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**300 AREA
CLASSIFIED FILES**PLUTONIUM METAL TURNINGS FIRE

W. N. Mobley, Superintendent
 Z Plant Sub-Section

By E. G. Pierick

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R. S. Bell, Manager
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PLUTONIUM METAL TURNINGS FIRE

Description of Incident

On July 27, 1954, at about 2:15 p.m., 965 grams of Pu alloy contained in three standard quart size ice cream cartons were being removed from the process line in room 235 by two process operators using the plastic bag technique. After the plastic bag sealer had been energized for two or three seconds of the 6-second cycle, a brown spot which increased in size was noticed on the plastic bag about one-half way between the sealing bar and the nearest carton. Soon after, or coincidental with the brown spot, smoke appeared inside the plastic bag and it became apparent that the turnings in the cartons were burning. Seconds later the glowing turnings burned through the containers and plastic bag and then fell to the floor where they continued to burn until they were completely oxidized. Although the room became grossly contaminated, personnel contamination was minor and readily removed. All surface contamination was confined to room 235 and was deposited in gross amounts in the area surrounding Task IV and V.

Subsequent Decontamination Activities

Room 235 was successfully decontaminated and operations resumed within 19 days by following three major decontamination schemes as listed below:

1. All surfaces were vacuumed and mopped down to remove loose particles of plutonium oxide.
2. Decontamination techniques were employed to remove all smearable contamination. Removable equipment (desks, cabinets, balances, etc.) was packaged and removed to another room where it was dismantled, cleaned, and reassembled for installation in room 235 at a later date.
3. All exterior surfaces in room 235 were repainted to insure that any contamination that could not be removed was permanently fixed. At the location on the floor where the turnings burned, it was necessary to chip out the concrete floor in order to remove the contamination and then apply new cement.

At the completion of the above operations room 235 was surveyed and found to be free of contamination. Also, air samples showed negligible contamination, so the area was returned to normal operations. The direct costs incurred to accomplish the above cleanup from July 27 to August 19 (operations restarted on August 16) amounted to approximately \$20,000.

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Summary of Recovery

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The plutonium released through ignition was deposited in three major locations: The majority dropped on the floor in front of the hood, some particles of plutonium oxide powder were spread throughout the room by air currents and a slight amount was adsorbed onto the fiber glass mats covering the room 235 air exhaust. The material on the floor was picked up in moist rags which were later dried and shaken to free the loose plutonium oxide which in turn was recovered by dissolution in a HF-HNO_3 solution. Product left in the rags after the above treatment was recovered by igniting them to an ash and then dissolving the residue in HF-HNO_3 solution. The fiber glass mats which were installed over the grill work to the room ventilation ducts were found to have a discardable amount of adsorbed plutonium as determined by total dissolution of a representative sample and, consequently, will not be recovered. The dust collected in the bag filters of the vacuum cleaning system has been packaged and stored until the feasibility of recovery can be determined. Approximately nine (9) cubic feet of inert floor sweepings are associated with any plutonium picked up by the cleaner, thereby complicating the recovery. To date 95.4% of the original metal content in the turnings has been recovered.

Facts Unknown About Incident:

After a review of all available information the specific mechanism by which the turnings ignited cannot be definitely determined. However, one of two actions must have taken place; either the turnings ignited independently of their surroundings or they ignited by heat originating from the sealing bar used.

1. Plutonium metal is pyrophoric which means that in finely divided form it may ignite spontaneously on contact with air. The metal in this incident was a coarse form of turnings which had been washed with carbon tetrachloride, so it is believed that they were relatively free of fines. The atmosphere was air dried to a dew point of -10°F . Furthermore, plutonium turnings have been handled in the same way for about three years with no indication of spontaneous ignition. It is not definitely known, however, if turnings are capable of igniting spontaneously in dry air.
2. The ease with which plutonium turnings will ignite and burn is well known. Ignition and burning of turnings in the line are not uncommon if external heat is present and such cases can generally be tied to conditions which would readily support their burning, e. g., the heat generated by friction during the machining operation. Nevertheless, fundamental knowledge of the behaviour of highly reactive plutonium metal turnings under all possible conditions is at present quite limited. The highly reactive nature of plutonium is both a chemical and metallurgical property, similar to that exhibited by magnesium and uranium. It is not known how much heat is required to promote ignition and burning, nor is it known if friction be-

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Facts Unknown About Incident (cont'd)

tween turnings (when packaged and jostled under operating line conditions), or if chemical oxidation will supply this heat.

