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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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February 7, 1996

The Honorable Hazel R. O'Leary
Secretary of Energy
Washington, D.C. 20585-1000

Dear Secretary O'Leary:

As part of the Board's continuing oversight of activities at the Oak Ridge Y-12 Plant, a team of the Board's staff recently reviewed the status of highly enriched uranium (HEU) processing capabilities at Building 9212. A copy of their report is enclosed. It appears that Building 9212 has potential missions to keep it operational for several years, including support for the Stockpile Stewardship and Management Program, blending of surplus HEU, and production of HEU material for research reactor fuel. However, our staff reports that many aspects of the facility continue to require upgrading prior to operations including safety basis documentation, conduct of operations, criticality safety, and training and qualification of operators.

Additionally, Building 9212 and other facilities at the Y-12 Plant contain a large number of in-process HEU materials stored in hallways and operating corridors. Some of these materials have been present for more than 40 years and do not meet the criteria for interim or long-term storage. This in-process HEU material forms the largest portion of "material at risk" considered in Building 9212 accident analyses. The capability to process the materials exists within Building 9212; however, the ability to stabilize the materials awaits satisfactory facility restart efforts being pursued under DOE's Implementation Plan for Recommendation 94-4.

The Board and its staff have put forth considerable effort, through Recommendation 94-1, *Improved Schedule for Remediation in Defense Nuclear Facilities Complex*, and other activities, to address the potential threat to public and worker safety presented by unstable nuclear residues throughout the weapons complex. A substantial cause for this threat was poor management and lack of timely disposition of these materials when weapons production operations were halted. Corrective actions to remediate nuclear residues will require the expenditure of significant time and resources, and the Board hopes to prevent the occurrence of similar problems elsewhere in the complex.

The Board recognizes that several potential mission drivers may dictate operational priorities at Building 9212; however, the Board believes that stabilization of in-process HEU materials at Building 9212 should be given high priority. In many ways the in-process HEU materials are similar to materials identified for remediation in the Implementation Plan for Recommendation 94-1. However, in-process materials at Building 9212 are not scheduled for processing in the same time frame as the 94-1 materials. If not stabilized in a timely manner, these materials run the risk of becoming yet another part of the weapons complex legacy of nuclear wastes that pose a threat to public and worker safety.

Restart efforts for Building 9212 are addressed in DOE's Implementation Plan for Recommendation 94-4. In addition to those efforts, the Board would like to be apprised of actions that will be taken to characterize and catalogue the residues stored in Building 9212, and the priority with which these residues will be processed when operations are restarted.

If you have any questions concerning the above, or the report, please contact Mr. Steven Krahn of our staff.

Sincerely,

John T. Conway

John T. Conway
Chairman

c: The Honorable Charles B. Curtis
The Honorable Thomas P. Grumbly
The Honorable Tara O'Toole
The Honorable Victor H. Reis
Mr. Mark Whitaker
Mr. James Hall

Enclosure

DNFSB/TECH-9

STATUS OF HIGHLY ENRICHED URANIUM PROCESSING CAPABILITY AT BUILDING 9212 OAK RIDGE Y-12 PLANT

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December 8, 1995

STATUS OF HIGHLY ENRICHED URANIUM
PROCESSING CAPABILITIES AT BUILDING 9212
OAK RIDGE Y-12 PLANT

CONTENTS

I. SUMMARY

This report considers several potential missions for Building 9212 at the Oak Ridge (OR) Y-12 Plant and OR's ability to support those missions. Building 9212 contains more than 50 unit processes that provide the capability to process nearly any unirradiated chemical or physical form of highly enriched uranium (HEU) and produce a variety of purified HEU metals and oxides. Building operations were shut down in September 1994 due to Y-12 criticality safety and conduct of operations concerns raised by the Defense Nuclear Facilities Safety Board (Board) staff. Board Recommendation 94-4 (Appendix A) addresses these concerns.

Mission drivers for the operation of Building 9212 include support for the Stockpile Stewardship and Management (SS&M) Program, production of HEU metal and oxide for research reactor fuel, processing of uranium residues, processing and blending of surplus HEU, and elimination of the backlog of in-process materials. These missions represent operational demands for Building 9212 that may require start-up of the facility in early 1996. For most missions, purity and enrichment specifications will require operation of nearly all wet chemistry processes.

Of concern, however, are the upgrades required in the authorization basis, Criticality Safety Approvals (CSAs), training, procedures, and conduct of operations in Building 9212. Unsuccessful implementation of these programs in the past indicates a lack of Department of Energy (DOE) and contractor management commitment and the necessary resources to correct these deficiencies. The Board's staff believes that greater management attention is necessary to solve these problems before the restart of Building 9212.

The mission most relevant to safety is one of processing the backlog of in-process materials at Y-12. In Building 9212, these materials occupy space in the hallways and operating corridors and some have been present for more than 40 years. The in-process materials do not meet the criteria for interim or long-term storage and no criteria for in-process storage have been developed. In-process materials form the largest portion of the "material at risk" considered in Building 9212 accident analyses and contribute significantly to the dose consequences of those accidents. These materials pose the greatest risk for spills, decomposition, or criticality safety infractions, make inventories difficult, and increase worker exposure risk due to their location in the workplace.

The Board's staff believes greater emphasis on stabilizing in-process materials at Building 9212 is necessary and that reduction of the backlog be started as soon as possible after the facility upgrades the authorization basis and demonstrates readiness to operate. If not treated promptly, these materials may become part of the weapons production legacy of abandoned residues -- particularly in light of the alternative considered in the SS&M Environmental Impact Statement (EIS) to move the capabilities of Building 9212 to a national laboratory.

II. INTRODUCTION

A. Background

This report documents the results of a technical review of the HEU processing capabilities of Building 9212 at the Y-12 Plant. The review team was tasked to determine what portions of Building 9212 are required to be operational to support ongoing weapons programs and residue remediation programs that involve HEU. Nuclear weapons program missions include dismantlement of weapons components, stabilization of material for long-term storage, potential design modifications, and other activities consistent with the SS&M Program. Residues that may require processing at Building 9212 include residues discussed in Board Recommendation 94-1, in-process HEU materials stored at Y-12, and other commercial and defense related HEU materials.

Building 9212 is located at the Y-12 Plant near Oak Ridge, Tennessee, and is operated by Lockheed Martin Energy Systems for DOE. Historically, Building 9212 operations included wet chemistry processing and metal casting to produce HEU metal components for the nuclear weapons program and HEU oxides for other programmatic missions. Most of the facility has been in standby since September 1994 when the Y-12 Plant shut down to correct criticality safety and conduct of operations deficiencies identified by the Board's staff. Board Recommendation 94-4, included in Appendix A, describes these deficiencies and the expected corrective action.

