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Department of Energy

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DNF SAFETY BOARD

December 22, 1998

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20005

SUBJECT: Idaho National Engineering and Environmental Laboratory (INEEL) Final Site Assessment Report on the Storage of Uranium-233 (OPE-AM-98-041)

Dear Mr. Chairman:

Enclosed is the Idaho National Engineering and Environmental Laboratory (INEEL) Final Site Assessment Report, which summarizes information, developed from inspections and assessments of material containing Uranium-233 at the INEEL. The report represents the deliverable for Commitment 9 of the Department's Implementation Plan for addressing the Defense Nuclear Facilities Safety Board's Recommendation 97-1 concerning the safe storage of Uranium-233 material.

This report describes the surveillance activities that were completed during 1998, proposes a plan for long term, continued surveillance and a plan for examining the plastic packaging that surrounds some of the pellets.

We have completed the actions identified under this milestone and propose closure of this commitment. If you have any questions, please contact me or have your staff contact Robert M. Stallman (208) 526-1995 or William D. Jensen (208) 526-7500 of my staff.

Sincerely,

J. M. Wilcynski
Manager

Enclosure

cc: John Tseng, EM-66
Mark Whitaker, EH-9

Idaho National Engineering and Environmental Laboratory

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December 1998

Final Site Assessment for Safe Storage of U-233 at the INEEL

LOCKHEED MARTIN

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Final Site Assessment for Safe Storage of U-233 at the INEEL

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Published December 1998

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ABSTRACT

The U-233 Safe Storage Project at the Idaho National Engineering and Environmental Laboratory (INEEL) conducted the planned surveillance activities for ensuring the safety of the unirradiated fuel materials stored at the INEEL. No unusual conditions were observed that would cause any concern about the safety of the storage systems.

A program of continued storage surveillance is planned in future years to provide the background information for a long-term baseline for comparing system performance. In addition to continued surveillance, a program is underway to retrieve a drum containing pellets of U-233 ceramic stored in a plastic container for inspection. The results of the inspection will help verify that the pellets are safely contained, the plastic is not deteriorating, and there is no degradation of the structure of the pellets.

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1 INTRODUCTION

This report documents the final Idaho National Engineering and Environmental Laboratory (INEEL) site assessment information for CY 1998 concerning the storage of unirradiated U-233 materials at CPP-749 and the Radioactive Waste Management Complex (RWMC). The following pages provide a summary of the various materials, their storage systems, and the system performance. The information presented here is intended to supplement the *INEEL Initial Site Assessment Report: The Storage of U-233* and complete this year's assessment work. A significant amount of background information can be found in the *INEEL Initial Site Assessment Report on the Storage of U-233 [INEEL/EXT-98-00336], March 1998.*

The Atomic Energy Commission and its successors were participants in a program that started during the 1960s to explore the feasibility of using U-233 as the fissile driver fuel and natural thorium as the fertile fuel material in a Light Water Breeder Reactor (LWBR) concept. The legacy of this program is a reactor core of highly irradiated spent fuel and a partial core of unirradiated fuel, fuel rods, and pellets, all of which have been stored at INEEL's CPP-749 and the RWMC facilities since the late 1970s and early 1980s.

1.1 Fuel Materials

Most of the U-233 material stored at the INEEL is fuel, fuel components, and waste forms from fabrication activities for the LWBR reactor fuel. Ceramic pellets, made of thorium oxide/uranium dioxide that has been sintered at 1790°C for at least 12 hours, are the basic fuel unit. This treatment has resulted in a robust and stable pellet, which averages 98% ThO_2. Because the U-232 content in the uranium was specified to be less than 10 ppm, the U-232 content in the final product is between 0.2 ppm and 1.2 ppm in the fuel meat. The combination of a low U-232 content and the high thorium content, which provides significant shielding for the gamma emitters, results in low radiation fields. Furthermore, the robust, stable, high-density ceramic pellet provides a chemically-resistant and physical damage-resistant material that equates to a primary containment barrier for this material.

The fuel and fuel components are stored in sealed canisters that are housed in second-generation, below-grade storage vaults in CPP-749 at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant. Additional fuel components are stored in 6M drums at the RWMC. These drums are isolated by overpacks or earth that are protected from the environment by being housed in structural buildings.

At INTEC, a seed (driver) fuel module is stored in the single large storage vault in the unirradiated fuel area. Forty containers of Zircaloy IV fuel rods and stainless steel storage tubes, both of which are filled with pellets, are stored in 20 of the other 21 storage vaults. These canisters are stacked two deep, one on top of the other, in the smaller diameter vaults. The seed module contains 16.56 Kg of U-233, and the forty canisters of rods contain a total of 318.7 Kg of U-233.

Early in the development of the LWBR, U-233 oxide was blended with zirconium oxide ($Zr0_2$) and fabricated into fuel for criticality experiments conducted in 1966 and 1967. The fuel is a

UO_2/ZrO_2 ceramic that is believed to have been prepared in the Oak Ridge National Laboratory (ORNL) Kilorod facility, set up in one of the cells in Building 3019. The composition of the fuel pellet is $26^{W}/o^{233}UO_2$ in ZrO_2. The assemblies were rod-type assemblies 15-inches high.

