DEFENSE NUCLEAR FACILITIES SAFETY BOARD

November 23, 1993

MEMORANDUM: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Dan Burnfield

SUBJECT: Report on Spent Fuel Storage Basins

1. Background: From late March to early August 1993, D. L. Burnfield conducted a review of those defense nuclear facilities of the Department of Energy (DOE) complex that store spent nuclear fuel. The purpose of this review was to determine the technical adequacy of the storage facilities and the status of the fuel stored in these facilities.

2. Summary: As a part of this cross-cutting review, the staff visited facilities at Hanford, Idaho National Engineering Laboratory (INEL), and Savannah River Site (SRS).

   The comments below apply to all the facilities except CPP 666 at the Idaho Chemical Processing Plant (ICPP). This modern facility meets most of the requirements for a commercial facility. The issues at CPP 666 are not as significant as those at the other facilities.

   Major observations from these reviews are summarized below and discussed in detail in the supporting discussion section (Attachment, 3) of this report.

   a. Facility Design: The basins at each facility are old (between 15 and 45 years) and were designed as short-term (several months to a few years) storage facilities. Until now DOE did not review the facilities systematically to determine if they could adequately serve as long-term (i.e., greater than 2-3 years) storage facilities. Most basins were constructed of unlined concrete and do not have adequate leak detection mechanisms.

   b. Systems Design: Most basins do not have water treatment, electrical, or ventilation systems that meet the national consensus standards for these types of facilities. Water quality in most basins is poor and this condition has resulted in the increased degradation of the fuel. Most of the material is stored in facilities that have neither a containment nor a confinement system.

      In addition, the electrical power provided to these facilities does not meet typical requirements for a nuclear storage facility. For example, some facilities have no power provided for emergency lighting, most facilities do not provide adequate power to provide lighting for ongoing inspections of the fuel stored in the basin, and one line diagrams supplied by most facilities were of poor quality. In particular, the reactor basins at Hanford do not have ventilation systems, emergency power systems, adequate water purification systems, or fire protection systems. Radiological monitoring systems at the Hanford facilities are limited to a few high radiation monitoring stations and a very limited airborne contamination monitoring capability. National consensus standards for commercial nuclear fuel storage facilities would require each of the above systems to be in place.

In all cases, except the fuel stored in CPP 666, at least one barrier relied upon in a typical commercial facility for defense in depth was either removed from the fuel design (i.e. cladding was removed), the original basin design or deliberately removed. There are no indications that DOE has taken compensatory measures to restore the level of defense in depth.

c. Fuel Design: The fuel stored at these facilities is primarily DOE defense programs fuel (approximately 79 percent of the spent fuel is stored in the K-Basins at the Hanford Site). This fuel (Navy fuel and some research reactor and commercial fuel excluded) was designed to allow easy dissolution and processing. There was no intent for this fuel to remain in basin storage for many years; yet some fuel has remained in storage for more than thirty years. Wet storage of any of the aluminum clad fuel for periods in excess of several years results in an increased potential for corrosion. Some fuel has already degraded in the reactor disassembly basins at SRS, in PUREX and the reactor fuel storage basins at Hanford, and in the CPP 603 fuel basin at Idaho.

   Some fuel is more highly reactive than other fuels and may require special controls to ensure that an inadvertent criticality does not occur. Additional analysis of such fuel at many facilities may be warranted.

d. Safety Documentation; Outdated safety documentation at each of these facilities needs to be upgraded to meet the requirements of the latest DOE Orders. Aggressive action at some facilities, such as those at the ICPP, have been taken to upgrade their safety documentation.

e. Environmental Issues: Many facilities are leaking (e.g., K-East Basin at Hanford) or have a high potential to leak. An increased leak rate at the K-East basin could result in large release of radionuclides to the ground and in a significant environmental impact. Most of the facilities have inadequate leak detection mechanisms. Past leaks (> 1000 Ci) from the K-East basin have shown that major leaks could occur without detection by existing environmental monitoring wells. Only the CPP-666 basin and the Advanced Test Reactor (ATR) canal have adequate methods for leak detection.

f. Office of Waste Management: The Office of Waste Management (EM-37) was recently created within the Environmental Restoration and Waste Management organization. EM-37 is responsible for the long range planning for the management of spent fuel and for the internal oversight of the spent fuel storage facilities. EM-37 is not, however, responsible for the day-to-day operations of these facilities, which remain under the cognizance of the Office of Waste Operations (EM-32). Using a systematic approach to resolving the problems that exist within the DOE complex, EM-37 is primarily attempting to develop a plan to allow storage of the spent fuel until a repository is available. However, many concerns that currently exist are operationally oriented and, therefore, not under EM-37's cognizance.

g. Office of Nuclear Safety (ONS) Reviews: On August 19, 1993, the Secretary of Energy directed EH-1 to have ONS perform reviews of the spent fuel storage facilities and to inform her of the vulnerabilities associated with these basins. ONS hosted the first meeting on September 9 & 10, 1993, among EH, the operations offices, and the contractors. An initial report is to be provided to the Secretary of Energy by November 20, 1993.

