

INSTRUCTORS GUIDE

Page 35.3.1-5 Potted History of Radio**Para 11**

1837 Mr C Wheatstone of the firm Cooke & Wheatstone Electric Telegraphy company constructed the world's first working telegraphy system. It began at a length of 1.5 km and was completed at a length of 21 km. It was located in the West End of London..

1844 Morse gave the first demonstration of his coded system.

1851 The first commercial submarine cable was laid between England and France (it was achieved through a private company).

1868 The first transatlantic cable came into operation between the UK and Canada.

1909 Marconi receives the Nobel prize for physics for inventing Radio.

1929 The British Broadcasting Company (BBC) makes its first television broadcast from London.

1936 BBC starts experimenting with colour transmissions for television.

Page 35.3.1-6 Bandwidths Used in Broadcasting**Para 13**

Radio transmitters used for broadcasting sound programmes in the low, medium and high wavelengths are normally amplitude modulated. These modulation frequencies are from approximately 50 Hz to 5 KHz. If both sidebands are broadcast then for a 5 KHz signal the space occupied will be 10 KHz. There are places in the world that only allow the modulation frequencies to reach a maximum of 4.5 KHz, thus giving a bandwidth of 9 KHz.

Frequency modulated signals for broadcast are used in VHF radio and are about 15 KHz per sideband. The main difference is that the sidebands may be extended up to six times that width. This means that a broadcast may be in the order of 180 KHz in width. This is due to the higher frequencies with more space.

Signal	Bass Bandwidth	Channel Bandwidth
Morse (CW)	20 Hz	100 Hz
5 Unit teleprinter	25 Hz	120 Hz
Line telephony (using single sideband)	3.1 KHz	4 KHz
High quality sound	15 KHz	200 KHz
405 line television	3 MHz	6 MHz
625 line television	6.5 MHz	8 MHz

Page 35.3.2-2 Noise
Para 3

Noise receivers can be a very serious problem and great care is taken to eliminate it. Most types of noise have their own sound and a name to describe them by. Here are two examples:

Hum. A steady note of low frequency caused by the power supply breaking through to the receiver circuitry. This is caused by poor screening.

Hiss. A steady note of high frequency and can be likened to a whistle.

Noise is used in certain equipments to simulate traffic and in so doing keep the circuits active (TACAN is an example of this type of use).

Many systems have been used to communicate over distances. Perhaps the best known of these is semaphore used primarily in the Navy. The first telegraphy code was Morse Code in 1837. This code was a combination of dots and dashes and the original idea was for the receiver to “read” the message using the ear. This was later modified so that incoming messages were recorded using a device called a ticker-tape (so called because of the sound it made while punching the tape). Morse is still used today to transfer information over radio waves.

By 1874 Emile Baudot, a French inventor, had developed a new telegraphy system. Morse was exclusive because very special training was needed to understand and work the system. Baudot’s system used a series of five characters (called 5 unit). This meant that every character had five dots (either blank or solid). The letter “A” would look like this ●●○○○ This code in reality is a binary system similar to those used in computers. 5 unit code is still heavily used today and forms the foundation for ITA2 which is an international standard for communications.

Page 35.3.2-2
Para 4

The diagram shows a simple receiver. It is possible to build this receiver as a project or to gauge the understanding of the subject but is not mandatory. The em waves are concentrated within the ferrite rod. The inductance produced forms a resonant circuit with the variable capacitor. The rod has 50 turns and they are to be all wound in the same direction. By adjusting the capacitor the resonance can be varied so stations within the medium wave band can be selected. Demodulation is achieved by using the diode coupled with the fixed capacitor. The headphones then convert the electrical variations into audible intelligence. At point A, a long length of wire should be attached to act as an aerial. the circuit should be earthed at point B, this will improve signal strength.

Page 35.3.3-11 In 1889 Heinrich Hertz, a German physicist, proved that radio waves were propagated in a similar manner, and travelled at the same speed as light waves. Therefore, radio and light waves were each a form of em energy - and shared another property, namely they could be reflected.

In 1904 Christian Hulsmeyer used a device to receive an echo of a rang bell. The device was called a telemobilescope.

Marconi sent messages over the Atlantic then went on to set up a world-wide network. In the 1930's thoughts turned to using radio waves to detect ships at sea or aircraft in the air.

