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ELF HISTORY: EXTREME LOW FREQUENCY COMMUNICATION

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ELF radio signals are considered useful for one-way communication to submarines because they penetrate seawater to depths of several hundred feet.¹ ELF is the only available system which, according to the US Navy, will allow continuous contact with submarines while they are at patrol depth and cruising speed.

The US Navy's interest in ELF started in 1958, but this activity was held in secrecy for ten years. In 1969 the Navy constructed the ELF Test Facility in the Chequamegon National Forest south of Clam Lake, Wisconsin. The test facility consists of 28 miles (45 kilometers) of antenna cable strung above ground on poles. This antenna is in two segments of 14 miles (22.5 kilometers) each which are laid out in the form of a cross to provide bidirectional transmission.

A. SANGUINE

In 1968 the Navy broke ELF secrecy and announced plans for a hardened system in Wisconsin called Sanguine. Sanguine was at that time believed capable of surviving a nuclear attack. The survivability assessment changed when the Soviet Union started deploying multiple independently-targeted reentry vehicles (MIRVs) on their missiles because that allowed more warheads to be targeted at the ELF complex. Full scale development was scheduled to begin in May 1977, but Sanguine ran into political difficulties before that.

The Sanguine concept envisioned over a hundred unmanned transmitter capsules, measuring about 20 feet diameter by 60 feet long, which would all be underground. They would operate in the 72-80 cycle per second (Hertz, or Hz), range. Each transmitter was to be self-sufficient with its own emergency power system. The antenna cable elements, measuring about 2 inches diameter by 40-50 miles long, would be buried 4-6 feet deep. The entire 6,000 miles of cable would have many elements placed 3-5 miles apart in a grid arrangement. This would require an area of about 6,500 square

¹SASC-1985, 7 February 1984, Part 2, p. 936. Also see SASC-1977, 6 April 1976, Part 12, pp. 6956-6957; and ACIS 1980, p. 48.

miles.² The idea was that even if a number of the transmitter capsules were destroyed the system would still operate.³

Public concern over physical and environmental effects from electromagnetic radiation forced the Navy to abandon plans for Wisconsin. Texas was then chosen for the Sanguine site. But again public resistance forced the Navy to retreat.

B. SEAFARER

After two unsuccessful attempts at Sanguine, Navy officials restructured the ELF project. The name was changed to SEAFARER (Surface ELF Antenna For Addressing REMotely-deployed Receivers) in February 1975 to mask Sanguine's stigma. The nuclear survivability requirement was dropped and transmitters were to be above ground. Cables, however, remained buried.

Three potential locations emerged: the Nellis Air Force Base/Nuclear Test Site complex in Nevada, White Sands Army Missile Range/Fort Bliss complex in New Mexico, and the Upper Peninsula of Michigan.⁴ Preliminary estimates of requirements for a workable ELF system at each location were determined. Environmental impact studies were also started in 1975. Michigan was chosen and the environmental impact statement (EIS) was completed in 1977.⁵

An alternative concept to SEAFARER was called PISCES (Pacific Intertie Strategic Communications ELF System). It involved 850 miles of powerline stretched from Dalles Dam in Oregon down to Los Angeles. The 60 Hz frequency of commercial power is very close to the 72-80 Hz for ELF. The long parallel antenna was unsatisfactory, however, as it would emit a signal in only one direction. The two dimensional grid proposed for SEAFARER would transmit in all directions. Furthermore, the SEAFARER grid concept was modular and could be expanded. Navy officials claimed that PISCES was a backup to SEAFARER but there has been valid speculation that the purpose of PISCES was to determine how easily ELF signals from Wisconsin could be jammed. The only way to jam ELF is with a system equally as powerful and the Oregon-to-L.A. antenna provided that system for testing purposes.