3. Conclusion: More effort by the DNFSB staff is required to further quantify the issues discussed above. Significant upgrades are needed in systems and facilities at SRS, INEL, and especially at Hanford, to provide for basic protection of workers and the environment. Initial follow-on reviews by the DNFSB staff are scheduled to be conducted at Hanford in mid-November. Additional DNFSB staff reviews of other topical areas such as training and qualifications will be conducted soon for those facilities where large volumes of fuel are expected to be moved (e.g., the SRS facilities where the movement of the fuel from the basins to shipping containers will be required in support of fuel processing operations).

The data sheets used in the analysis of spent fuel storage basins are on file and are available to allow continued review of these basins.

Attachments

1. National Consensus Standards and NRC Documentation Used in this Review

2. Method of Review

3. Supporting Discussion

4. Ranking System
National Consensus Standards and NRC Documentation Used in this Review

ANSI/ANS Standards

2.19 Guidelines for Establishing Site-Related Parameters for Site Selection and Design of Independent Spent Fuel Storage Installation (Water Pool Type)

8.17 Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR fuel outside Reactors

57.2 Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants

57.3 Design Requirements for New Fuel Storage Facilities at Light Water Reactor Plants

57.7 Design Criteria for an Independent Fuel Storage Installation (Water Pool Type)

57.10 Design Criteria for Consolidation of LWR Spent Fuel

ASTM Standards

C 1004-84 Standard Matrix for LWR Spent Fuel Receiving and Storage

Regulatory Guides

1.13 Spent Fuel Storage Facility Design Basis

1.25 Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling & Pressurized Water Reactors (Safety Guide 25)

3.2 Efficiency Testing of Air-Cleaning Systems Containing Devices for Removal of Particles

3.4 Nuclear Criticality Safety in Operations with Fissionable Materials at Fuels and Materials Facilities

3.15 Standard Format and Content of License Applications for Storage Only of Unirradiated Power Reactor Fuel and Associated Radioactive Material

3.43 Nuclear Criticality Safety in the Storage of Fissile Materials

3.44 Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water-Basin Type)

3.47 Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Fuel Mixtures Outside Reactors

3.48 Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)

3.49 Design of an Independent Spent Fuel Storage Installation (Water-Basin Type)

3.50 Standard Format and Content for a License Application to Store Spent Fuel and High-Level Radioactive Waste

3.53 Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation

3.54 Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation

3.57 Administrative Practices for Nuclear Criticality Safety at Fuels and Materials Facilities

3.58 Criticality Safety for Handling, Storing, and Transporting LWR Fuel at Fuels and materials Facilities

3.60 Design of an Independent Spent Fuel Storage Installation

3.61 Stand Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask

3.62 Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks

3.67 Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities

5.52 Standard Format and Content of a Licensee Physical Protection Plan for Strategic Special Nuclear Material at Fixed Sites (Other than Nuclear Power Plants)

NRC Inspection Manual

2510 Light Water Reactor Inspection Program

2515 Light Water Reactor Inspection Program Operations

2690 Spent Reactor Fuel Dry Storage Systems Licensee Contractor and Vendor Inspection Program

86700 Spent Fuel Pool Activities

86718 Periodic Maintenance of Packaging

Attachment 2

Method of Review: The bases for this review were the technical requirements and standards that DOE and the DNFSB have agreed are applicable to defense nuclear facilities. In addition, the national consensus standards that would apply to a commercial spent fuel storage facility were also used as a basis of these reviews. Attachment 1 to this report contains a list of applicable standards and reference documents used in this review.

The review was intentionally limited to the design of the basins, the systems that support the basins, and the fuel. It specifically did not include reviews of issues that are known to be concerns at these facilities such as conduct of operations, training, and maintenance. In addition, Mr. Burnfield visited the spent fuel storage basins at the Hatch Plant and discussed issues relevant to the operation of their spent fuel storage basin. Discussions at Hatch included the concept of maintaining a defense in depth strategy to protect the public. Commercial facilities rely on several barriers to prevent a release of radioactive nuclides to the environment (i.e., the fuel matrix, the fuel cladding, the basin or container structure, and the ventilation system).

Attachment 3

Supporting Discussion: The initial discussions with DOE revealed that spent fuel was stored in several locations across the DOE complex. These included facilities at the Hanford site, INEL, SRS, West Valley site (WV), Oak Ridge, Brookhaven National Laboratory (BNL), Los Alamos National Laboratory (LANL), and Sandia National Laboratory (SNL). The specific basin storage facilities that were reviewed include:

a. The basins at the Idaho Chemical Processing Plant (ICPP) at INEL

b. The canal at the Advanced Test Reactor (ATR) at INEL

c. The K basins (both KE & KW) at the Hanford Site

d. The PUREX basin at the Hanford Site

e. The T Plant basin at Hanford

f. The F & H Canyon basins at SRS

g. The Receiving Basin for Offsite Fuel (RBOF) at SRS

h. The K, L & P Reactor basins at SRS

The staff reviewed the dry storage facilities at INEL because there is a potential that defense fuel could be moved to these facilities in the future. In addition, there is also a probability that any additional storage that is to be built at INEL may use these facilities as a model.

