Oblique Sounder System Development

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An article on oblique sounder systems, entitled "A High Frequency Radio Propagation Quality Figure," appeared in the October 1964 *Bureau of Ships Journal.* Additional information is now available as the result of shipboard engineering tests of commercial oblique sounder equipment. Militarized equipment intended for operational evaluation is now being developed.

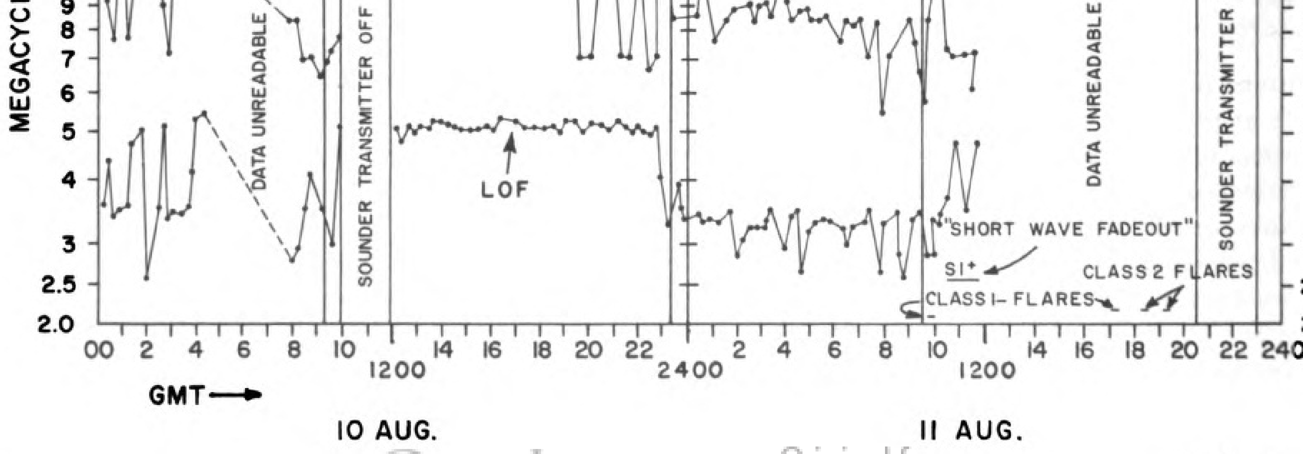
In July 1963, EMI-Cossor model 8000 oblique sounder system equipment was installed, with the transmitter at U.S. Naval Radio Station, Annapolis, and with three receivers aboard ships operating in the Atlantic. The experience gained and the results obtained from this test program have been helpful in assessing the shipboard utility of an oblique sounder system as an aid to HF communication frequency selection. The information has also been useful in developing equipment specifications for a prototype system.

The primary obstacle to successful operation of the sounder receiver aboard ship, which was recognized at the beginning of the program, is the very high local rf environment normally encountered aboard ship. The second major question was the suitability of normal shipboard receiving antennas. Answers to both these problems have been obtained; performance was satisfactory, but not necessarily optimum, in both cases.

The data shown in figures 1, 2 and 3 were collected aboard USS *Intrepid* while operating in the Atlantic approximately 850 km from Annapolis. Sounder transmissions were received from Annapolis, using 200 microsecond pulses and 30 kw peak effective power, fed into an omnidirectional conical monipole antenna. The shipboard receiver had one of the standard 35-foot whip antennas normally used for high frequency communications.

The useful frequency range (MOF minus LOF), shown in figure 1 for the daylight hours of 10 August and the early morning nighttime hours of 11 August, is the normal range of usable frequencies for this particular path at these times. The short-wave fadeout occurring near 1200 GMT on 11 August resulted in a complete blackout of the high frequency spectrum which lasted for several hours. The first data obtained from the sounder receiver shortly after sunset on 11 August showed a significant band of frequencies open, although the useful frequency range was appreciably compressed from the range indicated on the previous day.