B. Building 9212 Capabilities

Building 9212 can receive unirradiated HEU in practically any form and process it into a metal or oxide product. In the past, the materials received by Building 9212 have included alloyed or impure metals, pure metals, oxides, residues generated internally or externally, and combustibles generated internally or externally. The facility houses more than 50 distinct unit operations that support the overall purpose of the facility. The operations within Building 9212 are divided into three broad categories:

- Wet chemistry and metal production
- Casting
- Specialty oxide production

Wet Chemistry and Metal Production: In wet chemistry and metal production (also called chemical recovery), chemical processes purify the HEU and convert it to an oxide or metal. Wet chemistry consists of bulk reduction operations, dissolution, leaching, evaporation, and primary and secondary cycles of solvent extraction. The product from wet chemistry is the oxide UO_3. Subsequent processes are the reduction of UO_3 to UO_2 with hydrogen followed by hydrofluorination to UF_4 in successive fluidized bed reactors. The UF_4 is converted to metal buttons using a thermite reaction with calcium and lithium.

Casting: The casting section of the building (E-Wing) utilizes metal shearing and breaking operations, light machining tools, and vacuum induction furnaces to cast various HEU metal shapes.

Specialty Oxide Production: Specialty oxides are produced as a side stream of the wet chemistry operations. The uranyl nitrate hexahydrate (UNH) purified in the solvent extraction process is converted to an oxide using precipitation, sintering, hydrogen reduction, grinding, milling, and particle sizing operations. These operations produce a ceramic grade oxide and can be tailored to accommodate a wide range of oxide enrichments and purities.

The processes in Building 9212 provide a versatile means to convert practically any form of enriched uranium to metal or oxide. Appendix B provides a more detailed description of each process.

C. Authorization Basis

Present Status: The authorization bases for highly enriched uranium operations and storage in Building 9212 are specified in a DOE-controlled list called the "Authorization Basis List for the Y-12 Plant."[1] This list identifies several documents that combine to form the safety basis for Building 9212 and includes:

- Functionally-oriented Final Safety Analysis Reports (FSARs), dated 1983-1985, for chemical processing, manufacturing, and transportation of enriched uranium.
- System-specific Operational Safety Requirements (OSRs) written between 1983-1995.
- Safety evaluations for systems added or modified after the FSARs were approved.
- Hazard analyses conducted since 1991 as part of the Safety Analysis Report (SAR) Upgrade Program.

These documents do not meet the current requirements found in the DOE Orders on safety analysis reports and technical safety requirements. A Basis for Interim Operations does not exist, but the contractor plans to submit one to DOE in January 1996. A new FSAR is due to DOE in December 1996.

Safety Basis Deficiencies: The review team examined status and general issues related to the authorization basis at Building 9212, but did not delve into specifics. Previous Board staff reviews led to the observations that follow. The FSARs were written between 1983-1985 to the qualitative standards of DOE Order 5481.1B, *Safety Analysis and Review System*. The analyses identify inadvertent criticality as the bounding accident associated with enriched uranium operations. The documents provide a quantitative estimate of off-site doses resulting from a "worst-case" criticality accident. The analyses also identify the possible initiating events such as process upsets or seismic events. A few of the later OSRs have technical bases (derived independently -- not from the FSAR), but none of them are in the form of a Technical Safety Requirement. The known specific technical issues with these documents are:

- The documents present only a qualitative analysis of hazards and potential accident initiators. The risk is not sufficiently characterized such that the relative likelihood of each event can be assessed and only bounding scenarios are discussed.

- The assumptions in the analyses are not specified and the margin to safety is not defined.

- The technical link between the safety analyses and the OSRs is not clear.

III. DISCUSSION

A. Mission Drivers

1. Stockpile Stewardship and Management (SS&M)

Background: The SS&M Program provides the direction to ensure that the required numbers and types of nuclear weapons are available and in the proper condition to ensure operation at the specified yield. Historically, DOE has dismantled nuclear weapons as part of ongoing operations to maintain the active and inactive stockpiles and to retire obsolete weapon systems. The weapons were returned by the Department of Defense (DOD) to DOE for dismantlement at the Pantex Plant in Amarillo, Texas. The dismantled nuclear and non-nuclear materials were returned to various DOE plants for further disposition. Processing of HEU at Building 9212 provides the ability to reconfigure HEU to forms for long-term storage or weapons reuse as needed. Currently, secondaries shipped from Pantex to the Y-12 Plant are scheduled for interim storage and subsequent disassembly, except those secondaries designated as part of the strategic reserve that are placed directly into storage.

Current and Future Demand: Future HEU weapon disassembly rates at the Y-12 Plant should not exceed the 1993 rate.[2] In the years since the Cold War, the disassembly rate had increased to a peak of 1,031 units in 1993:

Year	Disassembled Units
1989	193
1990	534
1991	615
1992	850
1993	1,031

More recently, the Office of Weapons Facilities (DP-24) estimates the potential range of annual dismantlement rates through the year 2004 to be 400 - 1000 units per year, with an overall average of 600 units per year. These systems are shipped to Y-12 in a stable form and current planning, supported by the EIS process, calls for placement of these units into interim storage for up to ten years. The weapons production part of the SS&M Program is undergoing review. Until this review is complete, current Y-12 planning assumes production levels ranging from a low of "maintaining a capability" to a high of 300 units per year.[3]

Another part of the SS&M Program is Quality Evaluation. In this program, small numbers of weapons are disassembled, inspected, and tested to ensure the ongoing reliability and safety of the enduring stockpile. Y-12 performs this function for weapon secondaries. The small number of weapons evaluated per year and the type of material involved does not represent a capacity or technological challenge to Building 9212.

From time to time there may be a requirement to modify an existing system in the stockpile in order to increase its safety or reliability and/or to extend its stockpile life. Depending on the complexity of the modification, the capabilities and capacity of Building 9212 may be needed to provide the required purity or enrichment of HEU.

To support this mission and the research reactor fuel mission described below, portions of Building 9212 would have to be operated under a special operations package. This involves the installment of temporary, compensatory measures such as operations advisors. These advisors and other measures provide an additional level of protection to ensure safety during operations. Special operations packages will be required to operate the facility until improvements in the safety basis documentation, CSAs, training, procedures and conduct of operations are implemented and validated in an operational readiness review (ORR). The use of special operations packages is a stopgap measure and is not preferred to normal operations validated by an ORR.

