FREQUENCY USAGE MONITORING EQUIPMENT FOR HIGH FREQUENCY COMMUNICATIONS

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A large percentage of HF communication circuit outages and garbled messages can be attributed to interfering signals from both local sources and external uncontrollable sources. A communication circuit controller can also lose appreciable time during frequency selection while assigned operating frequencies are checked for the existence and nature of interfering signals. Further, the present procedure for manually tabulating and posting operating frequencies in use consumes many man-hours at times when workload and communication traffic volume far exceeds the available manpower at most naval communication stations and ships.

The Bureau of Ships has recognized the urgent need for automatically monitoring a large number of specifically assigned frequencies to determine and display the operational status in a near real-time sense. As a consequence, frequency usage monitoring equipment is being developed under the SS-267 program. This equipment will use state-of-the-art techniques in semiconductors, microminiature circuitry and frequency synthesis to provide monitoring and display equipment covering 160 individually selectable frequencies in the frequency band of 3-32 megacycles. The operator display will consist of a remotely located hard copy printer, equivalent to an electric typewriter, and a bank of "nixie" tubes indicating the level of signals or noise on each of the preselected frequencies. Figure 1 is a functional block diagram of the frequency usage monitoring equipment, as it is now envisioned.

Receiver Characteristics

The receiver will step tune automatically, under control of a programmer, through 160 preselected frequencies within the specified frequency range. The order of frequency stepping within each complete scan will proceed from the lowest frequency selected through the highest frequency selected. The frequency programming capability will allow the distribution of frequencies within the frequency range to be preselected. Each octave within the frequency range covered can be programmed to contain up to 100 of the 160 frequencies selected, and all frequencies will be multiples of 100 cycles. Local reference frequencies and programmer timing will be derived from an internal stable oscillator, or from an external frequency standard. The method used for programming and derivation of frequencies will allow an operator to program 160 new frequencies within 3 minutes.

The five "channel modes" of operation will be selectable by front panel control. These modes will represent various bandwidths to be received, and the relative position of each bandwidth with respect to the programmed frequency. These modes will be designated "mode one" through "mode five" as outlined in table 1.

Table 1. Modes of operation.

Mode	*Receiver Bandwidth, Kc*	*Bandwidth Position*
1	12	Centered on Fo
2	3	Fo minus 3 Kc to Fo minus 6 Kc
3	3	Fo to Fo minus 3 Kc
4	3	Fo to Fo plus 3 Kc
5	3	Fo plus 3 Kc to Fo plus 6 Kc

The output of the receiver will be processed and fed to an analogue to digital converter. The resulting digital output (ten levels from 0 to 9) will represent the amplitude of the RF input signal and/or noise received at the antenna terminal in quantized levels of approximately 10 decibels. The digital

