

**GENERAL PROCEDURE
FOR LAYING OF
SUBMARINE CABLES**

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LAYING OF SUBMARINE CABLES

1 SCOPE

Here follow general procedures adopted by P.C.S. Italiana for submarine cables laying between platform and land, between two platforms or between island and land.

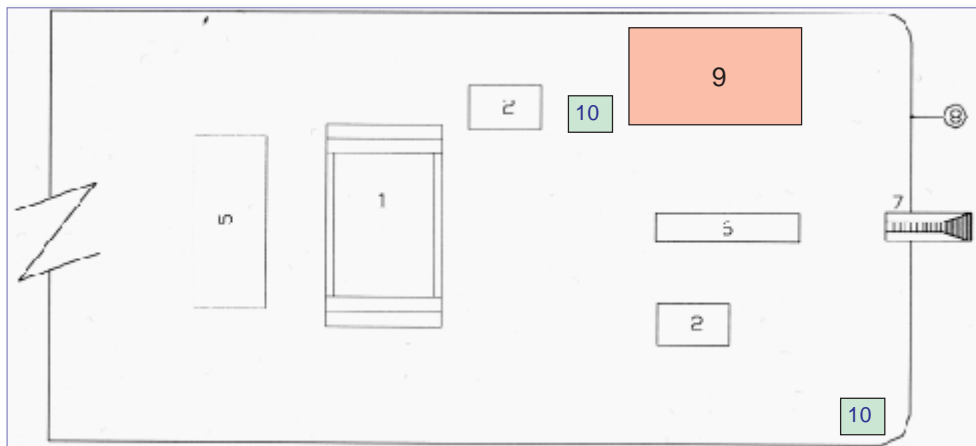
2 SUBMARINE CABLE

According to relevant dimensions (diameter, weight, length, etc.), the cable could be sent from the manufacturing Plant as per following options:

- Lengths shorter than 2.000 m: on regular drum ready to be set on the tensioning machine.
- Lengths longer than 2.000 m: on special drum; once on board, the cable will be transferred on suitable spool or tank.
- Lengths over 5.000 m in order to reach the requested length, special drums with maximum cable length possible will be sent to the yard in order to carry out "Field Factory Joints", before loading on board of the laying vessel on the final requested length.

3 LAYING VESSEL

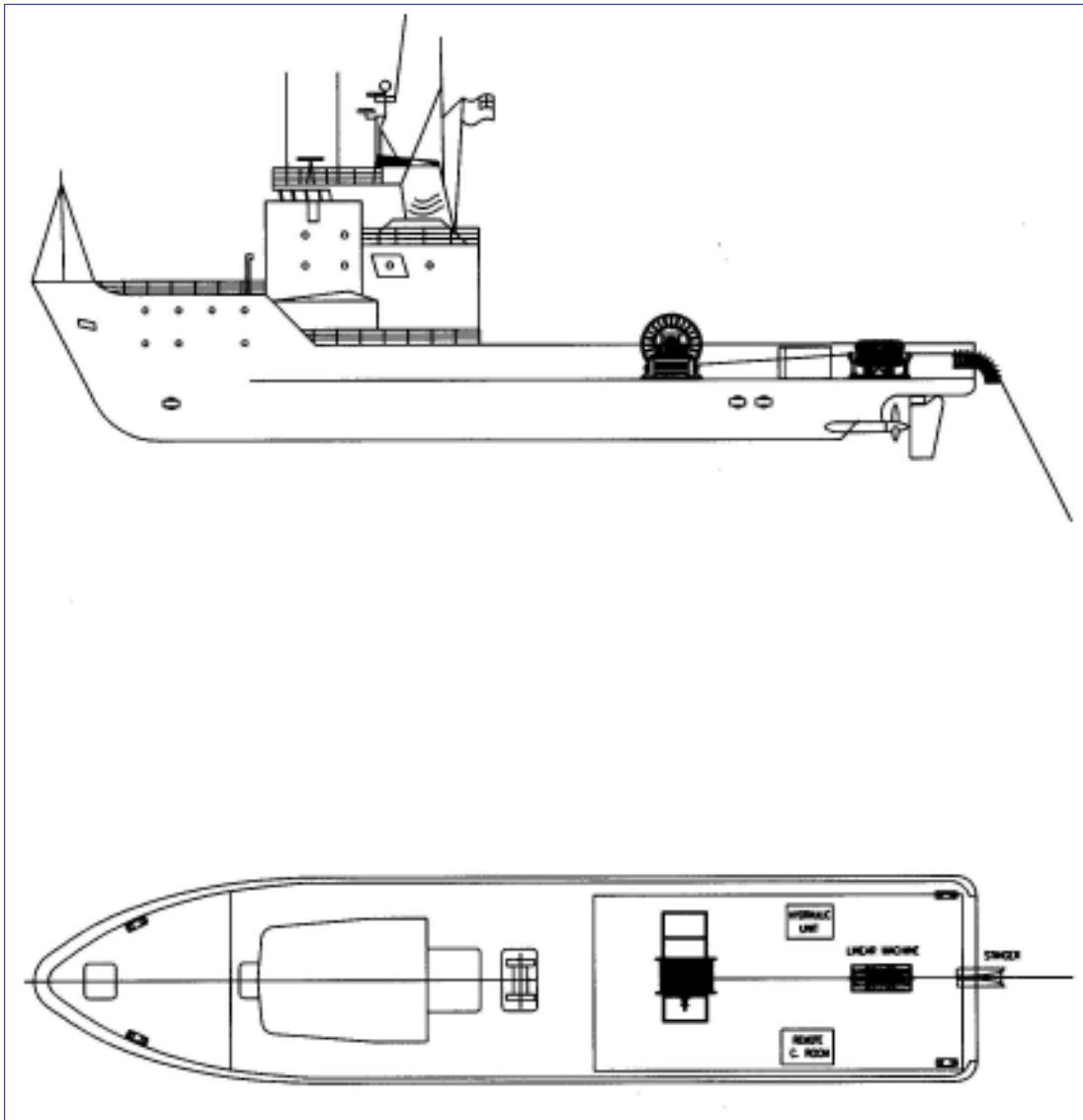
Laying vessel will be chosen according to cable and site characteristics and following criteria:



