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7. Abstract

This document provides the basis for a change to Operations Safety Requirements (OSR), WHC-SD-WM-OSR-006. The change is to allow the handling and storage of unsealed capped canisters. The current OSR requires that cansisters for stored fuel be sealed and purged (encapsulated) to provide a water free space in the top of the cansiters.

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OSR ENCAPSULATION BASIS - 100-KW

1.0 PURPOSE AND SCOPE

The purpose of this report is to provide the basis for a change in the Operations Safety Requirement (OSR) encapsulated fuel storage requirements in the 105 KW fuel storage basin which will permit the handling and storing of encapsulated fuel in canisters which no longer have a water-free space in the top of the canister.

The scope of this report is limited to providing the change from the perspective of the safety envelope (bases) of the Safety Analysis Report (SAR) and Operations Safety Requirements (OSR). It does not change the encapsulation process itself.

2.0 SUMMARY

The OSR requirements for the storage of encapsulated fuel at KW should be changed to permit the handling and storage of capped canisters which are not leak tight in the main storage basin. Such a change is consistent with the bases, criticality limits, safety analysis and safety classification presented in the OSR and SAR. The change is also intended to cover the handling and storage of canisters with broken locking bars. This is not to restrict the handling of individual canisters that have had their caps accidentally removed during storage and handling.

3.0 DISCUSSION

The following is a discussion of the need for and basis for a change in the OSR storage requirements for KW.

3.1 Background

The encapsulation process involves canister barrel capping and then purging, with nitrogen, to provide a water-free space in the top portion of the canister barrel. This isolates the water in the canisters from the basin water and prevents the escape of non-gaseous fissionable and/or radioactive material.

Safety Limit Section 2.1.2 of WHC-SD-WM-OSR-006 Rev 0-A, Operational Safety Requirements, state that the storage in 105-KW shall be in Mark I or II canisters which shall be sealed and purged (encapsulated) to provide a water free space in the top of the canister.

A number of canisters with broken locking bars are also present in the basin, see Occurrence Report RL--WHC-KBASINS-1991-1056, Broken Locking Bars on Mark II Canisters. It is assumed that an unknown number of these are no longer sealed.

3.2 Need for Change

Characterization activities will require encapsulated fuel in the KW basin to be uncapped for removal of fuel elements from the canister for shipment to 300 Area for subsequent analysis (WHC-SD-SNF-FRD-007 Rev 0, Functions and Requirements for K Basins SNF Characterization Shipping, January 1995). Other characterization activities will draw samples of gas/liquid from the closed canisters in KW basin for collection and analysis (WHC-SD-SNF-AP-001 Rev 0, Sealed Canister Liquid Sampling for Fuel Characterization Shipments, January 1995). The intent is to repurge and/or recap these canisters, however complete encapsulation in new canisters is not possible at present at KW in case new caps won't seal. A concern exists that a problem could be encountered during reencapsulation or a canister valve could fail. With the existing OSR requirement such occurrences would require the fuel elements to be relocated to a new canister. This process would result in a significant introduction of radionuclides and sludge into the relatively clean KW basin. Encapsulation equipment for new canisters has never been installed at KW, thus the reencapsulation would cause a delay in the characterization activities while equipment is installed.

The remaining corrective actions for the broken locking bar occurrence will be subject to existing OSR requirements and hence may require reencapsulation in new canisters.

3.3 Safety Bases OSR/SAR

The K Basin safety basis documentation which consists of WHC-SD-WM-SAR-062 Rev 1, Safety Analysis Irradiated N Reactor Fuel, and WHC-SD-WM-OSR-006 Rev 0-A, Operational Safety Requirements - 100-KE and 100-KW Fuel Storage Basins, were reviewed for areas relevant to encapsulated fuel. The results are summarized below, with complete citations of sections or paragraphs provided in Attachment 1.

Safety Limits Section 2.1.2 of the OSR states that KW Fuel Storage Basin is authorized for the storage of spike and lower enriched fuel stored in Mark I or II canisters which shall be sealed and purged (encapsulated) to provide a water free space in the top of the canister. It further states that fuel canisters be decapped and stored (after decapping) in the decapping station area only. The Basis for the section, page 16 of 56, 3rd paragraph, only states that all future shipments of encapsulated fuel will be in Mark II canisters with a positive locking lid which will preclude dumping the fuel from the canister.

OSR Limiting Condition for Operation (LCO) Section 3.7.3 allows a longer upper limit service time for ion exchange and filtering system components for KW. This implies that there is less fissionable material concentration, Pu for the case of the LCO, in the KW basin water than for KE. This is in fact due to encapsulated fuel, however, the basis section does not address any reason for the difference between KW and KE.

Design Feature Section 5.4 of the OSR states that encapsulation of the spent fuel elements in the modified or new design fuel canisters is intended to prevent the escape of solid and dissolved radionuclides into the KW Storage Basin. Gaseous fission products are vented from the fuel canisters and dissipated through the building ventilation system.

