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DATE: April 10, 1956

SUBJECT: Ignition of Thorium Metal

TO: J. E. Cunningham

FROM: E. S. Bomar

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J. E. Cunningham

DATE X-16

TO
LOCATION

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DATE MAR 16 1957

ANSWERING LETTER DATE April 10, 1956

ATTENTION

For The Atomic Energy Commission

SUBJECT Ignition of Thorium Metal

COPY NO. 1ain

W. K. Eister
J. C. Suddath
W. F. Schaffer
O. C. Dean
D. C. Gary
E. S. Bomar

H. F. Canale
Chief, Declassification Branch

This memorandum has been written to inform you of the ignition of metallic thorium under circumstances which would not normally be expected to cause burning of the metal. This occurrence may obviously hamper current work on the Metallux Program.

The metal ignited in the course of preparing metal chips to be used as feed stock in a nonconsumable electrode arc melting furnace. The thorium was the remnants of an unsatisfactory extrusion which resulted in the generation of a fair quantity of thin slivers of thorium. The extrusion billet was fabricated by hot pressing the reformed product of the Metallux process following loading into a mild steel can and evacuating while heating to a temperature of 330°C and a pressure of 0.03 microns. For hot pressing, the mild steel can and thorium charge were heated to 750°C. The canning material, except for a small quantity of infolded steel, was removed by machining. The residual infolded metal was etched out with approximately 3.5 M nitric acid. Straight nitric readily attacks iron but passivates the surface of thorium. Prior to extrusion, the thorium billet was given a surface treatment in the form of surface arc melting with an inert arc in an argon atmosphere. Preheating for extrusion was carried out by submerging in a fused salt bath containing 35% lithium chloride and 65% potassium chloride.

Preparatory to accumulating stock for the arc melting experiment, the thorium slivers were pickled to remove surface oxide. The solution used was composed of 8M nitric acid plus 0.05 M fluoride addition to catalyze attack by the nitric acid. The metal was placed in a glass storage vessel filled with argon to protect the metal until needed.

A time lapse of about three weeks occurred before removal on Friday, April 6 for cutting into chips. A technician, James H. Terry, began cutting the thinner pieces with a pair of hand shears. Two slivers had been cut into about 1/4 in. wide segments and he had selected a third measuring about 3/4 in. x 3 in., to be cut. As soon as the shears cut into the metal, there was a flash of light and an accompanying explosion which either blew the sample from Terry's hand or caused him to drop it. Two fragments burned completely but the bulk of the sample became red hot with only superficial oxidation. The metal was quenched with a small quantity of water. All samples became hot enough, however, to mark the composition tile floor covering. Terry sustained a cut on the thumb of the left hand in which he was holding

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the metal, and a burn on the thumb sufficient to cause a sizable blister to form on the inner surface of that finger. Immediately following the accident, he was treated at the Dispensary for a skin abrasion containing alpha contaminated material. Two other people were in room 16 of building 2000 at the time of the mishap namely, J. I. Federer and R. M. Padgett. Both report either hearing the sound of the explosion or seeing the light.

The event as described by Terry points to a rapid decomposition of something associated with the surface of the sample. A pyrophoric compound between thorium and copper has been reported.¹ An accident involving the explosive decomposition of this compound is recorded in "Report on Explosion of Extruded Thorium Metal" ². However, copper is not present in the material in question since the canning material was iron. The possibility of forming thorium hydride in the pickling step should be considered. Even metals which do not form stable hydrides, such as iron, will readily absorb appreciable quantities of hydrogen upon exposure to acid solutions. Hydrides have been credited in many instances with initiating combustion of uranium. Thorium is quite similar to uranium in its ability to form hydrides. Thorium hydrides pyrophoricity is equal to or greater than that of uranium.

On three previous occasions, spontaneous ignition of Metallux thorium has been observed following pickling. These events were not reported formally at the time. In one instance, the burning proceeded with explosive violence. This was thought to be the result of a chemical reaction between pickling solution retained in the porosity of the sample and acetone which was being used to dry the metal sample. The other two samples ignited within an hour following the cleaning operation while contained in small glass bottles. These burned quietly, however, with the evolution of considerable heat causing breakage of the glass container but at a rate enough to avoid spreading the burning metal.

Since the stability of the thorium metal following the various steps of the Metallux Process is of considerable importance relative to the safe completion of that process, an attempt will be made to verify the pick-up of hydrogen in the cleaning step. Also, information on the stability of such a compound, if present, will be sought.

1 The Reactor Handbook, Vol. 3, Materials, USAEC

2 BNL - PL-63

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