# ANNEX 38H

## FIBRE OPTIC TYPES

**1.** An optical fibre (or optical fibre) is a flexible, transparent fibre made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair. Optical fibres are used most often as a means to transmit light between the two ends of the fibre and find wide usage in fibre optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables. Fibres are used instead of metal wires because signals travel along them with lesser amounts of loss; in addition, fibres are also immune to electromagnetic interference, a problem which metal wires suffer from excessively.

**2.** Optical fibres typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fibre to act as a waveguide. Fibres that support many propagation paths or transverse modes are called multi-mode fibres (MMF), while those that support a single mode are called single-mode fibres (SMF). Multi-mode fibres generally have a wider core diameter and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibres are used for most communication links longer than 1000 m (3300 ft)[1].

**3.** An important aspect of a fibre optic communication is that of extension of the fibre optic cables such that the losses brought about by joining two different cables is kept to a minimum. Joining lengths of optical fibre often proves to be more complex than joining electrical wire or cable and involves the carefully cleaving of the fibres, perfect alignment of the fibre cores and the splicing of these aligned fibre cores. For applications that demand a permanent connection a mechanical splice which holds the ends of the fibres together mechanically could be used or a fusion splice that uses heat to fuse the ends of the fibres together could be used. Temporary or semi-permanent connections are made by means of specialised optical fibre connectors.

### 4. Fibre Optic Network and Architecture

a. Traditional fibre optic cables were installed by pulling cable through ducts in the same way as other cable types. In the ever-advancing need for increased communications, connectivity and speedy access to data there is a subsequent requirement for increased capacity and flexibility. The result being the need for a cabling system in the form ducting to support multiple fibre types across the interconnected data network with the capacity and ability to expand and upgrade in future years. This is delivered in the form of blown fibre systems/networks.

b. The RN has chosen to utilise two brands/types of blown fibre installations - Emtelle (fitted to T45s) and Brand-Rex (fitted to the Queen Elizabeth Class (QNLZ) and also to be fitted to legacy ships (LPD, LPH, T23, MCMV)[2].

1. ‘Optical Fibre’. http://www.thefoa.org/. The Fibre Optic Association, Inc. Retrieved 17 April 2015.
2. DES Ships Maritime Combat Systems (MCS) Platform Blown Fibre Network Implementation Strategy dated 10 Dec 14.

c. A blown fibre network is a low smoke, halogen free tubes containing individual optical fibres, utilising large capacity tubes for the backbone. The network is formed with a number of strategically placed access points allowing smaller local tubes to break out and allow connection to 'user systems'.

d. The blown fibre network is comprised of 3 main elements:

(1) **Protected Microducts.** These are bunches of thin plastic tubes, which when suitably configured, allow the optical fibres to be routed from A to B across the network.

(2) **Tube Flexibility Points (TFPs**). These are the main junction boxes on the network where individual ducts are connected together to construct a route.

(3) **Fibre Optic Patch Panels (FOPP).** These are the connection points for user systems or devices, using a suitable fibre patch lead.

e. Once a microduct network route has been connected, the optical fibre is physically blown through the ultra smooth ducting. The fibre is specifically designed to be carried along the ducting on compressed air. Once the fibre reaches the required destination suitable connectors are spliced to the ends. When no longer required or if replacement is necessary (eg a new fibre of a different size or performance standard is required) the fibre can be blown out, to allow it to be reconfigured to provide a different network route.

f. The construction of a blown fibre has an external PTFE blowable coating which enables the fibre to be carried inside the duct. Due to the nature of this coating, it is not possible to add fibre to an already populated bore; therefore the default should be to blow all cores at once, whether or not they are currently required. Blown fibre on RN warships generally comprises of either 1, 4 or 19 way microducts.