The U-233 used in these experiments contained 38 ppm U-232 at the time of manufacture (early 1960s) and would now contain approximately 30 ppm U-232. This material was shipped to the RWMC in Idaho in 1980. The shipment consisted of 20 drums of Zircaloy rods filled with fuel pellets and 2 drums of loose fuel pellets. The drums used for the shipment were the standard DOT 6M/2R drums used by the Bettis Laboratory for the shipment of all of the other LWBR material. These drums are 55 gallon, galvanized and coated steel drums containing a small diameter, pipe cap-sealed 2R container centered in the drum by particle board spacers. The twenty drums of rods in this shipment contained 5.112 Kgs of U-233. The two drums of pellets contain 340 grams of U-233. There were a total of 386 Zircaloy rods in the shipment. The UO_2/ZrO_2 ceramic is an extremely stable composition having many properties in common with the UO_2/ThO_2 pellets. These drums are stored as part of the 107 drums stored in the Transuranic Storage Area (TSA)-Retrieval Enclosure berm.

1.2 Storage of the Material at RWMC

There are a total of 172 drums stored at the RWMC. 65 drums have been overpacked and are stored in a metal waste storage building; 107 drums are in the earth berm on the TSA pad and are dispersed among the other drums in the stack of drums. They will be among those retrieved when the stack is dismantled for treatment in the Advanced Mixed Waste Treatment (AMWT) Facility. Because of the high concentration of U-232, there will be a high radiation field associated with these drums—much higher than the other 85 drums containing material that had been specified to be less than 10 ppm U-232 at the time of fabrication and that would now contain 6 to 7 ppm or less. Accordingly, these drums will be easy to find by their high radiation signature. The drums containing the UO_2/ZrO_2 material will be segregated so that the pellets and the packaging can be examined. The Zircaloy rods would be expected to have no degradation under these storage conditions. But packaging, if it is plastic and if it were packed in the 1960s, could have significant radiation damage by now. The examination of these drums will follow the same course that the other 85 drums from the stack will be subjected to.

172 drums of U-233 material are in storage at the RWMC in the form of rods filled with pellets and loose fuel pellets that have been packed in 2R containers, which were then placed in 6M DOT shipping drums. Sixty-five of these drums containing a total of 16.5 Kg of U-233 are loaded into lead shielded overpacks and are stored in a Resource Conservation and Recovery Act (RCRA)-compliant building at RWMC. In addition, there are 107 other 6M drums (17.5 Kg of U-233) with a 2R inner container that are dispersed among the 129,000 Rocky Flats waste drums and about 1,700 drums of U-233 waste bearing materials. All of these drums are under an earthen cover on an asphalt pad. The berm containing these drums is scheduled to be excavated beginning in 2003 and end in 2015 as part of the AMWT process, but may occur as early as 2001. In anticipation of this, a steel building was erected over this berm as a weather shield.

A more complete description of the fuel materials and the storage locations and conditions is described in the *INEEL Initial Site Assessment Report on the Storage of U-233.*

2 1998 U-233 SURVEILLANCE PROGRAM

The INEEL Surveillance Program is designed to identify potential problems before they result in any kind of containment failure. Typically, the surveillance activities are indirect measurements of indicator parameters that are used to determine whether a storage canister is leaking or whether the storage vault has lost its integrity.

2.1 CPP-749 Storage Facility

The U-233 fuel material is stored in a steel-lined storage vault consisting of two ⅜-in. thick, carbon steel pipes with grout poured in the annulus between the pipes. The inner pipe is sealed with a welded steel plate on the bottom. A sump arrangement is also present to accumulate any liquids present. The vault is sealed with a gasketed, bolted lid. Detailed design drawings are available in the *INEEL Initial Site Assessment Report on the Storage of U-233.*

2.1.1 Surveillance at CPP-749

CPP-749 is a secured area inside the INTEC fenced area. The 22 storage vaults for the unirradiated LWBR fuel material lie along a single north-south line. The vault at the south end is the 30–in. diameter seed module vault, while the other 21 vaults are the 12-in. diameter vaults for the canisters of fuel rods. One of the 21 small diameter vaults is a spare. The vaults are set into a 12-in. thick, 8-ft. wide, and 218-ft. long concrete pad.

Failure of a vault would be detected by surveys for contamination on the concrete pad, contamination on the surfaces of the vault lids, and contamination identified inside on the vault walls of any opened vault. Another method of detecting failure would be the presence of cover gases from the storage canisters. Health physics monitoring of the contamination and the sampling of the vault for these cover gases would identify leakage. The third parameter is the condition of the vault walls and the outside surfaces of the canisters as determined by visual inspection by a video camera. A secondary benefit of this inspection is that the camera, which contacts the sides of the vault and the canisters, will be surveyed for any sign of contamination that it might pick up while in the vault. The video inspection will include an examination of the coating on the vault walls, welds of the vault and the canister, canister lids, crush pads at the bottom of each canister, and the sump at the bottom of the vault.