The SAR, WHC-SD-WM-SAR-062 Rev 1, addresses encapsulation in Sections 5.1 and 5.3.3 as a difference from 100-KE that reduces the release of contaminants into the cooling water and consequent load reduction on ion exchange and filtering systems. Also provided is a significant reduction in personnel exposure. Sections 5.7 provides details of decapping/recanning at 100-KW, section 5.7.4.1.1 requires the decapping station to meet hemispherical safe mass storage limits of Table 5.3 that includes limits for the higher enriched MK 1A fuel and does state that all canisters containing fuel must be encapsulated before being returned to the main basin. Section 5.7.4 states that criticality limits would be the same for 100-KE as those for 100-KW if the higher enriched Mark 1A is introduced into 100-KE. Section 5.7.4.2 states that sludge layer limits, due to higher enriched MK 1A, apply at 100-KW even though fuel is encapsulated. The criticality limits in vessels, pumps, and piping are based on Pu only as addressed in Section 5.7.4.2. Section 7.0 extends the Pu only basis to criticality limits for filter media. Section 8.1.4 states that encapsulation is intended to prevent the escape of solid and dissolved radionuclides into the basins, gaseous fission products are vented and release of non- gaseous radionuclides into KW storage basin water can take place only through a leak in a canister or cap assembly.

Addendum 2 of the SAR which is WHC-SD-NR-SEL-001, Safety Equipment List for K Area, identifies the canisters as Safety Class 3 components.

3.4 Broken Locking Bars

Occurrence Report RL--WHC-KBASINS-1991-1056, Broken Locking Bars on Mark II Canisters addresses the discovery and corrective actions because of the discovery of broken locking bars on several canisters in KW basin. It is presumed that some of the seal will fail upon breakage of the locking bars. The basin storage of potentially flooded canisters with broken locking bars is accepted pending completion of the remaining corrective actions. The final occurrence report has been issued and approved.

4.0 EVALUATION

The OSR Safety Limit Section 2.1.2 defines encapsulation as capped canisters that are purged and sealed to provide a water free space in the top of the canister and limits main basin storage to encapsulated canisters. This definition and/or restriction is unnecessarily limiting for the following reasons.

- There are no surveillance requirements to assure that the water free space is maintained.

- o The criticality limits for KW are different from KE, which does not have encapsulation, only because higher enrichment fuel can be stored in KW.

- o The bases only address the need for future shipments to be encapsulated.

- o None of the SAR criticality analyses or non-criticality accident analyses take credit for encapsulation or even capped fuel.

- o The OSR and SAR state that the intent of encapsulation is to minimize release of radioactive isotopes to basin water, which is an operational ALARA and cost concern not an OSR safety concern.

- o The affects of dissolved fuel material on criticality limits for ion exchange equipment and filters is the same for both KE and KW because the limits are based on Pu only.

- o The requirement, at a minimum, for capping the canisters that are to be stored in the basin is expected to limit the exchange of canister water with the basin water such that the longer upper limit for service time of ion exchange and filter systems is still valid.

The above provides justification to change OSR Safety Limit 2.1.2 to allow the storage of unsealed capped canisters. As discussed this is consistent with the bases, criticality limits, safety analyses and safety classification presented in the OSR and SAR. The presence of the cap itself provides an unspecified measure for limiting the canister water exchange with the basin water even without sealing.

It should be noted that the new basis provided would support the storage of all open rather than all encapsulated canisters in KW just as it does for KE.

A change in the OSR would in no way change the programmatic or operational encapsulation requirements.

OSR CITATIONS RELEVANT TO FUEL IN CLOSED CANISTERS WITH FAILED SEALS

From SAFETY LIMITS Section 2 of OSR

Specifications:

2.1.2 The KW Fuel Storage Basin is authorized for the storage of spike and lower enriched fuel

0.71 w/o U-235	Mark IB and IVB
0.95 w/o U-235	Mark IC and IV
1.25 w/O U-235	Mark IA (0.95 w/o U-235 Inner)

stored in Mark I or II canisters which shall be sealed and purged (encapsulated) to provide a water free space in the top of the canister. Fuel canisters shall be decapped and stored (after decapping) in the decapping station area only.

From bases for OSR Safety Limits Section 2

All future shipments of encapsulated fuel will be in Mark II canisters with a positive locking lid which will preclude dumping the fuel from the canister.

From OSR LCO Section

3.7.3 A cartridge filter, ion exchange module or pre-filter shall not be in service more than six months in 100-KE or one year in 100-KW.

From Design Features Section of OSR

5.4 Fuel Encapsulation

N Reactor spent fuel elements destined for storage in the KW basin will be encapsulated in standard N Reactor fuel storage canisters modified by welding a seal plate on the bottom and installing a sealing cap on the top of the canister. New designs of fuel canisters incorporate these features.