- | | | |
|----------------------------------|-------------------------------|-----------------------------------|
| 1 - Motorized spool | 6 - Linear Machine | 9 - Remote Control Room |
| 2 - Hydraulic power units | 7 - Stinger | 10 - Video-TV localization |
| 5 - Container | 8 - Laying stern barge | |

- Supply vessel or self-propelled barge or floating barge having preferably a dynamic positioning system GPS compatible or alternatively with joystick and bow thruster or two propellers.
- Suitable dimensions in order to guarantee the maximum manoeuvrability and safety.
- Low draught, when cable has to be laid between land and platform/island, in order to allow mooring close to land.
- Mooring system suitable for the site conditions, in order to maintain a safe position in safety conditions.
- Suitable space on on the deck to place the laying equipment.

For long length cable, laying vessel will be exclusively a D.P. Vessel and laying equipment installed on board will be composed by adequate turntable (one or more than one) and Linear Machine in accordance to the quantity of cable to be installed and "Laying plan".



4 SERVICE MEANS

For the auxiliary operations the following means shall be foreseen:

- Additional supply vessel D.P. or 4 points anchor winch system for diving assistance on deep water (if necessary).
- Suitable motorboat and/or inflatable boat with outboard engine.
- Fast launch for personnel transport to land in case they can not stay overnight on board of the main barge.

5 PERSONNEL

Laying and control operations, electrical connections, etc. will only be made by our specialized personnel. External personnel could be employed only for crews, diving team and for non specialist operations.

6 LAYING EQUIPMENT

The main equipment to be used for laying could be either motorized spool or modular cable tank as hereunder specified:

6.1. MOTORIZED SPOOLS

Two different motorized spools are available :

- Standard (for drums > 10 Tons.) (Dimensions: accepted for regular transportation)
- Medium (for drums > 120 Tons.) (Max. Dimensions: Ø int. 2.00 m - Ø ext. 4.20 m - Length 6.00 m)

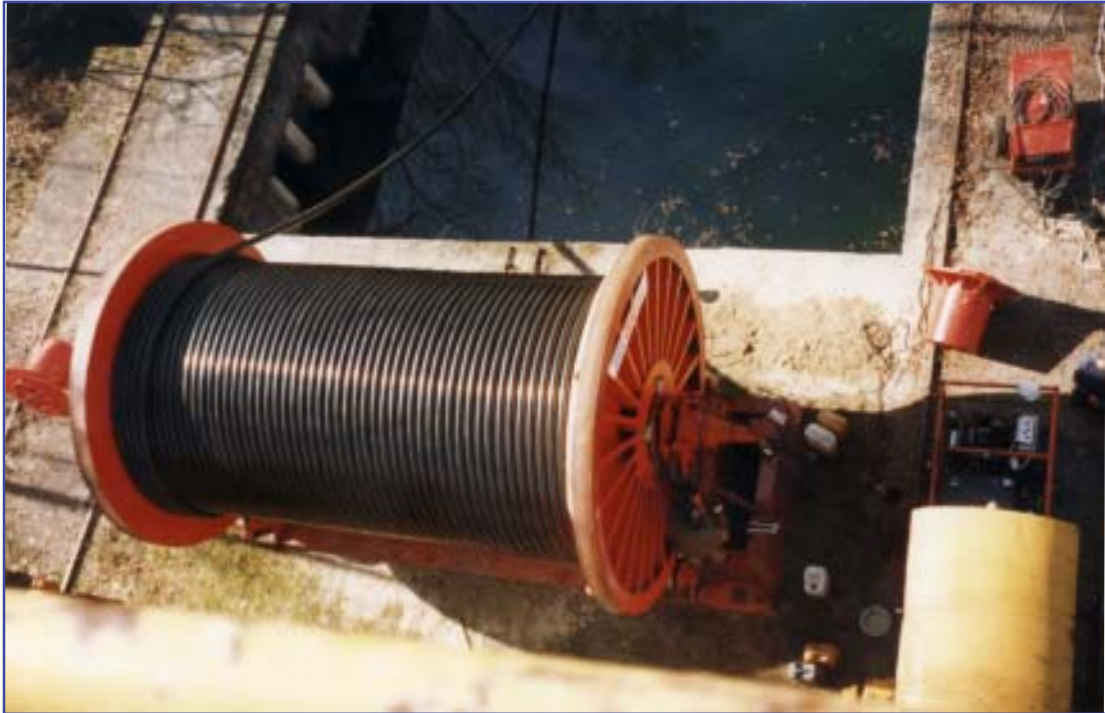
Drums

For standard and medium motorized spool, the drum utilized for transportation is the same used for laying.



Standard motorized spool

"Medium" and "maxi" motorized spool



Motorization

In accordance with laying necessities, the motorization will be made by:

- different hydraulic power units (electric or diesel) with relevant hydraulic pumps from 20 to 300 HP.
- Electric generators from 60 to 200 kW
- Hydraulic engines from 1,200 kg/m to 12,000 kg/m

Accessories

- Laying automatism.
- Length and stress meter.
- Stinger
- Roller way

Maximum concentrated load

All our motorized spools are dimensioned to allow a max. concentrated load on the deck (on laying vessel) of 5 T/m²

6.2 MODULAR TURNTABLE TANKS

We have the following 4 different type of modular turntable tanks:

- Mini (max. capacity > 200 Tons) max. dimensions: Ø int. 2.50 m - Ø ext. 6.00 m - Height 2.00 m
- Small (max. capacity > 400 Tons) max. dimensions: Ø int. 2.50 ÷ 4.00 m - Ø ext. 9.80 m - Height 3.00 m
- Medium (max. capacity > 1,000 Tons) max. dimensions: Ø int. 2.50 ÷ 4.00 m - Ø ext. 13.20 m - Height 3.00 m
- Maxi (max. capacity > 2,000 Tons) max. dimensions: Ø int. 2.50 ÷ 4.00 m - Ø ext. 16.00 m - Height 3.00 m)



Motorization

In accordance with laying necessities, the motorization will be made by:

- Different hydraulic power units HP 300 - 600 - 800 - 1000 with relevant hydraulic pumps.
- Electric generators from 60 kV till the requested power.
- Hydraulic engines to be used in couple (2, 4, 6 or 8) according to performance prescriptions.

