Maintenance period of the pipe lines can be in parallel to the periodical shut down of the plant. If the plant requires multiple pipelines, spare lines for emergency cases shall be always considered during the design stage.

Each country has its own guidelines for the environmental monitoring of the line. Even if this issue has no direct relation with the maintenance of the pipelines, it shall be noted the presence of these kinds of regulations [14].

[14] For Turkey, pls. refer to “Deep Sea Outfall Monitoring Circular, dated 30.07.2009, with the number B.18.0.ÇYG.0.06.02-010.06.02”

24.1. Premise

Present procedure covers inspection and maintenance of marine pipelines in view of its structural conditions and operational effectiveness. Each marine project shall have its own inspection and maintenance manual which is prepared by its designers and by considering the local situations and operation conditions; therefore, this manual shall not be considered as an instruction and/or prescription.

It shall be taken into consideration that it can vary according to the particular conditions of the location and operation of the line and especially according to the particular requirements of the owner.

This manual should not be considered as a guide for discharge monitoring of the water quality. Diffuser ports maintenance is considered hereafter but discharge water quality, which is regulated by the country legislations/circulars, is completely another aspect of the operation and has no relation with the structural monitoring of the pipe line.

24.2. Control of the shore approach conditions

Shore approach refers to the area where surface waves break and create the surf zone and it is the transition between offshore and onshore regions. The shore approach up to a depth of approximately -5 m, where the trench for the installation of the pipeline and the related backfill may cause problems of erosion, with eventually wash out of the backfill itself.

(typical shore approach of a pipeline)

There are several ways for shore approach methods; mainly big rocks, articulated concrete mattresses (ACBM) or gabions are used in order to protect this area.

Missing backfill or armour layer, due to the bad workmanship or due to strong waves, can create risk against pipe protection. Therefore:

- The conditions of the armour layer at the shore approach shall be visually verified (in low tide, no wave condition)
- Check if there are uncertainties in the upper levelling of the backfilling

If there are signs of substantial level changes on the backfilled area, pipeline shall be inspected internally to detect if there is a deflection more than allowable values.

Period: This inspection shall be executed after each winter season.

Intervention needed only if the area has deteriorated heavily or if some of the existing armour stones/gabions/ACBMs are broken and have lost filling material or blocks.

24.3. Pipe external inspection/control

After the installation, external inspection of the pipeline is required, even if the line is fully backfilled. Especially backfill shall be checked against scour (Scour: removal of backfill by hydrodynamic forces).

Following inspections shall be executed:

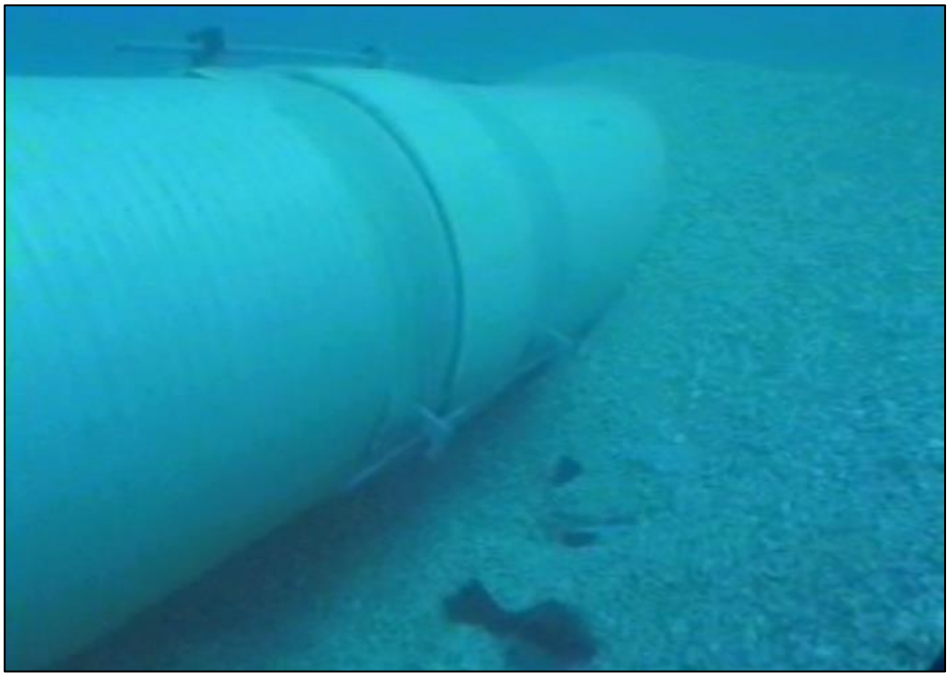
- Video inspection over the whole length of the pipelines; taking pictures on the significant points. Or it can be realized by two parallel passes with side scan sonar + visual/photographic inspection on the points of defects
- Evaluation of the scour depth; record the position of eventual areas of deep scour
- Check the conditions of the manholes (status of bolts, leaks, sedimentation on top, lid situation)
- Evaluation of the status of the backfill
- Record traces of anchors and fishing equipment

