

# The Navy's Interest in LF and VLF Radio— Background For

## The Giant Station At Jim Creek

The development of high powered, low and very low frequency radio is somewhat unique to the Navy. This development has continued over a period of almost half a century. A brief description of the Navy's fundamental concept of communications will show why interest has been focused on that field.

The basic requirement which naval communications must satisfy is the ability to communicate with mobile forces at sea or in the air, wherever they may be. This requirement is satisfied by three elements of the Navy communications system:

*First, the broadcast to ships at sea;*

*Second, ship-to-shore terminals at major stations, by which traffic from ships can enter the system;*

*And finally, the point-to-point circuits by which the major radio stations are linked.*

Very strong emphasis has been placed on broadcast methods because of the security afforded the mobile forces. This security results from the fact that the broadcasts deliver traffic to these forces without requiring them to use their transmitters. LF and VLF are particularly well suited for the broadcast method because of their non-directive characteristics, and freedom from fading and ionospheric disturbances.

### LF Back in 1909

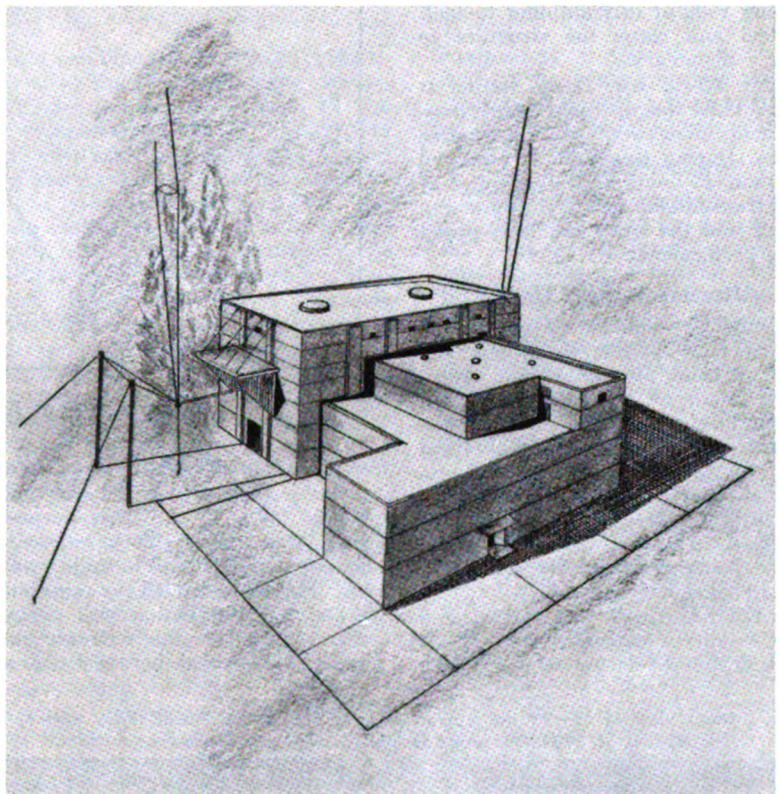
Recognition of the value of LF and VLF is not new to the Navy. In 1909 the Navy contracted for a 100 kilowatt, low-frequency transmitter for installation at Radio Arlington, Virginia. While the Arlington station was under construction, the Navy was engaged in the preparation of plans for its first chain of high power radio stations. Between 1913 and 1918 the Navy commissioned seven more low frequency stations with powers up to 350 kilowatts.

During World War I, the Navy also took over several commercial stations, including the Marconi station at Brunswick, N. J. It was from this station that President Wilson's "Fourteen Points" were transmitted to Germany.

In 1918, when the fighting in Europe was over, the United States found itself faced with a problem of maintaining contact with its occupation forces. It was for this purpose that an agreement was concluded with the French Government whereby the U. S. would construct

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Artist's conception of the transmitter building, central part of the Navy radio station at Jim Creek, Snohomish County, Washington.

a low frequency, high power radio station near Bordeaux. Radio Lafayette went into operation in August 1920 with a power of 1000 kilowatts.

All of the transmitters which have been mentioned thus far were of the spark, arc, or alternator type. In 1926 an 80 kilowatt vacuum tube transmitter was installed at San Diego by the Navy. This transmitter was still functioning very satisfactorily on thirty point six kilocycles when it was retired in 1949 in favor of one of its modern successors.