The staff did not review the facilities at Oak Ridge, BNL, and WV, since they contained only spent fuel generated by reactors operated by universities, or the Office of Nuclear Energy (NE), or reactors operated by the public utilities. Several spent fuel storage facilities at INEL also were also considered to fall in this category. The staff did not review the spent fuel storage areas at SNL and LANL because of the small amount of fuel stored at these facilities. In addition, later reports by DOE question the amount (if any) of spent fuel stored at NTS.

From the detailed discussion which follows on each facility the staff considers that the facilities at Hanford require the most effort from the staff. The SRS basins are also important in that they are scheduled to receive all highly enriched research reactor fuel (both domestic and foreign).

1. INEL The INEL Fuel Storage basins are the best managed fuel storage facilities in the complex. The newer facilities, ATR, Dry Storage facilities, and CPP 666 are basically equivalent to similar commercial facilities. Although the CPP 603 basin is among the oldest and has several significant problems associated with its operation, the low levels of contamination in the basin and the administrative controls applied there make this facility adequate for the storage of fuel. The dry storage locations contain spent and new fuel from commercial reactors such as Fort St. Vrain, the Light Water Breeder Reactor, and research reactor. The facility constructed for storage of the Fort St. Vrain fuel is collocated with the basin in CPP 603. It is an NRC licensed dry spent fuel storage facility.

   i. CPP 603

      (1) Facility Design: The CPP 603 facility was constructed in the 1950s. The original predicted lifetime of the facility expired in the 1980s and was extended to the late 1990s. Current plans for the facility would result in the facility being operational until approximately 2005. The facility has three separate non lined basins. The north and center basins were constructed in the early 1950s. Unlike more modern facilities which use storage racks, the fuel in these basins is stored in buckets that are suspended from a monorail by hangers. These hangers are made of either carbon or stainless steel. The South, basin constructed in the late 1950s is more modern in construction and the spent fuel stored in this basin is in storage racks similar in design to many storage racks used in the commercial industry. This basin and the basins in CPP 666 are the only basins in the DOE complex that use this more modern storage concept. Current problems related to the facility design include:

         (a) The resolution of an unreviewed safety question (USQ) concerning the failure of a carbon steel hanger, which allowed a bucket of fuel to fall approximately four inches to the floor of the basin. Each carbon steel hanger is to be fitted with a stainless steel rigging to provide the primary support of the fuel.

         (b) The canning of some Borax V fuel has degraded to the point that a piece of fuel has fallen out of the canning and now lies horizontally in the bottom of a bucket. A close packed array of this fuel, if it were to all fall into the bottom of the bucket, could result in a violation of criticality standards. The codes used to calculate Keff do not predict a criticality. The standard is Keff= 0.95 and the predicted value is Keff= 0.98.

(c) The facility lacks an accurate way to determine whether basin water might be leaking to the environment.

(2) Systems Design: The staff reviewed the following systems:

(a) Water Purification: The water filtration system has sand filters, and an ion exchange system consisting of cation exchange beds only. An anion exchange system has been identified by DOE as a required system modification and is scheduled to be added in 1996. An ultraviolet light system was added to the system in the late 1970's to combat a biological growth problem. Prior to the inclusion of the ultraviolet lighting system, chlorine and iodine compounds were added to keep the biological growth in check. This addition accelerated the corrosion of the fuel cladding. There are no water chillers connected to the water purification system.

(b) Fire Protection: The fire protection system is adequate based on a limited review.

(c) Ventilation: There is no ventilation system in the facility.

(d) Electrical: A thorough review of the electrical system in the facility could not be performed because of the quality of the documentation received.

(e) Radiological Protection Instrumentation: The facility appears to have adequate criticality, high radiation, and airborne radioactivity monitoring equipment.

The staff had the following observations related to the systems design:

(i) The concentration of dissolved radionuclides in the water is higher than desired. The conductivity of the water is approximately 600 Çmho/cm. The addition of the anion exchange system is expected to reduce the conductivity of the water to the desired level of 10 Çmho/cm. The addition of this system is also expected to reduce the concentration of dissolved radionuclides.

(ii) A review of the water purification system performed in the fall of 1992 suggested that the addition of chillers in the water purification system could result in improved prevention of biological growth.

(3) Fuel Design: Various types of spent fuel are stored in this facility. Much of the fuel is Naval fuel and is structurally sound. A recent inspection of this fuel found little or no corrosion. Other fuel in the basin is aluminum clad fuel, which has exhibited some corrosion. In addition, some fuel has been declad and is contained in aluminum cans. The oldest fuel in the facility is from the Aircraft Nuclear Propulsion plant that was fabricated in the 1950s. This fuel has exhibited significant corrosion. The staff is concerned that the resolution of an unresolved safety question involving the storage of SNAP fuel in the basin in cans that have either corroded through or may potentially corrode through has taken several months with no apparent progress.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23. It is not apparent that the documentation that exists today adequately defines the safety envelope. This documentation is being upgraded; completion of the next revision is expected in the spring of 1994.