Evaluate eventual risks and intervene in due time if particular areas of scour has been observed. This intervention can be done with the same backfill/armour material or some other practical methods can be used, such as big bags, ACBMs, etc.

No urgent intervention can be required. The decision shall be taken after a basic risk assessment of the scour depth.

In case, there are traces of fishing gears, dragging anchors or trawling boards, it will be opportune to verify from inside of the pipe if there had been any pipe movement causing openings in the joints.

Period: First inspection shall be realized after the winter season of the second year of operation. It shall be periodically repeated every 2 years.



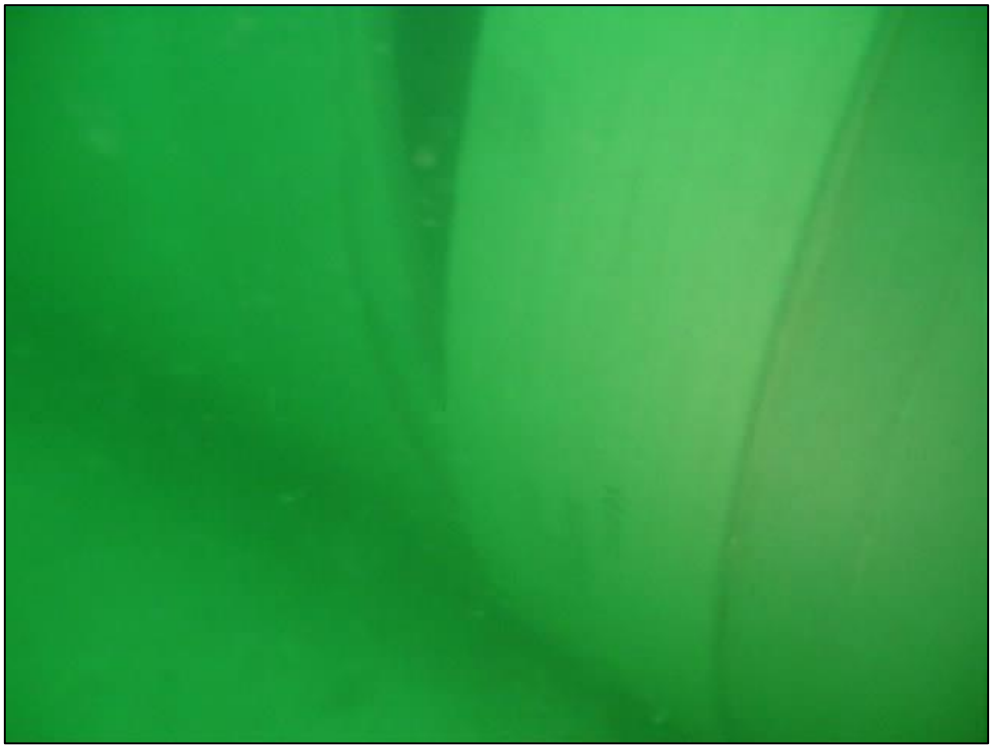
(pipe installation – half exposed)

24.4. Pipe internal inspection/control

In marine works, it is not achievable to have a compaction like land works; therefore, final backfill compacts itself in long time. Following internal inspections shall be provided one year after the operation of the line or at the first standby period of the plant maintenance.

