DEFENSE NUCLEAR FACILITIES SAFETY BOARD

October 22, 1993

MEMORANDUM FOR: Technical Director

COPY TO: Board Members

FROM: Davis Hurt

SUBJECT: Rocky Flats Plant - Report on Plutonium Storage

1. Purpose: This memorandum is a report by the DNFSB staff (Davis Hurt and outside experts Joseph Leary, Jesse Cleveland, and Homer Lowenberg) on a visit to the Rocky Flats Plant from September 22-23, 1993. The visit had three purposes:

   a. to inquire into the state of knowledge at Rocky Flats of long-term plutonium storage properties;

   b. to improve our understanding of the current plutonium storage situation at Rocky Flats; and

   c. to collect information useful to the Board on the question of which chemical forms and packaging methods would be most suitable for long-term plutonium storage.

2. Summary: Based on information obtained during this visit the staff has come to believe that there are immediate safety issues related to the storage of plutonium-bearing scrap materials (locally called "residues") at Rocky Flats. In the course of general inquiries into plutonium storage experience, the staff spoke with a senior plutonium scientist at Rocky Flats who has written a report on safety issues associated with the large number of 55-gallon scrap drums stored at the site. The report's findings were paraphrased to the staff during the site visit, and formed the basis for bringing this issue to the Board's immediate attention. The actual report ("Evaluation of Residue Drum Storage Safety Risks", William V. Connor, September 27, 1993) has been obtained since then, and has confirmed the impression formed by the staff in speaking with its author.

   The DNFSB staff and outside experts believe that there are several categories of scrap that are of immediate concern. In general, they are materials that combine fairly high radiation fields with reactive chemical environments. Some examples are

electrorefining salts, unpulverized extraction salts, and combustible items soaked with nitric acid. Hydrogen generation, overpressurization of containers, and accumulation of pyrophoric substances are the most serious issues. Some of the drums may contain ignition sources in the form of reactive metals, pyrophoric plutonium compounds, and unstable peroxides.

3. **Background:** The DNFSB has been aware for some time of potential safety issues related to the storage of plutonium and other special nuclear materials at Rocky Flats. The DNFSB staff first made inquiries into this subject in early 1992 in connection with Building 991. Later in 1992 the staff made further inquiries in connection with Building 779 and Building 371. In both cases, the staff concluded that plutonium materials were being stored in unsuitable environments. In the case of Building 779, it was clear that many of the Rocky Flats technical personnel involved were aware of the problem but felt constrained in their ability to address it by the plutonium operations suspension that affected the whole site.

   Rocky Flats management appears not to have recognized that there were serious problems with plutonium materials in storage until a specific compliance issue came into prominence in early 1993. It emerged that inspection of plutonium metals and oxides in storage had not been performed as required by the local health and safety manual (HSP 31.11). The manual was not intended to apply to many of the types of materials now in storage, such as residues, nor was it intended to cover the long storage periods now in effect. It is not clear that full compliance would resolve most of the safety problems.

4. **Discussion:**

   a. Plutonium scrap

   Many of the problematic plutonium materials stored at Rocky Flats are intermediate forms (such as solutions) or scrap (locally called "residue"). Many of these materials, particularly the ones with high plutonium content, were never intended for anything but very short-term storage. Because of the sudden shutdown at Rocky Flats, they have all been stored at least 4 years, and some of them pose significant dangers. There is a credible program at Rocky Flats to stabilize solutions, but the unstable scrap materials seem to have been somewhat neglected.

   An experienced plutonium chemist at Rocky Flats - EG&G has recently been assigned to analyze the scrap stability issue. He has written a report that discusses the safety hazards posed by the various scrap materials and proposes a ranking system for the categories. The DNFSB staff and outside experts met with him and found his oral summary of the report compelling. Since the trip, the DNFSB staff has obtained a copy of the report which confirmed the initial impressions.

The DNFSB staff and outside experts believe that there are several categories of scrap that are of immediate concern. Examples are electrorefining salts, unpulverized extraction salts, and combustible items soaked with nitric acid. The EG&G author identified several specific processes that could lead to the accumulation of hydrogen gas and has cited a substantial amount of actual data on hydrogen gas accumulation in similar drums. Some categories of scrap may contain ignition sources in the form of inclusions of reactive metal, pyrophoric forms of plutonium or americium, or unstable peroxides. He also identified categories of drums that may be susceptible to spontaneous combustion of flammable solids.