(5) Environmental: Although no leaks have been detected at this facility, adequate leak detection mechanisms do not exist. The site will be required to hasten the planned update to their environmental documentation because of the recent court ruling.

ii. CPP 666

(1) Facility Design: The CPP 666 facility is a modern facility, which was constructed in the late 1970's and went into service in the early 1980s. The original predicted lifetime of the facility extends into the 21st century. Current plans for the facility would result in the facility being operational until a permanent repository is selected for the final disposition of spent fuel. The basin has six separate stainless steel lined basins. Each basin can be segregated from the other basins for maintenance or other modification. These basins and the south basin in CPP 603 are the only basins in the DOE complex that use rack storage (similar to the current mode of storage at commercial facilities). The aluminum and stainless steel racks do not rely on poisons for criticality control. Thus, they do not have the problem of increasing reactivity from the loss of poisons in the racks that occurred in the commercial industry. Current problems related to the facility design include:

(a) A small leak was detected between the liner and the basin wall. The water is periodically collected. The concentration of radioisotopes in the leakage is very low (< 10-6 ÇCuries/ml). Although no known leaks exist in the concrete wall of the basin, the site is taking appropriate measures to determine how best to correct this situation.

(b) At the current rate of return from Naval vessels and with the plans to transfer fuel from CPP 603 to CPP 666 the basin in CPP 666 will fill up late in this decade. The site developed plans to ease the burden on the CPP 666 basins by reracking the basins using all stainless steel racks with a closer packed array. Following this reracking project, the CPP 666 basins will be able to store the expected fuel returns for the foreseeable future. The analysis of potential problems that may arise both during operations and during a design basis earthquake is continuing to ensure that an unintentional criticality does not occur under off normal conditions.

(2) Systems Design: The staff reviewed the following systems:

(a) Water Purification: The water filtration system has stainless steel disk type filters similar to those used in commercial nuclear applications. The ion exchange system has both cation and anion exchange beds. The water conductivity is measured continuously and is near 1 Çmho/cm. An ultraviolet light system combats a biological growth problem that is more of a problem at INEL than at the other sites. There are two water chillers connected to the water purification system.

(b) Fire Protection: The fire protection system is adequate based on a limited review .

(c) Ventilation: This is the only spent fuel storage basin in the complex that has a confinement system in place to provide additional protection in the case of an accident. The stack is monitored; however, current plans call for the removal of the monitoring system since it is not required for the fuel storage basins.

(d) Electrical: A thorough review of the electrical system in the facility could not be performed because of the quality of the documentation received. Additional documentation would be required to complete the review.

(e) Radiological Protection Instrumentation: The facility appears to have adequate criticality, high radiation, and airborne radioactivity monitoring equipment.

(f) The staff had the following observations related to the systems design:

Although no real sludge was observed a film is developing on the bottom of the pool. The site stated that this film will require monitoring to ensure that it is kept to a reasonable level.

(3) Fuel Design: The fuel contained in this facility is varied in design. Much of the fuel is Naval fuel and is structurally sound. Other fuel in the basin is aluminum clad fuel that has exhibited some corrosion in other basins, but none has been observed so far in this basin.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23. It is not apparent that the documentation that exists today adequately defines the safety envelope. This documentation is being upgraded; completion of the next revision is expected in the spring of 1994.

(5) Environmental: The site will be required to hasten a planned update to their environmental documentation because of the recent court ruling.

iii. ATR Transfer Canal

(1) Facility Design: The ATR transfer canal was constructed in the 1960s and is collocated with the Advanced Test Reactor. Current plans for the facility would result in the facility being operational for the foreseeable future. Although the mission of the ATR is uncertain. The canal is actually a nonlined basin that serves to hold the fuel from the reactor as well as test specimens (when required). The canal is constructed above a basement area that allows adequate inspection of the underside of the canal to ensure that leaks to the environment do not exist. The canal is not intended to become a long-term storage facility for either fuel or test specimens. Fuel which is no longer required for reactor operation is transferred to the basins at ICPP. The specimens are usually retrieved by the test sponsor expeditiously.

(a) As with CPP 603, a possibility exists that seepage of water into the prestressed concrete could result in a degradation of the carbon steel rebar. The site has not conducted an inspection to determine what, if any, degradation exists.

(2) Systems Design: The Staff reviewed the following systems:

(a) Water Purification: The water filtration system has two filters and 6 small mixed bed ion exchangers that are located in the bottom of the canal. An ultraviolet light system is used to combat a biological growth problem. There is one small heat exchanger connected to the water purification system. Water from this system is also passed through the site cooling tower. Two primary problems exist with this system.