Accessories

- Automatism necessary for laying.
- Length and stress meter.
- Stinger.
- Roller way.

Maximum concentrated load

Our turntable tanks are dimensioned for a max. concentrated load on the deck of 5 T/m² (for Maxi Tank could be possible to reach in some case 10 T/m²).

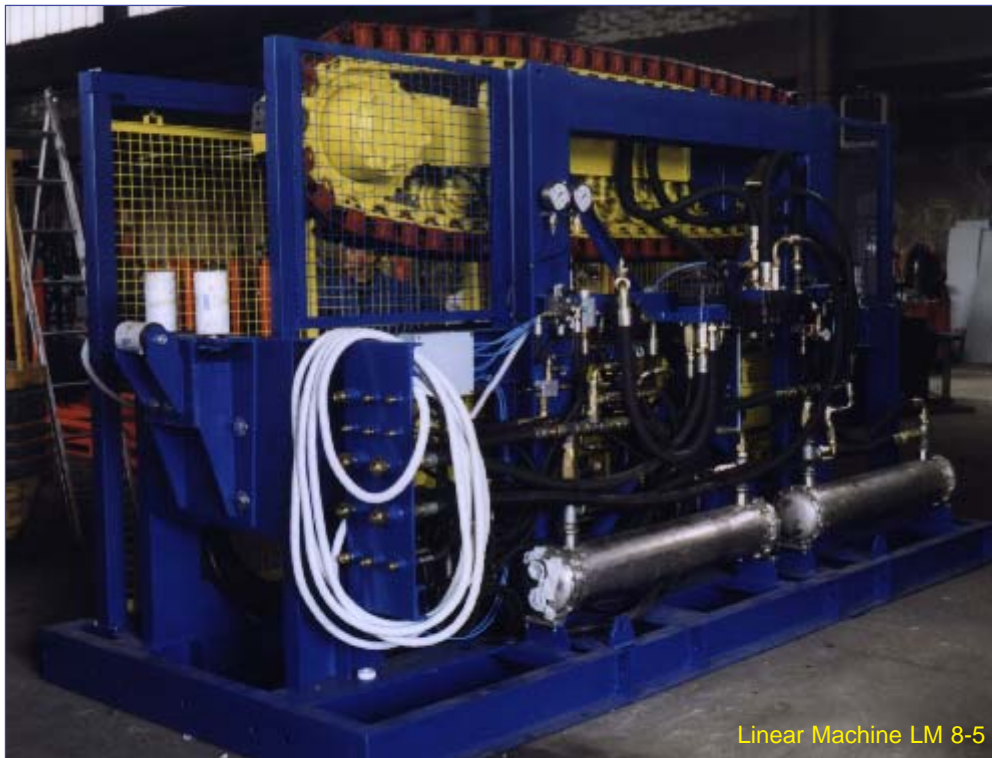
6.3 LINEAR MACHINE

Linear machine can be used both to haul cable for loading and recovery from the seabed and to act as hydraulic brake when laying cable onto the seabed to maintain the correct amount of residual tension.

Actually are available No. 2 linear machines having following data:

- **LM 8-5** tracked tension shoe with max pulling force of 8 Tons and max speed of 5 km/h - length of crawlers 3,20 meters.
- **Modular LM 35-5** tracked tension shoe with max pulling force of 35 Tons and max speed of 5 km/h - Assembling of crawlers: n° 4 opposed crawlers with a length of 8 meters/each. This machine is installed on a special inclinable skid in order to lay directly the cable without stinger.

The equipment is completed by a monitoring and manoeuvring panel (settings: automatic, manual and safety) which comprise: speed meter, cable pulling meter, counter meter and other laying parameters.



Linear Machine LM 8-5

6.4 TOPOGRAPHIC EQUIPMENT

Following main instruments are normally used for preliminary survey and laying operations:

- GPS Tremble or equivalent
- Computerized topographic station GEOTRONIC 422 LR
- Echo sounding Atlas Krupp DESO 25 or equivalent with sub bottom possibility
- Magnetometer FOSTER FOREX 4021
- Side scan sonar (if necessary)
- Boring machine for sea bottom samples
- Underwater cameras (T.V. and photo)

- Seawater sampler
- Thermometers
- Current meters
- Soil resistivity tester
- VHF radio

6.5 DIVING EQUIPMENT

For shallow water immersions (20 ÷ 40 mts.) during preliminary survey and laying will be used the following equipment:

- Air bottles
- High pressure compressor for bottles charging
- Low pressure compressor (for narghilè)
- Decompression chamber
- Underwater cameras (T.V. and photo)
- Underwater communication system
- Underwater tools (hydraulic hammer, underwater screwer, hydraulic grinder, underwater core equipment, etc.)
- Hydrodines and different floaters
- Water lift and water jets equipment
- Submersible high pressure pumps for "INCAVATRICE" water lift and water jets equipment
- Tools

In case of required or necessary burying of the cable (for its total length) we have also available our burying machines "INCAVATRICE" (patent 1215709) type FS1 or FS2 able to reach two meters under the seabed.

In case of diving assistance or R.O.V. (Remote Operated Vehicle) in deep water (over 40 meters) we can rely on specialized and well equipped subcontractors with saturation systems.

They will be selected according to: job peculiarities, relevant experience.