Another indicator of the condition of the exterior walls of the vaults is a corrosion evaluation of electrical-resistance, direct-buried corrosion probes that are bonded directly to the cathodic protection system in the CPP-749 storage area. These probes are made of the same material as the vaults and can indicate the rate of corrosion on an annual basis. Figure 1 shows the corrosion that these probes have experienced since 1985.

Because of the layer of corrosion product that has built up on the surface of the probe (and the external surface of the vault), the rate of corrosion has decreased to a nearly constant rate of approximately 0.1 mil/year. In the 13 years that the probes have been installed and monitored, slightly more than one mil of metal has been lost to corrosion; metal is currently being lost at a rate of 0.1 mil/year. The walls of the vaults are ⅜-in. thick (375 mils). As long as the corrosion continues at this rate, which is dependent on continued operation and maintenance of the cathodic protection system, the vaults should last for at least forty years.

Measuring these parameters provides confidence that the storage system is performing as expected with little probability of failure through at least 2035.

2.1.2 Results of the Surveillance at CPP-749

Contamination surveys at CPP-749 have not indicated any leakage from the storage vaults. Nor has any contamination been detected on the concrete pad or on the surfaces of the vault lid of the unirradiated LWBR Storage Vaults.

Two dry wells at CPP-749 were visually inspected using a video camera. The two wells, U-12 and U-14, were chosen because they indicated the highest concentration of hydrogen in the headspace gas samples. A high concentration of hydrogen should indicate more aggressive corrosion of the vault walls and the canisters. The interior portion of the lid showed no evidence of condensation or rust in either vault. The white, epoxy coated interior walls of the vault showed no indication of streaking resulting from the condensation on the wall in either vault. There was no evidence of corrosion of the stainless steel fuel canisters in either vault. The crush pads did not show any evidence of corrosion, and the corrosion engineers performing the inspection saw no evidence of water at any time in either of the vaults.

Analysis of the gases in the vaults was completed this summer. A review of the sampling procedure used to obtain the gas samples was also completed. In the previous sample history, it appeared that non-homogeneous samples were being obtained. Modifications to the procedure were made, resulting in better samples, but there are still improvements that could be made to improve the homogeneity of the samples. Ideally, the more homogeneous the sample, the more confidence one has in the results. In the case of gas samples, which contain light components (e.g., hydrogen and helium) that tend to stratify near the top of the vault, the sample will be biased toward the light gases and their concentration will be greater than if the gaseous contents were well mixed. The two gases that are biased high are the two gases that provide the most information on the status of the vaults and fuel containers. Thus, a high result is conservative because it indicates that the corrosion or leakage is actually higher than the current condition. In order to get more realistic samples, a circulating pump could be used to circulate the gas in the vault and get a well-mixed system. It is probably not worth the effort to develop and test a circulation system because the current sampling method provides the better "early indication" of a problem.

The analytical results obtained from the 1998 vault gas sampling effort are shown in Table 1. The samples were analyzed for hydrogen (H_2), helium (He), nitrogen (N_2), oxygen (O_2), neon (Ne), krypton-85 (^{85}Kr), xenon (Xe), and acetylene (C_2H_2). A separate analysis for the humidity and the dew point in the vaults was performed using a portable humidity instrument. ^{85}Kr is only present if a criticality has occurred; therefore, no ^{85}Kr was expected to be found, and none was. Xe, which is present in the Peach Bottom vaults but should not be found in the LWBR vaults, was not found. Ne, which was used as a cover gas in the containers of fuel, was not detected. He, which is formed during alpha decay processes and could be present, was also not detected. H_2, which would be formed during the corrosion reaction, was found in small amounts in all but one of the samples and is indicative that a small amount of corrosion is taking place on the vault wall surface.

The ratio of O_2 to N_2 in ambient air is approximately 0.2/0.8 = 0.25. The vaults were flushed with N_2, such that the N_2 concentration should be high. All of the vaults had ratios less than 0.25, although some of the vaults were beginning to approach that value. This seems to indicate that the vault seals were leaking and that the thermal pumping of air caused by the daily and the annual temperature fluctuations and diffusion were forcing some mixing of the N_2 atmosphere in the vaults with ambient air. However, there appears to be very little correlation between the H_2 concentration and the O_2 concentration.

Three of the measurements indicate that a problem probably existed with the instrument and are indicating unrealistic values for both temperature and humidity. It probably indicates a failure of the temperature measuring device and a lack of calibration or a failure of the instrument for measuring the humidity. The humidities are generally in the vicinity of 50% relative humidity at a temperature of 60°F, which is realistic for below grade vaults.

C_2H_2, which may be present in other vaults at CPP-749 containing carbide-based fuels (e.g., Peach Bottom or Fort St. Vrain fuel), was found at extremely low concentrations in samples from some of these vaults. This is believed to be cross contamination from the sample containers that are used for both the graphite fuel storage vaults and the LWBR vaults.

Based on this monitoring, there does not appear to be any degradation taking place that will result in the lifetime of the vaults to be decreased significantly. The ⅜-in. thick walls on both the inner and outer liners for the vaults will be more than adequate to provide the protection and safety of this material for as long as these vaults will be required.