**Fig 38H-1. Microducts**

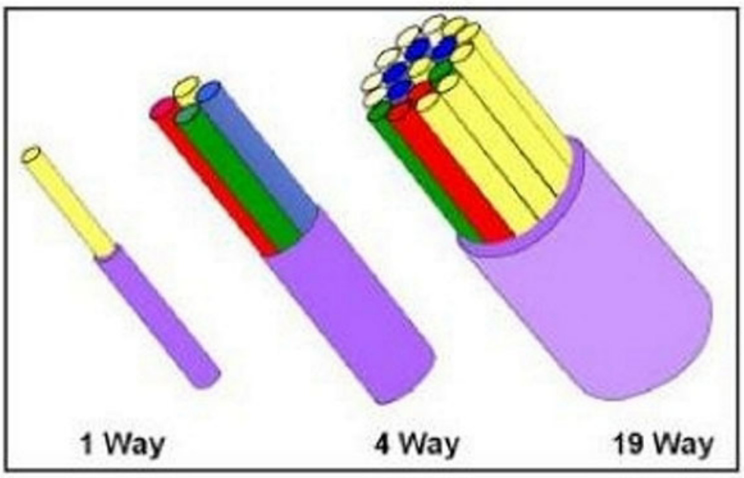


Fig 38H-2. Tube Flexibility Points (TFP)

Fig 38H-3. Fibre Optic Patch Panels (FOPP)

## 5. Fibre Optic Termination Types

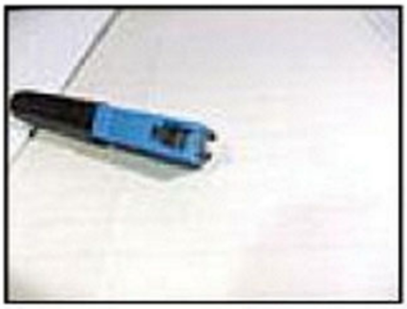
a. Fibre optic cables are terminated with a variety of types of connector (FC, SC, LC, ST, MFM, MTRJ, MPO, MU, SMA, FDDI, E2000, DIN4, and D4) to support the spectrum of network, system and equipment fits. The majority of RN fibre networks are fitted with FC, SC, LC, ST, MFM, MTRJ and SMA connector types.

b. FC connectors are specifically designed for data communications, telecommunication applications and also measurement equipment and provide non-optical disconnect performance. They have a threaded coupling for use in durable connections. The ferrule is PC finished to a pre-radius, which ensures low back reflection. It is commonly used with both single mode and polarisation-maintaining fibre. They are becoming less common, displaced by SC and LC connectors. The FC connector was originally called a 'Field Assembly Connector' by its inventors. The name 'FC' is an acronym for ferrule connector or fibre channel.

Fig 38H-4. FC Connector

c. The SC connector is a non-optical disconnect connector, available in simplex and duplex styles. This connector features a push-pull connection design for quick patching of cables into rack or wall mounts.

Fig 38H-5. SC Connector



d. The LC connector licensed by Lucent Technologies provides a pull-proof design and small size perfect for high-density applications. Available in simplex or duplex versions. The LC also incorporates a unique latching mechanism providing stability in system rack mounts.

Fig 38H-6. LC Connector

e. The ST connector utilises a bayonet twist-lock connection, available in single mode and multimode, the ST connector supports reliable and durable field installation.

Fig 38H-7. ST Connector

f. The duplex MFM connector is a high performance, lightweight connector designed and developed specifically for the harsh environment and used widely within the military.

Fig 38H-8. Duplex MFM Connector

g. The MT-RJ (Mechanical Transfer Registered Jack) uses a form factor and latch similar to the RJ45 connectors. Two separate fibres are included in one unified connector. It is easier to terminate and install than ST or SC connectors. The smaller size allows twice the port density on a face plate than ST or SC connectors do. There are two variations: pinned and no-pin. The pinned variety, which has 2 small stainless steel guide pins on the face of the connector, is used in patch panels to mate with the no-pin connectors on MT-RJ patch cords.

Fig 38H-9. MT-RJ Connector

h. Amphenol Fibre Optics was a pioneer in developing the first industry standard fibre optic interconnect system by introducing the SMA connector. The SMA 905 and SMA 906 series were the first fibre optic interconnect system to gain industry wide acceptance for military, industrial, data communications and medical applications. The SMA connector family utilises a threaded coupling nut system for mating and de-mating.

**Fig 38H-10. SMA Connector**