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AN EVALUATION OF VERIFICATION METHODS FOR INPUT-ACCOUNTABILITY MEASUREMENTS

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As part of TASTEX related programs two independent methods have been evaluated for the purpuse of providing verification of the amount of Pu charged to the head-end of a nuclear fuel processing plant. The first is the Pu/U (gravimetric method), TASTEX Task-L, and the second is the "Tracer Method", designated Task-M. Summaries of the basic technology, results of various studies under actual plant conditions, and future requirements, are given below for each of the Tasks.

Pu/U Method for Input Measurement

The primary function of the Pu/U method is to provide an independent estimate or verification of the amount of Pu in a batch of dissolved fuel without resorting to a concentration measurement and a knowledge of the volume or mass of solution contained in the tank. The method is simply based on a measurement of the Pu/U atom ratio in an aliquot of the dissolved fuel and a knowledge of the amount of uranium charged to the dissolver.

Recently, the Pu/U method was evaluated based on data from the Tokai processing plant. Both positive and negative results were obtained from these experiments. The basic premise of the method was proven sound when results for an entire campaign were compared. That is, the measured amount of Pu charged to the plant agreed with that obtained using the Pu/U method. On the negative side, serious discrepancies were encountered when individual batch data were compared. The problem was not with the method, but rather with the tankage in the plant. One primary requirement of the method is that all of the material charged to the dissolver must be completely dissolved and transferred to the accountancy tank. At the present time, there are two feed adjustment tanks between the dissolver and accountancy tank, thus complete transfer of the dissolver solution, as a unit, to the accountancy tank is not possible. Because of this feature discrepancies can be expected for individual batch data in any plant, and other methods of treating the data must be evaluated. Using a 5-batch moving average type calculation tended to smooth the results and give more meaningful information, provided each subsequent batch of fuel had similar burnup. Recently, the French have suggested that by proper design, the dissolver could be directly sampled thereby eliminating the intermediate tankage problem.

Perhaps the most significant items resulting from this experiment are: (1) that the method has merit as a verification method if representative samples are obtained, and (2) the need for design considerations for safeguard related efforts in new processing facilities.

Tracer Method for Input Measurements and Tank Volume Verification

The tracer method is based on the premise that if a known quantity of a specific element or isotope is added to a tank of solution and well mixed, the measured concentration of the tracer in an aliquot of the solution can be used to determine, or verify, the volume or weight of solution in the tank. If the uranium and/or plutonium in the sample aliquot is also measured relative to the tracer, the amount of uranium and/or plutonium in the tank can be determined independent of a separate tank volume measurement.

The selection criteria for a tracer to be used to verify the content of an input tank are: (1) compatibility with the plant process, (2) simple chemistry, (3) reasonably inexpensive, (4) availability, (5) low background in the sample, and (6) measurable with a high degree of precision. For highly radioactive solutions, the preferred measurement technique is isotope dilution mass spectrometry.

The addition of the tracer to the tank and the subsequent mixing of the tracer with the tank solution repr sent the largest potential source of error in the method. Of primary concern is the length of the tracer addition line and amount of rinse solution required. Mixing can present a serious problem especially if the tank is full and the specific gravity or viscosity of the tank solution and spike solution are quite different.

Experiments aimed at evaluating this method have been conducted at the Tarapur plant in India using Mg as a tracer and at the Idaho Chemical Processing Plant using Sr as the tracer.

Although only limited data are available the results indicate that the basic principles of the tracer method are sound. The primary problems appear to be mechanical in nature (tracer additions and mixing) and consideration of this fact should be given in the design of new plants.

The tracer method should be capable of providing an inspector with an independent method to verify tank volumes or to give an independent measurement of the uranium and/or plutonium content of a tank.