In 1935 Sir Robert Watson-Watts, the British scientist/engineer gave a practical demonstration of how radio waves could be used to detect aircraft. Using the BBC transmitter at Daventry, a transmitted signal was sent out and a receiving aerial array was set up some distance away. The receiving equipment was in the back of a truck and when the aircraft flew through the radio wave beam it was detected by Watson-Watt's equipment. The first radar was born. After this demonstration permission was given to build a radar station on the south coast, it was completed in thirteen days.

Page 35.3.4-8 Microwave Landing System (MLS)
Para 17

This system uses very high frequencies (5000 Mhz) ie. microwaves to form narrow beams of radiation of between 1 and 3 degrees. As these beams are so narrow they can avoid the usual obstacles encountered in siting a system near an airfield. The system can give cover in the azimuth of up to +- 60 degrees from the runway centre and 30 degrees in elevation.

Watchman Radar

The Watchman radar (also known as the airfield surveillance radar) detects the movement of aircraft up to a range of 60 nautical miles. This allows air traffic controllers to guide aircraft through their airspace and to within range of other navigational aids required for a safe instrument landing (ILS for example). The Watchman system needs two sites, these are:

Radar Site. Also known as the “Radar head” and has the two-beam aerials (or horns) with its associated turning gear. The antenna is connected to the transmitter and the Signal Processing Rack (SPR) in the radar container.

Display Site. This is normally housed in the ATC tower and consists of:

- a. Display consoles.
- b. Signal switching (from up to two radars).
- c. Distance from touchdown indicator (DFTI) if required.

Brief system overview.

Two pulses (one at 0.0000004 and one at 0.00020 seconds) are sent to the transmitter and fired from the main horn. The returning signals are received by both horns and are under the control of the Beam Switching Unit. This unit selects the signal from:

- a. Auxiliary Horn - for targets at ranges from 0 to 20 Nautical miles (this setting can be altered).
- b. Main Horn - for targets at ranges from 20 to 60 Nautical miles.

The SPR then extracts the information from the two signals and then displays this information on the operator’s console. The Watchman contains a number of sub-systems including:

- a. Aerial and tower assembly (with obstruction lights).

- b. Turning gear to rotate the aerial.
- c. Aerial Control Unit (ACU). This is a 3-way switch that controls the aerial.

The switch positions are:

- a. Local - controlled from the ACU.
- b. Isolate - no aerial control available and no RF transmissions allowed.
- c. Remote - controlled from the radar head control panel.

The Watchman radar (because of its range), is an important tool in the safe navigation of aircraft. It is versatile because it is mobile and so can be taken to any airfield and set up easily to provide needed cover. One will see Watchman on most RAF stations visited (if they have an airfield!).

TACAN

In the absence of interrogation signals, random receiver noise (squitter) is used to simulate interrogation signals, hence maintaining the beacon's duty cycle. The beacon is also responsible for self-monitoring.

TACAN is also available as a mobile version for emergency cover/use. This version has a range of 100 miles (half that of a fixed version).

ILS

ILS employs a battery backup system in case of mains failure so that operations can continue. The equipment is self-monitoring and is able to indicate any fault to the user (in the approach control) via a remote status indicator (RSI).

The codes received by the pilot as each marker is passed are:

Outer - 400 Hz keying at 2 dashes per second.

Middle - 1300 Hz consisting of alternate dots and dashes.

Inner - 3000 Hz keying at 6 dots per second or a station code.

Frequency Band	Frequency Range	Wavelength Range	Wavelength Band
Ultra high frequency (UHF)	300 MHz - 3 GHz	1 M - 10 cm	Decimetric
Super high frequency (SHF)	3 - 30 GHz	10 - 0.1 cm	Centimetric

Most radars operate in the ultra high frequency (UHF) or super high frequency (SHF) bands and the frequency of operation will depend on the function the radar is to perform.

Typical Radar Characteristics

Search Radar

High peak power

Low PRF

Long pulse duration

This type is a long range radar of range 200-300 miles.

Surveillance Radar

Medium peak power

Medium PRF

Medium pulse duration

This type of radar has a range of approximately 75 miles.

Secondary Surveillance Radar

Low peak power

Pulses transmitted in coded groups

Transmission and reception are on different frequencies

SELF ASSESSMENT QUESTIONS - ANSWER SHEET

Chapter 1 Page 35.3.1-10

- 1b
- 2a
- 3c
- 4a

Chapter 2 Page 35.3.2-4

- 1a
- 2c
- 3c

Chapter 3 Page 35.3.3-13

- 1c
- 2d
- 3a
- 4b
- 5a

Chapter 4 Page 35.3.4-14

- 1a
- 2b
- 3c
- 4d
- 5a