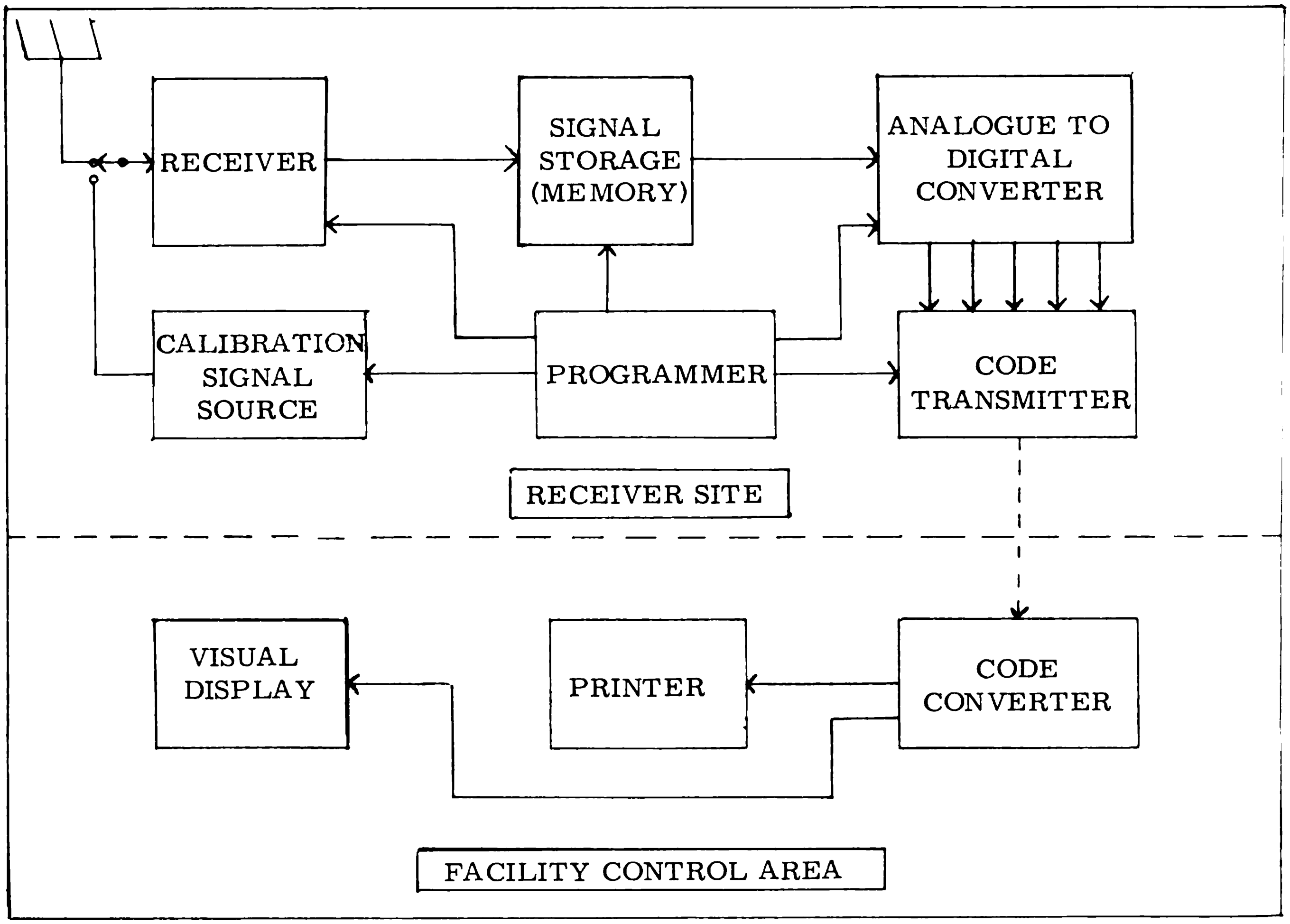

Figure 1. SS-267 frequency usage monitoring equipment.

Figure 2. Sample data printout.

1300	2 0 0 1 0 0 0 3 0 0 1 0 7 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 0 0 3 0 0 1 0 7 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
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	2 0 0 1 0 0 0 3 0 0 1 0 7 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
1305	2 0 0 1 0 0 0 3 0 0 1 0 7 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 0 0 3 0 0 1 0 7 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
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	2 0 0 1 0 0 0 3 0 0 1 0 0 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 0 0 3 0 0 1 0 0 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
1310	2 0 0 1 0 0 0 3 0 0 1 0 0 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 0 0 3 0 0 1 0 0 0 2 0 0 8 0 0 1 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
	2 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 0 0 0 3 1 0 0 0 2 0
Calibrate	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
1315	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
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	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
1320	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 8 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 2 0
	1 0 0 1 0 4 0 3 0 0 1 0 0 0 2 0 0 0 0 0 2 0 0 2 0 7	0 1 0 0 3 0 7 0 0 0 2 0 1 0 0 7 0 1 0 0 2 0 7 0 0 3 1 0 0 0 3 0
Frequency Number	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26	129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160

output of this equipment will facilitate the transfer of the frequency usage information directly to an appropriate computer such as is planned in the proposed Naval Communication Central Automatic Processor (NAVCOMMCAP) program or to the Southern Cross (SS-296 program) CAPE computer abroad ship. Automatic computer processing of the frequency usage information, simultaneously with oblique sounder propagation data, will indicate instantaneously the optimum available communication frequencies, significantly expediting the improving frequency selection.

A memory circuit will accept signals passed through an electronic gate and will store the received signals in one of two modes. In the first mode, the memory will record the peak amplitude of the highest magnitude signal received during each frequency dwell period. In the second mode, the memory will record the average level of all signals received during each frequency dwell period. Upon receipt of a trigger pulse, the memory will "dump" the stored voltage into an analogue to digital converter, and commence storing the next frame of signal information. An analogue to digital converter will accept the stored voltage from the memory circuit and convert it to a five-bit digital code. A code transmitter will scan the code contained in the output of the A/D converter and transmit this code to a remote printer and display.

An internal signal source under manual control of the operator will verify the signal level calibration. Manual control will activate the following automatic operations:

- Input to the receiver will be disconnected from the antenna input terminal and switched to the internal signal source.
- A single receiver scan will be initiated.
- The internal signal source will provide a calibrating signal at each of the 160 programmed frequencies. (Special frequency selection will not be required for this operation.)
- The resulting remote printout will consist of level "five" for each of the 160 frequencies, when the equipment is operating properly.

Remote Display

The normal shore installation of this equipment will consist of a receiver unit at a receiver site, and a remote display unit in the facility control area. Aboard ship, both units of the equipment may be installed in the same compartment or in different areas of the ship. Consequently, the receiving unit and the remote display unit may be physically separated by only a few feet, or by many miles. Two transmission modes can operate between these units as follows:

- The code transmitter in the receiver unit can key a dc loop provided by a conventional voice frequency tone generator AN/FGC-60 or equivalent. The remote printer code converter can receive the keyed dc signals provided by an AN/FGC-60 or equivalent, operated in the receive mode.
- The code transmitter and the remote printer code converter can operate when directly connected by twisted pair wires up to 5000 feet in length.