2.2 RWMC Storage Facility

The U-233 fuel materials are stored in DOT 6M drums with a 2R inner container. The drums are galvanized, carbon steel on both sides and coated with an epoxy coating. The lids of the drums are not galvanized, but are coated with the epoxy paint. The 2R container is a steel pipe, which has a seal-welded bottom plate and a pipe cap on the top. The 2R container is coated with a corrosion inhibiting paint. The 2R container is fixed in the center by a solid stack of particle or fiber board spacers in the drum.

The fuel-containing drums are stored under two conditions at the RWMC. The most concentrated fuel material (16.5 Kg in 65 drums) has been placed in eleven steel boxes that have a ¾-in. plate of lead for shielding. The shielded overpacks hold six drums each and are sealed with a gasketed, bolted lid.

The second set of fuel-containing drums (containing 17.5 Kg of U-233 in 107 drums) was dispersed among a large number of drums (129,000 drums) from Rocky Flats and Bettis Laboratories. These drums are on an asphalt pad in an enclosure created by stacking waste boxes around the perimeter of the stack. Plywood sheets are laid across the tops of the drums and then sealed with a layer of plastic sheeting, which extends down over the waste boxes. Finally, an earthen berm was constructed to cover the sides and top under several feet of earth. In anticipation of retrieving the drums from this area, a metal building was recently erected over the entire pad and berm as a weather shield.

2.2.1 Surveillance at RWMC

The surveillance program at RWMC includes the 65 drums that are in the shielded overpacks and that are stored in the RCRA-compliant buildings. Again, the program is to demonstrate that the storage system is performing without presenting any risk to the environment or to the safety of workers at the RWMC. This is done by regular contamination and radiation surveys around the overpacks, and by regular visual inspections of the overpack containers. There are constant air monitors (CAMs) in the facility, which monitor for any airborne contamination.

The materials in the 107 drums stored in the berm are not under surveillance because of the problems of accessing this material. When the stack is exhumed and the U-233 containing drums are segregated, they will be thoroughly examined and, if necessary, remediated before the drums are accepted into the inventory.

2.2.2 Results of RWMC Surveillance

Contamination monitoring of the shielded overpacks has been conducted on a regular basis. The monitoring consists of both smear samples around the overpacks, as well as CAMs, which operate in the vicinity of the overpack storage location. There has been no indication of any contamination coming from the overpacks.

The overpacks were not opened to perform an actual drum inspection nor was there any specific surveillance of the drums stored in the berm other than general berm monitoring. There is no reason to believe that there has been any deterioration of these drums since they were put in the overpacks in 1997.

3 COMPARISON OF INEEL STORAGE CONDITIONS AGAINST THE U-233 STORAGE STANDARD

The following paragraphs discuss the INEEL U-233 storage systems and evaluate their compliance with the U-233 Safe Storage Standard (DOE-STD-3025-98). Figure 2 provides a summary overview of the multiple barrier systems at CPP-749 and the RWMC. These systems provide adequate isolation, monitoring, and security for the materials that are managed by these programs.

3.1 Storage Systems

The inventory of U-233 stored at the INEEL consists of UO_2/ThO_2 ceramic pellets stored in sealed Zircaloy fuel rods, steel tubing sealed with o-ring sealed plugs, bare pellets in plastic containers, a small amount (approximately 5.5 Kg) of UO_2/ZrO_2 ceramic pellets in Zircaloy rods, and loose pellets. The smallest basic unit of all of this material is a high integrity, chemically- and thermally-stable, ceramic fuel pellet. The pellet is primarily high-fired ThO_2 or ZrO_2 in which a small quantity of UO_2 is intimately blended. The result is a refractory ceramic material that is highly resistant to thermal, chemical, and physical degradation.

The LWBR pellets of UO_2/ThO_2 were produced by firing an intimately mixed, pressed pellet at a temperature of 1790°C for a period of at least 12 hours. This resulted in a pellet that exceeds 97% of theoretical density.

The standard recognizes that a pellet of this type can provide a primary barrier that is highly resistant to physical and chemical dispersion scenarios and subsequent releases to the environment. The majority of the pellets are stored as Zircaloy fuel rods or in stainless steel tubes. Part of the material that is stored in the below-grade storage vaults are Zircaloy rods fabricated into a fuel element that is placed in a 25-in. diameter stainless steel storage canister, which then is placed in the carbon steel-lined storage vault. The remaining material is in Zircaloy fuel rods or stainless steel tubing that are placed inside a 7.5-in. diameter stainless steel canister that has an O-ring sealed stainless steel lid held in place with bolts. The bottoms of these canisters are seal welded to the tube. The material at RWMC is mostly Zircaloy or stainless steel rods in 2R containers inside a 6M drum. A small amount of material is pellets in plastic sacks or bottles.

According to Section 4.2.6 of DOE-STD-3025-98, the pellets meet the primary containment barrier of being a robust, high-fired ceramic. For secondary containment, the material at CPP-749 is stored in corrosion-resistant, stainless steel containers with bolted lids. The material at RWMC is stored in corrosion-resistant, carbon steel 2R containers with a screwed-on pipe cap inside corrosion-resistant, galvanized drums with an epoxy coating.