2. Research Reactor Fuel Demands

Building 9212 and other facilities at the Y-12 Plant have been supplying fuel material to research reactors worldwide for decades. Y-12 is the only site in the United States that can supply HEU for reactor fuel. The supply of reactor fuel is important to medical research and treatment, food sterilization, organic waste treatment, and the production of radiographic sources.

Current demand for HEU includes the need to refuel the reactors at the Massachusetts Institute of Technology and the University of Missouri at Rolla and to supply fuel to foreign governments. Additionally, Babcock and Wilcox (B&W), in Lynchburg, Virginia, cannot maintain its reactor fuel production line operational unless 33 kg of HEU metal is shipped to B&W by February 1996 and another 1089 kg of metal and oxide shipped by August.

Enriched uranium is supplied in two basic forms: metal and oxides. The metal is ordered as broken pieces to be formed later by the customer. Metal pins, plates, and rods requiring rolling and machining have been ordered on occasion. High purity oxides such as U_3O_8 are required for the High Flux Isotope Reactor (HFIR). This high purity material is not readily available and must be produced at Building

9212. Section III. B. below, explains the specifics of the unit processes required to support this mission.

3. Recommendation 94-1

Recommendation 94-1, issued by the Board on May 26, 1994, identified several materials throughout the nuclear weapons complex that can be categorized as residues remaining from weapons production operations. The implementation plan (IP) for the recommendation identified four residue sources that contain HEU. These sources are HEU solutions at the Rocky Flat Environmental Treatment Site (RFETS), HEU solutions at the Savannah River Site (SRS), fuel salts from the Molten Salt Reactor Experiment (MSRE) at the Oak Ridge National Laboratory (ORNL), and HEU deposits at the K-25 site in Oak Ridge. Current information and DOE planning indicate that the residues at RFETS, SRS and ORNL do not lend themselves to stabilization at Building 9212 and leave only the K-25 deposits for potential processing through the wet chemistry systems.

HEU deposits in piping and components at the K-25 Gaseous Diffusion Plant in Oak Ridge, Tennessee, are in the form of uranium oxides and fluorides (primarily UO_2F_2). Nondestructive assay measurements identified 54 areas within the processing system that contain more than 500 grams of U-235 in potentially unsafe geometries. To alleviate the risk of criticality in these areas, the deposits will be removed in two phases: a mechanical removal phase and a chemical removal phase. The deposits removed mechanically will be assayed and packaged at a new facility in the K-25 Building and then transported to the Y-12 Plant for storage and possible future processing. Deposits removed chemically will be maintained as UF_6 and stored at the K-25 Site. DOE has tentative plans to enlist the services of Building 9212 for further stabilization of the UO_2F_2 material to UO_3 or U_3O_8.

4. Other Mission Drivers

Other potential mission drivers for Building 9212 include the stabilization of miscellaneous HEU materials found throughout the nation at defense, commercial and research institutions. These materials include "surplus" HEU, formally designated by the President for removal from the stockpile to meet non-proliferation goals and stockpile and programmatic HEU that is of sufficiently high assay and purity to remain an important asset to weapons programs and other DOE research activities.

Non-classified descriptions of some of these materials can be found in the the 94-1 Integrated Facilities Plan (IFP)[4] and the Environmental Assessment (EA) for the Interim Storage of Enriched Uranium at Y-12.[2] The DOE plans to assess alternatives for the disposition of the many types of HEU in two EISs. These include the Disposition of Surplus HEU EIS,[5] and the SS&M EIS that has not yet been issued. In the interim, the increased HEU storage option from the EA for the Interim Storage of Enriched Uranium at Y-12 was approved by a Finding of No Significant Impact.

Surplus HEU materials: On March 1, 1995, President Clinton designated nearly 200 metric tons of HEU as surplus to national security needs. This surplus HEU exists in many chemical and physical forms throughout the nation and is slated for blending down to low-enriched uranium. Blending of surplus HEU presents a potential processing mission for Building 9212 that will require the operation of most unit processes in wet chemistry. Also among the surplus HEU is material of lower equity (lower enrichment) and material containing impurities. This "scrap" HEU is managed through the Central Scrap Management Office (CSMO) at the Y-12 Plant. In the past, processing of scrap HEU took place in Building 9206, but that building is now permanently shut down. Its functions are to be assumed by Building 9212 after installation of system upgrades and new equipment.

Stockpile and Programmatic HEU Materials: Stockpile and programmatic HEU will be handled and processed according to the SS&M Program described in Section III. A. above. However, included among this HEU are in-process materials at Building 9212 that exist in many forms including nitrate solutions, phosphate solutions, oxides, fluorides, and miscellaneous laboratory wastes. These materials are not subject to the criteria for storage of HEU because they are considered "in-process" and not in storage. No criteria exist for in-process materials. It is important to note that some HEU materials have been held in Building 9212 for more than 40 years without being processed and it is useful to consider the criteria defined for HEU storage.

The criteria for transient storage, interim storage, and prolonged low maintenance storage (PLMS) of HEU have been defined by the Y-12 Plant staff.[6] Interim storage requires that a) interim storage of enriched uranium be limited to ten years or less; b) enriched uranium in interim storage be stored for ease of retrieval, inspection, and inventory; and c) enriched uranium in interim storage should be contained in packages equivalent to, but not necessarily meeting, the requirements of 10 CFR 71, 49 CFR 173, and 49 CFR 178.

PLMS criteria require the HEU to be converted to a metal or to a stable oxide form. Most "in-process" materials in Building 9212 do not meet the criteria for interim storage or PLMS, although they have been stored there for decades. The Board's staff believes this is an undesirable situation that can be alleviated by processing the HEU materials into a more stable form that meets the PLMS criteria.

The Building 9212 Facility Safety Evaluation[7] includes an accident analysis section that identifies the adverse safety implications of the presence of in-process materials. Of all accident scenarios considered, 13 accidents were shown to be the most significant from an overall risk standpoint. The highest risk accidents were a hydrogen explosion accompanied by a uranium release, a hydrogen fluoride gas release, and several criticality accidents. Most of the material at risk in these accidents is in-process HEU in the C-1, B-1, and E wings of Building 9212 and includes material in racks, vaults and storage assemblies.

The draft SS&M EIS is due in February 1996 and will consider alternatives for continuing the stockpile stewardship and management mission with a reduced nuclear weapons stockpile. The EIS includes an alternative to downsize, in place, the capabilities of Building 9212 due to shrinking mission demands and an alternative to move the functions of Building 9212 to one of the national laboratories.