- Internal video record of the full lengths of the lines with ROV (remotely operated underwater vehicle) or divers to observe:
  - Accumulation of sediments particularly at joints
  - Marine fouling
  - Status of couplings and gaskets
  - For intake lines status of the chlorination pipes (with eventual use of dye for detecting leaks)
  - In case mechanical couplings are used, condition of the coating shall be checked
- Examination of the videos for evaluating the pipe conditions and detecting the points/areas at possible risk, particularly at couplings
- After the determination by video inspection of the risky couplings, divers shall inspect precisely the couplings (particularly with measure of gaps and position of gasket – comparison with last survey data)
- Inspection of manholes and eventual substitution of the gasket.

Leakage from the couplings, especially for the discharge lines, may seem not a particular problem as, sometimes it is considered as a normal discharge from a coupling like discharge from diffuser, which is a completely wrong approach. This leakage in the coupling can cause in due time big gaps in the connection and cavities in the main wall of the pipe. Backfill material can easily fill the pipe and can cause more problems in the future.

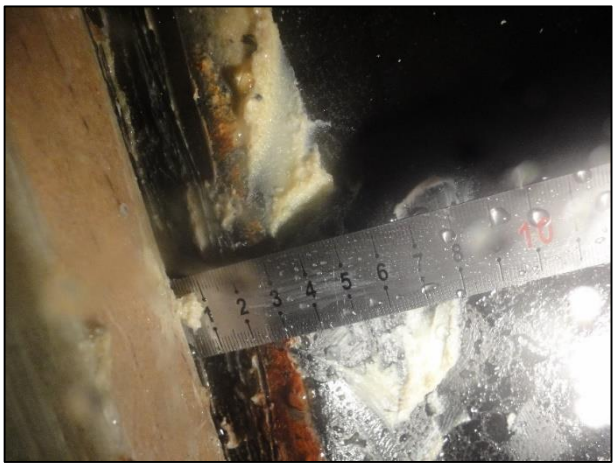


(opening in the coupling)

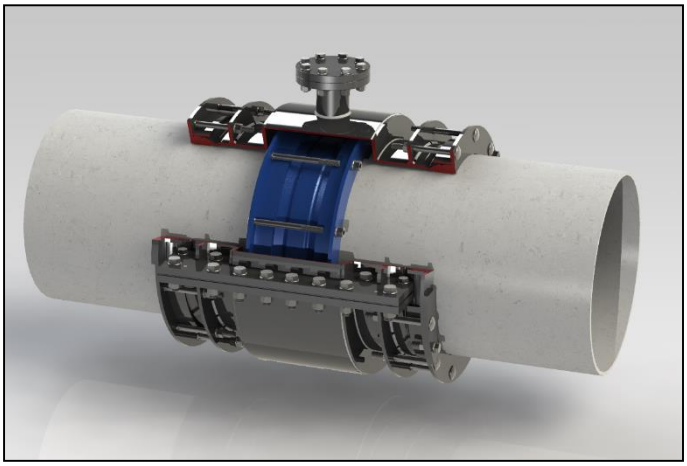
If there is the risk of leakage in the coupling, intervention with internal seals (Amex or Trelleborg) shall be done. If there is a leakage in the couplings of the chlorination lines, the coupling shall be substituted.

(Typical internal sealing installation)

If the damage is not only on the coupling but also on the pipe itself, internal seals will not be effective. In this case, Superlit shall be informed and a particular engineering study shall be executed for the remedy works. Depending on the conditions, remedy works can be done by substituting a section of the pipe or by external sealing of the damaged area by mechanical repair couplings.



(Gap measurement)



(Mechanical coupling for external repairs)

If there is accumulation of sediments or marine fouling in the pipe, divers shall clean the areas of heavy fouling or sedimentation. Same method as indicated in the ports cleaning can be used.

(marine fouling)

Period: one year after the operation of the line or at the first standby period of the plant maintenance. After that, it shall be repeated for the following 2 years.

24.5. Diffuser structural control

Diffusers are the riskiest part of the line as its risers and ports are more subject to be damaged by human interventions (anchor dragging, fishing equipment, etc.); therefore, particular attention shall be paid to diffuser control. In some projects, extra protection methods for diffusers are used but whatever extra precautions are taken, this part of the line is always at risk, especially where marine traffic is high.

