

## STANDARDIZATION OF SUBMARINE FIBER OPTIC CABLES

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**Abstract:** The field of submarine fiber optic systems continues to be a growing business opportunity for connecting cities, countries and continents. Subsea cables are laid in water at a high rate. Saudi Aramco has and will install a tremendous amount of kilometers of subsea cables as a result of its offshore oil and gas expansions in the Arabian Gulf and Red Sea. With the great expansion in the submarine fiber optic systems' installations over the world, there is a need for a detailed material specifications document for optical fiber cables. This will help both manufacturers and users to sell/buy their products. Moreover, it will help to ensure interoperability and compatibility between different systems, which will in turn help expand the business.

Currently, there are few international standards addressing the specifications of these systems, mainly in the ITU-T G.97x series. They set the road map for submarine fiber optic cables; however, these documents lack the full detailed technical requirements, features and performance parameters for such systems.

This paper emphasizes the need to have a comprehensive standard and specification for submarine fiber optic cable, which Suboptic should take the lead in. It will discuss the efforts in the area of standardization. Then, the paper will present Saudi Aramco's experience in this area. Finally, a standardization proposal will be introduced to SubOptic delegates based on Saudi Aramco's experience and business needs.

### 1 INTRODUCTION

The submarine fiber cable industry has evolved in the recent years to be one of the most service enabler in various areas.

The concept of submarine cables has been in use for many decades; from the coaxial cable to recently fiber optic cables carrying 40G (and beyond) Dense Wave Division Multiplexing (DWDM) traffic.

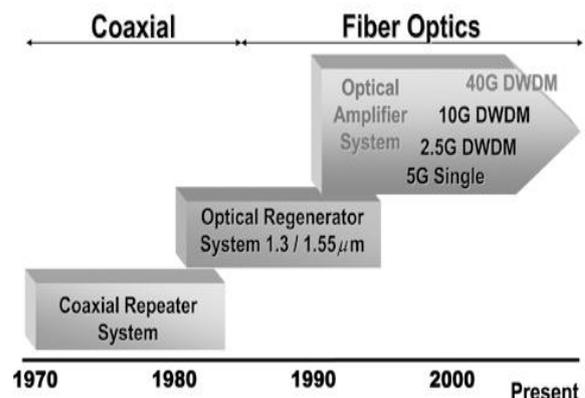


Figure 1 : Evolution of Submarine Cable Industry

With this rapid investments in the submarine fiber cable industry comes the necessity of having comprehensive international standards that address all aspects of this industry; design, installation

and cable construction characteristics. Such standards will promote the reliability and interoperability of growing market. The International Telecommunication Union (ITU) is the United Nations (UN) standards body working to develop the technical standards that ensure networks and technologies seamlessly interconnect. ITU-T Study Group (SG) 15 is responsible to addresses the optical transport networks and access network infrastructures (including submarine fiber optic cables).

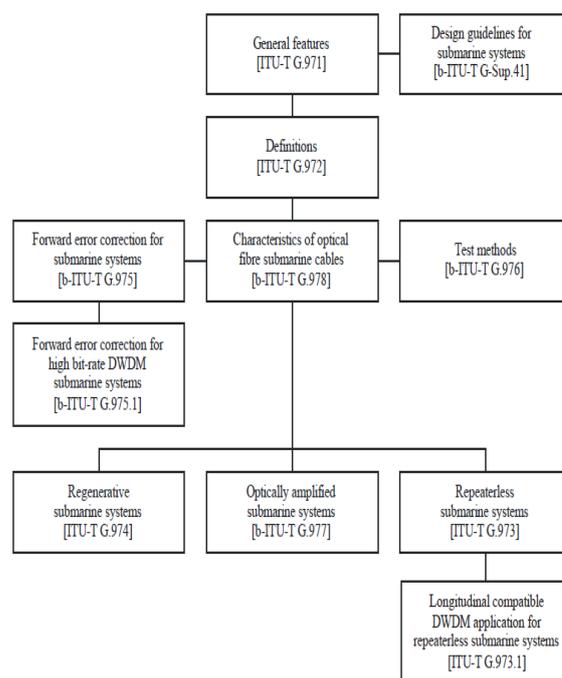
## 2 EXISTING STANDARDS

### 2.1 ITU-T Standards

ITU-T Series G addresses the transmission systems and media, digital systems and networks. ITU-T G.970 to G.979 represent the current standards addressing submarine fiber optic cables systems. In this section, we will shed some light on these standards.

G.971 recommendation (general features of optical fibre submarine cable systems) focuses on the main features of optical fiber submarine cable systems. It also provides information on relevant ITU recommendation in the same subject.

Figure 2 represent the correlations and relationship between the current ITU-T recommendations for submarine fiber optic cables.



**Figure 2: Relationships amongst ITU recommendations for Submarine Fiber Optic Cables (source: ITU-T G.971)**

ITU-T G.978 represents the main standard addressing the characteristics of these systems. It covers the transmission characteristics of the optical fibers used in submarine cables and the characteristics of these cables as well. Mechanical and electrical aspects of these systems are addressed in this standard.

G.978 provides a good source for the submarine fiber optic cable systems purchasing and procurement. However, there are some characteristics are not yet identified in the standard. For example, the standard talks about some guidance on the cable handling with regard to four aspects:

**Cable breaking load (CBL):** The minimum guaranteed breaking strength of the cable, with ends fixed, taking into account material and dimensional tolerances of the cable components,

**Nominal transient tensile strength (NTTS):** The maximum short-term tension that can be applied to the cable during an at-sea recovery operation over a cumulative period of approximately one hour without significantly reducing the system performance, lifetime and reliability.