In all cases, the containers are marked with a stamped steel identification plate, which is welded to the container or drum. All of these containers could be radiographed using standard industry practice for the Non-Destructive Assay requirements resulting from Materials Control and

Accountability requirements. Thus, this material meets the requirements for ceramic fuel materials as defined by DOE-STD-3025-98.

3.2 Surveillance Programs

A defined surveillance program is required for the accessible material. The program is oriented at demonstrating that the Safe Storage System is performing its intended function to (1) provide containment of the material, and (2) prevent criticality, accidental exposure to radiation, and releases and subsequent uptake of radionuclides. To fulfill this function, the system must continue to provide spacing, shielding, and containment. Should any part of this function not perform, the system is not performing safely.

The surveillance techniques being used are designed to recognize the failure of the containment, spacing, or of the shielding. Spacing is defined by the geometry of the vault array or the configuration of DOT 6M drums and by loading limits. Periodic review of the configuration of 6M drums against criticality controls and the appropriate technical specifications and standards are used to verify that adequate geometric spacing is being maintained. Monitoring the containment integrity provides early detection before significant degradation occurs. These techniques include contamination surveys around the vaults or storage containers, CAMs around the storage overpacks at RWMC, surveys of the interior surfaces by contamination monitoring of probes inserted into the CPP-749 vaults, CPP-749 vault head-space gas analyses, surveillance of the cathodic protection system at CPP-749, and video inspection of the CPP-749 vault interior surfaces and the exterior canister surfaces.

4 PLANNED SURVEILLANCE PROGRAM

It is not always prudent to break into containers or packaging systems that are functioning well. However, when radioactive materials are packaged with degradable materials (particularly plastics), the materials should be periodically examined.

In CPP-749, the pellet package material consists of the Zircaloy rods or the stainless steel rods. There are no organic plastic sacks or bottles associated with this package. The packaging is all metal (Zircaloy rods or stainless steel tubing) inside a stainless steel container. Both the stainless steel rods and the stainless steel canisters are sealed with a Buna-n O-ring, which has a projected life in this radiation field in excess of 100 years. Seal leakage will be detected by periodic gas sampling of the vaults. Consequently, there are no surveillance issues associated with the CPP-749 material that require modifying the existing surveillance program.

4.1 Examination of Plastic Packaging

At the RWMC, most of the drums contain Zircaloy rods and steel tubing, both of which are filled with pellets. A fraction of the drums, however, contain bare pellets in either a PVC plastic sack or in polyethylene bottles. Plans are currently underway to retrieve a drum during 1999 from one of the shielded overpack containers that contains pellets in a sack or a bottle. This drum will be sent to an alpha cell where the drum will be opened and the bag or bottle of pellets removed for further examinations. The plastic material will be examined to determine whether there has been significant degradation of the plastic that might compromise the containment properties. An examination of the pellets will also be made at that time to determine whether degradation has occurred, affecting the pellets' containment properties. A stainless steel rod will also be opened to determine whether any degradation has compromised the O-ring seal.

Following these examinations, the plastic sack or bottle will be discarded, the pellets placed in a DOE-STD-3025-98-compliant steel container, and the rods repacked in the 2R container and resealed in the 6M drum for storage back in the shielded overpack container. The storage canister containing the pellets could be put back into the 2R container or could be shipped to ORNL for inclusion with the material at that facility. Because this material is unique and similar to the other 360 Kg of material currently stored at the INEEL, it is recommended that this material be retained at the INEEL for management with the rest of the LWBR unirradiated fuel.

4.2 Examination of Drums on the TSR-RE

During the 1970s and 1980s, 172 drums of fissile material were shipped to the RWMC in 6M/2R containers. Some of these fissile material drums were segregated and are currently stored in the shielded overpacks in one of the waste storage buildings at the RWMC. The rest of the fissile material drums were intermingled with the 1,700 LWBR waste drums and 129,000 waste drums from Rocky Flats that are currently stored under plywood, plastic sheeting, and dirt inside a large warehouse building on the TSA pad.

The entire collection of drums (approximately 130,000 drums) will be processed through the AMWT Facility operated by British Nuclear Fuels Limited. The plan is to segregate the LWBR fissile material shipping drums as they are located while the stack is being exhumed. It is expected that the retrieval of drums will begin as early as 2001 and will continue until 2015. Because the exact locations are not known, the exact dates that the 107 fissile material shipping drums will be retrieved cannot be predicted.

When a drum is retrieved, it will be managed by the AMWT program pending a determination of its disposition. If they are transferred to the Safe Storage program, drums will be carefully inspected to verify the following:

1) The surface condition of the drums, specifically for indications of major corrosion, penetration, or damage. This includes top, sides, and bottom.

2) The integrity of the internal packing/spacer material. This material is pressed wood or fiberboard. Of particular concern is delamination or swelling of this material, which is common when it gets wet. This spacing material is part of the criticality control measures associated with these drums.

3) Corrosion of the 2R container that has resulted in penetration of the container.

4.3 Corrective Action Indicators

Corrective actions will be implemented for each of the following conditions:

1) If the drum or lid surfaces have been perforated, the drum or lid will be replaced.

