NAVY RADIO TRANSMITTING STATION

Battle Point, Bainbridge Island, Washington

By A. H. Brudwig, *Electronics Engineer, Supervising Engineer, Electronics Shore Station*

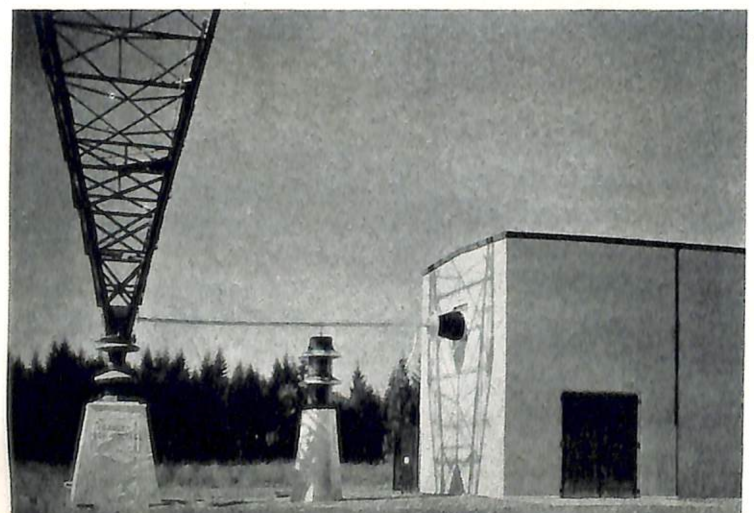
The Navy Radio Transmitting Station, Battle Point, a component of the Navy Communication Station, Bainbridge Island, Washington and the transmitting facility for "Radio Seattle," was constructed in 1942. Battle Point is situated near the northwesterly end of Bainbridge Island, seven miles from the Puget Sound Naval Shipyard, ten miles from the Thirteenth Naval District Headquarters in Seattle and six miles from the Navy Communication Station (receiving) at the southern end of the island. The station reservation contains approximately ninety acres of level ground, lying at an average elevation of 145 feet above mean sea level and within 750 feet of salt water. The surface soil consists of deep moist clay, having good electrical conductivity. Factors which influenced the selection of this site were: (1) the absence of mountains or high terrain in the immediate vicinity; (2) transmission paths to San Francisco, Alaska and the North Pacific area have "take offs" almost entirely over salt water; (3) sufficient elevation is available to permit the use of v-h-f radio links with control points; (4) availability of space for future expansion; and (5) security against encroachment or sabotage. The site possesses many of the qualities desirable for a radio transmitting station.

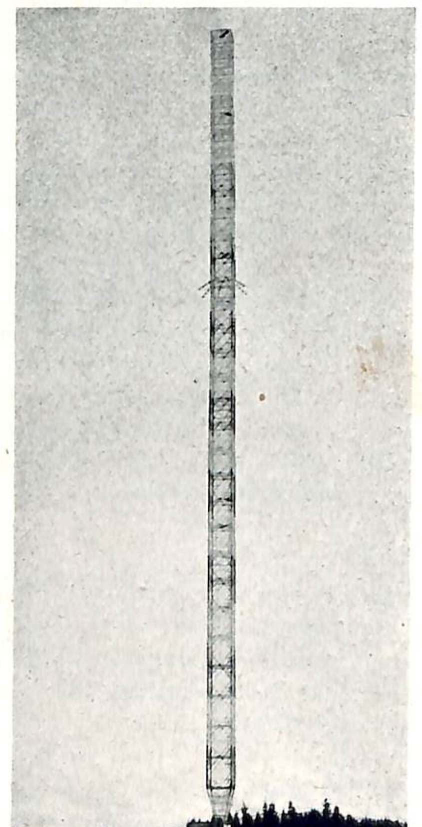
The transmitter building is of reinforced concrete construction and provides a transmitter room measuring 32 x 95 feet. Office space is contained in a wing measuring 22 x 23 feet. A full basement provides space for the 375 KVA Diesel engine-generator standby power unit, transmitter water cooling system, storage rooms, heating plant and related utilities. A portion of the wall at each end of the building is made of translucent glass blocks which admit light to the transmitter room. Wiring ducts in the floor of the transmitter room provide a convenient means for the installation of inter-connecting wiring between transmitter units, control panels and power panels. Antenna lead-ins and transmission lines enter the building through ports in the building walls.

