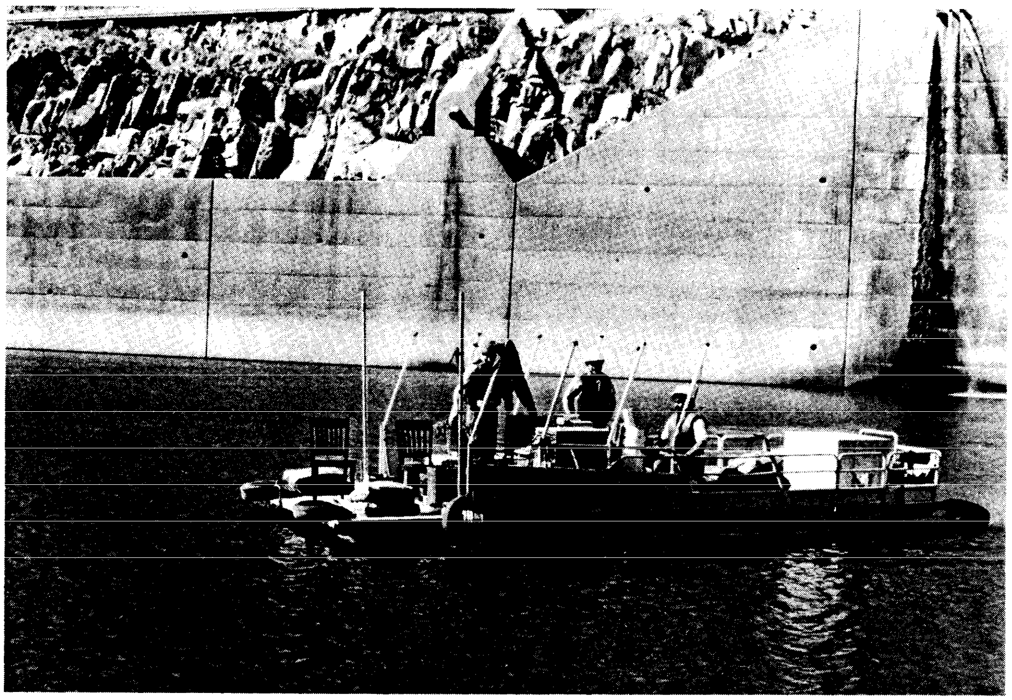
REMR TECHNICAL NOTE CS-ES-3.1

SYSTEM FOR RAPID, ACCURATE SURVEYS OF SUBMERGED HORIZONTAL SURFACES



Survey boat equipped with acoustic mapping system performing survey of stilling basin floor of Folsom Dam, a US Bureau of Reclamation project near Sacramento, CA

PURPOSE: To provide information on an acoustic mapping system that has been successfully used in underwater mapping of stilling basin floors.

APPLICATION: Performing rapid, accurate surveys of submerged horizontal surfaces such as stilling basin and lock chamber floors. The system can be used in water depths of 5 to 40 ft and produces survey results with accuracies of ± 2 in. vertically and ± 1 ft laterally.

ADVANTAGES: Avoids: (a) expense and user inconvenience associated with dewatering of structures and (b) dangers and inaccuracies inherent in diver-performed surveys.

LIMITATIONS: Use of this system is limited to a calm water environment with no significant wave action. Wave action causing a roll angle of the survey vessel of more than 5 degrees will automatically shut down the system.

AVAILABILITY: A detailed description of the system and complete specifications are available and can be furnished on request. The description and specifications can be used in preparing a Request for Proposals to conduct a survey.

COSTS: Costs will be job-specific, depending on such factors as on-site support furnished to the surveying team, transportation of equipment and personnel, etc. Estimated costs have been prepared for three sizes of jobs:

Area of Surface To Be Surveyed (sq ft)	Job Cost ($)	($/sq ft)
4,000	5,000	1.25
36,000	10,000	0.28
85,000	24,000	0.28

These costs include preparation of a report of the survey by the surveying team.

FIELD PERFORMANCE: The system has been successfully used in surveying the stilling basin of Folsom Dam, a US Bureau of Reclamation project near Sacramento, CA (Ref a), and the stilling basin of Ice Harbor Dam in Walla Walla District near Richland, WA (Ref b).

