CHAPTER 50

AN UNDERWATER SURVEY SYSTEM FOR RADIONUCLIDE-TAGGED SEDIMENT TRACING'

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ABSTRACT

Survey equipment for use in tracing sediment tagged with radionuclides has been designed and field tested The system is unique in its ability to operate on the dry beach, in the surf, and in deep water, making it possible to synoptically examine the beach face, surf zone, and off-shore marine environment The ball-shaped radiation detector vehicle is towed behind an amphibious vessel Data are collected on punched tape at a rate of one set of data (position, radiation counts, time) every two seconds Gold-198 and xenon-133 have been used for tagging sand indigenous to the survey area under study Operational characteristics and detection sensitivity are discussed

This underwater survey system was developed for use in the RIST program which is under the direction of the U S Army Corps of Engineers, Coastal Engineering Research Center The survey system was designed and built at Oak Ridge National Laboratory and was sponsored by the U S Atomic Energy Commission, Division of Isotopes Development

The design criteria for the instrument were

1 It must be capable of operating as a gamma spectrometer
2 It must automatically correlate radiation counts, position, and time
3 It must be capable of operating on the beach face, in the surf zone, and off shore

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The components of the basic detector unit are shown in Fig. 1. The detectors are 2 in. by 2 in. sodium activated cesium iodide crystals enclosed in aluminum cans which have 0.030-in.-thick walls. Since the detectors are exposed to water pressure, a 1/2-in.-thick Plexiglas light pipe is used as a pressure barrier between the crystals and the photomultiplier tubes. Four detector assemblies and the preamplifier are mounted in a water-tight chamber suspended from the axle of an open mesh ball-like cylinder (Fig. 2). As the "ball" rotates on the stationary axle, the detectors remain oriented toward the surface over which the ball rolls.

Fig. 1. Underwater Detector Components

Fig. 2. Radiation - Detector Vehicle

When designing the underwater survey vehicle, we were concerned with its ability to travel over moderately rocky areas that are common to the West Coast The ball design, chosen over a sled-type, functions well over rocks that are up to 1 to 2 ft in diameter and over rock outcrops It is fabricated from rectangular steel bars to form an open lattice with a minimum of shielding of the detectors The entire device is covered with expanded metal to exclude stones and other debris The detector chamber is weighted with lead to maintain the detectors in a vertical position

The ball was tested for underwater tracking characteristics at the U S Naval Ship Research and Development Center in Washington to determine hydrodynamic performance The physical characteristics of the vehicle are listed in Table 1

Table 1 Physical Characteristics of Detector Vehicle

Overall width, in	50
Overall diameter, in	30
Housing width, in	42
Height, in	30
Distance from center shaft to tow point, in	32
Weight in air, lb	505
Weight in fresh water, lb	410

The minimum length of cable required to maintain the detector vehicle in a surveying position on the ocean bottom is shown in Fig 3

We are using approximately 100 ft of cable and travel at a speed of approximately 3 knots The vehicle is very stable under these conditions, and during an average survey the detector vehicle will cover approximately 1% of the total survey area

A schematic of the overall survey system is shown in Fig 4

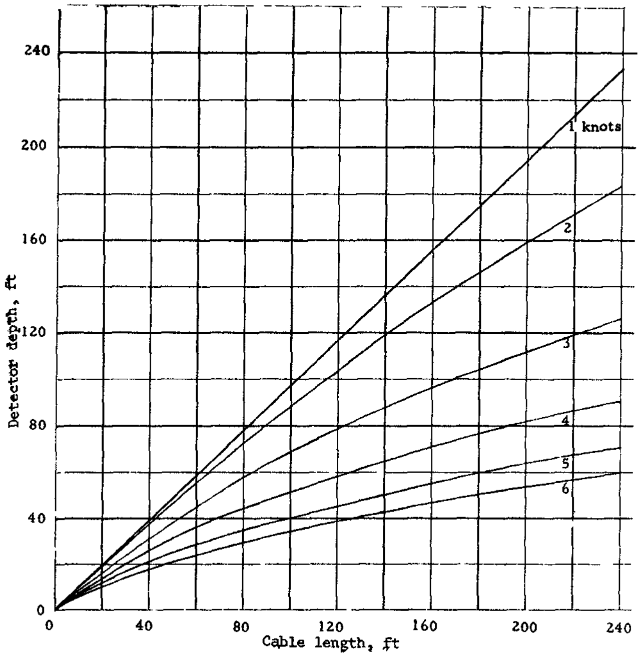

Fig 3 Minimum Required Cable Length as a Function of Detector Depth for Various Speeds