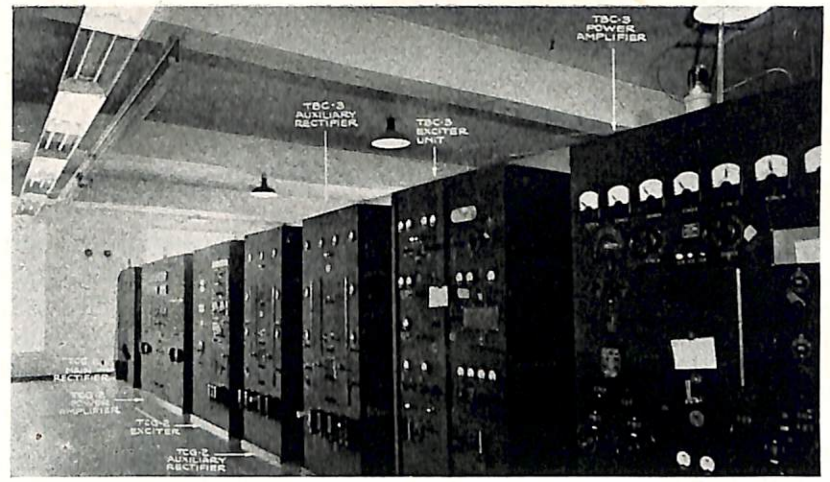
Seventeen transmitters, including the Models TCG–2, TBC–3 and TEB in the higher-powered group, are installed in the building. The transmitters' power outputs range from 500 to 50,000 watts over the frequency range of 50 kc to 27 Mc. All high-frequency transmitters and the Model TCG–2 low-frequency transmitter have been modified for frequency-shift-keying. This method of keying is used on all point-to-point circuits and to some extent on ship-to-shore circuits. Transmitters are controlled either from the Navy Communication Station (receiving), located at the south end of the island, or from the Thirteenth Naval District Headquarters in Seattle. Leased lines as well as v-h-f communication control links extend to both control activities from the transmitting station. Adequate CCL channels are available for both telegraph and voice circuits to meet all present requirements.

A variety of antennas are available for either directional or non-directional transmission. Four 300-foot self-supporting steel towers arranged in a diamond pattern around the transmitter building support seven medium-frequency and eight high-frequency non-directional antennas. Seven rhombic and four inclined terminated V-antennas are employed on point-to-point circuits or where directional transmissions are desired. Each rhombic antenna is of the inclined three-wire curtain type, having a slope angle of seven degrees. On six of the antennas, 100-foot poles are used at the tangent end, 70-foot poles at the sides and 20-foot poles at the transmission line end. Leg lengths on these antennas vary from 280 feet to 335 feet and tilt angles vary from 72°–24′ to 74°–50′. The seventh rhombic antenna was designed and constructed for operation in the frequency range of 6 to 10 Mc. It is supported by a 150-foot pole at the target end, 115-foot poles at the sides and a 20-foot pole at the transmission line end. The length of each leg is 460 feet and the tilt angle is 76°–10′. The terminating resistance for each antenna consists of a two-wire dissipation line of No. 8 stainless steel wire, with six-inch spacing and a length of approximately 1000 feet. The ends of the lines are short-circuited and grounded, thus providing a means for draining off static charges collected by the antenna. The transmission lines, extending from the transmitter building to the antennas, are of the open two-wire type and are constructed of No. 4 solid copper wire, spaced 12 inches and supported on 12-inch pedestal

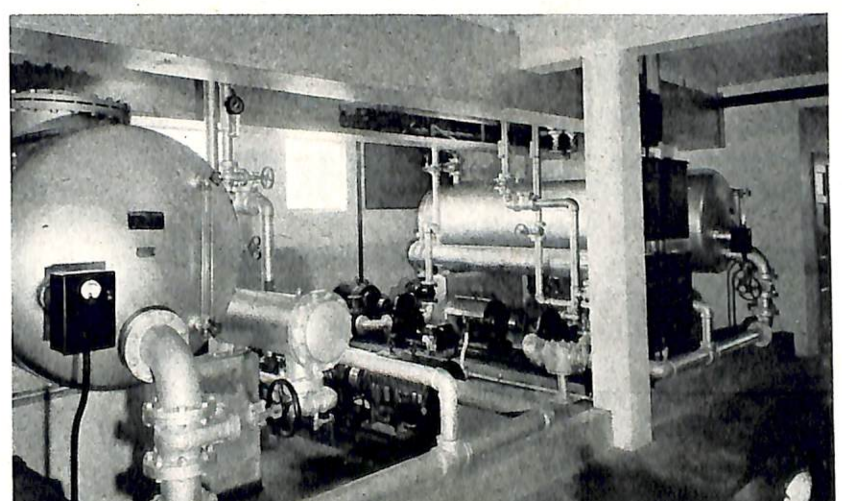
800 FOOT TOWER for Model TCG transmitter (at right). Helix house and base for the tower (below).