There is a possibility that some of these materials could explode if the drums are dropped, punctured, or otherwise roughly handled. There is also the possibility of spontaneous reactions in some of the drums. The report's author has defined five risk categories. The number of 55-gallon drums in the highest risk category is 1,095 and the number of drums in the second highest is 1,037.

The potential reactions in these drums pose a significant immediate safety issue. Somewhat longer term, there is also a serious scrap characterization issue. Many of the scrap materials are not well characterized. The DNFSB staff and outside experts believe it is important to start characterizing the unknown ones as soon as possible. It may not be wise, though, to wait for extensive characterization before taking steps to deal with the drums in the dangerous categories.

b. Improperly packaged line items

In response to a safeguards directive in late 1991, many of the plutonium items in the glove box lines, mostly metal, were packaged hastily and placed in vaults. The engineers supervising the packaging were compelled by pressure of time to package most items directly in plastic bags because there was not time to use the downdraft tables, which would normally have been the way to remove metal items from the glove boxes without using plastic. According to the people with whom the DNFSB staff spoke, it was perfectly well understood that plutonium items should not be packaged in direct contact with plastic if they are to be stored for more than a short time.

Unsafe packaging methods were used because of the overriding emphasis on getting the plutonium into the vaults by a deadline. The engineers responsible had to hope there would be opportunity to re-package the items in the near future. It seems that the dangerous situation exists today not because of inadequacies in established practice, but because established practice was not followed.

It is not correct to make a general conclusion that there was no sound "technical basis" for storage practices at Rocky Flats. The engineers responsible for storage had sound reasons for doing what they normally did. For the short-term storage with which they normally dealt, their practices were usually successful. Some of the practices were not

codified to any great extent, but that is not the same as having no technical basis. The problem in the view of the DNFSB staff and outside experts is that practices that were safe for the short term are not safe for the long term.

c. Standards for Long-Term Plutonium Storage

There are apparently no complex-wide standards for long-term storage of plutonium-bearing materials. This deficiency has undoubtedly contributed to the present unsafe situation. It is useful to think about the issue in terms of two types of plutonium materials: materials that are already in a form roughly suitable for long-term storage, and materials that are not. There seems to be general agreement among the experts that metals and oxides, properly processed and packaged, are suitable forms, and that most other things are not. Rocky Flats has a great many materials in the "not potentially suitable" category.

The Department of Energy (DOE) is developing a new interim storage standard for metals and oxides. The DNFSB staff and outside experts believe DOE has made a good start. DOE has put together a particularly comprehensive technical background document ("Assessment of Plutonium Storage Issues at DOE Facilities", still in draft form). The DNFSB staff believes it is important that this work continue.

For scrap and intermediate plutonium materials, the need is less for the development of storage standards than for prompt action to stabilize the materials themselves. Everyone with whom the DNFSB staff spoke agrees that these materials should not be stored any longer than necessary. Ideally, they should be stabilized in a way that makes them as suitable as possible for long-term storage. But there is an urgent need to start stabilizing the worst items, if only to an interim form. It is unfortunate that DOE did not foresee years ago the need for interim storage standards for some of these materials. Stopping all work now to develop a new standard does not make sense, and runs the risk of distracting key people from the actual stabilization work. The DNFSB staff believes an aggressive parallel effort needs to be pursued by DOE.

d. State of Knowledge

The body of knowledge at Rocky Flats of the properties of plutonium metal is still very extensive, even with all of the recent retirements. A great deal is known about the long-term (10-20 year) behavior of metal in two or three specific environments. The pit interior environment is by far the best understood, both theoretically and practically. There is somewhat less experience, but still a significant amount, with one or two other storage environments involving metal sealed in atmospheres different from the pits. Long-term behavior in adverse environments (wet ones, for example) is less well known, although a few important particulars are understood based on individual experiments or incidents.

Local knowledge of oxides is much more casual. Judging from the people with whom the DNFSB staff spoke, there has been relatively little systematic thought given to understanding how oxides interact with packaging and environment, even short term. There may be a great deal more knowledge at some of the other sites.

As far as the DNFSB staff could tell there is little local knowledge of the storage behavior of scrap and intermediate materials. Process chemistry of these materials is, of course, well understood. But, with few exceptions, little thought seems to have gone into their storage properties.