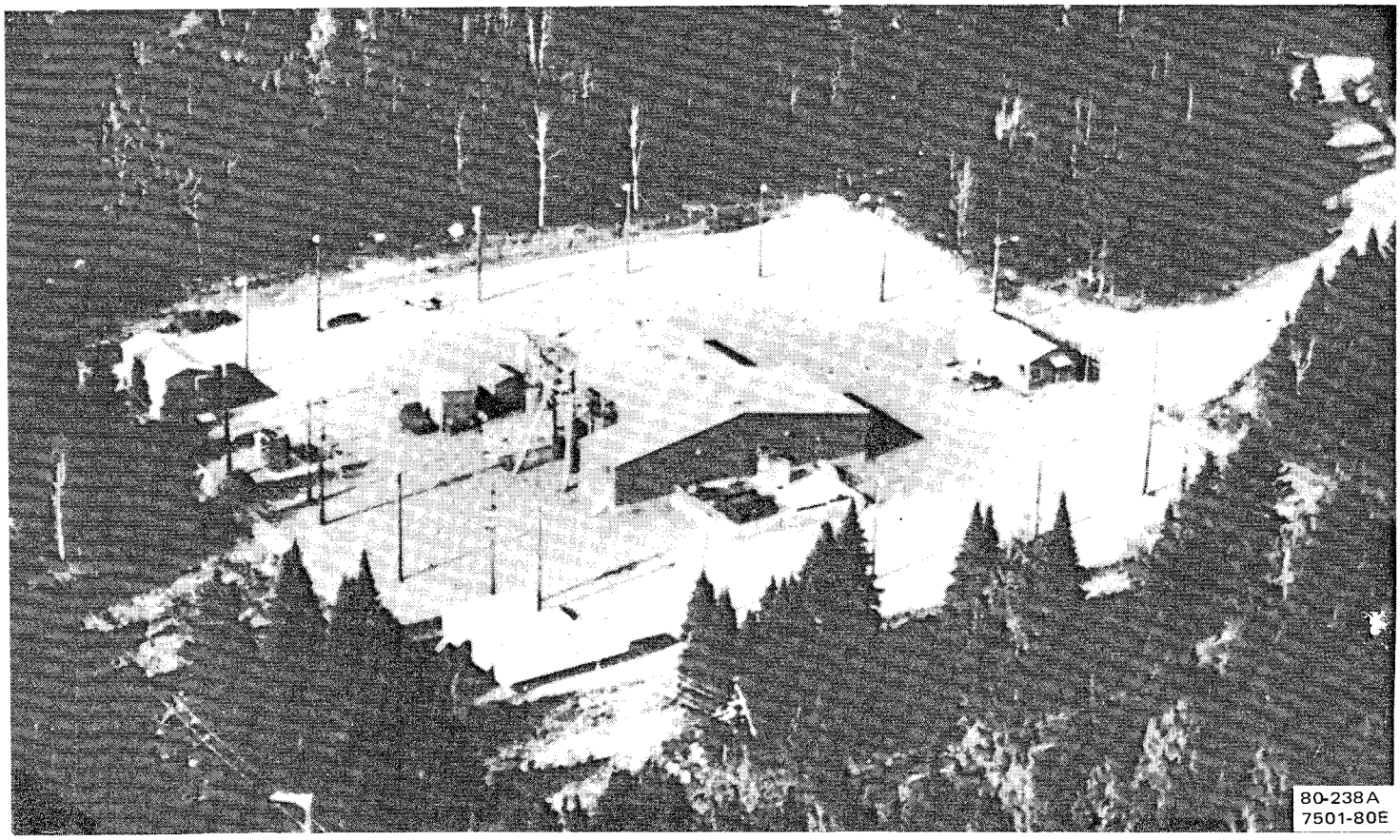
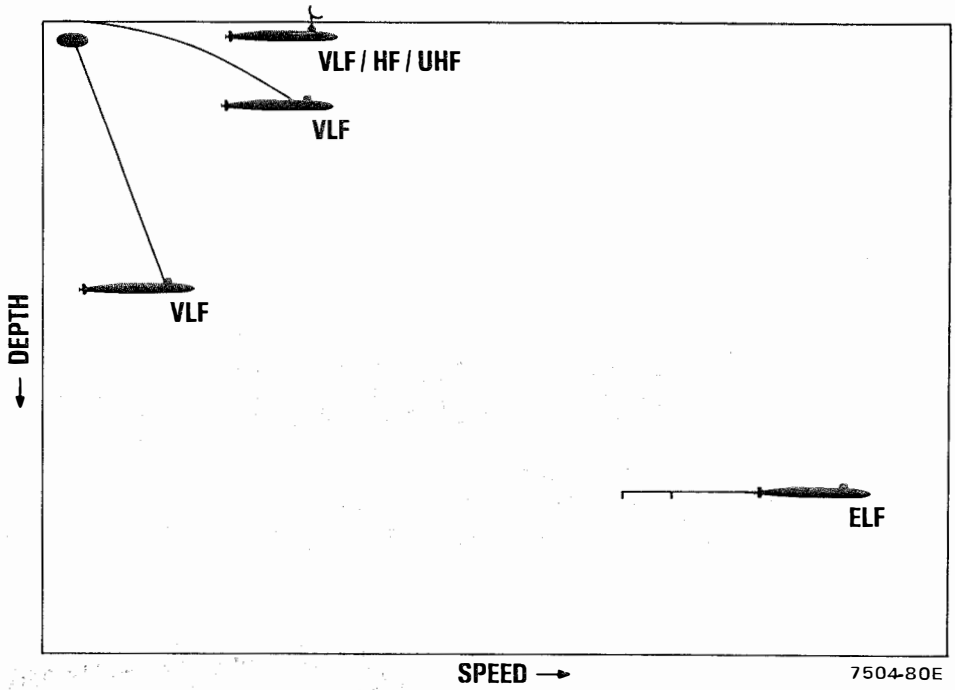
Information about ELF Communications



