RADIOACTIVE WASTE LOCATION VIA INFRARED SCANNING TECHNIQUES*

by

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Irradiated reactor fuel elements at the Hanford complex are routinely processed to separate the uranium, plutonium and fission products present in the elements. The fission product waste materials are stored underground in large steel-lined concrete storage tanks.

Radioactive waste management facilities are currently being built to isolate the long-lived fission product isotopes and to solidify the remaining salt cakes within the underground waste storage tanks. The wastes will be removed from the storage tanks by a sluice mining technique in which jets of water are used to break up the sludge in order to facilitate pumping the material from the tanks. Due to the high level of radioactivity in the tanks, physical access to them is obtained only via access risers through the tank domes. These risers impose several physical limitations on any instrumentation which is to be used in the tanks.

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DISCLAIMER

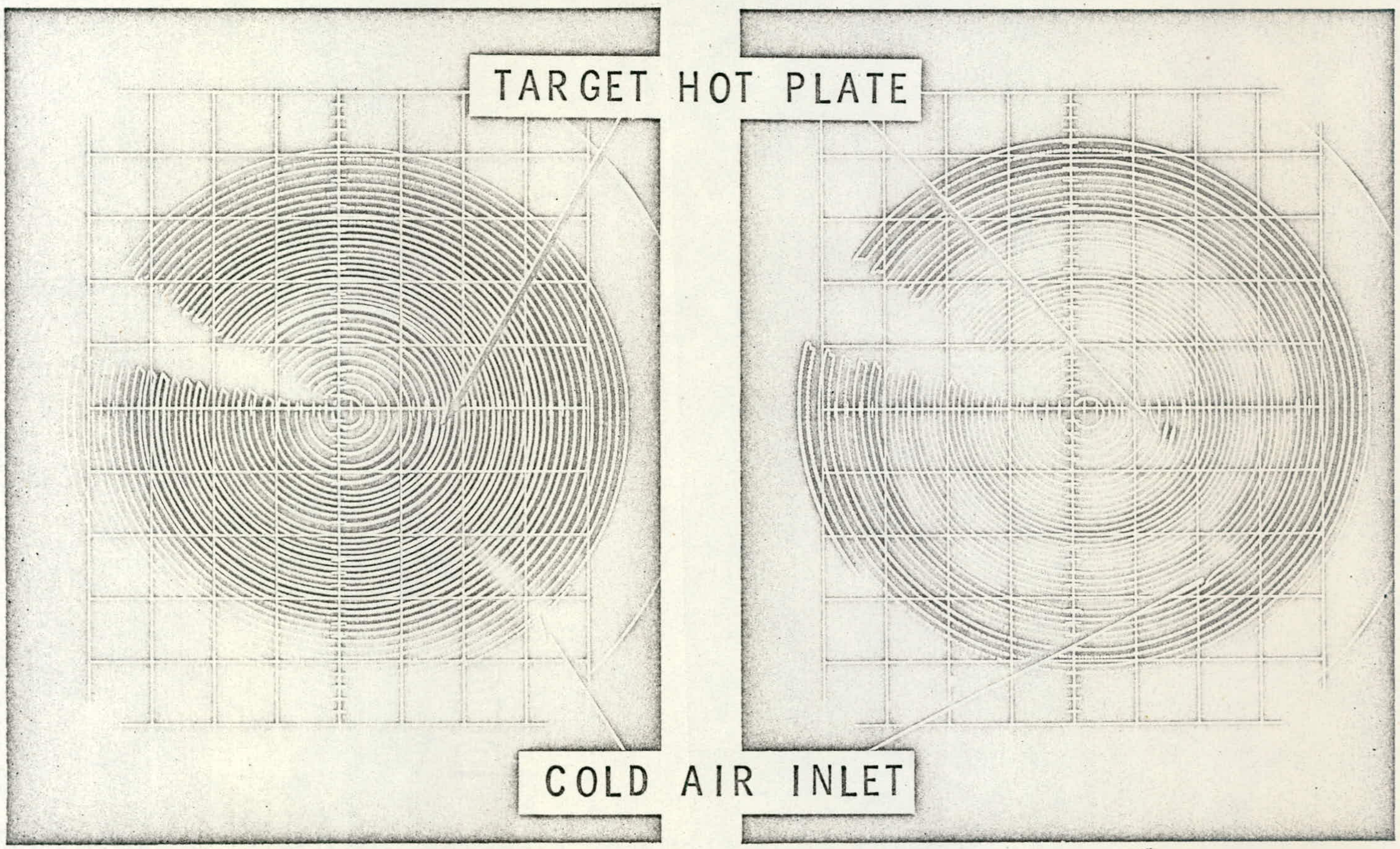
Since the sluice mining operation is carried on remotely, it proves difficult to determine whether or not all of the sludge material is removed from the tanks during the mining operation. It is, thus, desirable to have a system by which the tank bottoms can be scanned to locate residual deposits of sludge which require additional sluicing.

Various techniques have been proposed to yield this information; direct photography, scanning with optical periscopes, and gamma ray spectrometers have all been tried with varying degrees of success. An infrared scanning system offers a number of unique advantages, and provides a solution to the data acquisition problem. Data obtained with this system can be used to complement data from other sources such as visual photography and thermocouple temperature monitors. Infrared imaging data can provide significant additional information about the scanned environment when properly interpreted and correlated with information from other sources. At the request of the Atlantic Richfield Hanford Company (ARHCO), the Pacific Northwest Laboratory (PNL) constructed such a system and obtained preliminary data indicating the usefulness of this approach.

The radioactive sludge material in the storage tanks exhibits a self-heating property due to the energy release caused by isotope decay and the absorption of alpha and beta particles, and gamma rays in the material. A given volume of sludge material thus dissipates energy in the form of heat, and gives rise to temperature gradients in the tanks which, in general, reflect the amount of sludge in any given area of the tank. It is thus possible to locate concentrations of sludge by detecting the varying amounts of infrared energy emitted from different regions in the tanks.

The infrared scanner relies upon the self-heating nature of a concentration of radioactive materials for its operation. Infrared energy emitted from the material is collected in an optical system and focused on an infrared detector. The detector output signal is electronically processed and is used to intensity-modulate a cathode-ray oscilloscope. A photographic record of the oscilloscope display provides the required display map. The resulting maps yield information on the location of remaining waste deposits in the tanks and by proper interpretation of the maps, the operator can locate the residual sludge deposits for subsequent removal. Figure 1 illustrates 2 maps obtained with the scanner while viewing a calibration hot plate in one of the large tanks. The instrument is capable of resolving a one-square foot area on the bottom of a 75' diameter sotrage tank if the temperature of the area differs from the background temperature in the tank by 3^{o}C or more. The instrument will respond to such temperature differences and produce a useable display map, provided that the tank background temperature does not exceed 80^{o}C.

Experiments performed during the course of the project indicate that in addition to the usefulness of the scanner for producing thermal contour maps, it is also possible to make absolute temperature measurements in the tank if a calibration heat source is available in the tank.


TARGET HOT PLATE
COLD AIR INLET

LIST OF FIGURES