High-Level Core Sample X-Ray Imaging at the Hanford Site

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Westinghouse Hanford Company Richland, Washington
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Waste tank sampling of radioactive high-level waste is required for continued operations, waste characterization, and site safety. Hanford Site tank farms consist of 28 double-shell and 149 single-shell underground storage tanks. The single shell tanks are out-of-service and no longer receive liquid waste. Core samples of salt cake and sludge waste are remotely obtained using truck-mounted, core drill platforms. Samples are recovered from tanks through a 2.25 inch (in.) drill pipe in 26-in. steel tubes, 1.5 in. diameter. Drilling parameters vary with different waste types. Because sample recovery has been marginal and inadequate at times, a system was needed to provide drill truck operators with "real-time feedback" about the physical condition of the sample and the percent recovery, prior to making nuclear assay measurements and characterizations at the analytical laboratory.

The Westinghouse Hanford Company conducted proof-of-principal radiographic testing to verify the feasibility of a proposed imaging system. Tests were conducted using an iridium 192 radiography source to determine the effects of high radiation on image quality. The tests concluded that samplers with a dose rate in excess of 5000 R/hr could be imaged with only a slight loss of image quality and samples less than 1000 R/hr have virtually no effect on image quality. The Mobile Core Sample X-Ray Examination System, a portable vendor-engineered assembly, has components uniquely configured to produce a real-time radiographic system suitable for safely examining radioactive tank core segments collected at the Hanford Site. The radiographic region of interest extends from the bottom (valve) of the sampler upward 19 to 20 in.

The purpose of the Mobile Core Sample X-Ray Examination System is to examine the physical contents of core samples after removal from the tank and prior to placement in an onsite transfer cask. The samplers enter and leave the system through a sealed adaptor coupled to a drill platform. Sample manipulation (raising/lowering) within a sealed PVC contamination control sleeve is controlled by drill truck operators. The examination system uses highly-stabilized (80 to 160 kV) X-rays to determine sample contents and approximate the fill volume prior to shipment to analytical laboratory facilities. Hardcopy image prints of the sample examination are immediately available to evaluate drill performance and estimate percent sample recovery. The examination is recorded on video tape for review, if necessary.
The system is equipped with integral shielding. All accesses to the main X-ray cabinet (two lower access panels, X-ray cabinet cover-lid and adaptor coupling) have safety interlock switches which must be closed before X-rays can be generated. These interlocks, which are fail-safe in accordance with federal and state laws, provides the highest degree of safety since protection does not depend on compliance with any operating limitations.

The mobile imaging system features real-time radiography components that include an image intensifier, a 160 kV industrial X-ray machine, an image processor, a video recorder, a hard copy printer, a live video display, a processed video display, and a darkened operator viewing area. System electrical power is provided by a separate generator. The shielded cabinet protects personnel from radiation emitted from the examination equipment and the core sample in the main X-ray exposure cabinet. The image viewing monitors and controls for the system are protected from weather by a hinged cover. The system is mounted on, and detachable from, a small, 7,000 pound capacity, utility trailer.

To date, more than 50 core sample segments, some with dose rates of 12 to 15 R/hr, have been examined. Analytical laboratory results and photographs support the radiographs. Because of the system's success, several more systems will be needed to meet the needs of the Hanford Site Waste Characterization Program. This prototype imaging system has operated in a harsh field environment at a 100 percent availability rate, excluding a scheduled shutdown for servicing of the X-ray high voltage cable, since the second week of June 1995. The time line for the development of this system is shown in Figure 1.
Figure 1. Mobile Core Sample X-Ray Imaging System.

- 5-Months from Conception to Deployment
  - February 1995 - Concept Proposed
  - February 13, 1995 - Authorized
  - February 22, 1995 - NDE Proof-Of-Principle Testing Completed
  - March 3, 1995 - Functional and Technical Requirements Completed
  - March 10, 1995 - Request for Proposal Issued
  - April 10, 1995 - Contract Awarded
  - May 30, 1995 - System Received at Hanford
  - June 14, 1995 - Operational Test Procedures Completed
  - June 19, 1995 - System Accepted and Available for In-Field Use
  - July 11, 1995 - First Used, BY-110 Core Sampling