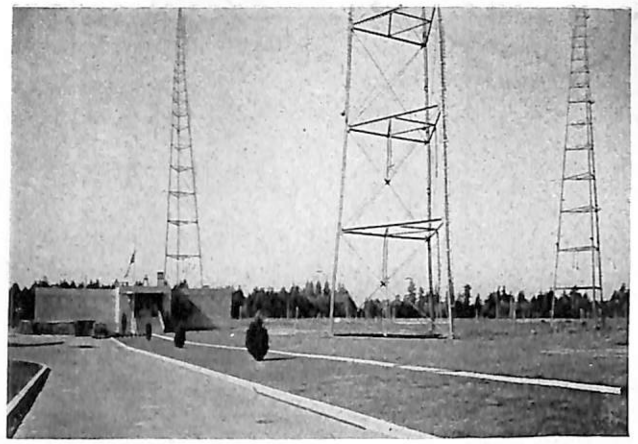




Interior of the TRANSMITTER BUILDING.



DUPLICATE WATER COOLING UNITS for TCG and TBC transmitters.



TRANSMITTER BUILDING.

insulators. The standing wave ratios on these lines range from a maximum of 1.25 to a minimum of 1.03 over the usable frequency range of the antenna.

Of particular interest is the low-frequency radiator used with the Model TCG–2 transmitter. This is an 800-foot guyed steel tower of uniform cross section, 20 feet square, resting on a single base insulator. Eight guys attached at the 515-foot level maintain the tower in a vertical position. The guys, consisting of 1⅞-inch wire rope, are each broken with four insulators, three placed near the attachment point and one near the ground end. The base insulator carries a load of 706,000 pounds at 60 degrees Fahrenheit; this loading is calculated to increase to 728,000 pounds at 0 degrees. The base insulator rests on a reinforced concrete pedestal which is covered with sheet copper to prevent heating of the reinforcing steel by the intense r-f field existing at the base of the tower. The tower is painted and illuminated in accordance with CAA specifications for tower markings. 1000-watt flashing beacons are located at the top and at the 400- and 600-foot levels. Positions midway between these levels are marked by 100-watt fixed lights placed at the four corners of the tower. Power for the lighting circuits is brought to the tower through a special high-voltage oil-filled transformer which isolates the radio frequency from the power supply system. A separate ground system is provided for the low-frequency radiator which consists of 240 radials of Number 6 bare copper wire, 600 feet long, buried to a depth of 12 inches and uniformly spaced at 1.5 degrees around the base of the tower.

The antenna loading inductor, antenna tuning variometer and coupling transformer are contained in a helix house located near the base of the tower. The helix house is a reinforced concrete structure 26 feet by 38 feet and 26 feet high. The ceiling is covered with sheet copper and grounded to prevent heating of the reinforcing steel and to reduce losses in the field of the antenna loading inductance. An open two-wire transmission line carries the radio-frequency energy from the transmitter building to the helix house, a distance of approximately 1000 feet.

At the operating frequency of 58 kilocycles the antenna has a resistance of 1.5 ohms, a capacitive reactance of 520 ohms and an effective height of 308 feet. Quarter-wave resonance occurs at 232 kc. Excellent coverage of the North Pacific area is obtained from the above described radiator. This is particularly important when high-frequency circuits to Alaska fail because of radio "blackouts" which are quite common in the northern latitudes. These black-outs occur at irregular intervals and may persist for a few hours to several days. During these periods the Model TCG–2 transmitter, frequency-shift-keyed on 58 kc, is used exclusively for radio teletype transmissions to Alaska, and handles not only the Navy's traffic, but that of the Army as well.

An inverted pyramid, broad-band antenna is under construction at the station for use in the 2- to 3-Mc band for ship-to-shore communications. The design is based on the published information collected during experiments with various types of broad-band antennas by the Naval Electronics Laboratory, San Diego, California. Since the antenna will be used only with low power from a Model TDO transmitter, Type RG–85/U coaxial cable will be used to connect the antenna to the transmitter.