The Board's staff urges prompt stabilization of in-process HEU at Building 9212 following the completion of upgrades in facility safety basis documentation and the demonstration of readiness to operate. If not stabilized, in-process materials at Building 9212 may become part of the weapons production legacy of abandoned residues. This is a real possibility, particularly in light of the alternative considered in the SS&M EIS to move the capabilities of Building 9212 to a national laboratory.

B. Processing Capabilities Required

1. Stockpile Stewardship and Management: This mission requires the process capabilities of casting and wet chemistry in Building 9212. Pure metal would simply be processed through degreasing, briquetting and casting operations, then either stored as metal or recycled as a metal part. If the metal is alloyed or impure, the full wet chemistry cycle (dissolution, evaporation, primary and secondary solvent extraction, denitration and conversion to metal) is required. Details of these operations can be found in Appendix B.

2. Research Reactor Fuel: Material for this mission is supplied from the HEU metal inventory. The product for this mission is a ceramic grade oxide or shaped metal. If metal is required, the metal is simply worked into the desired shape using the metal working processes available in Building 9215. For the near-term mission to provide metal to B&W by February 1996, no processing capability is required. The metal is available in the proper form and must simply be packaged and shipped.

   If oxide is required, some wet chemistry capability is needed. The metal is converted to chips, then oxidized in the chip burner, and dissolved with nitric acid in the oxide dissolver. The solution is precipitated with ammonium hydroxide and the precipitate is commonly reduced to UO_2 and sintered in the sintering furnace to a ceramic grade powder. Sometimes a U_3O_8 product is required and the reduction step is changed to an oxidation step before sintering. Details of the operations needed for this mission are found in Appendix B.

3. Recommendation 94-1 Material: The K-25 deposit material identified as 94-1 material is primarily UO_2F_2. This compound can be processed in the wet chemistry portion of Building 9212, if necessary, by dissolving it in nitric acid and aluminum nitrate and sending it to primary solvent extraction.

4. Other Material: Surplus HEU and in-process HEU materials represent a large processing mission for Building 9212. As a result of EIS decisions, it is likely that some surplus HEU will be blended as UNH or as an oxide at Building 9212. The unit processes required to perform the blending operation will depend on the form of the HEU when it arrives at Building 9212. Since the surplus HEU is chemically and physically diverse, nearly all unit processes are necessary. Initial (or head-end) processes for some of the more common materials include:

Material Form	Head-end Processes
Metal	Chip burner and acid dissolver
Dry residues	Crushing, grinding and acid leaching
Wet residues	Destructive distillation units
Oxides	Acid dissolver
Combustibles	Destructive distillation units, incineration

Once processed through the dissolvers and leachers, the UNH solution can be blended but then may have to be purified if it is to be used for commercial fuel. In this case, most of the remaining processes would be used: evaporation, feed adjustment, primary extraction, intermediate evaporation, secondary extraction, and denitration (also conversion and reduction if metal is needed).

Similarly, the in-process materials held at Building 9212 are chemically and physically diverse. The most abundant of these materials are: oxides (UO_3, U_3O_8, and oxides from the casting process), miscellaneous combustibles, miscellaneous alloys, processing hold-up materials, molybdenum, slag liner, process solids, fuel elements, phosphate solutions, carbitol (an extraction solvent), and other miscellaneous materials. Again, due to the different initial forms of HEU, nearly every unit process will be required to stabilize these materials and the processes described above for surplus HEU apply.

C. Readiness to Operate

Conduct of operations, and training and qualification preparations for the restart of Building 9212 are in the early stages of implementation. A lack of coordination in accomplishing program elements has resulted in ineffective actions for the first year of the recovery process. This lack of coordination is a symptom of a lack of management support for conduct of operations and has caused the failure of previous attempts to implement these programs.

1. Conduct of Operations: In the past there has been significant effort to implement formal conduct of operations in accordance with DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities,* but progress has been slow and many problems have recurred. As of November 1995, 13 months after the event that caused the shutdown of the facility, an approved implementation plan for conduct of operations was not available for the Enriched Uranium Operations (EUO) division. Interviews of management personnel and a tour of the facility showed that some actions had been initiated to define manager duties and responsibilities and to realign the shift structure to include a shift manager. Installation of other program elements was not scheduled to occur until November or later and no clear indication of progress could be obtained.

2. Procedures: Procedure adequacy has been identified repeatedly as a problem area in implementing conduct of operations and in supporting the training program. In a March 1994 letter from the Board to the DOE Assistant Secretary for Defense Programs,[8] it was stated that progress at Y-12 in upgrading operating procedures was slow, and most procedures in Building 9212 (more than 120) required upgrading. Compounding the problem is an immature and inadequate configuration management program including inconsistent equipment labeling, unapproved drawings, and a large maintenance backlog. Currently, alarm response procedures, emergency operating procedures and surveillance procedures require extensive work, but the lack of upgraded safety documentation has delayed their development.

3. Training and Qualification: Implementation problems similar to those experienced with conduct of operations also exist in the area of training and qualification. Previously, qualification was informal and consisted primarily of On-the-Job Training (OJT). Formal classroom instruction was not provided. Personnel were not formally designated as qualified watchstanders and no formal qualification requirements for operators or supervisors existed. New training and qualification programs were initiated in 1993. Included were fundamentals training, additional training for supervisors, higher levels of math, chemistry and physics training for certain key operators, and remediation training. However, implementation of these programs has been inconsistent and successful course completion rates have been low.

   The most recent Training Implementation Matrix (TIM) was approved in January 1995. It set new qualification deadlines of July 1995 for E-Wing (metal casting), November 1995 for Special Processing and July 1996 for Chemical Recovery. The first two deadlines have not been met. The training manager acknowledged that system descriptions and course outlines had not been prepared and that additional resources were needed to complete these documents. Additionally, drill scenarios that rely on system descriptions and operating procedures will have to be rewritten.

4. Criticality Safety Approvals: A key component of the Y-12 Nuclear Criticality Safety Program is the CSA. CSAs are the authorizing documents used to describe the operating department's proposed fissile material activities and set forth the limits and conditions of approval as determined by Nuclear Criticality Safety Program analysis.