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.



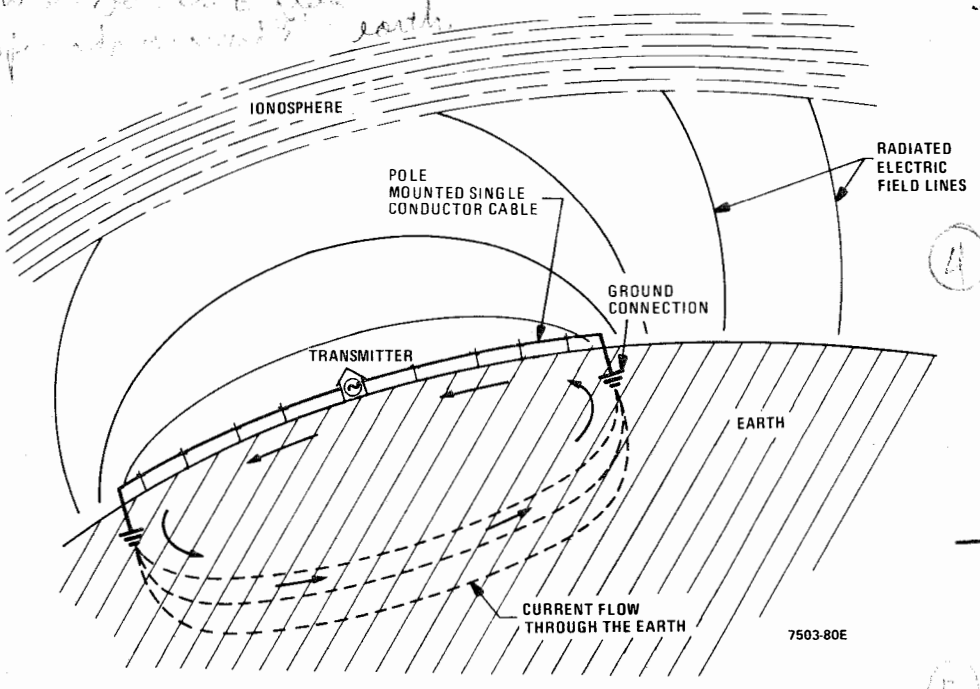
RADIO ANTENNA LIMITATIONS ON SUBMARINE SPEED AND DEPTH

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.



