Information about ELF Communications

The Wisconsin Test Facility
ELF (Extremely Low Frequency) is a frequency band at the extreme low end of the electromagnetic spectrum. AM and FM radio, TV, radar and microwaves are higher in frequency. The Navy's ELF radio system will operate at a frequency of 76 Hertz (cycles per second), similar to the electric power system which operates at 60 Hertz. Fields associated with electric power lines and appliances are quite similar to those created by an ELF antenna, except that ELF fields are many times weaker than power line fields as illustrated by the figure on the opposite page. However, they are formed by the antenna in such a way as to provide usable radio signals almost worldwide.

**ELF for Radio Transmission**

ELF is the region of the radio spectrum proven to penetrate seawater to considerable depths. It has been explored and developed for the fundamental purpose of communicating to submarines operating deeply. Other common military radio frequencies penetrate seawater only slightly or not at all. Therefore, submarines otherwise capable of operating at hundreds of feet and tens of knots have to either be at periscope depth or slowly trail an antenna wire or buoy near the surface to be able to receive radio messages. This is the final link preventing our submarines from remaining deep virtually all the time where they are designed to operate most effectively and most safely. ELF also permits them to vary their speed as operating conditions warrant without dragging the antenna away from the surface thereby breaking radio contact.

**Location of ELF Transmitters**

Because of the special type of bedrock which lies under Northwestern Wisconsin and Michigan's Upper Peninsula shorter antennas using less power can be built here than anywhere else in the U.S. and still produce the necessary signal to reach the submarine patrol areas. The two things that are necessary to propagate ELF are relatively long antenna lines and this layer of low conductivity rock. Elsewhere, the power necessary to get an equivalent signal out is many times the power needed here, and almost all of it is wasted by absorption in the earth. Also, much longer lengths of antenna cable would be needed at other locations, requiring more land, more construction, and greater expense for the taxpayers.

**The Wisconsin ELF Test Facility**

In 1969 the Navy opened a test facility near Clam Lake, Wisconsin in the Chequamagon National Forest to demonstrate that ELF is safe for humans and wildlife and does not interfere with public utilities or day-to-day activities by residents. It is known as the Wisconsin Test Facility or WTF. (See aerial photo on front page.) It consists of a transmitter complex on a two-acre plot in the forest and two 14-mile antenna lines in a rough cross pattern. These lines are on poles like power lines. Methods were developed and installed for isolating electric power and telephone lines from possible ELF interference, and the quality of those services has improved for many residents of the Clam Lake area.

In 1976 the transmitter was given a message handling capability, and for the following two years sent simple test messages to submerged submarines as far away as the Mediterranean Sea and the Western Pacific. One dramatic example of its effectiveness is the receipt from Clam Lake
of a message by a submarine operating under 30 feet of ice in the Arctic. During its peak operation in 1978, the facility employed more than 20 local residents.

ELF Safety and Environment

The world’s electric power systems operate in the same extremely low frequency range as ELF communications and have been in service for more than three generations. No recorded cases of injury or health impairment at anywhere near the low field levels of the ELF communications system are known. However, concerns about possible effects from ELF were raised and the Navy sponsored more than 60 biological research programs ranging from cell growth studies on simple organisms to complex monitoring of test mammals in controlled ELF fields. The negative results of these tests were to be expected because of the exceptionally low levels of the ELF field compared to fields of appliances we associate with every day. (See figure at right.)

In 1976 the National Academy of Sciences commissioned a panel of leading U.S. scientists to evaluate the Navy-sponsored research results and any others that could be located anywhere in the world. In 1977 the panel issued a report which concluded that the concerns that had been expressed about health hazards connected with ELF radiation were “invalid and unwarranted.”

The ten years of operation of the WTF without any effect on the health of station employees is perhaps the best testimony of ELF’s harmless nature.

In its broadest sense, “environment” is considered to include not only the “ecology” or natural life forms, but air and water quality, and the social structure and physical products of our modern culture as well. The Navy has prepared an extremely comprehensive Environmental Impact Statement (EIS) that assesses possible effects of ELF on all these factors in great detail, and concludes that ELF is compatible with a local environment as has been demonstrated by the WTF.

ELF System Status

In April 1981, President Reagan directed Defense Secretary Weinberger to reactivate the WTF, to reinstall experimental receivers on operational submarines and to conduct a thorough study of the Navy’s need for ELF. That study resulted in a recommendation to modernize the equipment but not extend the antenna at the WTF, and to supplement it with a new facility in Michigan consisting of a support center at KI Sawyer Air Force Base near Marquette to operate in conjunction with a new transmitter and a 56-mile overhead antenna located in nearby state forests. The two transmitters will be linked by leased telephone circuits and together will provide a unique, new communication capability that will enhance the effectiveness and survivability of our Poseidon and Trident Missile subs as well as our attack subs.

On the 8th of October 1981, President Reagan approved that plan and advised congressional leaders. Detailed plans and schedules are now being prepared to put the President’s directive into effect.
Expressions of the Need for ELF

• “... Sending our 2 billion dollar TRIDENT submarines to sea without the security provided by this system is unthinkable to us. We consider ELF vital to our nation’s defense. ...”
  - Admiral Holloway, III (Chief of Naval Operations in letter to the Secretary of the Navy, March, 1977)

• “... I assure you that the need for Seafarer [ELF predecessor system] is real and urgent; that it works, and that there are no adequate alternatives for communicating with our submarines without their having to put an antenna near the surface and run the danger of detection. New technology is rapidly increasing this danger. To keep our submarines safe, we have to keep them deep and their antennas away from the surface. To keep our country safe against the threat of nuclear attack, we must assure the safety of our submarine force.”
  - Admiral J. L. Holloway, III (Chief of Naval Operations in Senate Armed Services Appropriations Committee hearings, May, 1979)

• “I have told the President my view, which is that ELF is an extremely important communications means, that without it our submarine force risks vulnerability because it has to be nearer to the surface than otherwise in order to receive signals. ...”
  - Dr. Harold Brown (In response to question by Senator Proxmire during Senate Appropriations Committee hearings, May, 1979)

• “Stated in the simplest terms, the ELF project will allow the Trident to patrol at depth and therefore it will increase our confidence in the invulnerability of that submarine platform to localization [detection]. So I think it is an extremely important program.”
  - Dr. William Perry (Undersecretary of Defense for Research and Engineering to House Armed Services Committee in FY80 budget hearings)

• “... We, the operators, the people who have to make the ships work and do our jobs, who know the threat because it threatens us, have seen the flexibility it provides in operations and the increases in survivability it can provide for our missile submarines and we, without qualification, state that it is necessary and that we can find no alternative to ELF to do this job.”

• “... With the growing vulnerability of our land-based Intercontinental Ballistic Missile (ICBM) force and our concern for the bomber force, the conferees agreed that it is imperative that all steps be taken to insure the survivability of our submarine force.”