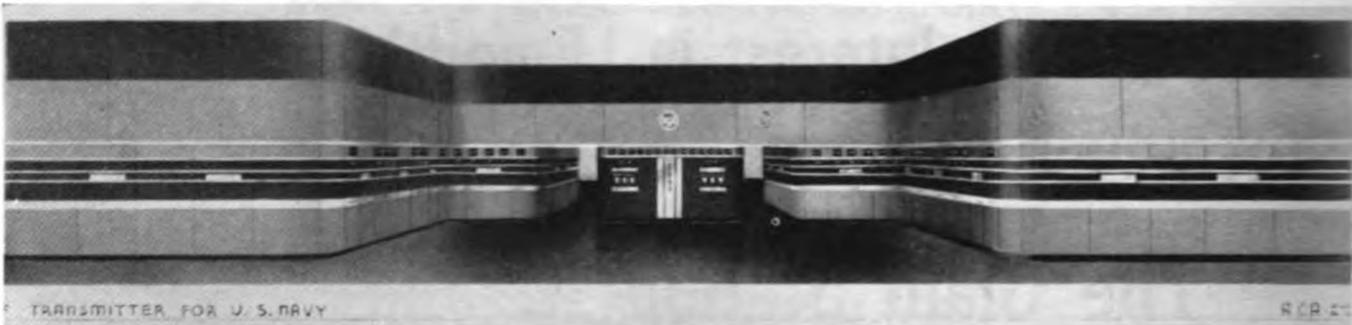
The success of the vacuum tube transmitter at San Diego encouraged replacement of arcs with more modern equipment. The first of a famous line of transmitters was constructed by the

General Electric Company and installed at Cavite in 1932. The voice of Radio Cavite was heard all over the world until the station was destroyed by the Japanese in December 1941. Three similar transmitters were installed in rapid succession at

Pearl Harbor  
Canal Zone  
Annapolis

The Pearl Harbor station was later moved to an isolated location at LUA-LUALEI and the power increased to 500 kilowatts.

Two incidents will serve to illustrate the problems involved in high power radio installations. When the radio transmitter was still at Pearl Harbor,



TRANSMITTER FOR U. S. NAVY

100 KW LVF transmitter built for U.S. Navy

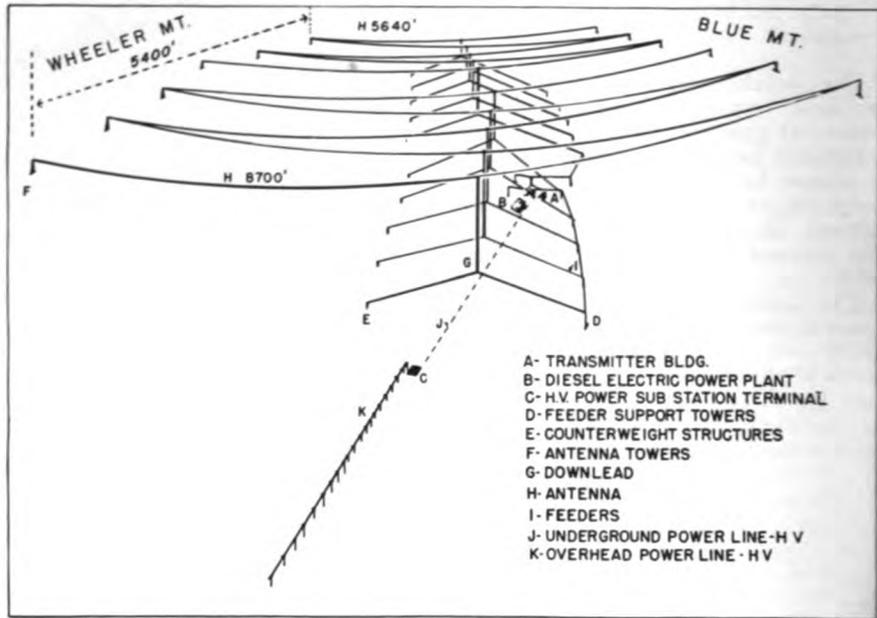
a tool shed was located in the vicinity of the antenna towers. Sufficient heat was generated in the nails of this shed by induced currents to set the shed on fire. When the transmitter was moved to LUALUALEI, a reinforced concrete building was used as a helix house. Sufficient current was induced in the reinforcing rods of this building to melt the steel and cause the structure to partially disintegrate.

During World War II the station at LUALUALEI was operated at full power for more than twenty-one consecutive months. During this time it averaged more than 23 hours and 50 minutes of actual transmission per day. The manufacturer and the Navy are both proud of this performance.

**Alternators Still Used**

Although development of the vacuum tube made it possible to replace the spark, arc and alternator type transmitters, some of the alternators still continue to give excellent service. During World War II the Navy obtained two of the alternators from the Radio Corporation of America. Both of these were installed in HAIKU Valley, on the island of Oahu, to augment the services being rendered by the LUALUALEI transmitter.