ELF PROPAGATION MODEL

The Wisconsin ELF Test Facility

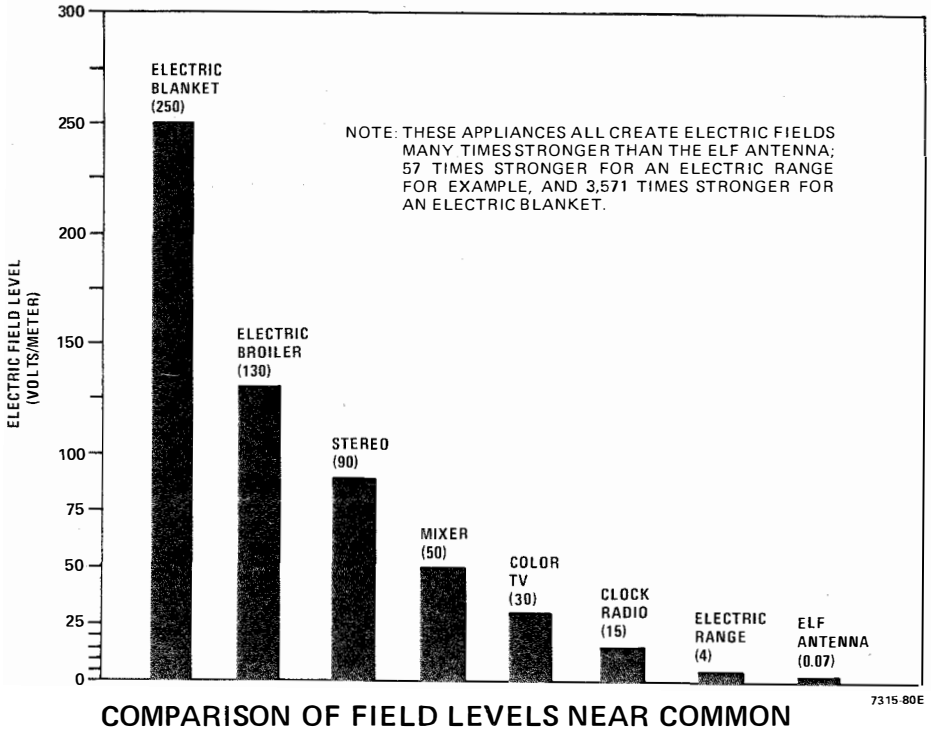
In 1969 the Navy opened a test facility near Clam Lake, Wisconsin in the Chequamagon National Forest to demonstrate that ELF is safe for humans and wildlife and does not interfere with public utilities or day-to-day activities by residents. It is known as the Wisconsin Test Facility or WTF. (See aerial 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.)