Following inspections shall be executed:

- Make a video record of the diffusers or take pictures of the ports while discharging (eventually mix the discharge water with some dye in the discharge chamber)
- Check the protection the diffuser for signs of damage; record position and type of eventual damages/breaks
- Check visually that each port discharges properly
- Check if any port is missing or damaged; if a port is damaged remove it completely
- Check the backfill conditions

If ports are not diffusing properly, they shall be cleaned during the first maintenance of the plant. In case, one or more riser and/or ports are damaged, they shall be substituted.

Period: Every year after the winter season

It is suggested to check visually the situation, if there are signs of changes in the flow rates or changes in the discharge levels in the chamber, especially after heavy winter storms.

(diffuser pipe and its risers)

24.6. Diffuser cleaning, port conditions, cleaning of the ports

If there is heavy marine fouling in the exit ports, discharge flow will be effected. During the dilution calculations, ports are calculated according to the actual diameter of the port (no marine fouling). If there is a reduction in the discharge flow rate, this may cause improper dilution. Also, even if the risk is very low, recirculation may appear for power plant projects.

Following inspections shall be executed:

- Control the flow by providing minimum flow rate conditions during inspection (in order to achieve the worst flow conditions)
- Inspect each port
- Check manually inside of the port (the part which can be reached) to verify if there is marine growth inside.

Period: Every year after the winter season

(discharged water)

If ports are fully blocked, it shall be cleaned as following:

- Remove the sediments around the ports to uncover the lower flange
- Remove the port elbows and bring them to land
- Clean the marine growth by immersion of the port in fresh water with sodium hypochlorite
- Remove mechanically with a hard nylon brush the marine growth (both inside and outside)
- Reinstall the elbow substituting the corroded bolts

Before the reinstallation, insert an air-lift in the port opening and check if sediments are present. Alternatively, insert a hose and pump at high discharge velocity towards offshore.

24.7. ROV and diver inspection

ROV inspections are executed to have a preliminary evaluation on the presence of sediments in the pipes and to have a preliminary control in the joint position. Also, it can be detected if there is air bubble accumulation around the elbows.

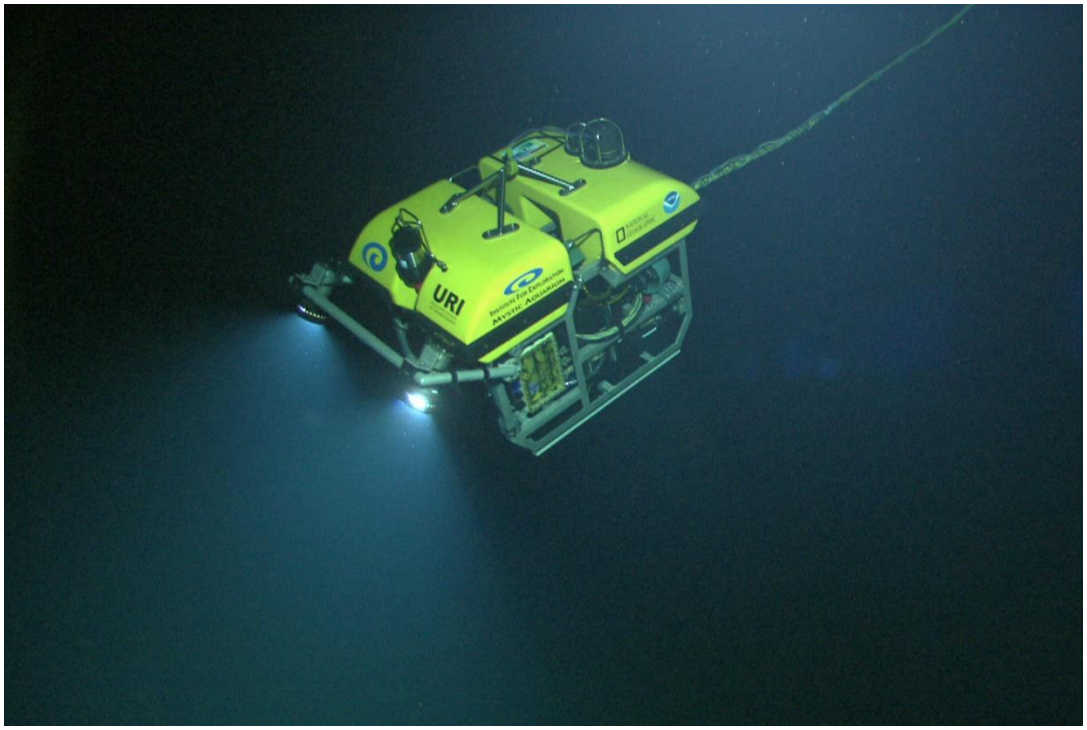
(ROV - remotely operated underwater vehicle)