The HAIKU Valley site was selected as the result of extensive surveys. It was desirable to locate a site which



Line sketch of Radio Station, Jim Creek, Wash.

would eliminate the need for large steel towers. Because of the wartime demands for steel for other purposes, it would have been almost impossible to procure enough steel to build such towers. HAIKU filled all the requirements. When the installation was completed, there was a very fine catenary antenna system suspended between two moun-

tain peaks. This system consists of four separate catenary strands. Each is more than seven thousand feet long. The downleads from these strands drop more than 1300 feet to the transmitter building in the valley below. The HAIKU alternator, although already a veteran was more than gratifying in its new job of working for Uncle Sam's fighting machine.

To cover the entire evolution of LF and VLF radio in the Navy would require much more space than is available in this article. Therefore, only a few of the better known highlights have been touched upon here. In any event, anything that might be said about LF and VLF radio is another compliment to the entire American communications industry. LF and VLF radio continues to play a very important part in the Navy's world-wide communication requirements. For this reason, the Navy is now constructing the greatest of them all.

**The "Jim Creek" Station**

A site for a high power VLF station has been selected at Jim Creek, approximately eleven miles from Arlington, Washington. Thus the Navy will have another "Radio Arlington," separated from the original Radio Arlington by thousands of miles and a half century

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Below: Interior view of one of the operating buildings of the Naval radio station, Mare Island, Cal. in 1904. Note old-fashioned meters and other equipment.



# I. T. & T.

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composed of the most highly qualified technicians within the various fields of IT&T research and development, together with representatives of the engineering, manufacturing, commercial, operating and patent departments. Technical committees that include representatives of all System organizations interested in a particular technical field meet periodically to exchange views and make detailed recommendations in furtherance of it.

Typical of IT&T's modern research facilities is the plant of the Federal Telecommunication Laboratories, with its 300-foot aluminum-sheathed microwave tower dominating the North Jersey landscape. An integral part of the ultra-modern laboratory building, the tower is designed to provide the highly exacting conditions required for research in the higher frequencies. Here, experiments are conducted in a variety of fields, with aerial navigation aids, television, frequency and pulse-type modulations and facsimile systems for broadcasting receiving primary attention.

## Telephone Communication

IT&T began its career in 1920 with telephone companies in Cuba and Puerto Rico. Within a decade, it had organized or purchased other telephone companies in Argentina, Brazil, Chile, China, Mexico, Peru, Romania, and Spain. Most of these operate by the usual landlines. However, radiotelephone was employed some 15 years ago, in Chile, to link remote localities with the main network; and today, in Brazil, IT&T is operating a telephone system by means of radio.

IT&T is prepared to undertake the reorganization, expansion, and modernization of national telephone systems even if the government's ultimate aim is to purchase and operate the network after its rehabilitation. Of the three governments that have done this—Argentina, Romania, and Spain—each contracted for continued technical advice and equipment from IT&T at the time of purchase.

Except for China, IT&T telephone operating properties now are limited to the Western Hemisphere. In Chile, Cuba, and Puerto Rico, IT&T companies have nationwide networks comprising the great majority of telephones in those countries. In Brazil, there are two IT&T companies operating by landline in the southern states of Parana and Rio Grande do Sul, in addition to the radiotelephone network already mentioned. In Mexico, a partially-owned IT&T company, Teléfonos de Mexico (Telmex), operates the national telephone system, while, in Peru, an IT&T telephone operating associate serves Lima and its outlying districts. Altogether, over half a million stations are presently in service.

Telephone service by IT&T companies is not limited by national boundaries. In fact, it has been estimated that 90

percent of the telephones in South and Central America and the West Indies are linked with one another and with Europe and North America through IT&T facilities.

## Cable and Radiotelegraph

The American Cable & Radio Corporation, an IT&T associate, is the only American-owned international telegraph carrier offering worldwide service by both cable and radio. Among its associated companies are All America Cables and Radio, Inc., The Commercial Cable Company, and Mackay Radio and Telegraph Company. These and other IT&T companies in South America operate approximately 47,000 miles of submarine cable, more than 8,800 miles of landline, and over 70 international radiotelegraph circuits.

## Marine Communication

The two most important IT&T associates in the field of marine radio are the Marine Division of Mackay Radio and Telegraph Company, New York, and the International Marine Radio Company Limited, Croydon, England. Both companies have played important parts in developing marine communication. Mackay pioneered commercial shore-to-ship radiotelegraph service in the United States as early as 1914, and today operates 10 powerful shore stations for communication with ships at sea.