At one time the Navy considered a super hard ELF system (SHELF) buried a mile underground in mineshaft-type tunnels so as to be extremely survivable. Vice Admiral Gordon R. Nagler, then Director of Command and Control for the Navy, said burying SHELF two miles underground was considered.⁶ SHELF's transmitter and self-contained power unit would also be underground. Several hundred thousand dollars was spent looking into SHELF and research was known to be in progress as late as 1978.

As regards SEAFARER, it grew after Michigan was selected. The number of transmitters remained at three but the antenna network doubled to 2,400 miles of cable. Grid spacing was reduced from 4-6 miles apart to 3.5 miles. The entire grid would then occupy 4,700 square miles .

²*World Armaments and Disarmament*, p. 401.

³SASC-1975, 29 March 1974, Part 6, pp. 3136-3169.

⁴Marienthal

⁵Marienthal.

⁶HASC-1984, 24 March 1983, Part 3, p. 859.

May 1977 was the scheduled time for SEAFARER to begin full scale development. But on 18 March 1977 then Michigan Governor William G. Millikan vetoed the project. In a telegram to Defense Secretary Harold Brown he said: "The people of Michigan do not want SEAFARER, nor do I."⁷ President Carter terminated SEAFARER on 16 February 1978 and directed that additional studies be performed before making a decision on how to proceed with ELF. Congress restricted funding for fiscal year 1979 unless the President certified that ELF was in the national interest, that a site had been selected, and that the site had been approved by the President. The Wisconsin Test Facility was placed on caretaker status.

C. AUSTERE ELF

A further scaled-down ELF system emerged shortly after Millikan's veto. In December 1977 the Navy recommended construction of an amended concept, called Austere ELF, in Michigan's Upper Peninsula. On 2 March 1978 Vice Admiral Robert Kaufman formally announced this project.⁸

It was to consist of 130 miles of antenna cable divided into three elements of 32, 45 and 53 miles long. Each of these elements would terminate at K.I. Sawyer Air Force Base where the single transmitter would be located. The cables would be buried along public roads and other right of ways.

The Wisconsin Test Facility, 165 miles away, was to have been improved with its transmitter slaved to the one in Michigan via leased telephone line. The two facilities combined would then provide five antenna elements totaling 158 miles of cable. Cables at the Wisconsin facility were, of course, above ground. Austere ELF was planned to be operational by 1 October 1983.

By early 1981 Austere ELF was in difficulty from citizen resistance and budget constraints. Admiral Thomas B. Hayward, then Chief of Naval Operations, told Congress: "No threat has emerged that causes us concern about our SSBN [nuclear-powered ballistic missile submarine] force. And, therefore, it is not essential to press on with ELF at the present time."⁹ Navy Secretary John F. Lehman recommended to Defense Secretary Caspar Weinberger that the ELF communication system be shelved.¹⁰

D. PROJECT ELF

The Reagan Administration did not agree with Pentagon assessments, however. On 8 October 1981 the Pentagon, under direction from the President, released plans for a further scaled down ELF system called Project ELF. It was a three-pronged effort to (1) upgrade the Wisconsin facility, (2) install a second transmitter with antenna at K.I. Sawyer Air Force Base in Michigan, and (3) install ELF receivers in submarines.¹¹

Plans for Michigan were similar to Austere ELF except that only 56 miles of cable, in Escanaba State Forest, was planned -- exactly double that at the existing Wisconsin test facility. It

⁷Cited in Greenwood Fact Sheet.

⁸Ruehr.

⁹HASC-1982, 2 April 1981, Part 3, p. 644.

¹⁰HASC-1982, 1 April 1981, Part 4, p. 869.

¹¹SASC-1985, Part 2, p. 936.

was to be above ground. Pentagon officials now said the Wisconsin and Michigan transmitters would be connected by "secure data links."¹² Each transmitter could work independently but the signal strength would be lower. Original plans were for initial operation in 1985 and full operation with receivers on all submarines by 1987. It was not until the 1990s that all submarines had ELF receivers.

