J-SERIES TRANSDUCERS

Transduction

The USRD J-series transducers require special explanation because the design and use is so different from the piezoelectric transducers that dominate the technology in naval underwater electroacoustics. It is a family of reversible transducers for the audio- and infrasonic-frequency range that uses the electrodynamic or moving-coil principle of transduction. This provides the large volume displacements needed to produce low-frequency sound pressures without resorting to very large radiating areas. A special design feature described in Ref. 12 permits these large linear displacements while still retaining good baffle conditions with a high acoustic impedance at the diaphragm periphery. Although reversible, these electrodynamic transducers perform poorly as hydrophones and are used almost exclusively as projectors.

Selection

Among the J9, J11, and J13, the larger model numbers have the higher maximum source levels and lower frequency limits. The J15 is a special case; a larger depth capability with a passive compensation system available at the cost of a smaller frequency range.

Pressure Compensation

A static pressure compensation system is needed for the very compliant diaphragm of underwater electrodynamic transducers to balance the external hydrostatic pressure with an equal internal air pressure and thereby keep the moving coil in the magnetic air gap in a neutral static position. Basic design for all of the J-series transducers uses a passive system consisting of a rubber bag squeezed on the outside by the hydrostatic pressure and connected internally to the inside of the transducer. The complete collapse of the bag limits the depth at which the transducer can be used. The varying volume of air inside the bag is part of the acoustic system and the varying acoustic impedance results in changes in the response near the resonance frequencies at the low end of the frequency range.

For depths exceeding 23 m, an active pressure compensation system using the SCUBA equipment can be added to the J9, J11, and J13 transducers to extend the depth limits to about 180 m (see Appendix F for more details). This option stiffens the acoustic impedance of the air bag and reduces the response at frequencies below 300 Hz. It is available only upon special request and for additional cost.

Directions for inflating the air bags in the compensation systems are given in Appendix D.

Driving Limits

A moving-coil transducer is vulnerable to overloading. An electrical driving signal that exceeds prescribed limits may cause the coil to move beyond the magnetic gap and thereby distort the radiated

signal. It may also mechanically damage the diaphragm. An oscilloscope should be used to monitor the acoustic output signal; when distortion is detected, the input signal should be reduced.

Large Source Levels

If a source level is needed that exceeds the limit of one transducer, one option is to use two or more transducers rigged side-by-side and electrically connected with polarities that insure in-phase acoustic signals. Two transducers will increase the source level by approximately 6 dB, three by 9.5 dB, etc. These changes are approximately because the baffle conditions also change when more than one transducer is used.

Baffles

All of the J-series transducers radiate some sound through the compensation bag in back since this bag must be exposed to the water. This back-radiated sound will not be in-phase with that radiated by the diaphragm. Thus, baffling is required to minimize the destructive interference of the two signals and the resulting dipole effect. It is for this reason that when two or more transducers are used together that they should all face the same direction and the direct exposure of the bags to the water should be kept to a minimum.

Directivity

The dipole mode of radiation has only a small effect on the directivity patterns in the J-series transducers and, for practical purposes, the transducers can be assumed to be approximately omnidirectional at audio and infrasonic frequencies.

Stability

Electrodynamic transducers such as the J series are inherently less stable and uniform in performance than are piezoelectric transducers because they have several vibrating parts and a generally low mechanical impedance that includes the mechanical impedances of the internal air cavities, particularly the air bag used for passive hydrostatic pressure compensation that varies in volume and density. Consequently, the typical response of an individual transducer may vary several decibels from the typical curves shown herein. At the low end of the frequency range, or below the basic resonant frequency, the variation may be even larger - of the order of 5 to 10 dB.