   On September 22, 1994, several members of the Board's staff identified a violation of a CSA in a special nuclear material storage vault at Y-12. The required immediate response to the violation was delayed by the inability of on-site personnel (a senior manager, a nuclear criticality safety specialist and a DOE facility representative) to interpret the applicable CSA. As a result, the decision was made to stop operations performed under CSAs throughout the plant. The contractor conducted a comprehensive site-wide review of compliance with CSAs that identified 1344 violations. Additionally, the Board issued Recommendation 94-4 (Appendix A). The DOE IP for this recommendation presents a schedule of near-term actions that provide a foundation to support the resumption effort and lay out a path of programmatic improvements to provide assurance of safety over the long term.

   The management at Y-12 is currently reviewing the CSA process to find a methodology that will require operators to use only operating procedures and not a mix of operating procedures and CSAs. In addition to operating procedure changes, the new program will require incorporation of current CSA requirements into general requirements procedures, system status control, and other affected areas. Y-12 management plans to complete this improved system for criticality safety control before upgrading the procedures and programs in EUO. Once defined the new program will require extensive work to upgrade the EUO Nuclear Criticality Safety Program documentation.

IV. CONCLUSION

Several potential missions for Building 9212 have been identified that will require nearly all the wet chemistry and metal casting capabilities of the facility. Included among these missions are support for the SS&M Program, production of HEU metal and oxide for research reactor fuel, processing of Recommendation 94-1 residues, processing and blending of surplus HEU, and elimination of the backlog of in-process materials.

The potential mission for Building 9212 involving the largest volume and the largest number of items is processing surplus HEU and in-process HEU materials. Surplus HEU is slated for blending and sale to commercial vendors or for blending and disposal depending on the outcome of the EIS for the disposition of surplus HEU.

In-process materials in Building 9212 have not been processed in the past, but have been present for many years in forms that do not meet storage criteria. While criteria for formal storage have been developed, criteria for in-process materials do not exist. In-process materials form the largest portion of the "material at risk" considered in Building 9212 accident analyses and contribute significantly to the dose consequences of those accidents. The sheer number of these materials poses problems for inventory, management and worker exposure risk. The Board's staff believes it prudent to process these materials at the earliest opportunity, after Y-12 management upgrades the authorization basis and demonstrates readiness to operate.

Under the SS&M mission and the research reactor fuel mission, production capability at Building 9212 may be required as early as CY 1996. Both wet chemistry and metal casting operations are necessary to support these missions. Similarly, many of the wet chemistry processing systems would be required to process K-25 deposit material, but no demand exists for the HEU contained in the deposits and the decision to process the material has not been made.

To support SS&M and reactor fuel missions, start-up of Building 9212 processes would occur before the required upgrading of management systems and would require approval of special operations packages. The Board's staff urges caution in taking this approach and suggests that DOE and the contractor do everything possible to improve the safety basis documentation, criticality safety program, conduct of operations, procedures, and training before the start of operations.

RECOMMENDATION 94-4 TO THE SECRETARY OF ENERGY

pursuant to 42 U.S.C. § 2286a(5)
Atomic Energy Act of 1954, as amended.

Dated: September 27, 1994

The Defense Nuclear Facilities Safety Board (Board) has issued a number of recommendations concerning formality of operations, including Recommendation 92-5, *Discipline of Operations in a Changing Defense Nuclear Facilities Complex.* In that recommendation, the Board stated that facilities scheduled for continued operations should develop a style and level of conduct of operations which is comparable to that achieved at commercial nuclear facilities. Recommendation 92-5 further noted that, prior to achieving an acceptable level of formality, major improvements were required in a number of areas, including safety analysis reports, limiting conditions of operation, and training and qualification of personnel.

The Board and its staff have been monitoring the Department of Energy's (DOE) efforts to implement an acceptable level of conduct of operations at the Y-12 Plant in Oak Ridge, Tennessee, which is scheduled for continued operations. The Board has forwarded a number of reports to DOE during the last two years indicating the existence of safety-related concerns regarding operations at Y-12. DOE and its operating contractor, Martin-Marietta Energy Systems (MMES), have taken some actions to correct deficiencies; however, a number of recent events have led the Board to the conclusion that more aggressive and comprehensive management actions are required to bring the level of conduct of operations at Y-12 to a satisfactory level.

The Board notes that during the past four months a number of violations of Operational Safety Requirements and other safety limits have occurred at the Y-12 Plant. Most recently, the Board's staff identified a substantial violation of nuclear criticality safety limits within a special nuclear material storage vault at Y-12. When the staff identified this deficiency to on-site personnel, including a senior MMES manager, an MMES nuclear criticality safety specialist, and one of DOE's facility representatives, immediate corrective actions that were required by Y-12 procedures were not taken. In fact, proper corrective actions were not taken until the Board's staff informed the DOE Y-12 Site Manager. Subsequently MMES curtailed a number of operations at the Y-12 Plant. Reviews of compliance with nuclear criticality safety limits at the Y-12 Plant revealed that a widespread level of non-compliance exists.

In its Annual Report to Congress (February 1994) the Board noted that personnel and procedures are complementary elements in implementing conduct of operations. The report stated, "The health and safety of the public and workers rest on a properly trained workforce accomplishing tasks in a formal, deliberate fashion in accordance with reviewed and approved procedures." In responding to the Board's Recommendation 93-6, *Maintaining Access to Nuclear Weapons Experience,* DOE is evaluating the impact of expertise presently being lost through ongoing staff reductions on their ability to perform nuclear weapons dismantlement at Y-12.

The Board recognizes that DOE and MMES management have begun taking aggressive actions to correct the specific problems of adherence to nuclear criticality safety limits, since the nuclear criticality safety occurrence referred to above. However, the Board believes that more remains to be done. Accordingly, the Board recommends that:

(1) DOE determine the immediate actions necessary to resolve the nuclear criticality safety deficiencies at the Y-12 Plant, including actions deemed necessary before restarting curtailed operations and any compensatory measures instituted. These actions should be documented, along with an explanation of how the deficiencies remained undetected by MMES and DOE (line and oversight).

(2) DOE perform the following for defense nuclear facilities at the Y-12 Plant:

  (a) An evaluation of compliance with Operational Safety Requirements and Criticality Safety Approvals (CSAs), including a determination of the root cause of any identified violations. In performing this assessment, DOE should use the experience gained during similar reviews at the Los Alamos plutonium facility and during the recent "maintenance mode" at the Pantex Plant.

  (b) A comprehensive review of the nuclear criticality safety program at the Y-12 Plant, including: the adequacy of procedural controls, the utility of the nuclear criticality safety approvals, and a root cause analysis of the extensive level of non-compliance found in recent reviews.