IMRC was organized in 1930 to install and operate aboard British merchant vessels the commercial Radiotelephone equipment that IT&T laboratories had been instrumental in developing. The company rapidly expanded into allied fields and was awarded contracts by Cunard White-Star, Ltd., to install and operate the complete telephone and telegraph equipment, and the usual navigational and safety devices, aboard its fleet, including the *Queen Mary*, the *Queen Elizabeth*, and the postwar *Caronia*. These installations were designed by IMRC, and much of the equipment involved was manufactured by associated IT&T companies.

## Technical Advisory Service

For the operation of its varied activities, IT&T has built up a staff of experts unique in their experience of rehabilitating and expanding telecommunication services and factories in many lands. Where IT&T is retained as a consultant, it makes available its technical advisory service for the solution of problems involved in the construction and maintenance of physical plant, the training of employees, the choice and application of operating techniques and financial procedures, and the establishment of satisfactory public relations.

## Export Activities

Export to foreign countries and possessions is normally handled in one of two alternate ways—through an export department maintained in New York City by IT&T's associate, International Standard Electric Corporation, or

through more than 250 sales outlets maintained by that Corporation or its subsidiaries outside the United States. For the convenience of its customers, ISE also maintains an engineering division that will survey, plan, and estimate the cost of projects ranging from a single radio transmitter to complete telegraph, telephone, and airport installations.

During the first decade of its existence, IT&T built a worldwide telecommunication and electronic industry second to none in the extent and variety of its activities. During the next decade and a half, IT&T survived storms of depression, revolution, and war that overthrew strong governments and the League of Nations, the gold standard and multilateral trade. Since the war, IT&T has greatly expanded its manufacturing position in the United States, where it now ranks among the leaders in its field.

Today, IT&T is supported in both hemispheres by research laboratories whose achievements are generally recognized. Its products can be manufactured locally, if markets warrant, by 32 associated factories in 21 countries. Where local manufacture is not warranted, equipment is supplied, installed, and maintained by a sales and service organization with outlets throughout the world.

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## “Jim Creek”

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of time. This will be the world's highest powered VLF radio transmitting station. It will have a power of 1000 kilowatts, twice that of LUALUALEI, and will be capable of really worldwide coverage. Although of the same output as Radio Lafayette, the use of a vacuum type transmitter will make the new station approximately six times as effective.

The transmitter itself was manufactured by RCA at Camden, N. J. and is designed to be used at a power of either 1000 kilowatts or 500 kilowatts. When operated at the lower power, a complete spare 500 kilowatt unit is available for alternate use. The frequency range is 14 to 35 kilocycles.

The antenna system will consist of ten catenaries spanning Jim Creek Valley. These catenaries will be suspended from 200 foot towers on the tops of Wheeler and Blue Mountains. The catenaries will be 5640 to 8700 feet in length, with actual radiators approximately 5000 feet in length. Downleads, averaging 1200 feet in length, will be connected to two central bus feeders. Each bus will consist of a conductor 26 inches in diameter and will be supported on 14 towers about 140 feet in height.

The transmitter building is the heart of the Jim Creek Station. Its general arrangement is functional. All unnecessary features have been eliminated. Because of the unique equipment to be

## "Jim Creek"

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located in the transmitter building, a number of unusual features have been incorporated into its design. Reinforced concrete construction is used. As a result of the unfortunate experience at LUALUALEI all the reinforcing steel is spot welded together at every intersection and in turn, grounded at intervals of not more than 5 feet around the perimeter of the building to a copper mat. This ground mat extends underneath the entire building and approximately 30 feet beyond the outer walls. The magnitude of the radio frequency field requires the installation of non-combustible roofing material. All roof areas are covered with sheet copper which is connected to the copper ground mat. The building is without windows. This design feature serves two purposes.

First, it reduces the amount of dust that will get into the building; and second, it provides a certain amount of security from blast damage.

Because of the power involved, the helix rooms require a space approximately 75 feet square and 60 feet high, completely shielded with copper.

The antenna buses from the transmitter building come out the sides through 20 foot square ports which are provided with copper covered canopies to keep out snow and rain. This arrangement will be discarded when a bushing is developed which will permit running the buses vertically through the roof. In anticipation of this, soft patches approximately 15 feet in diameter have been provided in the roof slabs in the center of each helix area.

The terrain is such that a very limited space is available for building construction. To secure the required space, the course of JIM CREEK has been diverted. Electronic considerations have dictated that an area 1600 feet in diameter around the transmitter building be cleared of nearly all vegetation. Approximately 1500 acres of additional space must be cleared to a lesser degree.