6.6 ACCESSORIES & MISCELLANEOUS

- Rigidimeters from 24 up to 110 kV for testings
- Ohmmeters
- Teleflex
- OTDR (for optical fibre testing)
- Pulling heads
- Floaters for lightening the cable
- Tirfor's with associated hydraulic power pack for cable recovering from riser on platforms
- Other equipment (by air or electrical) for cable recovering
- Winch for pulling cable from land (when connecting platform with land)
- Open and closed mechanical pulling sockets (of different lengths and diameters)
- Kit for watertight of the cable ends
- Kit for Field Factory Joints execution
- Kit for submarine joints execution (power, optical fibre and instrumentation)
- Kit for sealing ends execution
- Crimping tools (hand and hydraulic operated) for connectors and terminal
- Hydraulic cable cutters
- Tools



7 PRELIMINARY SURVEY

In accordance with the Customer, immediately after the awarding of the contract, it will be carried out a preliminary survey in order to verify the effective validity of the proposed cable route or to search for eventual alternative routes and to identify main engineering points.

It will be carried out the following activities:

- Topographic investigation at landing areas and bench marks.
- Bathimetric investigation along the cable route with concentration on the landing and in eventual critical points.
- Standard sub-bottom and/or soft sub-bottom analysis by means of further echo sounder transducers.
- Magnetometric investigation to find eventual services or presence of metallic pieces with landing points relief.
- Side scan sonar investigation (if necessary)
- Execution of little borings or penetration testing on landing points in order to select the better cable protection system.

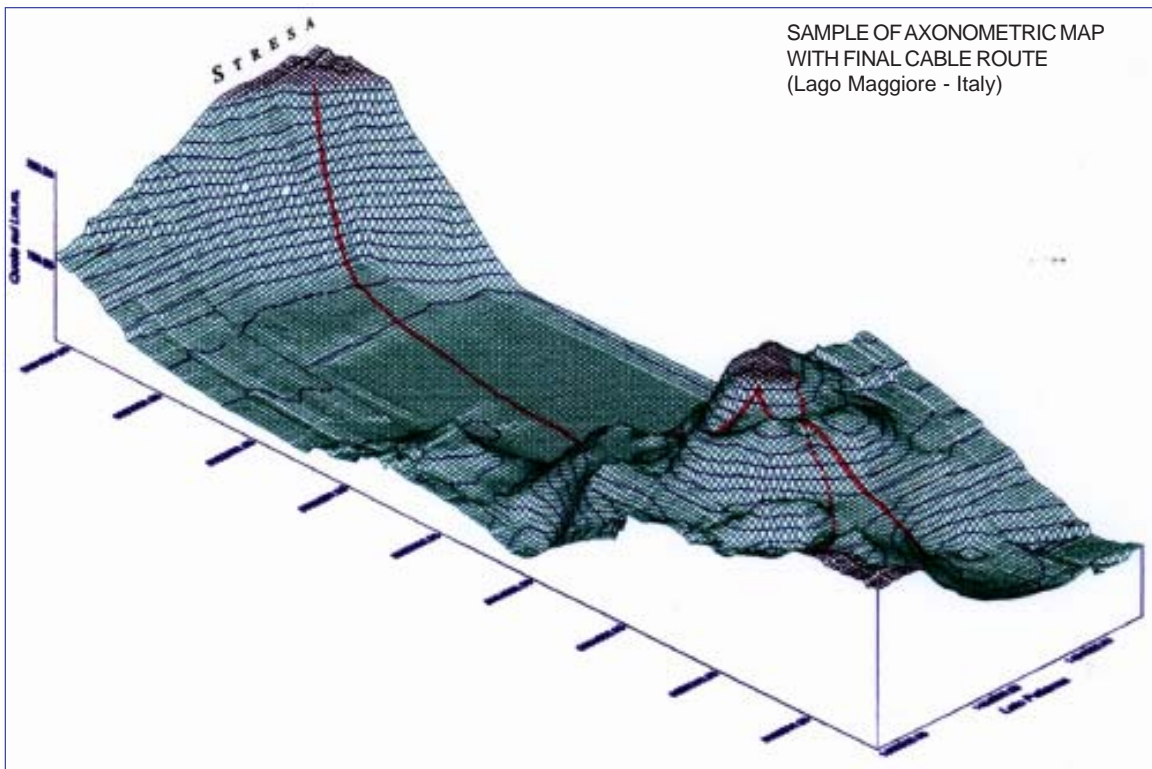
In case the protection will be required for the complete length of the cable, such evaluation will also be made in other points along the route.

Obtained samples will be analysed in laboratory.

- Superficial sampling of the seabed soil.
- Marine current investigation of the laying area.
- Sampling of water sea and relevant analysis.
- Underwater inspection in critical points and on landing points.
- Platform investigation risers, risers to cabin cable route, winches anchoring points for recovering of the cable from the riser and deviation points definition.
- Data collection from Authorities to identify eventual existing or programmed services interfering with the cable route.
- Investigation about eventual obstacles or crossings (other cables, sealines, water pipes etc.).
- Soil resistivity on the interested land portion.
- Collection of authorizations and prescriptions to be respected during job execution.
- Study of the mooring plan of the naval equipment on site and eventual marker buoys to be agreed with local authorities.
- Specific arrangements to be taken to make the job.
- Specific marking or signals (if required by local Authorities).
- Collection of all possible meteorological data from local offices and whichever useful to make job engineering and execution.
- Verification of available lifting equipment in the area.
- Verification of available stocking space in the area.
- Selection of potential subcontractors for civil works.
- Custom, harbour and agency fees on site.
- Transportation of supply material and equipment and searching for personnel lodging.

Data processing, maps and sketches drawing and relevant rendering will be handled by our technical dept. at finishing of the laying project which consist of:

- Identification of the landing points and definition of the cable lengths.
- Identification of the type of cable protection on the landing and on critical points.
- Definition of installation and laying procedure.
- Definition of the type and number of testing to be executed before, during and after laying.
- Definition of emergency procedures (abandon, adverse weather conditions etc.).
- Identification of suitable equipment and vessel for the laying, definition of the deck charging for the equipment.