2) If swelling or delamination of the spacer material is observed, the internal packaging will be replaced.

3) If the 2R container is corroded to the extent that its structural or containment properties are compromised, the 2R container will be replaced.

4) If the material in the 2R container has been damaged, it will be repackaged in accordance with DOE-STD-3025-98 or placed in a drum that meets existing DOT shipping requirements.

Once the inspections and any corrective actions have been taken, these drums will be accepted into the U-233 Safe Storage Program, overpacked in shielded containers, and placed in covered storage on a concrete pad.

While it is expected that all of the 6M/2R drums containing the rods and pellets will be recovered, it is possible that one or more will be processed in the AMWT Facility. However, in order to miss one of the drums, the conspicuous identification plate would have to be missing or overlooked.

The radiation level would have to be less than 200 mR/hr at contact, and the neutron interrogation device would have to have missed the larger than average fissile content.

The Safety Analysis Report for the AMWT process will have to consider the effect of processing these drums because of the possibility of one or more being inadvertently introduced to the process. This would include criticality and environmental effects both at the AMWT Facility and at the Waste Isolation Pilot Plant in New Mexico. Because they are planning to co-process the Rocky Flats transuranic waste with the 1,700 drums of LWBR waste material, the addition of U-233 to the system is not expected to significantly alter the composition of the waste.

5 CONCLUSIONS

At CPP-749, all of the LWBR fuel materials stored in the CPP-749 vaults consist of pellets in Zircaloy rods or stainless steel tubes, which are stored inside stainless steel canisters inside the carbon steel vaults. It is not expected that any environmental conditions will have degraded the material stored in these vaults.

5.1 Current Storage Deficiencies

There are two recognized deficiencies with the U-233 stored at the INEEL, both associated with the material stored at the RWMC. The first deficiency recognizes that a small fraction of the storage drums contain bare pellets stored in PVC plastic bags or in polyethylene bottles and that the condition of the plastic surrounding these pellets is unknown. A program is being planned to retrieve one of the drums containing bare pellets from one of the overpacks so that the plastic sack that contains the pellets can be examined for radiation damage and the pellets themselves can be examined for signs of degradation of the ceramic structure. A stainless steel tube holding pellets will also be opened to examine the Buna-n O-ring for signs of degradation due to the radiation field. This examination is planned to take place during 1999.

The second deficiency involves the 107 drums of U-233 fuel materials that have been stored under an earthen berm at RWMC for nearly 20 years. Because of their inaccessibility, these drums have not been inspected since their burial, leaving their condition unknown. This collection of 129,000 drums is going to be disassembled for processing through the AMWT Facility and, at that time, the 107 fissile material storage drums containing U-233 will be segregated and inspected before they are incorporated in the ^{233}U Safe Storage Program. The inspection will consist of radiography and visual inspection of the internal and external components of the package. Any problems identified with these drums will be corrected before the drums are accepted into the safe storage inventory. Degraded drums will be repackaged prior to further storage.

5.2 Safety Basis

The safety basis for the safe storage of the U-233 material containers primarily depends on the ceramic form of the material, which locks the dilute U-233 and U-232 atoms into a matrix that is nearly the theoretical density of a UO_2/ThO_2 mixture. Each uranium atom is surrounded by thorium atoms in the nearest neighbor lattice positions and, generally, in the next nearest neighbor lattice positions. The result is that the uranium atoms are unlikely to be free to migrate from the ceramic lattice. ThO_2 forms an extremely stable refractory ceramic material having the fluorite cubic structure, particularly when a small fraction of heavy metal atoms are present. This ceramic structure can be put into solution only with great difficulty. Accordingly, this matrix forms an extremely stable storage matrix for the isotopes of U-233 and U-232. A similar argument exists for the UO_2/ZrO_2 material.

The material under the berm is inaccessible for inspection but has been stored under a layer of plywood across the top drums of the stack. After the plywood was laid down, a layer of heavy plastic sheeting was laid over the plywood, followed by several feet of dirt. In the arid conditions of eastern Idaho (annual average total precipitation of approximately 8.7 inches), water does not penetrate very far into the soil. Thus, drums that were stored dry likely remained dry during their years in the berm. Drums from one part of the berm were retrieved and examined several years ago. Those drums recovered from the properly constructed berm did not exhibit significant degradation. However, drums retrieved from any area in which no plywood was used showed significant degradation. The U-233 drums are believed to be in the area of the stack that is protected by the plywood and plastic barriers.

Thus, there appears to be little risk associated with the inspection of either the drums, the containers, or fuel material. This will be confirmed when the first drums are retrieved from the berm sometime in the next decade and when the bare pellets are examined from the drums in the shielded overpack in 1999.