  (c) A comparison of the current level of conduct of operations to the level expected by DOE in implementing the Board's Recommendation 92-5.

  (d) Development of plans, including schedules, to address any deficiencies identified in the analyses conducted above.

(3) DOE evaluate the experience, training, and performance of key DOE and contractor personnel involved in safety-related activities at defense nuclear facilities within the Y-12 Plant to determine if those personnel have the skills and knowledge required to execute their nuclear safety responsibilities (in this regard, reference should be made to the critical safety elements developed as part of DOE's response to the Board's Recommendation 93-1).

(4) DOE take whatever actions are necessary to correct any deficiencies identified in (3) above in the experience, training, and performance of DOE and contractor personnel.

John T. Conway

John T. Conway, Chairman

APPENDIX B - Building 9212 Unit Processes

Background: The unit processes of Building 9212 are relatively uncomplicated and comparable to those found in the chemical industry. The differences between processes in Building 9212 and ordinary chemical operations are the nuclear safety requirements, the health physics problems, and the value of the material being processed. The processes in Building 9212 are run with very high product yields resulting in a near zero discharge to the environment. The vulnerability of the material also complicates processing because in-process inventory is required. Criticality is of prime concern in Building 9212 and all the techniques of batch size, geometry, and administrative control are used.

There are nearly one hundred separate unit operations in Building 9212. The unit operations to be used on a material depend on form, purity, enrichment, and the final product to be produced. The operation of some of these processes generates side streams that also have to be processed to maintain the zero-discharge philosophy and to capture the equity of the material being processed. Below are summaries of the unit processes used on metals, oxides, residues and combustibles followed by unit-by-unit descriptions of the processes:

> Alloyed or impure metals: Alloyed or impure metals must be purified and made into metal castings. The metal is first sized, sheared, and burned to an oxide, U_3O_8. The oxide is dissolved in nitric acid, concentrated, and purified through the primary and secondary solvent extraction cycles. The purified UNH is denitrated to UO_3, reduced to UO_2, and hydroflourinated to UF_4. UF_4 is reduced to metal using the thermite reaction with calcium and lithium.
>
> Pure metals: Metal deemed pure enough to be returned directly to metal stock is sheared, crushed, or made into large metal turnings. The turnings are degreased, briquetted, and cast. If the "pure" metal is not within specification, a small portion is sent through the wet chemistry and metal production to be purified. This small amount of purified metal, called "sweetener," is added to the major portion of the metal during the casting operation to bring the metal product within specification.
>
> Oxides: Materials received as oxides are dissolved in nitric acid and processed in the wet chemistry and metal production process. If the oxide is pure, it can skip several processes and be inserted directly into secondary solvent extraction.
>
> Residues and Combustibles: Wet residues and combustibles are incinerated or passed through a destructive distillation process. The resultant material is crushed, ground, and sieved along with dry residues. The resultant product is leached with nitric acid. The leachate is sent to primary solvent extraction and processed through the wet chemistry and metal production process.

The metallurgical operations include the following unit processes:

1. Mop Water Pour Up: The Pour-up system receives, filters, and stores generated mop water prior to disposal. This is required for good housekeeping, routine floor cleaning, and equipment cleaning to keep contamination levels low.
2. Storage: Storage includes temporary and permanent storage of materials and consist of floor arrays, racks, cages, and vaults.
3. Process Ventilation: Provides once through ventilation of the casting area, machine shop, hoods, boxes, and workstations.
4. Casting: HEU and uranium alloy parts are cast in one of twelve induction furnaces.
5. Pack/Ship: This operation performs four functions. Feedstock is received, weighed and assayed. Parts to be shipped are weighed and assayed. The operation also serves as a storage area for chips, sample cans, birdcages, trays, etc.
6. Special Nuclear Material (SNM) Door: This operation involves the locking, unlocking, and access to roll-up doors for the Building.
7. Break and Shear: An alligator type shear is used for cutting large pieces of scrap into smaller pieces roughly 3 by 4 inches. A 45-ton press is used to flatten, break, and crush metal parts into small pieces for use in the production stream.
8. Batch Makeup: A batch consists of reduction buttons, rolling mill scrap, retirement scrap, and lugs from cast shapes. Various combinations of batch makeup materials are used to control the chemistry of the batch.
9. Dry Vacuum: A dry vacuum system is provided to remove uranium, graphite and oxide dust generated by the various metallurgical process.
10. Inventory and Verification: This operation accounts for all discrete parts/batches at a bimonthly frequency.
11. Sampling: This operation involves drilling buttons, billets, or logs to obtain chip samples for establishing material specifications.
12. Sample shipment: This operation provides special shipment activities for International Atomic Energy Agency (IAEA) activities.
13. Ultrasonic Cleaning: Ultrasonic cleaning is used to clean uranium chips from machining operations to remove impurities such as coolants and oils.
14. Chip Processing: This operation begins with cleaning, drying, and compression of HEU chips into briquettes in a 75-ton press. The briquettes are stored until ready for processing where they are submerged in a Freon degreaser. The briquettes are then dried in a low oxygen drying oven.
15. Auxiliary Caster: This process melts the HEU briquettes for retirement use or for reuse in the production stream or for long-term storage.
16. Pickling: Pieces of oxidized HEU metal are cleaned in the metal pickling system using 30% nitric acid.
17. Oiler: This system is a piped delivery of machine oil for lubrication of the machining equipment.

Important wet chemistry unit processes include:

18. Atmospheric Environmental Control (AEC) Scrubber: This system uses a scrubber to reduce nitric acid vapor emissions
19. B-1 Laboratory: The B-1 laboratory provides process sample analyses such as pH, specific gravity, activity, and ppm uranium.
20. Westfalia Centrifuges: The centrifuges remove suspended solids from uranyl nitrate solution exiting the high capacity evaporators.
21. Wet Vacuum System: This operation supplies vacuum to operate diaphragm pumps, solution filtration , and the transfer of solutions.
22. Decontamination Operations: Decontamination removes uranium from material and equipment prior to disposal, maintenance or reuse.
23. Bottle Rocking: These devices agitate safe bottles of solutions prior to sampling.
24. High Capacity Evaporator: This process is used to reduce the volume of UNH solutions intended for primary solvent extraction. The system is comprised of two identical steam heated evaporators. Filters and storage tanks are shared between the two evaporator systems.
25. Headhouse Holden Furnace: This natural gas fired furnace is used to dry wet residue materials and for burning small amounts of solids. The furnace has a controlled air supply and automatic fuel cutoff in the event exhaust air is cutoff.
26. Recovery Furnace: This furnace is used to burn combustibles contaminated with uranium. The ash falls into a glove box where it is canned for the ash leacher.
27. Tri-*n*-octyl Phosphine Oxide (TOPO) Treatment: This solvent extraction step removes uranium from laboratory wastes.
28. Organic Cleanup: Organic cleanup is a sodium hydroxide precipitation process for recovering uranium from used tributyl phosphate (TBP) or dibutyl carbitol. A glass column is used for a contacting volume. The solution is drained into safe bottles and filters at the pan filter station.
29. Primary Solvent Extraction and Feed Adjustment: The feed adjustment system adjusts the specific gravity of UNH and adds molten aluminum nitrate to achieve a specific gravity of 1.35 to 1.37, which is critical to the operation of the primary solvent extraction cycle. Primary solvent extraction consists of four similar extraction batteries each consisting of pulsed counter-current perforated plate extraction columns. Dibutyl carbitol (diethylene glycol dibutyl ether) is used as the organic phase because of its extremely high affinity for extracting uranium ($E^\circ_A = 195$ versus 5.5 for TBP) and its extremely high separation factor for Al (7×10^6). Dibutyl carbitol has the disadvantage of also having a high affinity for nitric acid. Nitric acid in carbitol can be explosive if the nitric acid concentration becomes too high. For this reason low acid concentrations are used in the feed. Raffinates from this battery are expected to contain 0.5 - 2.0 ppm uranium.
30. Secondary Solvent Extraction: Secondary extraction includes a set of centrifugal contactors for extraction, scrub, and strip processes. TBP in kerosene is used as the organic phase. The purified uranyl nitrate is sent to the secondary evaporator while the raffinate is returned to the high-capacity evaporator.
31. Ash Leacher: The ash leacher is a nitric acid dissolver system which dissolves ash residues from the destructive distillation, incineration, or crushing operations.
32. Blending/Sampling Hoods: This operation blends oxides in a hood.

33. Primary and Secondary Intermediate Evaporators: These evaporators concentrate feed prior to secondary extraction. The evaporators also recover nitric acid.
34. Muffle Furnace: These are electrically heated horizontal tube furnaces used for drying, distilling, and burning solid material.
35. Sampling Columns: The sampling columns consist of critically safe tanks equipped with air sparging equipment to homogeneously mix solutions prior to sampling.
36. Denitrator: This process is a stirred trough calciner which denitrates UNH solution to uranium trioxide powder at 315°C. Nitrogen oxide produced in this process is passed though a two-stage scrubber and exhausted to the stack.
37. Argon Glove box: This glove box is used to passivate weapons teardown material and to weigh oxide for use in precipitator feed makeup.
38. Storage Tanks: These tanks store solutions from Special Processing prior to transfer to the high-capacity evaporators for recovery.
39. Beaker Leaching: This process is an open beaker, hot plate, dissolution operation which dissolves small quantities of HEU unsuitable for leaching in other process equipment.
40. Secondary Evaporation: Secondary evaporation includes a wiped-film evaporator used to concentrate product from the secondary extraction process. Feed enters at approximately 10% uranium and exits at 45% uranium. The product is stored in steam-jacketed tanks until fed to the denitrator.
41. Tube Furnace: The tube furnace is comprised of three 6.5 inch diameter, 78 inch long electrically heated pipes used to produce uranium oxide. Platinum boats containing uranium peroxide or ammonium diuranate are loaded in each furnace. The gas environment is controlled with nitrogen and/or hydrogen to produce the desired oxide, UO_2, UO_3, or U_3O_8. Furnace offgas is routed through an water cooled U-tube condenser, through an oil-filled seal pot, and vented to the atmosphere. Dry ice is used to stabilize the UO_2 when it is removed from the furnace.
42. Nitric Acid Recovery: Nitric acid is recovered from the condensate from the vacuum evaporator used in aluminum nitrate recovery. A glass distillation column is used for this purpose and nitric acid is recovered in the reflux stream. 30% nitric acid is produced then sparged with 1% ozone to remove any accumulated chlorides and sent to a 13,000 gallon storage tank.
43. Aluminum Nitrate Makeup: Raffinate from the primary solvent extraction system is concentrated in a vacuum evaporator and transferred to a 1,000 gallon crystallizer tank. Condensate from this process flows to a feed tank for acid recovery. The aluminum nitrate crystals are separated from the solution by centrifugation. The centrifuge overflow is sent to biodenitrification. The crystallized aluminum nitrate is melted and stored in the molten aluminum nitrate tanks for reuse.
44. Carbon Burners: The carbon burners are cylindrical furnaces where carbon materials (graphite molds, crucibles, cores, and pour rods from casting operations) are burned to ash that is suitable for leaching in nitric acid.
45. Destructive Distillation Units: These units are electrically heated retorts used for burning rubber hoses, rubber gloves, shoes, prefilters, bag filters, HEPA filters, carbon burner filters, and other combustibles not suitable for burning in the incinerator.