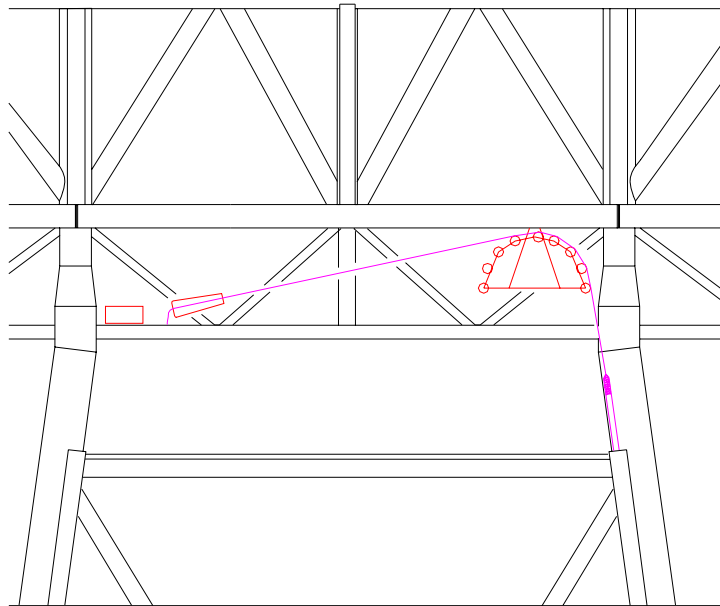
- Cable burial procedure, type of “INCAVATRICE” equipment to be used and relevant accessories to guarantee the defined burial depth.
- Definition of site Quality Control Plan (QCP).
- Issuing of the definitive working schedule.
- Definition of the final project, cable manufacturing plan and supply accessories.
- Final verification and analysis.
- Provisional jobs to execute.

8 INSTALLATION

8.1 PRELIMINARY OPERATIONS

As soon as site organisation (personnel and equipment) will be mobilized and operative and in accordance to the working schedule and site QCP, it will be carried out following preliminary operations:

- On the deck of the laying vessel will be installed the laying equipment in accordance with the cable length and water depth.
Cable drum will be transferred on board and installed on the motorized spool or the cable will be transferred on the turntable tank according to the defined laying procedure medium and short length of cable.
- Installation of the adequate turntable (one or more than one) for long length of cable.
- Installation of the adequate Linear Machine in accordance to the “laying plan”.
- Defined route will be marked with special reference points and the definitive route will be inserted into the GPS system
- If necessary, critical points and crossings could also be indicated.
Anyway these will be as well inserted into the GPS system.
- In case the laying will be made with a vessel having a DP system, GPS will be connected to the system.



- On the platform will be anchored the pulling winch to recover the cable from the riser and the necessary steel structures.
- In case of land/island connection, at the landing points will be positioned winches and all necessary to recover the cable.
- In case necessary, it will also be installed the emergency mooring system or to be used by the auxiliary means
- All laying, submarine, topographic and floaters equipment will be tested and calibrated. The same will apply to communication, control and testing equipment.
- Buoys field will be installed in connection to what already defined.
- Verification of the “messenger line” inserted into the risers on platform.
- Personnel and equipment will be settled for laying trial which will continue until all manoeuvres and co-ordination between technical, maritime and underwater technicians is reached.

8.2 LAYING BETWEEN TWO PLATFORMS

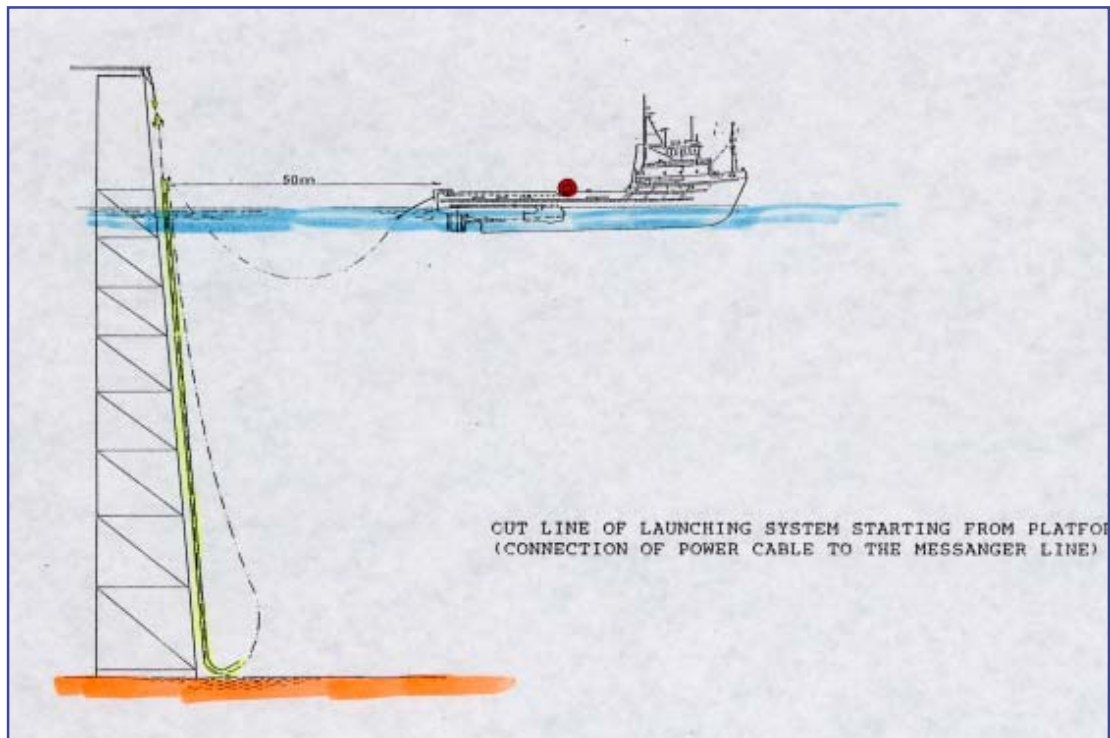
In good meteorological condition and with good weather forecast, the laying barge will moor near the starting platform.

The power cable end (with pulling socket and swivel already placed) will be connected to the messenger line already threaded into the riser.