6 PATH FORWARD

The path forward for all of the U-233 in the complex depends upon the issuance of a Record of Decision for an Environmental Impact Statement for any changes in the Status Quo of this material. At this point, the LWBR unirradiated material is part of the desirable, low U-232 material. But in order to effectively make use of the material, it must be separated from the ThO_2. There are several options for this material. It could be sent to ORNL, as is, for inclusion with the balance of the U-233 inventory. This could take place without separating the ThO_2. Another option is to include the material with the LWBR irradiated fuel for disposition. Other options also being considered for the disposition of this material include isotopic dilution prior to storage or processing via dry or aqueous blending techniques. Another possibility is that this material will be classified as a national resource and maintained in as pure a state as possible awaiting program application. In this case, the material will continue to be stored in accordance with DOE-STD-3025-98.

Regardless of the final disposition path, there is no identified degradation mechanism in its present storage configuration that would preclude the material from being safely stored for the next 50 years.

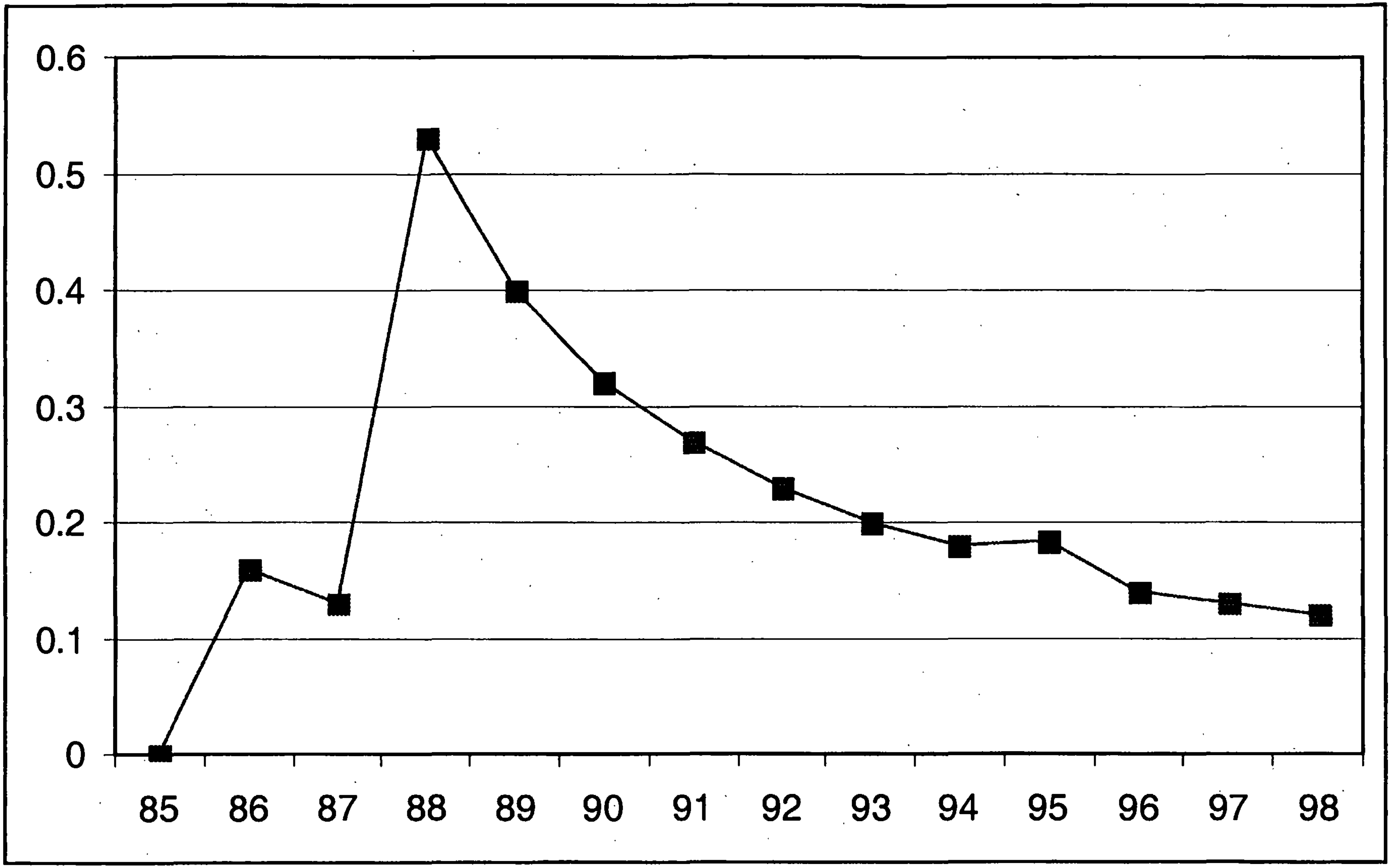

Figure 1. Corrosion probe data (in MYP) for the electrical resistance, direct buried probes in the CPP-749 storage area.

