

# **Installation Handbook for Submarine Power Cables**

## 1 Preface

Submarine cables feature high capacity, high quality, high reliability, EMI immunity, good concealment and survivability etc., so they bring about a qualitative leap to the marine development undertakings, and become an important means for connecting power and optical fiber communications between mainland and islands, islands and islands, offshore petroleum work platforms.

The characteristics of submarine cables is as follows: Submarine cable is installed in a very complex ocean environment, and it will suffer from the pressure of ocean-water , lash from waves and stream, abrasion from reefs, corrosion from ocean living beings, as well as the impacts from fishing and ship anchoring. In addition it will be subjected to the effect of engineering machinery during the installation and maintenance of the submarine cables. Consequently, submarine cables must offer the features of water-pressure resistant, abrasion resistant, tension resistant, and corrosion-proofing.

Jiangsu Zhongtian Technologies Co., Ltd. devotes itself to the research and development of submarine power cables, submarine fiber optic cables, submarine electric/optic composite cables and the exploration of construction methods for submarine cables. In order to assure the smooth progress of submarine cable' installation and avoid the loss of manpower and material resources due to improper construction, this installation handbook is developed.

This handbook provides some basic description to the installation affairs of submarine cables. The methods and precautions involved are used for reference only for the link designers and installation people.

## 2 Preparation before Construction

In order to assure the smooth progress of the construction it is necessary to take full preparation before the construction. The preparation includes route survey, material checking, the fixing of construction scheme and the equipment of construction machinery and so on.

- (1) The geological structure along the route of submarine cable installation should be surveyed carefully before the installation. For the geological structure which will harm to the submarine cables, such as the exposed bed rocks, rapid stream and other factors, it is necessary to provide suitable protection measures for the submarine cables.
- (2) The cable should be inspected before shipment to make sure that the cable has no mechanical damage. The electrical characteristics such as conductor resistance should be tested before shipment to make sure that they are perfect, and the attenuation of the fibers is in accordance with the specification, cable

shall be carried out the DC voltage-withstand test when necessary.

- (3) The type, voltage rating, and specifications of the submarine cable should be in accordance with the design.
- (4) According to the requirement of sealing the cable end with lead, the submarine cable must be sealed and the pull-off head must be mounted.
- (5) Make the cable cutting tools, cable sealing material and tools ready.

### 3 Cable Installation

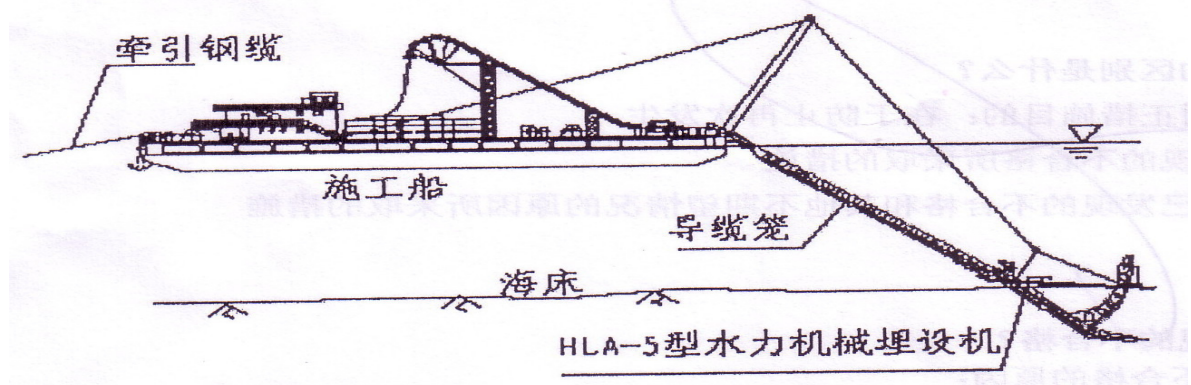
- (1) Check if the operation of all kinds of machinery for installation is normal, if the electrical equipment safe and reliable. In case there is any abnormal fault, it should be removed.
- (2) When the cable to be installed by the machinery, a twisting preventer should be mounted between the pull-off head or steel-wire net-sleeve and pull-off steel cable.
- (3) The side pressure which the cable is subject to during installation must be less than 600 kg/m.
- (4) When the cable is installed by the machinery, the pull-off force should not exceed the cable maximum pull-off force:
- (5) The allowable minimum bending radius of the cable will be 25 times of the cable diameter.
- (6) During installation the deviation between the cable installation bearing and the planned cable route should be measured regularly, and corrected at all times, so as to assure the cable being installed along the predetermined route.
- (7) It is advised to plot a relief map of the cable installation route, correct the position of the cable laying ship during installation at all times, and record the position of the installed cable. In the same time the installation tension should be paid attention. After the cable entering the sea-water the pay-off length of the cable and the laying distance should be checked and adjusted at all times. Do your possible to avoid the cable laid in sea-water being over tightened ( Once the cable forms a catenary status due to its suspension it will become the places where the cable is subject to local damage), or over lax (having a tendency of kink). A slight tension is necessary during the cable being installed. And the cable entrance angle into the sea-water should be varied according to the different water depth and ship speed.
- (8) Generally the installation depth of submarine cables is between 1.5-2.0 m.
- (9) The laying pay-off stand should let the minimum untwisting height of the cable not less than 1/2 drum winding length. After the installation finished, it is

necessary to send divers diving into the sea-water to check if there is any kink along the route. If finding any kink, the cable should be straightened.