Figure 1. Useful frequency range for daylight 10 August and nighttime 11 August.



The useful frequency range was compressed during the entire day of 12 August, figure 2, but recovered to a seminormal condition during the nighttime hours of 13 August. The class 1 flares which occurred just before and at sunrise on 13 August produced no significant effects on the oblique sounder results at the time of occurrence, but apparently did result in a severe compression of the useful frequency range approximately 4 to 8 hours later.

This is an excellent example of the value of oblique sounder data. No other practical means of measuring and displaying this pinch-out of usable

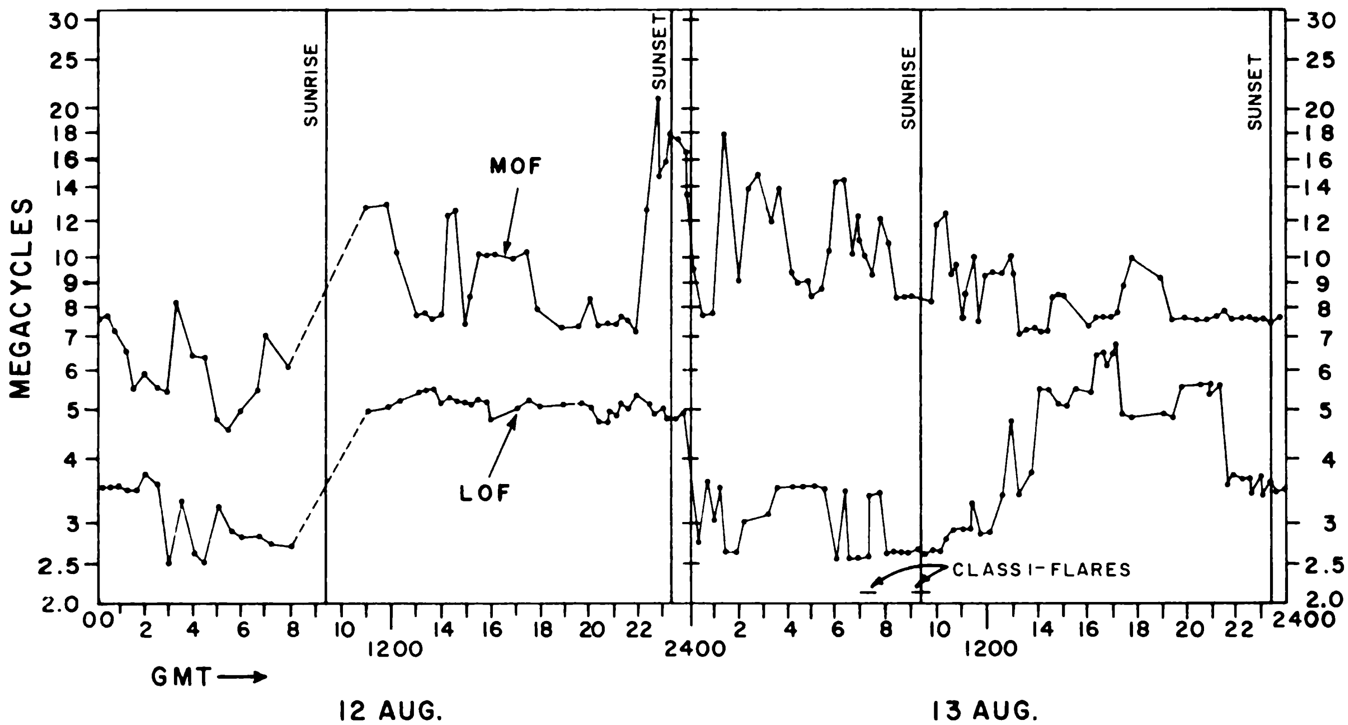
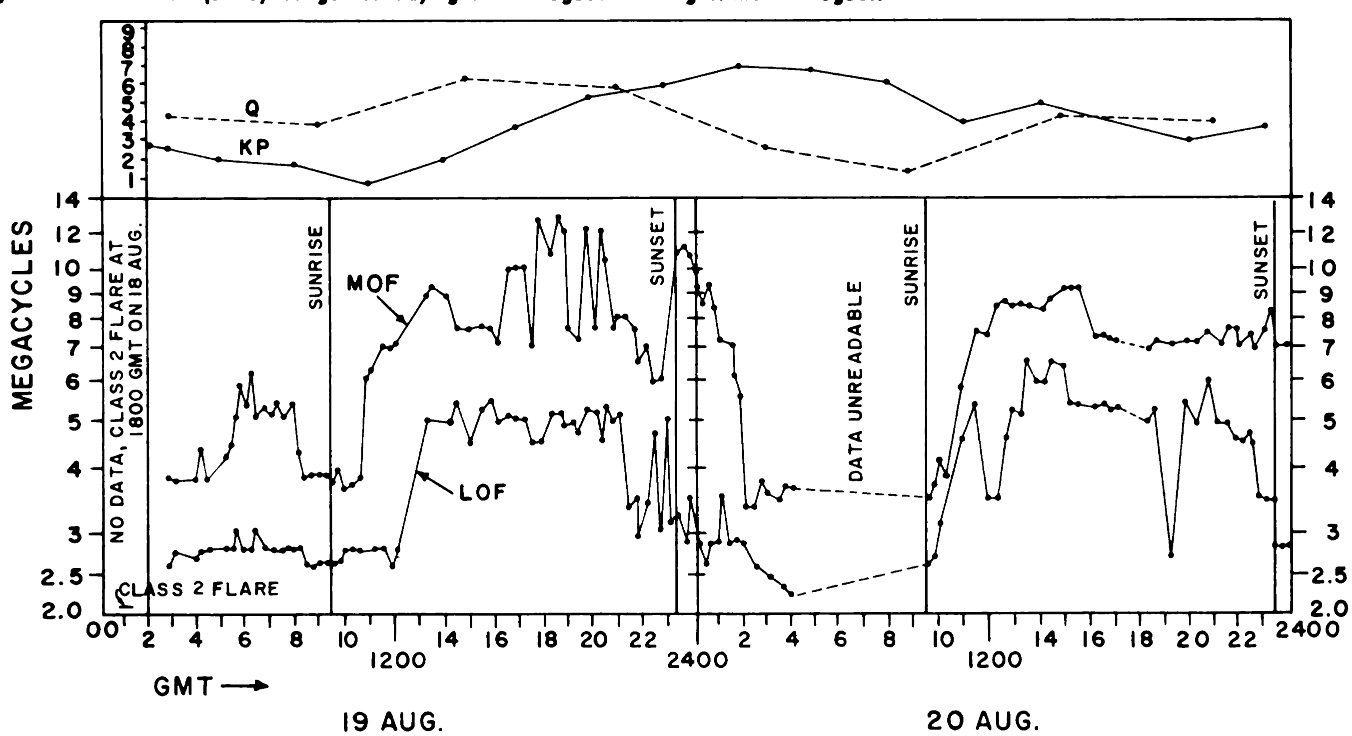