(i) The ion exchange system requires frequent maintenance. This maintenance is expensive and somewhat high in exposure. The site plans to replace the system with a more maintenance free system.

(ii) In the past the heat exchanger was operated during fuel cutting operations. This resulted in the heat exchanger becoming highly contaminated. Temporary lead shielding was added to the heat exchanger because of the high radiation fields associated with the contamination. It was not clear whether an adequate structural analysis was performed for the heat exchanger, its supports and the associated piping after the additional loading was applied.

(b) Fire Protection: The fire protection system is adequate based on a limited review.

(c) Ventilation: There is no ventilation system in the facility that covers the fuel transfer canal.

(d) Electrical: A recent review by the contractor of the electrical distribution system resulted in several modifications to ensure that adequate electrical power is distributed in case of an outage.

(e) Radiological Protection Instrumentation: The facility appears to have an adequate criticality monitoring system. The high radiation and airborne radioactivity monitoring equipment are old and the site is in the process of replacing this equipment.

(3) Fuel Design: The fuel contained in this facility is designed specifically for operation in the ATR. Since the fuel is not stored for long periods of time. It exhibits little corrosion while in the transfer canal. A high quality water treatment system is required for this facility to ensure that localized corrosion does not begin prior to long-term storage at ICPP.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23. It is not apparent

that the documentation that exists today adequately defines the safety envelope, which is based on reactor accidents. A complete probabilistic hazards analysis has not yet been performed for the facility.

(5) Environmental: Adequate leak detection mechanisms do exist to ensure that no leaks to the environment have occurred. The environmental documentation is being upgraded as a part of the site wide Environmental Impact Statement that is being completed.

iv. Dry Storage Areas: There are two major types of dry storage area at ICPP the first (an outside facility) was constructed to handle some commercial and research reactor fuel and currently contains the fuel from the Light Water Breeder Reactor and some Peach Bottom fuel. There are two major designs of dry storage at this facility. Type 1 storage has a single shell tube inserted into the ground with a flanged top. The fuel is stored vertically and only minimal instrumentation is installed. In-leakage has been observed in these tubes. Type 2 storage is of double walled construction and has a more complete instrumentation package. No leakage has been detected in these storage tubes. A review is being conducted to determine how best to transfer the fuel out of the type 1 storage. Besides this storage, a modern indoor facility was constructed to house the Fort St. Vrain fuel. This facility is collocated with the CPP 603 facility. The facility has a modern control room and up to date handling equipment and systems. This NRC licensed facility is included in the report only for completeness.

2. Hanford The Hanford facilities are in effect the worst fuel storage facilities in the complex. At the K basins the concept of defense in depth is nonexistent since material is known to be leaking to the environment. The Purex basins and the T Plant basins are located within canyons but have essentially no supporting systems.

i. K Basins The K basins are effectively two facilities K-East and K-West. Because K-East is known to be in worse condition than K-West this review focused on K-East. The K-East basin has no defense in depth remaining. The facility contains fuel which is broken and corroded. A 14 inch sludge layer coats the basin floor. This sludge is contaminated with transurance wastes. The basin leaks periodically to the ground water. Unless otherwise indicated, the discussions in this section of the report are primarily related to K-East.

(1) Facility Design: The K-reactor basins, K-East and K-West, are old facilities that were constructed in 1951. The original predicted lifetime of the facilities expired in the 1970's and has since been extended. Current plans for the facilities would result in the facilities being operational for the foreseeable future and would include the storage of fuel that is currently stored at PUREX. The basins are partially lined. The unlined portions were coated originally. The spent fuel is stored in canisters that are stored in buckets. The K-East basin is by far in worse condition than the K-West

basin, which was reconditioned in the late 1970s.

The K-East basin is currently leaking and no detection mechanism exists to accurately detect the material that has leaked into the soil. The calculation methods used to determine the leak rate are based on a lake effects model and may not be indicative of the actual leak rate experienced by the facility. The K-East basin experienced major leaks in the 1970's (approximately 2500 Curies of Sr90 and Cs137). The basin was repaired to correct this leak, however, no significant clean-up of the environment was performed. The current concentration of radioactive isotopes is extremely high. Approximately 200 Curies of radioactive isotopes (including Pu) are removed per month by the water filtration system. By comparison, the total curie loading of the CPP 603 basin water is 0.6 Curies. Current problems related to the facility design include:

(a) The resolution of an unreviewed safety question (USQ) concerning the loading of a portion of the K-East basin used for back flushing the sand filters with a quantity of Pu beyond the OSR limit (greater than 1.5 Kg). Back flushing operations were terminated and at the current filtration loading rate the sand filter will exceed its OSR Pu concentration limit sometime this fall.

(b) The criticality safety criterion is that Keff does not exceed 0.98 when analytically modeled. The site stated that it is assumed that this value is acceptable based on the low enrichment of the fuel. Similar commercial facilities use a value of Keff equivalent to 0.95, as does ICPP.

