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TITLE: CONTAINMENT OF PLUTONIUM AND URANIUM

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Containment of Plutonium and Uranium

at Los Alamos Scientific Laboratory

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Need for Encapsulation

Radioactive materials such as plutonium and uranium are usually processed inside a glove box or similar enclosure. However, storage, shipping, and usage often require that the material be removed from the glove box. Upon removal, metal capsules are usually used to contain the individual samples or pieces.

Public concern about the handling, storage, and disposal of radioactive materials as well as prudent industrial safety practices dictate that the encapsulation be as reliably safe as possible. Therefore, the encapsulation procedure deserves a substantial amount of attention.

Types of Capsules

The type of material and its use determine the encapsulation procedure. Material of relatively low radioactivity such as U^{235} is normally sealed in a single stainless steel capsule whereas the more strongly radioactive materials such as Pu^{238} may be triple encapsulated. Samples that would be exposed to high temperatures require capsule materials of nickel or even platinum or iridium. The Pu^{238} heat sources used in the Viking program (Mars lander) utilized a Pt-Ir-W alloy for the capsules. Other materials such as Pu^{239} are normally single encapsulated in Type 304 stainless steel capsules.

Capsule Requirements

The capsules must remain leak-tight ($< 10^{-6}$ cm^3/s at STP) over an indefinite period of time and must be capable of sustaining moderate mechanical abuse. The atmosphere inside the capsules must be inert to prevent oxidation or other contamination of the material. And, of course, the exterior of the capsules must be "cold" (free of radioactive contamination).

Encapsulation Method

Several methods have been evaluated for encapsulating Pu and U at LASL. Each method involves welding two end caps to a tube. The first cap (bottom) is welded cold; i.e., prior to insertion of the fuel. Depending on the activity of the fissile material, the second weld may be done in a glove box or in a cold inert chamber.

The capsule design is such that the U-shaped cap slips inside the tube with the open end out. The edge joint may be either edge-flange or melt-through seam welded.

I will illustrate the encapsulation procedure by describing the encapsulation of a sample of ^{239}Pu.

The encapsulation begins with the hot material in a glove box. At this point the identification and weight of the material is verified. The material is wrapped in aluminum foil and moved to a pass-thru door adjacent to an updraft hood. The technician holds the sample in one hand and with the other opens the pneumatically-operated pass-thru door and holds the capsule. After dropping the sample in the capsule, he closes the door and presses a cap on the capsule. The capsule is then monitored to make sure the outside of the capsule is cold.

The encapsulation welding is done at one of three welding stations, depending on the size of the capsules and the level of radioactivity. The three stations are located in close proximity to each other and are serviced by one console containing the power supplies and controls. One set of remote controls is used with the three stations.

The first station (and most commonly used) is a 9-inch-diameter glass bell jar. The rotary fixture and chuck will accept capsules of up to 1-inch-diameter. The GTA electrode is bare; that is, no concentric gas shielding is used. The inert atmosphere in the bell jar is achieved by evacuating the jar to 50 ~~torr~~ microns (6500 ft) and backfilling with He to just below atmospheric pressure. The evacuation-backfill cycle is repeated two more times. On the third backfill, a mixture of approximately 50% He - 50% Ar is used. The welding is then done semi-automatically.

This encapsulation station is similar to the first. The fixture is larger and will accept cans up to 3 inches diameter and the aluminum enclosure bonnet is larger. The evacuation-backfill sequence is the same.

The third encapsulation station is an inert atmosphere glove box. Parts are passed into the glove box through an airlock so the atmosphere within the box is maintained. While the first two stations are maintained radioactively cold, this glove box is hot and is used for encapsulating the more radioactive isotopes such as ^{238}Pu and ^{242}Am. Capsules which have been welded in the glove box are removed to an updraft hood for decontamination of the exterior of the capsules. The swipe-free capsules are then re-encapsulated in one of the cold systems for further safety.

This is the control console servicing the three stations. It contains two power supplies (50 and 300 amperes), programming, pulsing, and arc oscillation controls, and the gas, water, fixture, and other controls.

At the present time we encapsulate approximately 9 samples each week.

In describing a process like this it's probably equally interesting and informative to talk about the deficiencies and problems associated with the present methods and to suggest improvements.

The main shortcoming of the existing process is the long time required to complete an encapsulation. We have one man devoting approximately 90% of his time to encapsulation along with the associated maintenance of his equipment and the necessary paperwork.

A new plutonium processing facility is currently under construction at LASL. We are in the midst of designing the welding equipment to go into this building.

We plan to use the same glove box-to-hood loading technique just illustrated but will load a batch of capsules - whatever is to be welded that day. The capsules will then be assembled in a handling rack and placed in the air lock of a cold inert glove box. After the appropriate evacuate-backfill sequence to purify the atmosphere, the rack will then be moved on into the glove box where the capsule lids will be inserted and the welding completed.

One of the objectives is to reduce the time required for encapsulation from a full day to 2 hours. At the same time, we will be able to certify the atmosphere within the capsules and improve the quality of the welds.