Figure 2. Useful frequency range for daylight 12 August and nighttime 13 August.

Figure 3. Useful frequency range for daylight 19 August and nighttime 20 August.



frequency is known. Knowledge of this small range of useful frequencies and appropriate frequency allocations allows communications to continue without a large number of frequency shifts and test transmissions. Obviously, this information can reduce the circuit downtime to an absolute minimum.

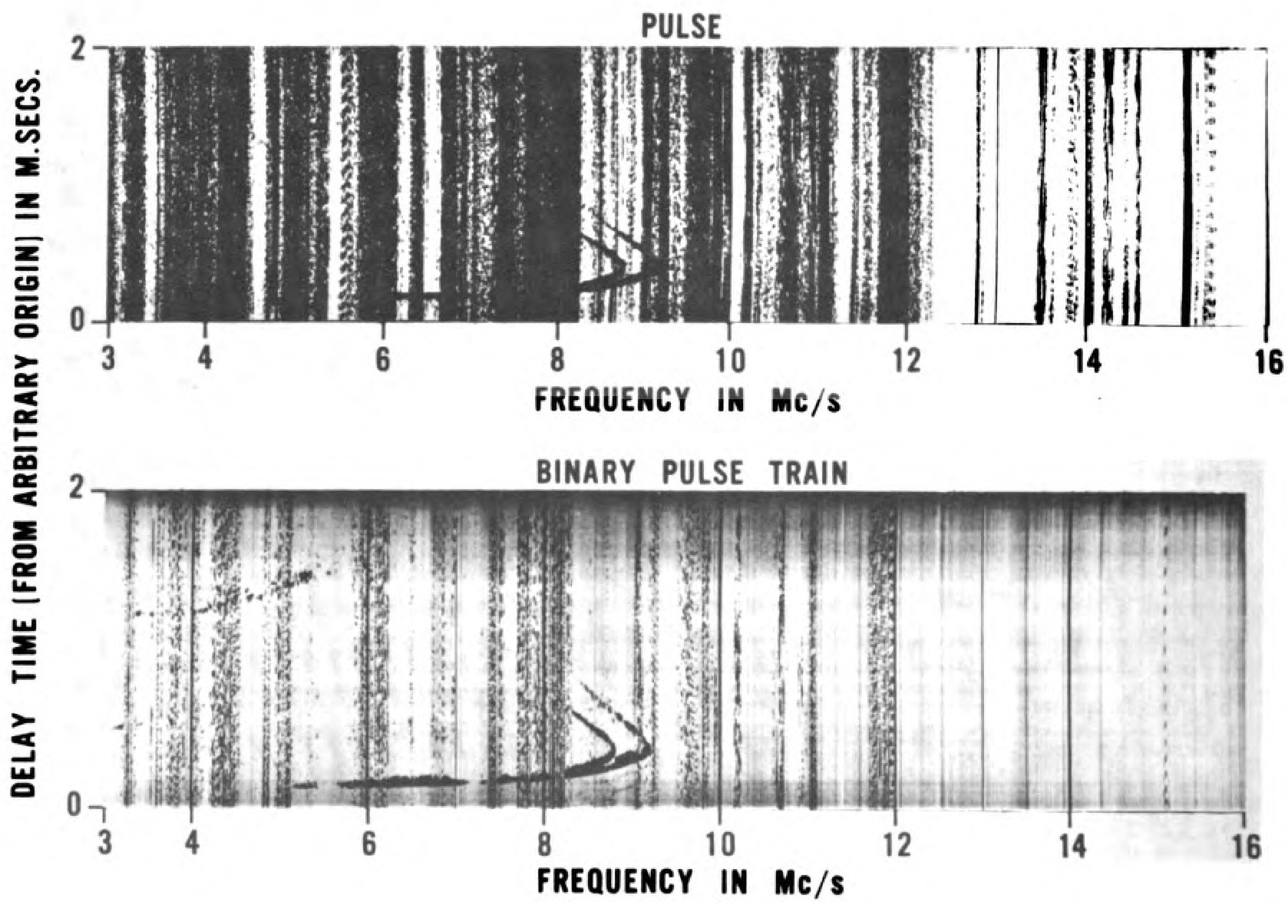
The data shown in figure 3 for 19 and 20 August again show a significant compression and depression of the useful frequency range, attributed to class 2 flares and SWF which occurred on 18 August. These results are further substantiated by time correlated plots of Q, the North Atlantic radio propagation quality figure and K_p magnetic indices published by the Central Radio Propagation Laboratory (CRPL).