- ROV cables shall be checked if they are sufficient to reach at least ¼ of the length of the next insertion manhole by considering also the change in depth.
- It shall be lowered through the manhole
- When it reaches to the level of the top of the pipe, adjust the buoyancy to neutral
- Rotate the ROV ±180 degrees horizontally and ±90 degrees in vertical direction to verify the mobility
- Test the lights and the focus and evaluate the visibility
- Verify that the propellers do not create significant turbidity
- As a test observation, inspect the edges of the manhole lamination

If necessary, remove the ROV to revise the settings and repeat the insertion and control

Inspection:

- Set the ROV almost vertical and lower it towards the pipe bottom.
- When it is approximately at mid pipe diameter or lower, depending on the presence of material and on the visibility, tilt it at 45° and proceed slowly away from the manhole or from the starting point.
- Observe the presence of sediments and evaluate from the video their level.
- Observe if the spacing between the pipe spigots is visible.
- When the run is complete, return backwards placing the ROV at mid pipe diameter
- Look towards the wall and observe the spigot distance
- Repeat the run on the other side.
- If the visibility is adequate, the 4 runs should give a good indication of the volume of sediments and of the integrity of the pipe connections



(ROV - remotely operated underwater vehicle)

If there are risky couplings, internal sealing, as indicated above, shall be used. If there is heavy sedimentation, a flushing plan (discharge at maximum flow rate for periods as long as possible) shall be prepared. The discharge line shall be closed by the sluice gate at the discharge chamber. After that, control the rise in the level of water and when it reaches to the maximum level, let the line discharge again.

Period: Every year after the winter season

24.8. Intake line operating monitoring

The definition of the hydraulic conditions of the intake lines shall be provided as soon as possible (water level in the intake chamber in different conditions).

Flow rates shall be observed in the circuit to determine the operating head losses in the intake lines.

If there are problems with the flow rates, offshore intake structures` grids shall be inspected against blocking by fishes, jelly fishes or by other means. Eventually, if there are fish protection nets and oil booms are installed, they shall also be checked.

24.9. Discharge line operating monitoring

The definition of the hydraulic conditions of the discharge lines shall be provided as soon as possible (water level in the discharge chamber in different conditions).

Flow rates shall be observed in the circuit to determine the operating head losses in the intake lines.

If there are problems with the flow rates, diffuser structural control and related inspection tasks shall be provided.

24.10. Diving safety

Regardless the extent of the diver intervention, all the safety precautions and permissions shall be taken. Before the diving, the diver shall be precisely instructed on what and how to inspect/check the positions. It shall never be permitted to a single dive operation.

Turkish Diving Legislation and related other standards shall be followed.

The diving team shall provide the following safety checks with the presence of team supervisor who will be responsible for the operation:

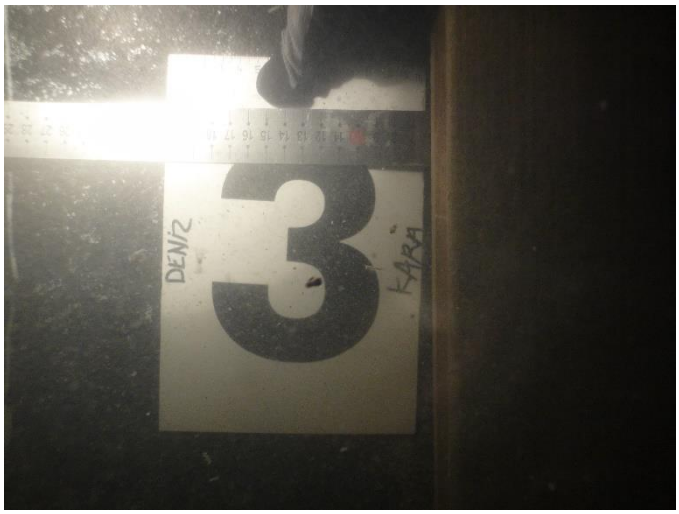
- Diver's Responsibility: he shall know the scope of the dive
- Equipment Evaluations: all the diving equipment shall be controlled
- Site Evaluation: weather and wave conditions and short term weather forecast shall be available.

