EXTREMELY LOW FREQUENCY

Definition

Extremely low frequency (ELF) is the band of radio frequencies from 3 to 30 Hz.

Basics

Extremely low frequency (ELF) is should not be confused with other low frequencies, namely low frequency (LF) and very low frequency (VLF).

Description: The subradio frequency is described in medical peer-reviewed journals with frequencies of 50 Hz and 50–80 Hz. United States Government agencies, such as NASA, describe ELF with ranges between the standard 3 to 30 Hz,>0 to 300 Hz.and even, according to WHO, from >0 to 100 kHz. At frequencies this low (>0 to 300 Hz), "the wavelengths in air are very long (6000 km at 50 Hz and 5000 km at 60 Hz), and, in practical situations, the electric and magnetic fields act independently of one another and are measured separately."

Military Communications: The United States Navy utilized extremely low frequencies (ELFs) as radio band and radio communications.

The Submarine Integrated Antena System (SIAS) was a research and development effort to communicate with submerged submarines. The Soviet/Russian Navy also utlized ELFs for submarine communications.

Explanation: Because of the electrical conductivity of seawater, submarines are shielded from most electromagnetic communications; signals in the ELF frequency range, however, can penetrate much deeper. Two factors limit the usefulness of ELF communications channels: the low data transmission rate of a few characters per minute and, to a lesser extent, the one-way nature due to the impracticality of installing a transmitter of the required size on a submarine (transmitters need to be of exceptional size for the users to achieve successful communication). Generally ELF signals were used to order a submarine to rise to a shallow depth where it could receive some other form of communication.

Difficulties of ELF communication: One of the difficulties posed when broadcasting in the ELF frequency range is antenna size. This is because the antenna must be at least a substantial fraction of the size (in at least one dimension) of the wavelength of the frequency of the EM waves. Simply put, a 1 Hz (cycle per second) signal would have a wavelength equal to the distance EM waves travel through your chosen medium in 1 second. For ELF, this is very slightly slower than the speed of light in a vacuum.

As used in military applications, the wavelength is ~299,792 km(~187,370 mi) per second divided by 50–85 Hz, which equals around 3,450 to 5,996 km (2,140 to 3,730 mi) long; by comparison, Earth's diameter varies from 12,715 km (7,901 mi), pole to pole to 12,756 km (7,926 mi), equatorial. Because of this huge size requirement and, to transmit internationally using ELF frequencies, the earth itself must be used as an antenna, with extremely long leads going into the ground. Various other means are taken to construct radio stations with substantially smaller sizes, such as electrical lengthening.

The US maintained two sites, in the Chequamegon-Nicolet National Forest, Wisconsin and the Escanaba River State Forest, Michigan (originally named Project Sanguine, then downsized and rechristened Project ELF prior to construction), until they were dismantled, beginning in late September 2004. Both sites used long power lines, so-called ground dipoles, as leads. These leads were in multiple strands ranging from 22.5 to 45 kilometres (14.0 to 28.0 mi) long. Because of the inefficiency of this method, considerable amounts of electrical power were required to operate the system.

Ecological impact: There have been some concerns over the possible ecological impact of ELF signals. In 1984 a federal judge halted construction requiring more environmental and health studies.

This judgement was overruled by a federal appeals court on the basis that the US Navy claimed to have spent over 25 million dollars studying the effects of the electromagnetic fields with results indicating that they were similar to the effect produced by standard power distribution lines. The judgement was not accepted by everyone and during the time ELF was in use, some Wisconsin politicians such as Senators Herb Kohl, Russ Feingold and Congressman Dave Obey called for its closure. Similar concerns have in the past been raised about electromagnetic radiation and health.

Other uses: Transmitters in the 20 Hz range are also found in pipeline inspection gauges, also known as "PIGs". Some radio hams record ELF (or even lower) signals from very large homemade antennas, and play them back at higher speeds to catch natural fluctuations in the Earth's electromagnetic field. Increasing the playback increases the pitch, so that it is brought into the audio frequency range.

Naturally-occurring ELF waves are present on Earth, resonating in the region between ionosphere and surface. They are initiated by lightning strikes that make electrons in the atmosphere oscillate. Though VLF signals were predominently generated from lightning discharges, it was found that an observable ELF component (slow tail) followed the VLF component in almost all cases.

The fundamental mode of the Earth-ionosphere cavity has the wavelength equal to the circumference of the Earth, which gives a resonance frequency of 7.8 Hz. This frequency, and higher resonance modes of 14, 20, 26 and 32 Hz appear as peaks in the ELF spectrum and are called Schumann resonance. They have also been tentatively identified on Saturn's moon Titan. Titan's surface is thought to be a poor reflector of ELF waves, so the waves may instead be reflecting off the liquid-ice boundary of a subsurface ocean of water and ammonia, the existence of which is predicted by some theoretical models. Titan's ionosphere is also more complex than Earth's, with the main ionosphere at an altitude of 1,200 km (750 mi) but with an additional layer of charged particles at 63 km (39 mi). This splits Titan's atmosphere to some extent into two separate resonating chambers. The source of natural ELF waves on Titan is unclear as there doesn't appear to be extensive lightning activity. Finally, huge ELF radiation power outputs of 100,000 times the Sun's output in visible light may be radiated by magnetars. The pulsar in the Crab nebula radiates powers of this order at the frequency 30 hertz. Radiation of this frequency is below the plasma frequency of the interstellar medium, thus this medium is opaque to it, and it cannot be observed from Earth.

Exposure: In electromagnetic therapy and electromagnetic radiation and health research, electromagnetic spectrum frequencies between 0 and 100 hertz are considered extremely-low-frequency fields.

Since the late 1970s, questions have been raised whether exposure to ELF electric and magnetic fields (EMF) within this range of frequencies produces adverse health consequences. In October 2005, WHO convened a Task Group of scientific experts to assess any risks to health that might exist from "exposure to ELF electric and magnetic fields in the frequency range >0 to 100,000 Hz (100 kHz)." It has been scientifically proven that ELF electrical and magnetic fields at a high-level short-term exposure have a negative impact on health (ICNIRP, 2003). However, in regards to recognized ELF safety standards, the "Health effects related to short-term, high-level exposure have been established and form the basis of two international exposure limit guidelines (ICNIRP, 1998; IEEE, 2002). At present, these bodies consider the scientific evidence related to possible health effects from long-term, low-level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits." A common source of ELF fields in the United States is 60 Hz electric and magnetic fields from high-voltage electric power transmission lines and secondary distribution lines, such as those found in residential neighborhoods. The International Agency for Research on Cancer (IARC) has evaluated the scientific data and has classified ELF magnetic fields as being "possibly carcinogenic" or, in other words, that there is inadequate and weak evidence that EMFs may contribute to an increased risk of cancer to humans or animals.

Source: http://www.juliantrubin.com/encyclopedia/electronics/elf.html