A hard-copy printer will print 160 numeric characters (0 to 9) per line, corresponding to the quantized signal level received on each preset frequency. Figure 2 illustrates the type of record that will be produced for the 160 preselected frequencies as a function of time. The printer will use a standard paper in rolls of 100 feet or more. The size of the printed characters will be no smaller than standard pica type. At least 14 lines of the printout will be visible to the operator at all times. A scale will permit the operator to resolve individual frequencies, and will contain sufficient space for insertion of typewritten individual frequency identification.

Upon receipt of a "carriage return" code, the code converter will cause the printer to advance the paper and initiate a new printout line when appropriate control signals are received.

In addition to the remote printer, a remote visual display will be provided. The remote display operator can manually select and display the 160 received frequencies in groups of 40 frequencies at a time. Each group of 40 frequencies will be preset to any combination of frequencies selected from the 160 frequencies scanned by the receiver. The 40 selected signals will be converted to the signal format required to provide a visual display on 40 "nixie" tubes or equivalent. Numeric display of each "nixie" will be identical to the numeric printout of the printer for each of the 40 corresponding frequencies. The display elements will retain each level of display until receipt of a new display signal at the time of the succeeding receiver scan cycle. At this time, they will change to indicate the new level of received signals. The levels indicated on the "nixie" tubes can be read at a distance of 20 feet by an operator with normal vision.

Development Schedule

The development contract for the frequency usage monitor equipment was awarded on 30 June 1965, with delivery of prototype equipment scheduled for 15 months from date of contract.

The frequency usage monitoring equipment will undergo a technical evaluation by the Bureau of Ships/Navy Laboratory and then an operational evaluation at selected naval communication stations, followed by an operational evaluation aboard ship, if deemed appropriate.

GUARDFISH (SS(N)-612) Launched

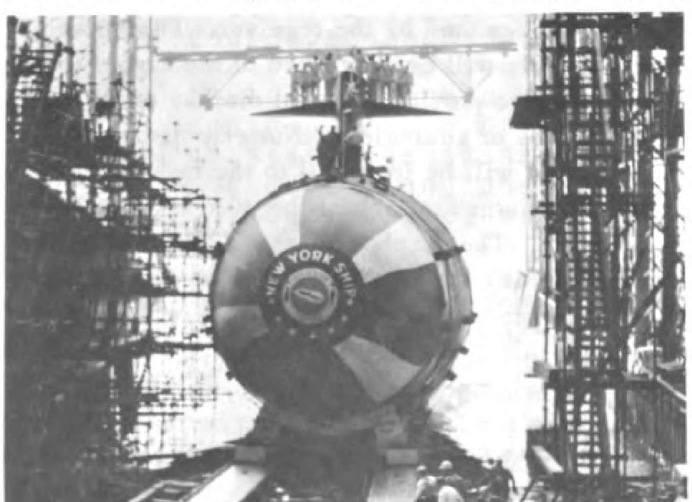
Guardfish (SS(N)-612). was launched on 15 May 1965 at New York Shipbuilding Corporation, Camden, New Jersey, highlighting Armed Forces Day ceremonies in Camden.

SS(N)-612 is an attack submarine, the third nuclear-powered submarine to be launched by New York Shipbuilding Corporation. Specifically designated as an anti-submarine weapon, *Guardfish* has an advanced hydrodynamic hull and is driven by a single propeller powered by a water-cooled nuclear reactor. Combining the endurance and environmental independence and high speed of nuclear power, *Guardfish* carries the latest in advanced anti-submarine warfare weapons systems.

Guardfish, named for a voracious, green and silvery fish with a pike-like body and long narrow jaws is the second submarine to bear the name. Her predecessor, the SS-217, commissioned in 1942, started her first war patrol eight months after Pearl Harbor and served throughout the war, winning two Presidential Unit Citations and eleven battle stars.

Guardfish was christened by Mrs. Kenneth E. BeLieu, wife of the Under Secretary of the Navy. The principal speaker was the Honorable Kenneth E. BeLieu.

The nuclear-powered, attack submarine *Guardfish* (SS(N)-612) sliding into the Delaware River at New York Shipbuilding Corporation. The launching was a feature of the Armed Forces Day celebration at Camden, New Jersey.



JAMES K. POLK (SSB(N)-645) Launched

James K. Polk (SSB(N)-645), the Navy's 35th Polaris-firing submarine, was launched at the Electric Boat Division of General Dynamics Corporation, Groton, Connecticut, on 22 May 1965.

The 7,000-ton ship, named for the 11th President of the United States, was christened by Mrs. Horacio Rivero, Jr., wife of the Vice Chief of Naval Operations.

The principal address at the launching ceremonies was given by Representative William R. Anderson of Tennessee.

***James K. Polk* (SSB(N)-645) slides into the Thames River during launching ceremonies held on 22 May 1965. The 7,000-ton ship, named for the 11th President, is scheduled to become operational in 1966.**