It shall be taken note that:

- Diving Supervisor is responsible for the safety of all diving operations
- Diving Supervisor shall record for any diver the daily immersion data (working time, depth, decompression time if applicable) and take care that no diver is employed longer than authorized by the standards. Moreover, no diver shall be permitted to operate alone inside the pipes.
- The owner shall have at site a full time, qualified, safety supervisor.
- Any diving operation shall be coordinated under the safety aspect
- All the diving permissions shall be taken in due time and if there is marine traffic during diving operations, diving shall be postponed.
- Diving team (or company if it is subcontracted) shall be registered according to national regulations or laws on the Diving Activities, or the divers employed shall be authorized and qualified by the relevant national or local Authorities or by the relevant regulatory body.
- All divers shall be recorded in the diving log, and have a diver's certificate or work permit and a recent health certificate, as prescribed by the existing regulations.
- All divers shall demonstrate to know, or to be trained on, and shall accept to respect any national and international Safety Standard or any limiting regulation which may be issued in relation to the safety.
- Any diver not certified or qualified or not respecting any safety rule issued in relation to the works will not be permitted to execute diving services and will be removed from site.

24.11. Inspection and Maintenance reporting

All the inspections shall be recorded by high definition cameras and significant positions shall be pictured. The photographs shall be taken by good quality cameras; not screen shots of the video recordings.



During the line internal video survey, divers shall record the pipe number in visible conditions. There shall be hand boards for divers showing the pipe number, side of inspection (land - sea) and position degree of the coupling where the picture is taken. The engineer shall direct the diver by on board communication system if he needs more pictures on specific points.

All the inspection works shall be recorded as per the plants documentation formats. Divers` verbal interpretation shall also be a part of the reporting. The report shall also indicate the differences between the last survey and present survey.

24.12. Buoys and Beacons

Buoys and beacons are the indicators of marine facilities. They are all marked in the nautical charts for navigation aid. Local fisherman will avoid fishing (or any other activity) along the alignment of pipelines.

Their flashing sequence shall be established by Coast Guard in order not to interfere with other nearby navigation lights.

Therefore, buoys and land beacons shall also be controlled.

The buoys and beacons shall be manufactured as per IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) guidelines.

Buoys` lamps (every night) and metallic parts (such as chains-shackles for corrosion or wear) shall be checked periodically every 2 years.

The sinker blocks of the buoys shall also be checked against cracks on the concrete or corrosion in the reinforcement, if visible.

In any case, the supplier shall provide its own maintenance and inspection manual.

24.13. Recommendations/Conclusion

All Superlit pipes are tested by factory quality department engineers and certified as “fully complies production specification” before the shipment starts.

During shipment and handling of the pipe, some defects may occur. In these cases, Superlit site team shall be informed in order to prepare the appropriate repair intervention. Nobody from the owner or subcontractor shall be permitted to have a repair intervention on the pipes.

It shall be taken note that underwater pipes shall not be forgotten after their installation in deep sea till an eventual problem occurs; monitoring of the pipes as per the plants own “maintenance and monitoring manual” shall be respected.

During the installation of the pipes, owner’s supervision team shall inspect the pipe and installation conditions. This supervision team shall be completely independent from the marine subcontractor and the team shall be instructed properly on how and what to check.

All the countries have their own “marine pollution regulations” and all deep sea outfalls are designed fulfilling the requirements and limitations which are specified in these regulations. During the design of outfalls, the ambient conditions that are observed from the marine surveys are used as input data and the modelling studies are also based in these physical, meteomarine and hydrographic conditions. But on the other hand, sometimes the same input data may change in real conditions. Considering these changes, Environmental Ministries of the countries have established their own monitoring regulations and inspect deep sea outfalls time to time. Therefore, in order not have dilution problems, owners shall follow their maintenance and monitoring manual strictly.

Superlit Company policy does not only cover production and selling.

Our aim is to deliver to the end user fully operating marine pipelines.

You may consider Superlit site and engineering team at your disposal in case you need clarification about this manual and/or other engineering studies for deep sea GRP pipelines.