Separate investigations by BuShips into application of pulse compression techniques to oblique sounder systems resulted in the conclusion that, among other benefits, pulse coding and pulse compression techniques provided approximately 15 db rejection to unwanted or interfering CW signals. This technique was incorporated in BuShips specifications for development of prototype equipment scheduled for delivery in June and August 1965.

In the interim, the Defense Research Telecommunication Establishment (DRTE) in Ottawa, Canada, has implemented the pulse compression technique on an oblique sounder system and provided BuShips with information on the results. Some of these results, presented in figure 4, clearly show the significant improvement in the quality of the ionogram when using the pulse compression (binary pulse train) technique as compared with the normal pulse ionogram. By reducing the effects of the CW interfering signals, the clarity of the ionogram is improved, which in turn improves the readability and accuracy of selecting an operating frequency.

DRTE further introduced special limiting circuitry (digital reception) ahead of the pulse compression circuitry which drastically reduced the effects of CW interference. However, the limiter circuit introduces an undesirable characteristic in that it destroys signal amplitude information of the received sounder signals. It is desirable to retain the sounder signal amplitude information to indicate propagation path loss, and a decision on the use of the limiter circuitry is yet to be made.

Figure 4. Oblique sounding, Ottawa-Halifax, 3:27 pm, e.s.t., 18 August.