46. Chip Burner: The chip burners are two rotating calciners in series. They are used to convert HEU turnings to UO_3. Combustion rate is controlled by maintaining HEU feed rate and oxygen flow. The first calciner output passes through a screen allowing smaller particles to enter the seconded calciner. Larger particles are processed in the head house beaker leaching operation.
47. Reduction Fluid Bed: Hydrogen is introduced into a fluid bed reactor containing UO_3 fluidized with nitrogen at 530 °C. The UO_3 is converted to UO_2 and transferred to the hydrofluorinator.
48. Hydrofluorination Fluid Bed: Hydrogen fluoride gas is introduced into a fluid bed reactor containing UO_2 fluidized with nitrogen at 275°C. The product is uranium tetrafluoride, UF_4 powder.
49. HF Supply: This operation supplies HF vapor to the hydrofluorination step of the fluid-bed operation and a scrubber to removed unreacted HF from the exhaust gases of the reactor.
50. Sintering Furnace: This operation consists of three electrically heated sintering furnaces used to sinter uranium oxide to a ceramic grade U_3O_8.
51. Bomb Reduction: This process reduces uranium tetrafluoride to metallic uranium in a thermite reaction where calcium and lithium are used as the reducing agent. The reaction takes place at elevated temperature and reduced pressure in a closed vessel.
52. Slag Dissolver: The Slag Dissolver consists of a variety of processing equipment used to crush, calcine, and dissolve slag associated with the bomb reduction process. The slag is crushed, calcined, then dissolved in nitric acid and aluminum nitrate (to prevent fluoride corrosion of process vessels).
53. Precipitator: The precipitator system consists of uranyl nitrate, ammonium hydroxide, and hydrogen peroxide feed tanks, two 6-inch diameter 4-foot long Pyrex precipitator columns, pumps, piping, and instrumentation. It is used in special operations to convert UNH solution to ammonium diuranate, $(NH_4)_2U_2O_7$, or uranium peroxide, $UO_4 \cdot 2H_2O$.
54. Oxide Dissolver: The oxide dissolver is used to dissolve pure U_3O_8.
55. Beaker Leaching: Small batches of contaminated metal, oxides, etc. are leached in 4-liter beakers with 30% nitric acid and aluminum nitrate.
56. Salt Dissolver: The salt dissolver utilizes nitric acid to dissolve potassium carbonate and lithium carbonate mixtures contaminated with U_3O_8 . The system is heated with steam coils and the uranium is dissolved and separated from the salts by filtration. The filtrate is sent to the high capacity evaporator.
57. Biodenitrification: The overflow from the aluminum nitrate crystallizer tank is fed to the biodenitrification tank. The feed solution containing as high as 25% nitrates is reduced to 60 ppm nitrate by digestion utilizing anaerobic bacteria (pseudomonas stutzeri). The system includes a 10,000 gallon raffinate tank and a 10,000 calcium acetate tank (nutrient for the bacteria). The raffinate solution and acetate are transferred to the 25,000 gallon bioreactor where the bacteria digest the nitrate ions forming nitrogen and water and digest the acetate to form carbon dioxide. The bacterial process leaves a biomass residue containing dead bacteria and heavy metal contaminants. The bacterial actions also produce enough calcium carbonate to cause precipitation of the metallic

contaminants. The precipitates and biomass form a sludge which is withdrawn from the bioreactors and treated in the Waste Treatment Operation.

58. Utilities: The process required in Building 9212 also require common and specialized utilities for support including steam, air, water, vacuum, nitrogen, oxygen, natural gas, hydrogen, argon, helium, brine, nitric acid, and caustic.

Each type of material being processed requires some or most or the unit operation listed above. Some common input material to be processed include unalloyed or pure metal, alloyed or contaminated metal, oxides, wet and dry residues, and combustibles. To illustrate which processes are required for each mission, a matrix has been prepared in the table below.

	Mission			
Process	SS&M	Research Rx Fuel	In-Process Materials	K-25 Deposits
1 Mop Water Pour Up	X	X	X	X
2 Storage	X	X	X	X
3 Process Ventilation	X	X	X	X
4 Casting	X	X	X	X
5 Pack/Ship	X	X	X	X
6 SNM Door	X	X	X	X
7 Brake and Shear	X	X	X	X
8 Batch Makeup	X	X	X	X
9 Dry Vacuum	X	X	X	X
10 Inventory and Verification	X	X	X	X
11 Sampling	X	X	X	X
12 Sample shipment	X	X	X	X
13 Ultrasonic Cleaning	X	X		
14 Chip processing	X	X		
15 Auxiliary Caster	X	X		
16 Pickling	X	X		
17 Oiler	X	X		
18 AEC Scrubber	X	X	X	X
19 B-1 Laboratory	X	X	X	X
20 Westfalia Centrifuges	X	X	X	X
21 Wet Vacuum System	X	X	X	X
22 Decontamination Operations	X	X	X	X
23 Bottle Rocking	X	X	X	X
24 High Capacity Evaporator	X	X	X	X
25 Headhouse Holden Furnace	X	X	X	X
26 Recovery Furnace	X		X	
27 TOPO Treatment	X	X	X	X
28 Organic Cleanup	X	X	X	X
29 Primary Solvent Extraction & Feed Adjustment	X		X	X
30 Secondary Solvent Extraction	X	X	X	X
31 Ash Leacher			X	X

	Mission			
Process	SS&M	Research Rx Fuel	In-Process Materials	K-25 Deposits
32 Blending/Sampling Hoods		X		
33 Primary and Secondary Intermediate Evaporators	X		X	X
34 Muffle Furnace	X	X	X	X
35 Sampling Columns	X	X	X	X
36 Denitrator	X		X	X
37 Argon Glove box	X	X	X	X
38 Storage Tanks	X	X		X
39 Beaker Leaching	X	X	X	X
40 Secondary Evaporation	X		X	X
41 Tube Furnace		X		
42 Nitric Acid Recovery	X	X	X	X
43 Aluminum Nitrate Makeup	X		X	X
44 Carbon Burners	X	X	X	X
45 Destructive Distillation Units	X		X	
46 Chip Burner	X			
47 Reduction Fluid Bed	X	X	X	X
48 Hydrofluorination Fluid Bed	X	X	X	X
49 HF Supply	X	X	X	X
50 Sintering Furnace		X		
51 Bomb Reduction	X	X	X	X
52 Slag Dissolver	X	X	X	X
53 Precipitator		X		
54 Oxide Dissolver	X		X	
55 Beaker Leaching	X	X		X
56 Salt Dissolver			X	
57 Biodenitrification	X	X	X	X
58 Utilities	X	X	X	X

ACRONYMS

AEC	Atmospheric Environmental Control
B&W	Babcock and Wilcox
Board	Defense Nuclear Facilities Safety Board
CFR	Code of Federal Regulations
CSA	Criticality Safety Approval
CSMO	Central Scrap Management Office
DOD	Department of Defense
DOE	Department of Energy
EA	Environmental Assessment
EIS	Environmental Impact Statement
EUO	Enriched Uranium Operations
FSAR	Final Safety Analysis Report
HEPA	High Efficiency Particulate Air
HEU	Highly Enriched Uranium
HFIR	High Flux Isotope Reactor
IAEA	International Atomic Energy Agency
IFP	Integrated Facilities Plan
IP	Implementation Plan
MMES	Martin Marietta Energy Systems
MSRE	Molten Salt Reactor Experiment
OJT	On-the-Job Training
OR	Oak Ridge
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
OSR	Operational Safety Requirement
PLMS	Prolonged Low Maintenance Storage
RFETS	Rocky Flats Environmental Technology Site
SAR	Safety Analysis Report
SNM	Special Nuclear Material
SRS	Savannah River Site
SS&M	Stockpile Stewardship and Management
TBP	Tributyl Phosphate
TIM	Training Implementation Matrix
TOPO	Tri-*n*-octyl Phosphine Oxide
UNH	Uranyl Nitrate Hexahydrate

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