E. RAPID DEPLOYMENT ELF

In addition to the permanent Project ELF site in Wisconsin and Michigan, Pentagon interest has also been shown in a rapidly-deployable ELF system. One such concept is a mobile system using trucks and trailers; variously referred to as "Mobile ELF", "Elusive Voice" and "Transportable ELF." As early as 1982, five million dollars had been appropriated to investigate this concept.¹³

Mobile ELF could eventually consist of a fleet of trucks and trailers carrying thirty miles of ELF cable, transmitters, generators, security equipment, and radiation protection equipment. Deployment would probably take place in Wisconsin and Michigan.¹⁴ Presumably, during time of emergency these trucks would roll out on the highways and reel out the cable in segments. The segments would then be connected to form a 30-mile antenna element. With the mobile transmitter slaved to Project ELF transmitters, this would provide rapid expansion of that system to provide higher transmission speeds.

Another form of rapidly deployable ELF is the so-called "Balloon ELF." In early 1978 Pentagon officials told Congress about a proposal to use balloons for lifting an array of vertical antennas.¹⁵ Although the testimony at that time conveyed a tone of skepticism -- major problems having to be overcome -- the Navy, in 1981, contracted with Pacific-Sierra Research Corporation of Santa Monica, California to study Balloon ELF's feasibility.¹⁶

In his fiscal year 1985 Defense Advanced Research Projects Agency (DARPA) report, director Dr. Robert S. Cooper referred to a VLF/ELF transportable communication system. He said this is a balloon-supported vertical dipole antenna, a demonstration of which was to be performed jointly with the Navy during fiscal year 1985.¹⁷ Balloon ELF is another method, possibly a complimentary method, of increasing Project ELF's data rate in times of imminent crisis.

F. CONCLUSION

The history of ELF resembles a political exercise to get a foot-in-the-door. It started with Sanguine which was to be a hardened system comprising over a hundred buried transmitters and 6,000 miles of underground cable covering 6,500 square miles. When that wasn't accepted the Navy proposed SEAFARER with three above-ground transmitters and 2,400 miles of buried cable occupying 4,700 square miles. Then it was scaled down to Austere ELF with two surface transmitters and 158 miles of cable -- 130 miles of it buried along utility and roadway right-of-ways. Now there is Project ELF, still with two transmitters and only 84 miles of cable hung on utility poles.

¹²HAC-1985, 1 May 1984, Part 4, p. 666.

¹³Reported in Stop Project ELF Newsletter, p. 6.

¹⁴Reported in Stop Project ELF Newsletter, p. 6.

¹⁵HAC-1979, 4 April 1978, Part 4, p. 507.

¹⁶*Defense Daily*, p. 306. Also see *AW&ST*, p. 63.

¹⁷DARPA-1985, p. III-16.

In June 1977 the ad hoc ELF review group of the Secretary of Defense decided that a small ELF system would be of marginal utility and was not credible as the ultimate ELF system. It recommended building the small ELF, however, because "the modified version would provide a basis for future system growth if ELF requirements later increased."¹⁸

The ELF system is modular and can be expanded quickly with mobile systems during emergencies to increase the data rate. Both truck mobile and balloon suspension have been investigated.

ELF is a dangerous system which will significantly contribute to a destabilizing first strike capability and other aggressive activity by the United States and its allies.¹⁹ Global security would be enhanced if the ELF communication system is canceled and the existing facility dismantled.

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¹⁸Cited in Stop Project ELF letter, p. 13.

¹⁹See PLRC-010218.

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GLOSSARY

DARPA	Defense Advanced Research Projects Agency
EIS	Environmental Impact Statement
ELF	Extreme Low Frequency
Hz	Hertz (One cycle per second)
MIRV	Multiple Independently-targeted Reentry Vehicles
PISCES	Pacific Intertie Strategic Communications ELF System
Sanguine	A hardened ELF concept.
SEAFARER	Surface ELF Antenna For Addressing REmotely-deployed Receivers
SHELF	Super Hard ELF
SSBN	Nuclear-powered ballistic missile submarine.
US	United States
VLF	Very Low Frequency