(c) There is a possibility that the seepage of water into the prestressed concrete could result in a degradation of the carbon steel rebar.

(d) A significant amount of sludge (an estimated 1 MTU equivalent of Pu as well as other radioisotopes) is in the bottom of the K-East basin. The cleaning up of this sludge is expected to be a high risk job resulting in potential high exposure rates to the workers.

(e) Penetrations may exist through the walls of the basin for the support of structural members. Recent documentation obtained regarding commercial nuclear facilities suggests that in other facilities this type of penetration was considered to be detrimental to the structural soundness of the facility in a seismic event.

(2) Systems Design: The staff reviewed the following systems:

(a) Water Purification: The water filtration system for each facility has one sand filter, two cartridge type filters, and a mixed bed ion exchange system, which draw water from the main body of the pool and from surface skimmers. There is one water chiller connected to the water purification system. No organic growth problem has been identified.

(b) Fire Protection: There is no fire protection system at these facilities. Fire mains are located outside the building.

(c) Ventilation: There are no ventilation systems in these facilities.

(d) Electrical: Westinghouse performed a thorough review of the electrical system in these facilities and all motor controller centers have been walked down and the loads verified. This review resulted in major efforts being scheduled to reduce the electrical supply to the basins from that was previously used for the reactor plant. There is no emergency power system supporting these facilities. The radiological monitoring equipment does not appear to be connected to a back up power supply of any type.

(e) Radiological Protection Instrumentation: There are no fixed criticality monitors in the facilities; there are a limited number of airborne contamination monitors, there are a limited number of high radiation monitors in the facility.

(f) The following observations relating to the systems design were noted:

(i) The concentration of the dissolved radionuclides in the water is higher than at any other facility. Approximately 10% (or 105 Ci) of the radiological loading of the fuel is thought to be located in the sludge. As stated before this compares to a loading of 0.6 Ci in CPP 603.

(ii) The systems that are typically installed at other DOE facilities are lacking in quality or are missing at these facilities. Significant upgrades would be required to bring this facility up to the standards used at the other DOE sites.

(3) Fuel Design: The fuel is a mixture of reactor grade fuel and weapons grade fuel taken from the N-reactor and earlier single pass reactors. Much of the fuel is damaged and corroded. It is Zircaloy-2 clad fuel and approximately 50% of the fuel is known to have some damage. The canning in the K-East basins allow the corrosion products to disperse throughout the basin, which has resulted in the high concentration of

radionudides in the basin water. The fuel in the K-West basin has been reencapsulated with newly designed containers which limit the flow through the cans. But, some cans in this facility have indications that gas tight mechanism is beginning to loose its effectiveness.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23. It is not apparent that the documentation that exists today adequately defines the safety envelope. A revision to the facilities Safety Analysis Report (SAR) is not scheduled to be implemented until 1996.

(5) Environmental: Major leaks from these facilities are known to have existed in the past. An Environmental Assessment was issued in 1992. The subsequent EIS is not expected to be completed for 8-15 years. The facilities generate approximately 4-6 sets of spent ion exchange columns per year because of the TRU loading in the basins. These columns are classified as TRU waste. Approximately 40 of these canisters are in storage on site.

ii. PUREX Basin The PUREX basin is a small basin located in the PUREX canyon. As such, it poses little risk to the safety of the worker or the public. However, several observations should be made. The fuel stored in this basin remains from the operation of the K-reactor (not the N-reactor), it is therefore approximately 25 years old. The fuel is stored in buckets, which were hung cantilevered from the wall of the basin. Pieces of scrap handling gear were stored above the fuel, lying on I beams that spanned the basin. Neither the I beams nor the material stored on the I beams was secured to prevent them from dropping onto the fuel in the event of a seismic occurrence. The basin has no supporting systems (ventilation, fire protection, radiological monitoring, or electrical) of any kind. The site stated that the fuel will be transferred to the K basins for long-term storage, as the PUREX facility is preparing for decontamination and decommissioning.

Besides the fuel in the basin, several pieces of scrap fuel remain on the floor of the PUREX canyon. This fuel is considered by DOE-RL and WHC to be pyrophoric. No fire protection system exists for this canyon. This concern was raised with DOE headquarters (EM-37) and DOE-RL personnel in July 1993 and later with ONS. To date no explanation was provided by DOE or Hanford regarding the acceptability of this fuel remaining on the floor of the facility for an extended period.

iii. T Plant Basin The T-Plant basin is similar to the PUREX Basin in many ways. However, the basin does contain a small water purification system. This basin contains the fuel from the Shippingport PWR-2 plant. This facility is of interest because it is collocated with a facility that houses very highly contaminated material from PUREX and other defense nuclear facilities. In the same canyon separated only by a corrugated metal wall, 2500 pounds of sodium are stored in bottles. It is not known what effects would be realized on the highly contaminated material or on the fuel basin in the event, of a seismic event since that end of the building was closed when the Liquid Metal Reactor Program ceased operations, and no analysis of the facility has been performed. In addition, the T-plant basin is leaking. This leak is contained within the building.