Excessive erosion would be detrimental since it would reduce the conductivity of the ground. It would also tend to fill JIM CREEK and increase the possibility of floods. Therefore, steps must be taken to stabilize the slopes of the valley. Since the area under the antenna system must be maintained clear of objectionable growth over the years, the cost of future clearing operations must be considered. Studies have indicated that the cleared areas should be planted with low growing shrubs such as snowberry, salmonberry and spirea. These shrubs will provide sufficient roots to keep the top soil in place. Growths such as alder and maple must be eliminated in order to avoid expensive clearing operations in succeeding years. Consideration is being given to poisoning such objectionable growths.

One of the electronic requirements for a station of this type is a ground

system under the antenna. For ideal operations a considerable portion of the valley should be copper plated. Obviously, this cannot be done. However, a reasonably accurate substitute is being provided. Radial wires will extend 2500 feet from the copper mat under the transmitter building. These wires will be spaced at angular intervals of one degree twenty minutes. A large portion of the area to be covered consists of rock out-croppings. For this reason special means are being devised to prevent the wires becoming displaced by debris. The wires will also complicate the problem of soil stabilization. In areas where soil is available, they will be buried at least one foot below the surface.

Another problem which has required careful study is the power supply for the station. The total load is estimated to be 2500 kilowatts. Of this, 1800 kilowatts represents the power required by the transmitter plate circuits. This is the load which is flashed on and off as the transmitter is keyed. The design of the tubes is such that voltage variations in excess of five percent may cause failure. It is obvious that the power supply must be designed for very close regulation. The main supply will come by a transmission line from a power substation at the town of Arlington, about 12 miles away. Diesel generators will be provided for emergency operation.

The magnitude of the JIM CREEK installation is dramatic proof that LF and VLF radio have vital roles to play in naval communications. The Navy is proud to have pioneered in this field and proud of the achievements of the communication industry in providing the equipment.

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## Horne Speech

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operate in this band. However, since it cannot be stated without qualification that all of the functions required can be accomplished in these bands, investigations must be carried out to determine the practicability of combining the functions. Certain other functions such as landing monitoring, airport surface movement and position determining will operate in their allocated bands. It is emphasized that the foregoing radio frequency spectrum requirements do not represent the entire frequency requirements of the aviation service.

Point to point communication in the future will be provided by interphone equipment, automatic air traffic control point to point equipment, and microwave and/or coaxial cable point to point relay circuits. Interphone equipment of the ultimate system will be required to handle aural intercommunication between ATC centers, aircraft operating agencies, weather bureau offices, air terminal control towers, and

related units essential in the functioning of Air Traffic Control System. The interphone system may function as the primary means of intercommunications between ATC units in low density traffic areas and as a secondary communication means in areas where air traffic density is high and control is achieved largely through automatic traffic control facilities.

The interphone system should provide an integrated means for full duplex voice telephone communication between two stations, among several stations, or among all stations within an ATC area. Extension of the interphone system through one or more ATC areas should be possible. The signal level at a receiving station should be maintained substantially constant regardless of the station of origin in the System. Means to signal stations on the system and selective and multiple signalling functions should be provided. The selective signaling means should function rapidly. Signaling should involve an overall time delay which is small compared to the twenty second duration of the average communication.

Increased emphasis is required on improved pre-flight planning to afford increased utilization of airway and airport facilities. It has been recommended that automatic ATC point to point communications be provided by a telegraphic code over wire facilities between airway traffic control towers, and points along the route of the aircraft, and points within the area of the airway traffic control center. The communication system shall be based upon the use of a five-element telegraphic code. It shall operate to transmit aircraft flow information in a sequential manner and shall be capable of expansion in message capacity by use of coordinated facilities. Transmission characteristics of the communication system shall be such that they are reliable over any distance required by air traffic control coordination. The communication system shall have a minimum speed of transmission in the range 200 to 300 characters per minute and anticipate a maximum rate of 600 to 700 characters per minute. The equipment used for transmitting aircraft flow information should be capable of selective message routing. The errors introduced in the transmission of messages should not exceed one ten thousandth of 1% of the total numbers of characters transmitted. The communication equipment should be capable of storing messages until such time as wire facilities are available for re-transmission. The storage equipment shall be located at each transmitting or receiving point associated with aircraft flow information.

Some areas of the country, due to the high density of air traffic, will require the transmission of intelligence, the type and volume of which cannot be efficiently handled by the ordinary landline wire circuits. In these areas, traffic control facilities will be inter-

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