THE ELECTRONICS OFFICE

The Electronics Office of the Puget Sound Naval Shipyard is organized in conformity with Chapter VI of the Shipyard Regulations. The organization is functioning very smoothly as the only new feature in the standardized organization which was not already included in the previous organization is the Electronics Services Section. This section has already proved its worth by relieving the Electronics Ship and Shore Sections of record-keeping and clerical problems, thereby permitting those sections to concentrate on affairs of a technical nature. By the same token, the Electronics Services Section is concentrating on those matters which were often deferred due to higher priority work, so that the shipyard's customers are, therefore, receiving improved service.

It may be of interest to readers to note that in this shipyard, the custody and maintenance of all electronic test apparatus is vested in the Services Section. This arrangement is proving very satisfactory.

PROGRAM

is for ZEBRA

By L. P. Campbell
Quarterman Radio Mechanic

Program ZEBRA, the latest addition to the rapidly expanding electronics family at the Puget Sound Naval Shipyard, was established in March 1948. This program, which is quite unique, consists of the restoration of electronic equipment which has been returned from the forward Pacific areas and which has been removed from ships and shore stations. The ultimate aim is to provide all activities with good serviceable equipment, particularly the Naval Reserve.

Much of the equipment which is received for restoration to "equivalent to new equipment" was in open storage for long periods in the extremely severe climates encountered in the tropical and semi-tropical areas; the results of high humidity and boiling suns have so greatly accelerated the fungus growth, rust and corrosion that the equipment might appear to the uninitiated to be beyond hope of restoration and doomed for the scrap pile! This, however, is not the case as the equipment can be reworked to issuable condition provided the units have not been too badly damaged by breakage. Over 90% of the units received have been restored to issuable condition!

It became apparent at the outset that, if the restoration work was to be performed on an economical basis, the shipyard must adopt "mass production methods" as distinguished from the customary shipyard practice of making repairs on a "custom" or "job-shop" basis. Accordingly, all plans were made to lay out the restoration work-lines for repetitive operations and to reduce the transportation handling to a minimum.

A separate supply department building, with adequate space and handling facilities, was selected for the receipt, segregation and shipment to Shop 67 of incoming equipment and the receipt, packing and shipment of restored equipment received from Shop 67. Equipment which was screened by the Program ERUPT lines at the Mare Island Naval Shipyard and by this shipyard is pallet packed and strapped for storage and shipment. These pallets are received in the supply department ZEBRA building where the units comprising the complete electronic equipment are segregated into lots of similar items, inventoried and made ready for issue to Shop 67 for restoration as required by the shop production rates.

Shop 67 is the lead shop for all Program ZEBRA restoration work, except for miscellaneous motor-generators, magnetic controllers, patch panels, etc., which are not associated with a specific type of electronic equipment; these latter items are issued direct to Shop 51.

To permit establishing "production line" processing of ZEBRA equipment in Shop 67, the former electronics laboratory was selected as the best suited location to house this program. It was essential that the building so selected be of sufficient size to house all phases of the electronics work and at the same time be physically separated from the main shop to avoid interferences with waterfront work. The former electronics laboratory not only fulfilled these conditions, but also is located away from the industrial area of the shipyard where noise levels are low and industrial dusts are practically eliminated.

The Program ZEBRA building of Shop 67 is "L" shaped and measures 102 feet across the front with a depth of 50 feet, and is 98 feet long on the side wing with a depth of 41 feet. The building, which was designed for electronic work, is of steel-frame reinforced-concrete slab construction with a brick exterior; all structural and reinforcing steel rods are thoroughly bonded and connected to a ground grid by heavy copper conductors. This special type of construction has provided a shop building which is well suited for electronic work because of the low noise level and the ease of cleaning.

Incoming shipments of electronic equipment from the supply department are off-loaded on the loading platform onto the freight elevator and transported to the basement, where all major disassembly and clean-up is performed. The objective is to confine all "dirty" work to one section of the basement. In addition to the disassembly and clean-up work, the basement houses a special d-c power plant, the paint refinishing booth, an assembly section for transmitters and the shipping and receiving sections.

The main floor, with the exception of the spaces on the front of the building which are assigned to the Electronics Office as a small laboratory, houses the radar assembly, repair, alignment, and final test sections; also