BACKGROUND: Erosion and downfaulting of submerged structures have always been difficult to accurately map using standard sonic surveying systems because of limitations of the systems. Side-scan sonar, fathometers, and other similar underwater mapping systems are designed primarily to see targets rising above the plane of the seafloor. Their broad sonic beams provide broad coverage, whereas a narrow beam is needed to see into depressions and close to vertical surfaces. In surveying submerged surfaces, there is also a need to know and record exactly where a mapping system is located at any instant so that defects may be precisely located and continuity maintained in repeat surveys. In order to permit surveys with the desired vertical and horizontal accuracy, as well as the required output, an acoustic mapping system was designed.

DESCRIPTION: The acoustic mapping system has three subsystems: an acoustic subsystem, a positioning subsystem, and a compute-and-record subsystem. The acoustic subsystem includes a transducer array bar having 10 transducers and a transceiver-signal processing module. The functions of the acoustic subsystem are to generate pulses to activate each of the transducers in the array bar; to amplify, rectify, and detect the reflected acoustic signal received at the transducer array; to determine the time-of-flight for the acoustic signal from the transducer to the bottom surface and back; and to output the time-of-flight data to a computer. The computer then calculates the elevation of the bottom surface using the time-of-flight information and prerecorded water level data. This information is displayed on a video terminal on board the survey boat, and the basic data are recorded on magnetic disks. The primary interrogation transducers are designed to have a narrow cone transmission pattern. Their nominal operational frequency is 360 kHz, and the narrow pattern is achieved by using a piezoelectric ceramic element whose diameter equals several wavelengths. The resultant cone dispersion is 1 degree at 6 decibels. The transducers are classified as flat-piston radiators and transmit an essentially flat acoustic wave front. Their narrow beam design provides the capability for looking into a depression of 2 ft or larger in diameter and detecting bottom elevation to within ± 2 in. During a survey, as the boat-mounted array is moved forward, the multiple transducers are sequentially pulsed. The first signal returning to each transducer from the bottom is detected, and depth and location data are recorded.

The positioning subsystem keeps track of the position of the transducer array bar. Since the array bar is mounted on a floating work platform, it is free to move in any direction and rotate about any of three orthogonal axes; i.e., it has six degrees of freedom. The positioning subsystem is capable of controlling or determining the displacement of the bar in each of these six degrees of freedom. Because the system has excellent vertical resolution, the lateral position of the survey boat must be determined with better accuracy than the 10- to 15-ft accuracy of standard ocean surveys to take full advantage of the system capabilities. The lateral positioning network consists of a sonic transmitter on the survey boat and two or more transponders in the water at known or surveyed locations. Boat position can be calculated from two known distances. As each transponder receives the sonic pulse from the transmitter, it radios the time-of-detection back to the survey boat. Distance from the boat to the transponder can be calculated from the time-of-flight, and the position is calculated and displayed by an onboard computer. The network can be easily re-established for subsequent surveys, and the survey boat and transducer array bar can be returned to any location within the network with the same accuracy.

The compute-and-record subsystem provides for computer-controlled operation of the system and for processing, display, and storage of data. Survey results are in the form of real-time strip charts showing the absolute relief for each run, three-dimensional surface relief plots showing composite data from the survey runs in each area, contour maps of selected areas, and data printouts of the individual data point values.

REFERENCES:

a. Final report: high resolution acoustic survey, Folsom Dam Stilling Basin floor. Prepared by SONEX, LTD., Richland, WA, for US Army Engineer Waterways Experiment Station, Vicksburg, MS, under Purchase Order DACW39-83-M-4340, Jan 1984.

b. Sonic inspection of Ice Harbor Dam Spillway Stilling Basin. Prepared by SONEX, LTD., Richland, WA, for US Army Corps of Engineers, Walla Walla District, Walla Walla, WA, under Contract DACW39-83-M-3397, Sep 1983, revised Feb 1984.

c. Corps-BuRec effort results in high-resolution acoustic mapping system. H. T. Thornton, Jr. In: The REMR Bulletin, Vol 2, No. 1, Mar 1985, US Army Engineer Waterways Experiment Station, Vicksburg, MS.