Low-frequency (LF) Communication Systems

THE low-frequency band covers the range 30–300 kc/s. Fixed services are allocated in the range 30–200 kc/s, which is shared by certain maritime navigational and broadcasting services.

Fixed-service systems provide very stable communication at distances up to 1200 miles (2000 km) by ground-wave propagation. Vertical polarization is used and the great fluctuations which are a feature of HF propagation using the ionosphere do not occur in this band. There is, however, a secondary ionospheric effect over paths between 600 and 1200 miles (1000–2000 km), due to D-layer reflections at heights between 40 and 60 miles. This effect is more pronounced by night than by day. Depending on the phase relationship between the direct and reflected waves, this can lead to either increased or decreased effective field strength, so that there is a need for careful computation where path lengths are greater than 600 miles (1000 kilometres). Beyond 1200 miles (2000 kilometres) the reflected wave predominates but reliable propagation beyond this distance is not possible without very powerful transmitters. Over the sea, the ground-wave is less attenuated than over land so that LF communication systems are ideal for providing services to shipping out to distances of about 1200 miles (2000 kilometres).

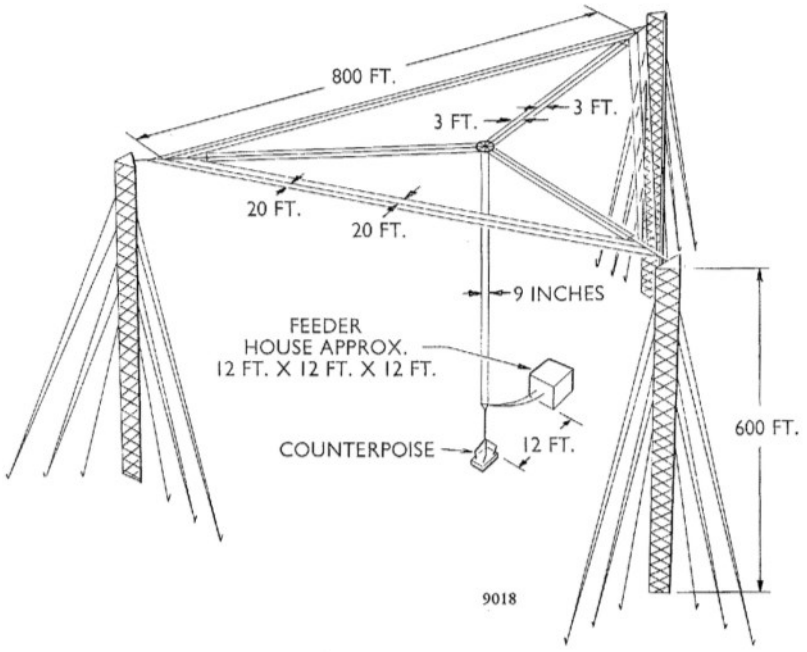

Diagram of an LF 'delta' aerial.

System design

Generally speaking, the main difficulty in the design of a low-frequency transmitting system is in the provision of an efficient and economic aerial. Even at 200 kc/s, the wavelength is 1500 metres, and so it is never possible to design an aerial system whose size is comparable with the wavelength. In fact, the aerials must always be regarded as a short vertical element above ground, giving the classical cosine diagram in elevation and omnidirectional cover in azimuth. The 'capacity-top' type is generally used and the design task is to achieve maximum capacity, minimum base voltage and maximum radiation efficiency from a given number of masts of suitable height.

For the band 30–80 kc/s at least three masts of up to 600 ft (180 m) in height are generally necessary. These support a triangular top structure of wires, in order to achieve reasonable aerial constants. Below 70 kc/s the system design becomes increasingly uneconomic and efficiency low (about 30% at 45 kc/s). Above 80 kc/s, two masts supporting a T-aerial with a multi-wire top may be used, but mast heights up to 600 ft (180 m) are still advisable up to about 100 kc/s. The importance of aerial height in obtaining a reasonably efficient LF transmitting system is still not generally realized.

It is not possible to provide wide-band services from an LF system. The frequency band is limited and, in addition, the bandwidth of the aerial system is small, since its resistance is low and reactance high. It is possible, however, to provide very reliable telegraph communications at speeds ranging from about 50 bauds at 30 kc/s to several hundred bauds at 100 kc/s and above. Frequency-shift and on-off keying are generally used, although a two-tone system has advantages, particularly where high stability is required.

Marconi's will undertake the full planning of LF systems complete with the aerial system, matching and feed arrangements. They can also give advice on propagation and forecasting.