3. Plutonium turnings are easily ignited by heat from an outside source. Experience and testing of the plastic bag sealer under arcing conditions has shown that the heat in the arc is sufficient to melt the copper bar. However, inspection of the sealing bar's dielectric media revealed that sealing bar arcing did not occur during sealing operation. It is not known, however, how far the turnings should be from the sealing bar to prevent the ignition during the sealing operation.

Why Facts Were Unknown About Reactive Nature of Plutonium

In the past, studies of the fundamental behaviour of plutonium metal have shown it to be highly reactive. Other metals such as calcium, magnesium, and uranium also exhibit this same characteristic. Industries associated with handling of these highly reactive materials have relied on handling techniques to minimize the safety hazards. Consequently, handling procedures at Hanford have taken into account this reactivity and were made sufficiently rigid to circumvent this hazard. Operating procedures to the date of the incident appeared to have been sufficiently adequate to render plutonium metal safe for processing, therefore, extensive studies to specifically determine what conditions are required to ignite plutonium turnings had not been made although development and research work was continually being prescribed in an effort to extend our knowledge of the properties of plutonium.

Prior to the incident it was recognized that safer methods of recycling these turnings could be employed. Whenever the contamination barrier is crossed a potential spread of contamination exists. Consequently, a turnings briquetting press had been fabricated and was being installed primarily to greatly minimize the need for removing turnings from the operating line. This installation was in progress at the time of the incident.

Plans For The Future

As a result of this incident, plans for reducing the recurrence of a similar incident from the potential hazards have been formulated as follows:

1. Briquetting Press Installation

A briquetting press, which has eliminated the need for routine removal of turnings, has been installed in the RMA Line.

2. Plans for Partitioning Walls

The spread of contamination in this incident was successfully confined to about half of the operating area by two previously installed partitions. Therefore, a study is now under way to determine how best to partition the area in order to further

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Plans For The Future

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2. Plans for Partitioning Walls (cont'd)

lessen the spread of contamination in the event of a recurrence. Access to the various partitioned zones would then be made through self-closing doors. Action as dictated by this study will be taken.

3. Review of Handling Procedures

The Process Unit of the Manufacturing Department, in conjunction with the Technical Section of the Engineering Department, has been requested by Z Plant Management to make a thorough review of the operating line handling procedures to insure that present operating procedures or revised operating procedures are adequate to circumvent the potential hazards. A preliminary report has been issued containing recommendations as follows:

- a. Precautionary steps should be taken to assure complete dryness of the reduction bomb and all its contents.
- b. Plutonium metal should never be stored in contact with flammable material. Whenever metal (except buttons for shipment) is removed from the line and stored for any length of time, it should be placed in a tight, metal container, evacuated, and the air replaced with dry air.
- c. In general, turnings should be removed from the line and should be handled as little as possible. They should be briquetted as soon as possible after machining and should be weighed and stored as briquettes.
- d. The present procedure of preparing buttons for shipment is probably satisfactory providing the following precautions are taken: Only good, smooth buttons with no evidence of unusual reactivity should be shipped, and the buttons should be sealed into the can immediately after sealing into the plastic bag.

4. Factors Influencing Pyrophoric Material

Development Laboratory personnel have started an extensive program directed towards determining the conditions that contribute to the production of pyrophoric material. This program is to encompass data findings to define conditions which may lead to difficulties but does not include as a primary part of this program a definition of the composition of the reactivity surfaces. It is estimated that it will take in excess of nine months to investigate the factors now under consideration.

W. N. Mobley, Superintendent
Z Plant Sub-Section

WN Mobley:EGP;vlf

By

E. G. Pierick
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**DATE
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