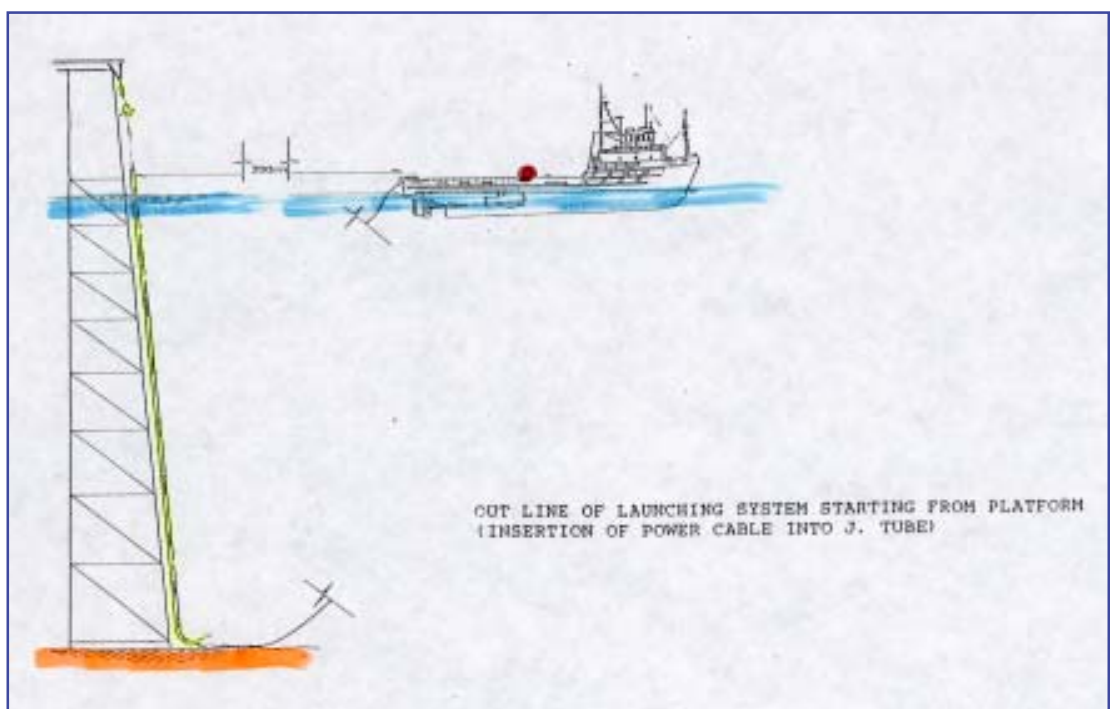
From the platform, by means of the installed winch, it will be carried out the recovery of the messenger line while on the laying vessel is left the quantity of cable required by the winch operator.

Pulling and recovering of power cable from the riser is made by the winch and control is obtained by the dynamometer placed at the deviation point or on the hydraulic power unit.

If necessary, divers and/or R.O.V. can control the introduction of the cable inside the riser or any other eventual critical phase of the work.



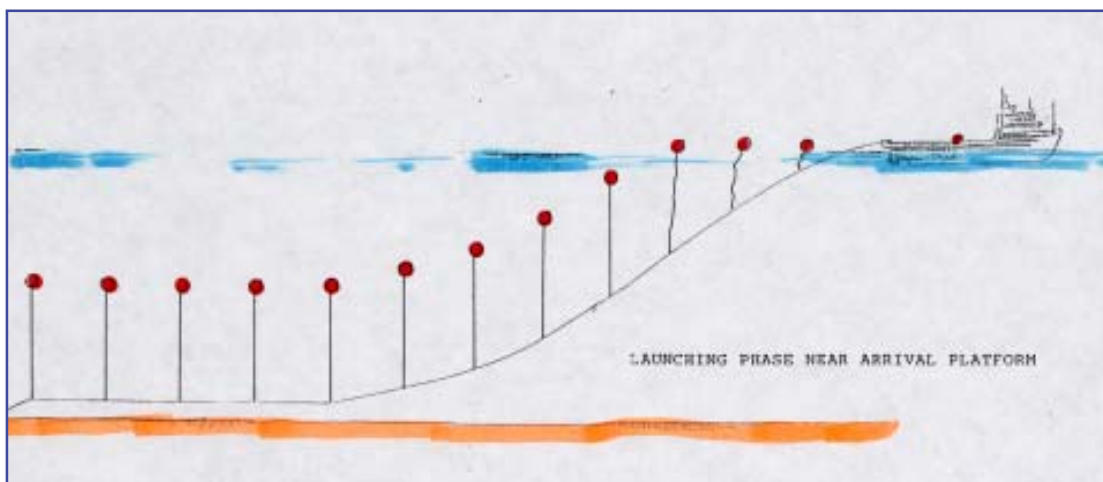
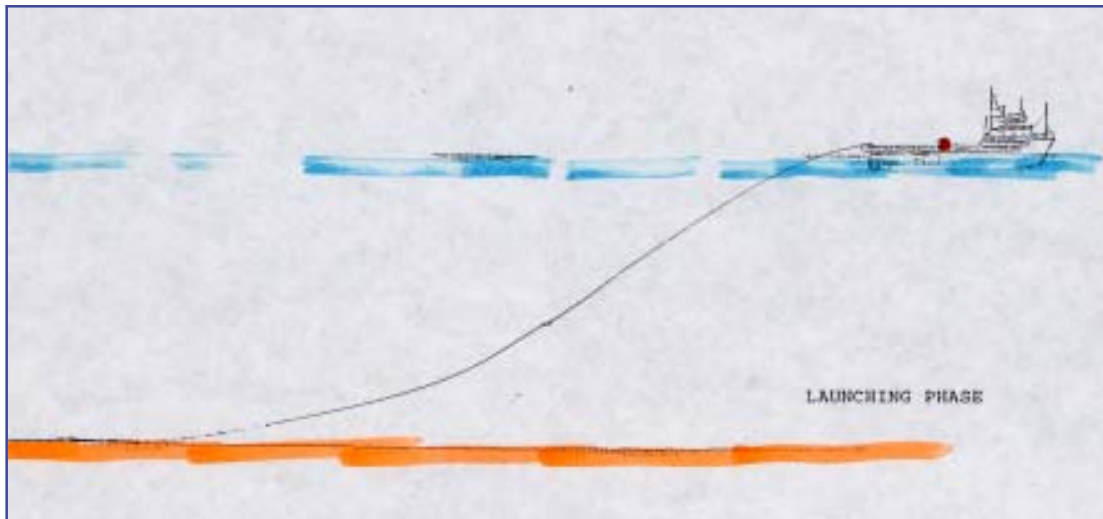
As soon as the necessary quantity of power cable has been recovered on platform a special clamp will be installed to stop the cable on the top of the riser. Only at this point the launching operation starts. During this phase, the laying equipment shall be regulated on "AUTOMATIC POSITION" in order to distribute in the proper way the defined tension on the cable and to avoid, consequently, the possibility of any damage. Anyway the equipment will work under surveillance and manual intervention could be made at any time.





