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MOUND LABORATORY-MONSANTO
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PLUTONIUM - BERYLLIUM NEUTRON SOURCES

Report on Trip to Los Alamos - August 15, 16, 1955

J. L. Richmond

Preparation of plutonium-beryllium neutron sources was discussed with A. S. Coffinberry, R. E. Tate, and V. O. Struebing August 15 and the health aspects of plutonium with Dean Meyer August 16. The purpose of the trip was a feasibility study of the preparation of this type of source at Mound Laboratory.

Preparation of Neutron Sources

Plutonium forms the compound Pu Be₁₃, which has been shown to be the most efficient combination for neutron production. The elements are weighed out in this ratio, or with a very slight excess of beryllium. The beryllium is either in one piece or is melted in a dense beryllia crucible obtained from Clifton Products Company. Plutonium is added and the crucible placed in a vacuum system which is held slightly below one atmosphere of pressure with argon. The crucible is placed in a tantalum cup and induction heated through its melting point of 630-640°C to 1200°C. Reaction takes place, raising the temperature 200° to 300°C. A sintered mass is formed which can be crushed and packed in the source container. Better sources have been made by melting the Pu Be₁₃ in the crucible in which it is formed, then breaking the crucible away and placing the cast pellet in the source container. The melting point of the compound is nearly 2000°C. The nickel source container is closed by silver soldering and is decontaminated with a nickel coat of five mils. The source is pressured to 200 p.s.i. with helium for one-half hour and immersed in alcohol to test for leaks.

Plutonium oxidizes readily. The oxide is removed with a wire brush just prior to weighing and loading into the crucible. The reducing action of plutonium is great enough to remove beryllium from the crucible if in direct contact at high temperature. Placing the plutonium on top of the beryllium allows more rapid mixing and more complete compound formation.

A limit of 15 grams of plutonium per source was set to minimize exposure of personnel to neutrons. The neutron yield from 15 grams of plutonium is about 10⁶ n/sec.

Approximately 10 sources per year have been made.

Health Precautions

Plutonium is a bone-seeker and has a body half-life of 80 years. Body tolerance is 1/2 microgram. It is not excreted rapidly. The maximum permissible level is a urine count of 7 d/m based on 1500 ml in 24 hours.

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When there is a known exposure, E.D.T.A. (Versene) is given immediately. It is known as a chelating agent and will increase the amount excreted nearly 100 fold. Excretion reaches a maximum after 30 days.

Equipment and Facilities

Source fabrication is carried out in four stainless steel dryboxes connected in series, one for loading the container, one for an analytical balance, one for nickel coating and one for pressure testing. The stainless steel seems the best material for the dryboxes because of ease of recovering plutonium oxide.

A good analytical balance is required to get the correct proportions of beryllium and plutonium.

An induction heater of 10 KW rating is best for the operations performed in order to raise the components quickly to high temperature.

Beryllia crucibles are made on special order. A batch of 200 pounds is processed at one time. Clifton Products Company must have sufficient orders or have the entire cost underwritten.

Though the sources have been sealed with silver solder, an improved technique would be heliarc welding. Welding equipment should be provided, for it is quite probable that the method of preparation can be improved through use of a welded container.

Major items which are not on hand are: Dryboxes, induction heater of 10 KW, vacuum pump, hydraulic press, heliarc welder, beryllia crucibles, analytical balance and neutron rate meter with probe. Miscellaneous items include chemicals, filters, heating coils, helium cylinder with gage, neoprene gloves, nickel deposition apparatus, Pirani gage, pressure gage, pressure vessel, tantalum, tools, tongs, tweezers, vacuum gage, vacuum jacket, variacs, and health surveying equipment.

Space Requirements and Layout

A room for preparation of sources should have a minimum width of 18 feet and length of 24 feet. A room 20 x 30 feet would be better.

Approximately one-half of the room should be partitioned to house the dryboxes. The dryboxes would have very little air flow through them and the air would be double filtered before joining the room exhaust. The room surrounding the dryboxes would have a normal rate of air exchange and be filtered before passing to an exhaust duct.

The other part of the room would be subdivided to house a health survey room and an office room to serve both the health survey and operations rooms.

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Costs

It is estimated that equipment will cost about \$20,000 and that services and room alteration will add \$10,000, making a total of \$30,000.

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