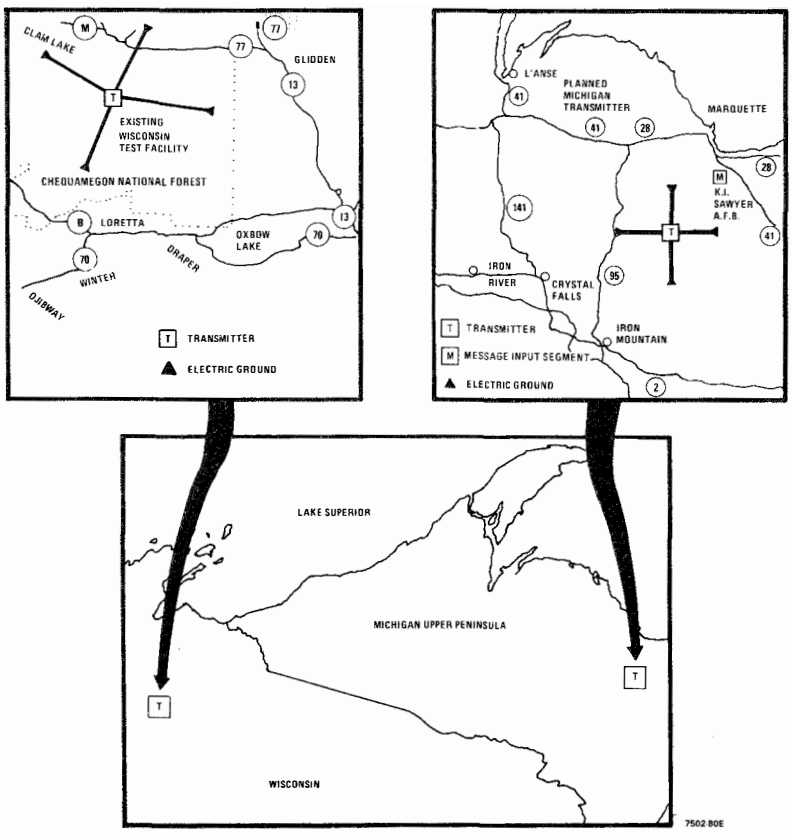


COMPARISON OF FIELD LEVELS NEAR COMMON ELECTRICAL APPLIANCES AND THE ELF ANTENNA

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 tnat 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.



PROPOSED LOCATION OF THE 2-SITE ELF COMMUNICATION SYSTEM

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. . ."*

  --- **Submarine Veterans of World War II** – (1980 National Convention statement to Congressional leaders)

- *". . . 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 letter to the Secretary of the Navy, March, 1977)

- *". . . We need a communications system capable of providing continuous contact with our SSBNs without compromising their location, and to SSNs that are operating in deep and fast modes. The ELF Communication Program will provide highly reliable, continuous, near-global communications coverage from a location in the Continental United States. The ELF system characteristics would free the submarines from having to deploy an antenna at or near the surface to receive messages, and would permit them to operate within the greater depth and speed envelope of their capabilities. The ELF Communications Program, by reducing these operational constraints, provides a hedge against a future Soviet ability to detect, identify, and track the submarines because of near surface observable phenomena that result from current operational Command, Control, and Communications procedures . . ."*

  --- **Dr. Harold Brown** (Secretary of Defense – to Senate Armed Services Committee, January, 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."*

  --- **Vice Admiral R. Y. Kaufman** (Director of Command and Control, Office of the Chief of Naval Operations – to House Defense Appropriations Subcommittee, May, 1980)

- *"Criticisms that the ELF system is both unnecessary and ineffective are not borne out by facts. The ELF system is a counter to future anticipated advances in ASW technology and will provide increased concealment which is not available to our strategic and attack submarines (who must receive communications today). . . In its operational mode, the recommended system will greatly enhance the long-term survivability of our Poseidon and Trident SSBN forces in the mid 1980s."*

  --- **Vice Admiral C. H. Griffiths** (Deputy Chief of Naval Operations for Submarine Warfare – before Senate Armed Services Committee, February, 1980)

- *". . . We should go ahead now. Significant gains in Soviet ASW capabilities are possible during the next six to seven years, which is the time required to acquire a full scale operational ELF Communications system if we start right now. . . We must continue to improve our own capabilities, including ELF communications in order to maintain our technological advantage over the Soviet Union in submarine warfare."*

  --- **Dr. Gerald Dinneen** (Assistant Secretary of Defense for Communications Command, Control, and Intelligence – in response to written question by Senator Humphrey during Hearings before the Senate Armed Services R&D Subcommittee, April, 1980)

- *". . . 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."*

  --- (From ELF text of Report by the joint House/Senate Conference Committee on the Defense Authorization Act for 1981)