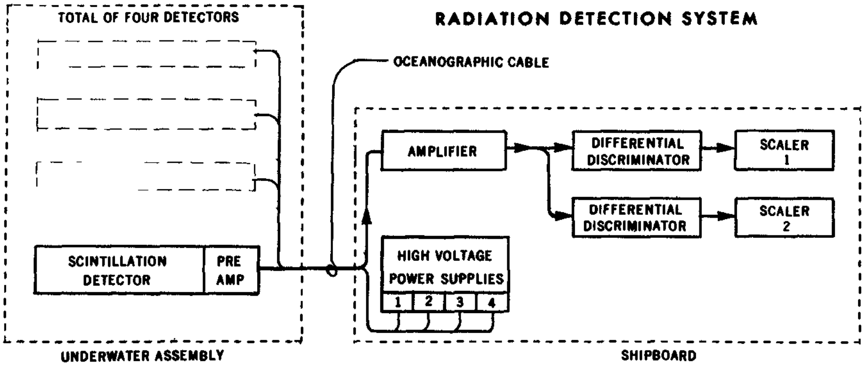

Fig 4 RIST Survey System Schematic

Signals from the individual detectors are mixed in the preamplifier whose output is matched to a 50-ohm coaxial cable which carries both the positive 24 V dc power to the preamplifier and the output voltage pulses The coaxial cable is part of a wire bundle that has an additional eleven conductors which provide high voltage to the photomultiplier tubes High voltage to each tube is supplied by individual power supplies which permit gain adjustment of the tubes so that the responses from all four detectors will be equal The cable assembly also serves as the tow cable and has a tensile strength of 30,000 lb The preamplifier output is amplified with a linear amplifier and feeds two differential discriminators for choosing which segment of the gamma spectrum is to be recorded The output signals from the discriminators are used to drive two buffered scalers The printout control unit samples each scaler and records the data on an 8-level punched paper tape The printout control unit also samples a scaler which generates a line number, a scaler which generates time, and the boat position data The boat position is determined by use of a microwave system which provides two distances from two fixed positions on shore A complete set of data can be collected once a second or in multiples thereof by switch selection on the console The data readout presents a log of line number, time, radiation channel No 1, radiation channel No 2, distance 1, distance 2, and water depth

The punched tape is used to provide data input to a computer for interpretation and the preparation of contour maps The detection sensitivity of the detector system submerged in water for gold-198-199 is 2 3 x 10^3 counts/sec when the activity concentration is 1 $\mu Ci/ft^2$

The tow vessel that is currently being used for surveying is an amphibious vessel (LARC-15) which is approximately 60 ft long This craft can easily operate in 6- to 8-ft breakers

In our early field tests with this equipment, xenon-133 tagged into sand indigenous to the test area was used as the tracing material While sand injection and health physics problems are greatly simplified with xenon-133, the quantity of activity that can be introduced into a survey area is limited to approximately 40 liters of sand tagged with approximately 800 mCi of xenon-133 This small quantity of activity tends to limit the scope of surveys We are currently using a gold-198-199 mixture The amount of activity that we can use is only limited by the equipment used to transport and dispense it Our recent experiments were conducted with 10 Ci of activity tagged onto approximately 1/2 liter of sand The use of the survey equipment is not limited to xenon-133 and gold-198-199, because it functions as a gamma spectrometer and can be used to monitor any gamma radiation above 30 keV Other possible applications for this equipment are conducting natural background surveys in inland lakes and streams and prospecting for heavy mineral deposits