b. SRS: The basins at SRS are also old being built in the 1950s and early 1960s. They do not have adequate procedures or technical equipment to preclude the degradation of the defence in depth concept. The basins at Savannah River are important because they will most likely receive all research reactor fuel (both domestic and foreign) in the foreseeable future.

i. F&H Canyon Basins The canyon basins at SRS are upgraded facilities similar in design to the basins at the PUREX facility. During the 1960's, however, the basins were upgraded to include a basin liner. They were meant to hold fuel/targets only while awaiting processing in the H and F canyons. They are physically located within the shielded wells of the canyon and therefore pose little risk to the health and safety of the workers. The basins have adequate systems support, provided the H&F Canyon facilities are operated soon. If delays are encountered beyond one to two years, additional systems may be required to ensure that the fuel does not experience the same corrosion problems that have been encountered in the reactor facilities at SRS.

ii. RBOF Basin

(1) Facility Design: The Receiving Basin for Offsite Fuel (RBOF) facility is an old facility that was constructed in the 1960s. Current plans for the facility would result in the facility being operational for the foreseeable future, since it is scheduled to receive fuel from foreign research reactors as well as United States university reactors. The basin is constructed of unlined concrete which at one time was coated. However, in several instances the coating has been severely damaged. Because of the varieties of different fuels and target material stored in this facility, several different storage mechanisms are employed. Most of the fuel is stored in horizontally oriented racks in the center. However, some of the material is stored on the bottom of the basin, and at the time of the review, one fuel canister was stored vertically against the wall of the basin and was held in place by tethering the top of the canister with a length of nylon braid line attached to the hand rail.

(a) There is a possibility that the seepage of basin water into the prestressed concrete could result in a degradation of the carbon steel rebar. A study is underway to determine what effects may have occurred. To date, the results of the study indicate no significant degradation of the rebar.

(b) The facility lacks an accurate way to determine whether basin water might be leaking to the environment.

(2) Systems Design: The staff reviewed the following systems:

(a) Water Purification: The water filtration system has a regeneratable filter, which uses a unique method of capturing material such that regeneration of the filter can be accomplished locally without the creation of excess waste. A mixed bed ion exchange system (i.e. both anion cation resins created) is used. The exchange media is regenerated by because of the low levels of material suspended in the water the regeneration is only required approximately once or twice per year. No water chillers are used at this facility and no biological growth problem has been observed.

(b) Fire Protection: The only fire protection system is external to the facility.

(c) Ventilation: The RBOF ventilation system is a once through system which has the intake air cooled dehumidified and filtered. The exhaust air is prefiltered and NEPA filtered.

(d) Electrical: A thorough review of the electrical system in the facility could not be performed because of the quality of the documentation received.

(e) Radiological Protection Instrumentation: The facility appears to have adequate criticality, high radiation, and airborne radioactivity monitoring equipment.

(f) The staff had the following observations related to the systems design were noted:

(i) The equipment for regenerating the mixed fuel resin is also used for regenerating the reactor fuel storage basins ion exchange equipment. The reactor basin ion exchangers are mounted on trailers, which are hauled to the RBOF Facility for regeneration. Because the reactor basin ion exchange resin beds are very highly loaded, the facility cannot turn these trailers around in a timely manner and the reactors are often left without an operational ion exchange system. Other facilities in the DOE complex (ICPP) and in the commercial nuclear industry have decided to refrain from the regeneration of resin in favor of resin disposal. It is not understood why SRS continues to regenerate their resin.

(3) Fuel Design: The fuel contained in this facility is varied in design. Much of the fuel is university and research reactor fuel, is clad with zircaloy or other stainless alloys, and is considered structurally sound. Recent inspections of this fuel found little or no corrosion. Other fuel in the basin is aluminum clad fuel that has exhibited some corrosion. In addition, some fuel has been declad and is contained in aluminum cans.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23, Nuclear Safety Analysis Reports. It is not apparent that the documentation that exists today adequately defines the safety envelope. This documentation is being upgraded.

(5) Environmental: Although no leaks have been detected at this facility, adequate leak detection mechanisms do not exist to ensure that no leaks to the environment have occurred. The nearest monitoring wells are several hundred yards away from the facility.

iii. Reactor Basins Three reactor disassembly basins at SRS (K, L, and P) currently contain spent nuclear fuel and/or target material. The L reactor disassembly basin was refurbished in the 1980's and is in significantly better condition than either of the other two basins. A description of these basins follows:

(1) Facility Design: The reactor basins at SRS but were constructed in the 1950s. The original predicted lifetime of the facilities has expired but has been extended. The site stated that it is expected that the spent fuel will be treated in the canyons during the next several years, but efforts are underway to provide a dry storage capability to replace these basins. In addition, the basins store highly radioactive radionuclides such as Co60 pellets. The basins are not lined; however, they were once coated, L basin was sandblasted and recoated in the early 1980s. The basins use a monorail system that suspends the fuel elements from hangers in a vertical orientation until structural F&M pieces can be cut off the ends and the fuel stored horizontally in the bottom of the basin. These hangers are made of carbon steel that has resulted in a galvanic couple between the aluminum clad fuel and the hanger. The fuel exhibits significant amounts of corrosion at the points of contact, and although no structural degradation has been observed, it is inevitable that the corrosion will eventually result in structural degradation of the fuel. Target material has been separated into individual slugs that are stored in carbon steel buckets in a portion of the basins away from the fuel elements. All movement of fuel or target

material is accomplished by using handling equipment attached to the monorail. Current problems related to the facility design include:

(a) Based upon the problems identified with the carbon steel hangers at INEL, a more detailed inspection of the hangers-used at SRS may be in order.

(b) There is a possibility that the seepage of basin water into the prestressed concrete could result in a degradation of the carbon steel rebar

(c) The facility lacks an accurate way to determine whether basin water might be leaking to the environment. In fact, environmental personnel suggested that it was probable that the L reactor basin has a significant leak to the environment. The personnel operationally responsible for the basins indicated that prior to the DNFSB review they did not know of any leaks in the basin.

(d) No seismic qualification has been performed on the basins.

(2) Systems Design: The staff reviewed the following systems:

(a) Water Purification: The water filtration system at each basin has two sand filters. But, at the K reactor basin, one sand filter housing has corroded through, and the remaining filter, which is still in operation, has exceeded its useful lifetime. At P reactor basin one filter has leaked and only one filter is in operation. The L reactor basin filters were replaced in the early 1980s. As indicated in the RBOF section of this report, mixed bed ion exchange systems exist for the reactor basins. However, they are in service only several days a month and, therefore, the conductivity of the basins is several hundred Çmho/cm. This contributes to the corrosion of the fuel. In addition, the make up to the basins is provided from in leakage from other systems in the plant and from filtered well water that has not been deionized. The fill water at most other sites in the complex and at the commercial facility that was visited is limited to deionized water to reduce the loading on the ion exchanger in the basin water purification systems. National consensus standards would require the use of deionized water as fill. There are no water chillers in operation for the water purification system. Plans were underway to begin operation of the K-reactor disassembly basin chiller system to allow better mixing of the basin water, however, the cooling water side of the heat exchanger was blanked off so cooling will not occur.

(b) Fire Protection: The fire protection systems are limited to fire mains external to the building. An upgrade had previously been planned but has since been cancelled.

(c) Ventilation: Ventilation system exist for the reactor basin, however, the ventilation is not filtered and does not constitute either a contaminant or a confinement system.

(d) Electrical: Based on a limited review, the electrical systems seem adequate. Back up power is provided to the Nuclear Instrumentation Monitoring System (NIMS), which provides the criticality monitoring protection. However, emergency lighting systems that would allow personnel to more safely egress and exit in the case of an emergency was cancelled because of funding constraints. The emergency lighting system is physically located in the facilities but has not been connected.

(e) Radiological Protection Instrumentation: The facility appears to have adequate criticality, high radiation, and airborne radioactivity monitoring equipment.

(f) The staff had the following observations related to the systems design:

(i) The concentration of dissolved radionuclides in the basin water is higher than desired. The conductivity of the water is several hundred Çmho/cm. The actual values of radionuclide concentration and conductivity are dependent on the amount of time the ion exchange system can be maintained on line.

(g) A ventilation system modification was halted when it was determined that the facilities would be placed in standby operations. The purpose of the upgrade was to ensure that the airborne radionuclide concentration was better controlled in the facility.

(3) Fuel Design: The fuel and target material contained in these facilities is all material that was originally irradiated in the three reactors at SRS. Although significant amounts of corrosion have been observed, it is considered by the site to be structurally sound. A recent inspection of the fuel in the horizontal storage on the racks on the floor of the basin found little or no corrosion. As noted earlier, the fuel stored vertically in the basin is aluminum clad fuel in contact with carbon steel hangers and has exhibited some corrosion. The oldest fuel in the facility is only several years old; but, prior to the current standdown of the processing canyons

the longest period individual fuel elements were left in the basins was several months. The corrosion rate in these facilities is much greater than at other facilities.

(4) Safety Documentation: The outdated safety documentation does not meet DOE requirements as defined in DOE Order 5480.23. It is not apparent that the documentation that exists today adequately defines the safety envelope. This documentation is being upgraded.

(5) Environmental: Although no leaks have been detected at this facility, adequate leak detection mechanisms do not exist to ensure that no leaks to the environment have occurred. As noted above, significant disagreement exists within the staff at SRS regarding the ability of the equipment to detect a leak.

Ranking System: To allow DNFSB staff management to quantify the priority in which effort should be expended in evaluating the issues discussed in this report, a ranking of the facilities is provided. In the following table risk, ranking factors suggest the degree of risk that I consider possible. A ranking factor of 1 is low where as a risk ranking factor of 4 is high.