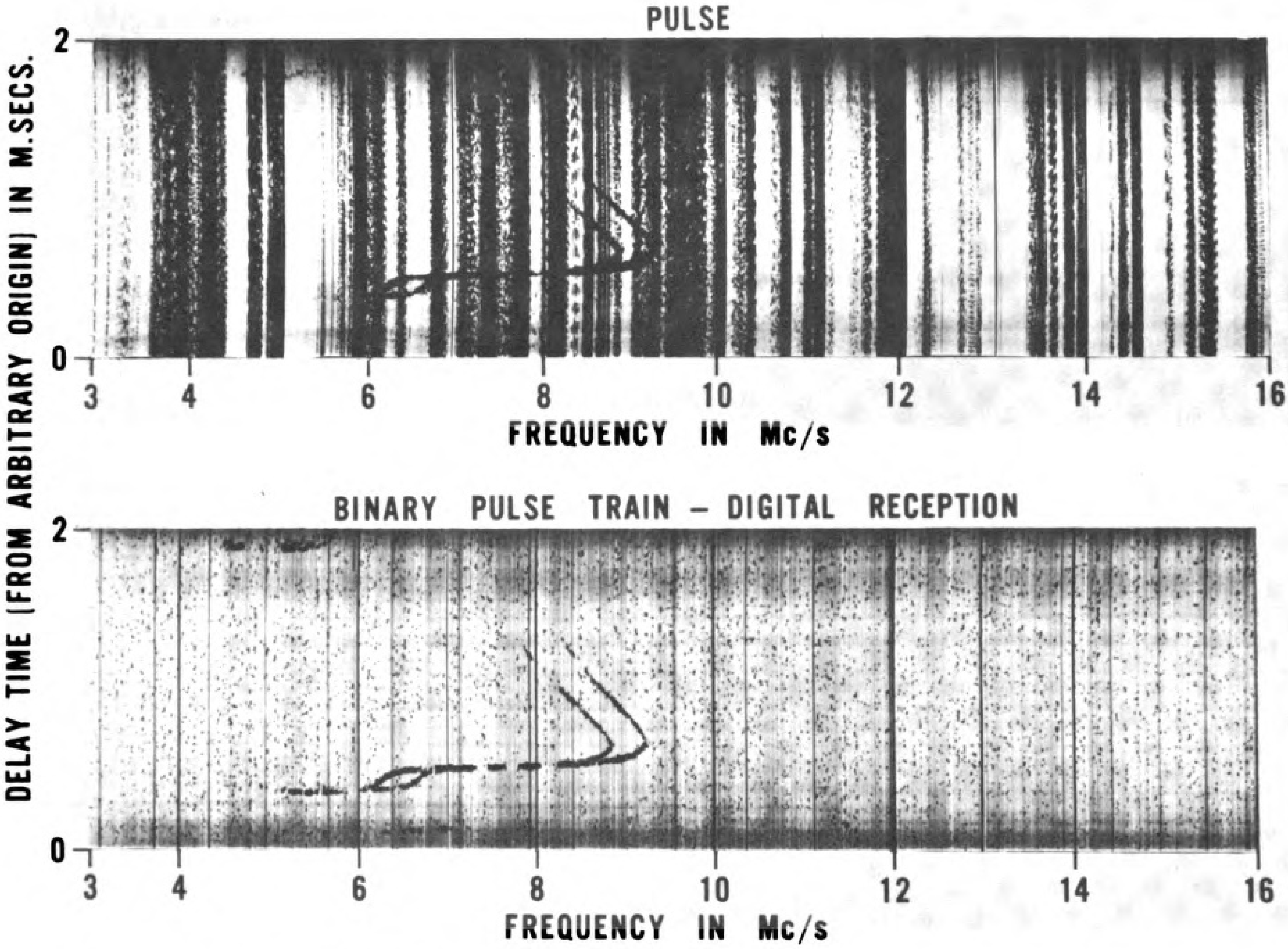
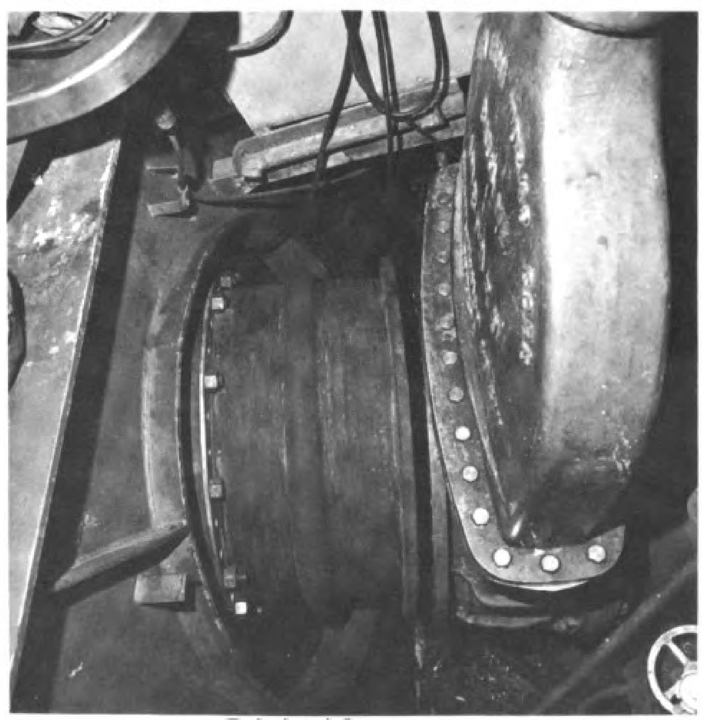


Figure 5. Oblique sounding, Ottawa-Halifax, 5:27 pm, e.s.t., 19 August.

Expansion Joints and Pipe Misalinement

Figure 1. Expansion joint showing piping misalinement.



The Bureau has recently received a failure report analysis involving a rubber expansion joint in the number one main condenser scoop injection line on USS *Sampson* (DDG-10). Upon removing the failed expansion joint a serious case of piping misalinement was discovered. When a new expansion joint was bolted to one flange, the joint would have had to be stretched or expanded from 1 to 1-3/8 inches axially and displaced 2 inches laterally to meet the opposite flange on a sea valve. This misalinement is shown in figure 1.

Such a gross misalinement will lead to early failure because the stresses produced by misalinement, when added to those produced by movement of the installed piping, can overstress the expansion joint.