As for the pull-off burial-laying method of the submarine cable, a pull-off hoister is provided in the construction ship. The hoister takes-up the pull-off steel cable which is pre-buried in the axis of the cable route, so as to pull the burial-laying construction ship moving forward. The heading deviation of the construction ship is corrected by the construction tugboat. Behind the stern of the burial-laying construction ship, the underwater burial machine is pulled off simultaneously, the cable entering the burial machine through a cable guiding cage then be buried deeply in the seabed.

Compared with the self-navigation burial laying mode, the pull-off burial laying mode features stable burial-laying speed, easy control of the heading deviation etc. The front of the construction ship is pulled off through steel cable, and the rear hydro-mechanical burial-machine which is pulled-off simultaneously corresponds to an anchor for stabilizing the ship. In the same time the heading deviation of the construction ship is controlled by the construction tugboat or the rudder-paddle side motive force positioning system, so as to control the burial speed and the deviation of the cable. Furthermore the burial-laying construction ship can land shoal and run aground, so that it can make the cable deeply buried through burial-machine as wide a range as possible, and avoid the disadvantage of burial-depth insufficient when using man power.

The whole construction process of a cable link can be divided into three steps: starting-end landing, intermediate cable burial-laying and ending-end landing. During the construction care should be taken to the cable tension, cable side pressure, cable bending radius, cable burial-laying speed, and the deviation control of the cable burial-laying.





Cable Untwisting



Construction ship

#### 4 Delivery, and Acceptance of the Cable

- (1) After the ending of the cable installation and accessory assembling, the whole system should be tested.
- (2) The delivery tests for the cable include DC voltage-withstand test and attenuation test of the fibers.
- (3) Only after these tests passed the cable can be put into operation.

#### 5 Cable Maintenance

- (1) If an abnormal fault is occurred a fast cable fault repair should be carried out according to the beneficial opportunity considering weather, tide, and visibility etc.
- (2) Use special-purpose instrument to locate the fault point and get ready for the maintenance and repair.
- (3) When the maintenance ship arrives the maintenance field, the positioning buoys are set up quickly. The buoys for linking cable should be set up in the places where at least 400 m far from the maintenance ship.
- (4) After finishing the maintenance the attenuation test of the fibers must be carried out according to the stipulation.

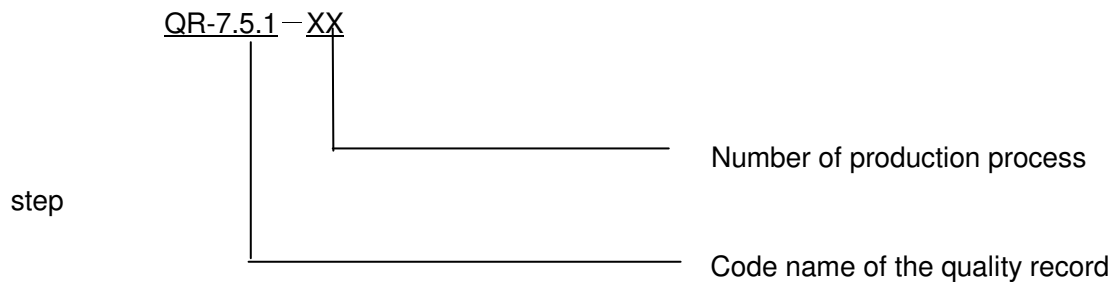
## 6 Matters Needing Attention

- (1) After the cable is put into operation, operation record should be well carried out.
- (2) The cable link should be checked regularly, and any abnormal problems should be treated in time.
- (3) Along the cable route all the fishing operations that will harm the cable by various fishing boats and/or ships should be prohibited strictly, also the events of cable damaging caused by the anchoring of all kinds of boats and/or ships should be prohibited strictly.

Attachment (the attachment of the present document)

## Special Purpose Quality Record and the Description

C.1 The unified serial number of the special purpose quality records are:



C.2 The contents of the special purpose quality records are as follows:

QR7.5.1-02 – Fiber drawing production original records

QR7.5.1-03 – Drum strander production original records

QR7.5.1-04 – Cross-linking unit production original records

QR7.5.1-05 – Copper tape shield production original records

QR7.5.1-08 – Plastics extrusion production original records

QR7.5.1-09 – Lead extrusion production original records

QR7.5.1-12 – 800 cage strander production original records

C.3 The format of special purpose quality record

C.3.1 Fiber drawing tower production original records

C.3.2 Drum strander production original records

C.3.3 Cross-linking unit production original records

C.3.4 Copper tape shield production original records

C.3.5 Plastics extrusion production original records

C.3.6 Lead extrusion production original records

C.3.7 800 cage strander production original records