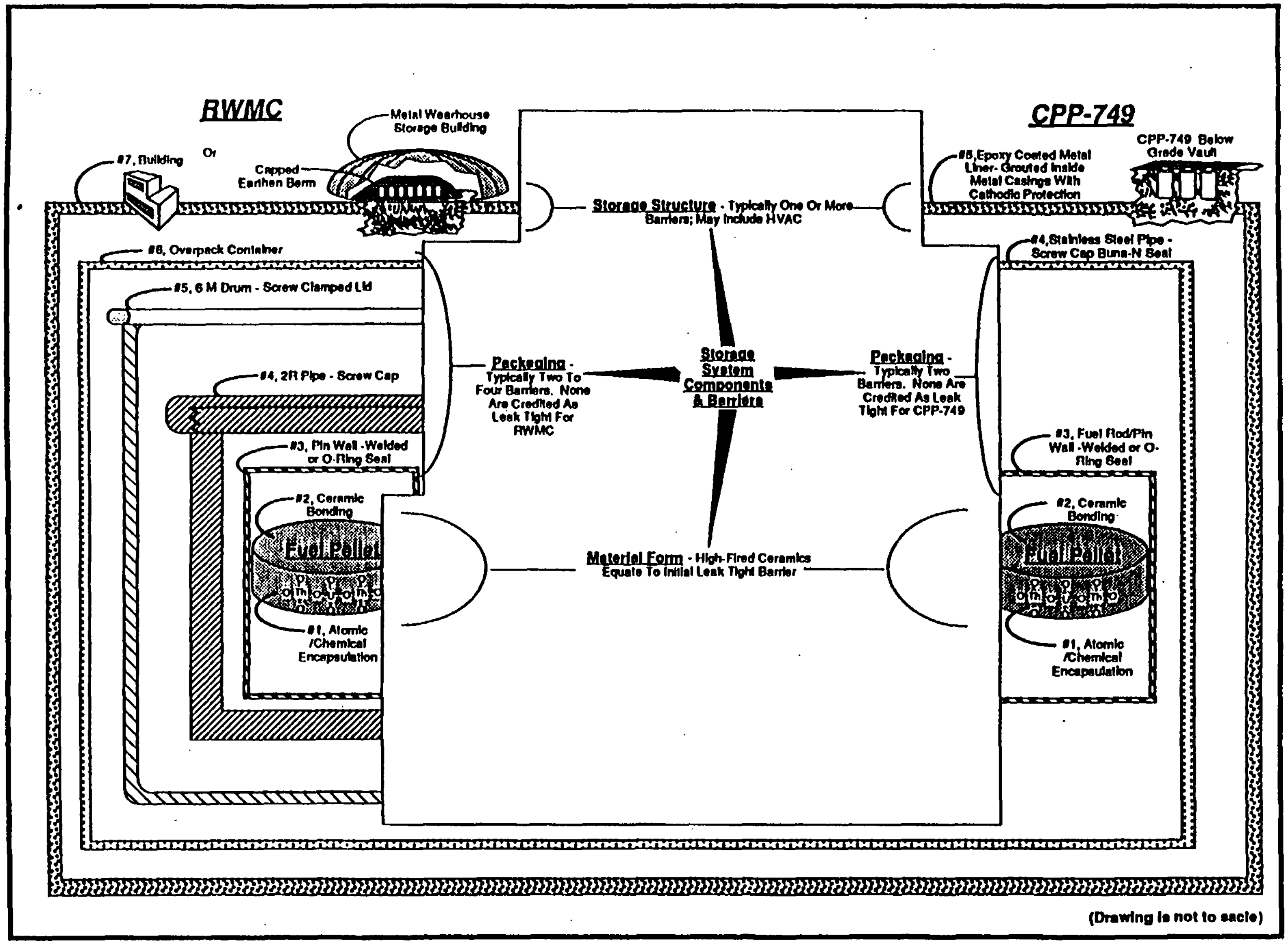

Figure 2. Overview of the Multiple Barrier Systems at CPP-740 and RWMC.

Table 1. Gas analysis results and relative humidity measurements on the even-numbered, unirradiated LWBR storage vaults.

Sample	Date	Time	H_2	He	N_2	O_2	Ne	^{85}Kr	Xe	C_2H_2	T°F	Relative Humidity
U-2	7/19/98	0742	.02	nd	90.05	9.48	nd	nd	nd	Nd	68.5	51.8%
U-4	7/19/98	0730	<.01	nd	92.86	6.79	nd	nd	nd	<.01	61.9	51.8%
U-6	7/19/98	0720	.02	nd	83.77	15.48	nd	nd	nd	Nd	65.5	49.2%
U-8	7/19/98	0710	nd	nd	83.44	15.81	nd	nd	nd	Nd	63.1	49.2%
U-10	7/19/98	0700	<.01	nd	87.78	11.66	nd	nd	nd	Nd	61.9	49.2%
U-12	7/19/98	0655	.03	nd	93.26	6.41	nd	nd	nd	<.01	61.	22 %
U-14	7/19/98	0645	.04	nd	95.46	4.28	nd	nd	nd	<.01	59.9	15.6%
U-16	7/19/98	0630	.02	nd	85.91	13.44	nd	nd	nd	<.01	59.7	26.1%
U-18	7/18/98	2005	.02	nd	81.51	17.66	nd	nd	nd	Nd	97	0
U-20	7/18/98	2000	.01	nd	96.33	3.49	nd	nd	nd	Nd	98	3
U-22	7/18/98	1950	.02	nd	95.91	3.84	nd	nd	nd	<.01	98	19

"Kr values in d/s/cm^3; all others mole percent