The laying vessel, keeping the stated velocity, will move alongside the fixed course, while paying out the cable which starts from the motorized spool (or the turntable tank) and passes through the linear machine.

Near the arriving platform the laying vessel will pay out the remaining portion of cable, after connection of adequate lightening floaters in order to avoid any possibility of burying the cable during this phase of work.



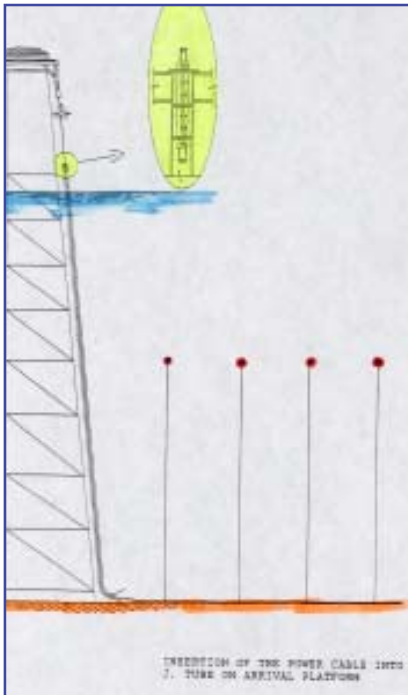
At the cable terminal end, will be applied a metallic pulling socket and swivel then connected to the "messenger line" passing through the riser.

By means of the winch already placed on the platform, the necessary quantity of power cable will be recovered.

This operation shall be carried out under diving and/or R.O.V. control in order to be sure that connecting ropes of floaters do not get tangled in the risers and to avoid consequently possible complications.

After the above operations, the cable will be fixed as already made on the starting platform).

During laying of power cable, the following data shall be registered on "Laying book":

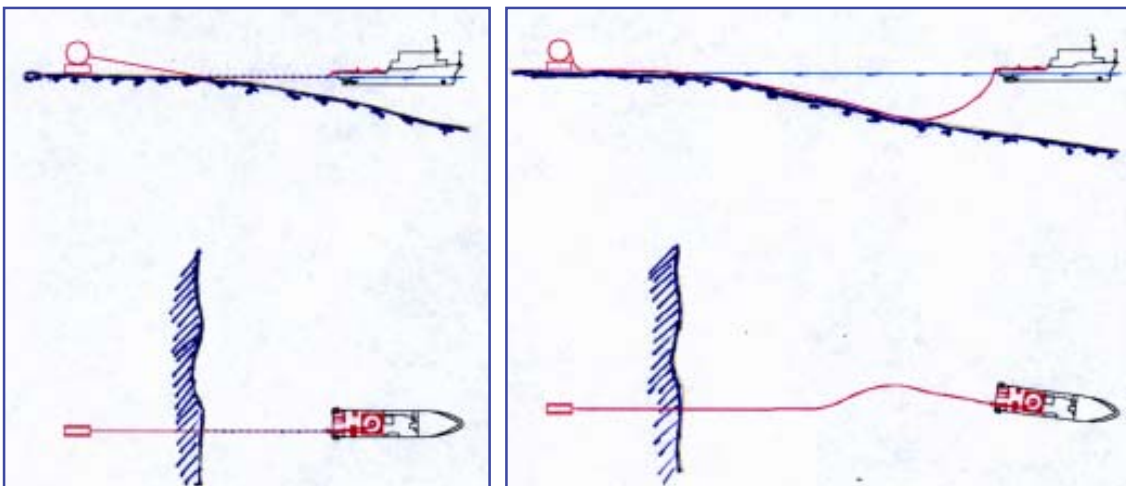


- Topographic positioning data.
- Length registered on meter-counter in connection with remarkable points noted on the book.
- Number and position of the marker buoys or floaters connected to the cable.
- Weather conditions.
- Tension of the cable registered on the linear machine.
- Continuous check of the cable by Ohmeter and Teleflex.
- Any other detail that could be used in order to ease the preparation of the "As built report and drawing" and the eventual discovering of possible damages in the cable.
- When possible, from one side of the cable is made a continuous integrity control to the complete cable length and for the total time of the laying.
- After launching of the power cable, relevant fixing to the platforms and prior to start any other working activity, a survey alongside the course and a preliminary electrical test will be executed to verify the integrity of the cable.

8.3 LAYING FROM LAND/PLATFORM TO LAND

The laying vessel will be moored as close as possible near the beach.