**Nominal operating tensile strength (NOTS):** The maximum average operational tension which the cable can support for the period required for marine operations (typically 48 hours) without significantly reducing the system performance, lifetime and reliability, and

**Nominal permanent tensile strength (NPTS):** The maximum permanent cable tension that does not significantly reduce the system performance, lifetime and reliability.

G.978 does not provide the recommended values of these four important parameters. As stated in the standard, the recommended values are left for further study.

While recommendation G.973 addresses the repeaterless submarine fiber optic systems, G.974 and G.977 focuses on systems with repeaters (optically or electrically generated).

ITU-T G.976 focuses on the main test methods for submarine fiber optic systems. It is considered a good guide to different test methods including optical, transmission and mechanical characteristics of the submarine cable systems. Like with G.978, this recommendation as well doesn't provide the recommended values for the mechanical characteristics like CBL, NTTS, NTOS and NPTS. However, it does give a recommendation of how to test these characteristics.

## 2.2 IEC Standards

The International electrotechnical Commission (IEC) is an international organization that publishes international standards for electrical and electronic technologies. IEC 60794 Part 3 is related to specifications documents for optical telecommunication cables. There aren't any documents that are specific to subsea cables; however, there is one specification (IEC 60794-3-30) that addresses underwater cables for lakes, river crossings and coastal applications.

It addresses as well some mechanical requirements but not to the same extent as in ITU recommendations. It includes a blank detail specification and minimum requirements table that works as a guideline and cable description document. However, this specification document can't be used widely for submarine fiber optic cable as it only addresses the coastal applications and river/lake but not the other installations in the oceans, which comprise the most submarine installations worldwide.

## 2.3 ICPC Recommendations

International Cable Protection Committee (ICPC) is responsible, as stated in their web site, to provide leadership and guidance on issues related to submarine cable industry from security and reliability aspects. It issued some recommendations with regard to the submarine cable systems. They are making it very clear that their recommendations are guidelines and not standards.

They have good information about the history and distribution of submarine cables, including submarine power cables.

ICPC issued 13 recommendations, one of which is addressing the mechanical test requirements of submarine telecommunications cables

(Recommendation No. 12). This recommendation is based on ITU-T G.976 standard with additional test levels based on the performance of the required system.

### **3 CABLE MANUFACTURERS QUALIFICATION TESTS**

Most of the submarine cable manufacturers recognize the above mentioned standards. In fact some of those manufacturers have participated in the ITU working committees to develop the G.97x documents. However some of them don't provide evidence that their cables are tested in accordance with any of those standards. Many have their own internal qualification test procedures that they follow. One reputable cable manufacturer uses an article in a 1980 CIGRE (The International Council on Large Electric Systems) magazines as a referenced test procedure.

### **4 SAUDI ARAMCO IMPLEMENTATION**

As the largest oil company in the world, Saudi Aramco business extends to the offshore as well as the sands of Arabia. Many of our oil and gas facilities exist in the shallow waters of the Arabian Gulf. We have been using the submarine fiber cables (both standalone and with power cables) for quite some time. Specification document outlining the technical requirement for submarine fiber optic cables has been developed. This document is based on ITU related standards. The offshore installations are based only on repeaterless installations due to short distances between offshore platforms and the shore. The submarine specification document outlines the cable construction as follows: metallic core tube, inner and outer jackets, filling compound, optical fiber, fiber strand packaging, color coding, color performance and armoring requirements. It addresses as well the

required tests for the system. These tests are organized in three categories:

- a. Fiber strands acceptance: based on certifications from approved lab that all fiber strands in the cable system has been tested as per the IEC 60793.
- b. Cable Qualification: for the completed cable assembly and it is based on certificates from an approved lab.
- c. Factory Acceptance: based on tests that need to be witnessed by company representatives, which include visual, attenuation and fiber construction tests.

With this material specification for submarine cables, there is an engineering standard document that governs the design and installation of these submarine systems during project installations. This document mainly address: route survey, cable laying, cable burial, platform transition, cable crossing and testing.

There are two important notes in this regard. First, there is no comprehensive international standard or document that outlines all required specifications and requirements for these systems. The ITU G.97x series represent the most detailed standards in this area so far. Secondly, there are some areas in these standards need to be addressed. Mainly, the mechanical characteristics of submarine fiber optic cables present important parameters for the cable installation, recovery and repair during the installation and handling. These parameters are CBL, NTTs, NOTS and NPTS. The recommended values are not yet identified. Many manufacturers use internal test documents and specify their own values for different qualification tests.

## 5 CONCLUSION

As a promoter to submarine optical fiber industry, Suboptic should take a lead in developing a comprehensive standard outlining all requirements of the submarine fiber optic cables and systems. There are two paths that can be persuaded to achieve this goal. The first path is through international standardization bodies ITU and IEC. We could to work with ITU study group 15 to complete the related ITU-T G.97x series especially those characteristics that are not yet identified; or through IEC. IEC 60794 can be expanded to include new group to address the submarine fiber optic cables. There is already one standard, IEC 60794-3-30 addressing the lake and coastal applications. Other standards can be developed then grouped under one group in the IEC 60794 family.

The second option is that the SubOptic 2013 committee decides to form a team that can develop such comprehensive standard or document addressing mainly those characteristics that were not fully addressed by international standards. The developed document can then be discussed with ITU or IEC in order to be adopted as international standards.

The submarine fiber optic cable industry is expanding and the development of such comprehensive standard document will be of great importance to further expand this industry.

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