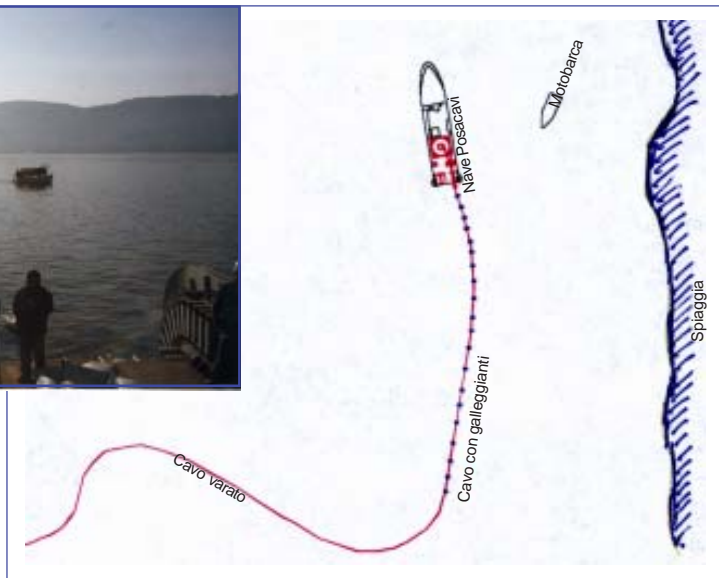
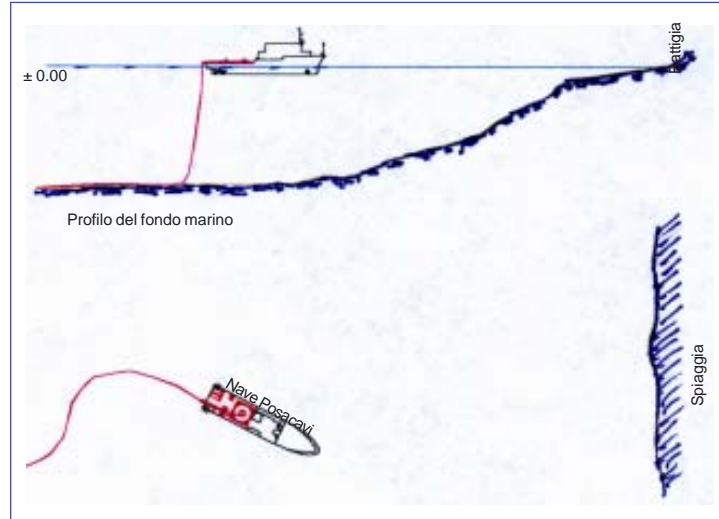
Consequently a messenger line arriving from the motorized spool already placed on land will be connected to the terminal end of the cable.



At the end of this operation will start the recovery of the cable.

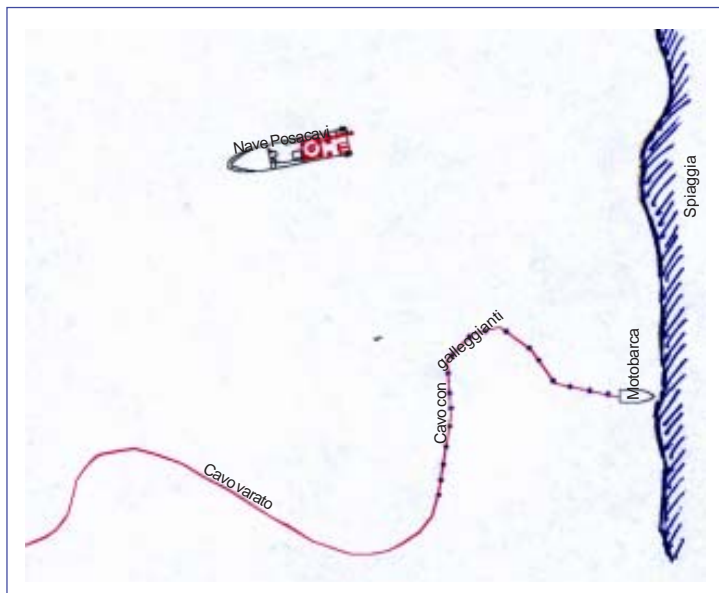
As cable is paid out from the vessel, suitable floaters (distance between them is defined in the final project) will be connected in order to avoid the cable sinking in the sea-bottom.

At the end of this operation will start the recovery of the cable.



After recovery of the required portion of power cable, floaters shall be disconnected and a submarine survey will be carried out to understand if the cable has landed in position.

After fixing of the cable on land and positive result of the survey, the laying phase will start and all following activities are made as per the connection between platforms.



8.4 PRELIMINARY TEST FORESEEN DURING THE INSTALLATION OF A SUBMARINE CABLE

In case of doubt for damages occurred during cable transportation, the power cable could be tested before starting installation operations.

Anyway a previous test is made at the end of laying activities in order to demobilize the laying vessel.

In case the project foresees a "post burying" of the cable, a new test will be carried out after this activity in order to guarantee that no damages have occurred and to demobilize personnel and equipment.

8.5 POST BURYING

In addition to the normal protection foreseen at the landing points and if foreseen by the design, by means of our burial machine "INCAVATRICE", we are also able to carry out the burial of the cable for its complete length up to the maximum penetration depth of two meters under the seabed.

For further details see the enclosed documentation.

8.6 TERMINATIONS AND ACCESSORIES

In addition to the above, we are able to supply and install the following accessories:

Platforms connection

- cable fixing clamps to risers (both single and multiples)
- polyfunctional joint boxes
- indoor and outdoor terminations
- submarine repair joints
- pulling heads
- bending restrictors
- special liquid to be inserted into the riser to protect the cable in "splash zones"
- inox steel and galvanized iron covers for cable protection
- special manufactures for services crossings

Connection on land

In addition to the above, we foresee the specific accessories:

- submarine land/sea joints
- anchoring cable system
- cable earthing with eventual dischargers closing to the joint bay



8.7 SUBMARINE JOINTS & REPAIR WORKS

For safety reasons, during laying activities, it is necessary to be prepared to a possible cable damage.

In order to overcome such a problem, the organization has to be in condition to find where the damage has occurred and proceed with the repair as soon as possible.

For this reason is usually foreseen in our personnel one technician who is specialized in joint execution and could anyway work on termination and joint boxes connection.

For the same reason we always prefer to include in our offer a set of submarine spare joints which will be kept for future needs in the normal case that during installation activities no damages will arise to the cable.

Jointing procedures are anyway listed in the jointing instructions contained in the joint kit.

8.8 FINAL TEST

As soon as all site jobs have been executed, a final test of the total "system" will be made according to the ruling standards, the project design accepted/required by the Customer.

8.9 "AS BUILT" DOCUMENTATION

At the end of the installation works, all information regarding the cable system and the laying operations daily registered in the "laying book", together with all the documentation related to cable, accessories etc. and the available photographic or video documentation is consigned to the Customer, within two months from the final test date, in the "as built" documentation.