Encapsulation of the spent fuel elements in the modified or new design fuel canisters is intended to prevent the escape of solid and dissolved radionuclides into the KW Storage Basin. Gaseous fission products are vented from the fuel canisters and dissipated through the building ventilation system.

SAR CITATIONS RELEVANT TO FUEL IN CLOSED CANISTERS WITH FAILED SEALS

5.0 STRUCTURE, COMPONENTS, AND SYSTEMS

5.1 General

The KW and KE reactor facilities were originally of essentially the same design and the modifications made to the KW facility under Project H-508 and to the KE facility under Project H-501 were basically the same.

Significant differences between the KE and KW facilities are:

- A pliable epoxy seal has been applied to the KW concrete basin,
- A pliable epoxy seal has been applied to the KE discharge chute,
- The KE storage racks have been filled with open (unencapsulated) canisters,
- Only encapsulated canisters of fuel elements are stored in KW,
- The decapping station in KW.
- A new roof was installed over the basin in KW.
- The KW basin has tapered walls.

The epoxy sealing of KW Basin and the use of encapsulated canisters are improvements made due to experience at KE. The epoxy seal reduces the probability of basin leakage and will facilitate decontamination on deactivation. The encapsulated canisters will significantly reduce the release of radioactive contaminants into the cooling water and consequent load reduction on ion exchange and filtering systems. It also provides a significant reduction in personnel radiation exposure.

5.3.3.3 Water Quality

Prior to storing N Reactor fuel in the cooling pools, the pool floors were cleaned. It is expected that some debris will be introduced to the pool during the transfer and storage of the irradiated fuel elements. KW should be the cleaner of the two facilities since only encapsulated canisters will be stored in it. However by controlling the pH and temperature and passing the water through filters in the recirculating system, the ion exchange columns and the sand filter, the water in each facility will be maintained at an acceptable quality as defined in the facility process standards.

5.4.2 Component Description

Following is a brief description of the major components that make up each fuel handling system.

5.4.2.1 Storage Canister (Figure 2.1)

The original N Reactor fuel storage canisters, designated Mark 0 (shown in parts A and B of Figure 2.1), were modified by welding a seal plate on the bottom and a sealing cap on the top, as shown in part C of Figure 2.1. A vent was provided on the cap to permit escape of gases generated by corrosion, without water interchange between the canister and the basin. Fittings were also provided for the introduction of solutions or gases into the canister or for sampling the solution in the canister. These modified Mark 0 canisters were designated Mark I canisters. The Mark II encapsulated canister (part D of Figure 2.1) is currently being used. It is similar to the Mark I encapsulated canister except that it uses new stainless steel body cylinders and an improved cap, closure and gasket assembly.

5.7.4 Safety Analysis

Introduction of Mark IA fuel into KE has been evaluated for nuclear criticality safety limits in those areas in which this higher enriched fuel will be processed, stored, or transported. Additionally, an analysis of the impact of sludge and dissolved corrosion products on criticality was performed to take into account the higher enriched sludge which could result from decapping canisters containing Mark IA fuel. Finally, a safety analysis of the new auxiliary ion exchange modules, located on the tracks of the northern rail spur, was completed.

5.7.4.1 Effect of Decapping Station Activity on Basin Operations

5.7.4.1.1 KW Basin

The decapping station must meet the hemispherical safe mass storage requirements of Table 5.3. All canisters containing fuel must be encapsulated before being returned to the main basin.

Canisters containing Mark IA scrap may be significantly more reactive than canisters filled with unbroken fuel. They require separate storage areas and may not utilize hanging storage. Operational Safety Requirements and Process Standards specify how these requirements are met.

5.7.4.1.2 KE Basin

If decapping of KW canisters is initiated in KE the criticality limits will require changes because of the introduction of the higher enriched fuel assemblies (Mark 1A) into the basin. The limits currently established in the segregation area are based on Mark IV fuel only. Therefore, introduction of Mark IA fuel into KE Basin was evaluated to take the higher enriched Mark IA fuel into account. Table 5.3 shows how the hemispherical safe mass limits have changed. As can be seen, there is a significant decrease in the safe mass of assemblies, outers, and scrap. Specific requirements must be given governing the storage of canisters containing Mark IA scrap. These canisters will be the most reactive in the basin. They will require separate storage areas and may not utilize hanging storage. Operational Safety Requirements and Process Standards will specify how these requirements will be met.

5.7.4.2 Analysis of Effect of Higher Enriched Dissolved Fuel

If the uranium to plutonium ratio, as found in the spent fuel, is maintained, any basin operation, including corrosion of fuel elements and sediment buildup, can be conservatively covered by using unirradiated uranium critical mass limits. However, it may be possible for certain chemical reactions to occur whereby the uranium to plutonium ratio in solutions and sludges is perturbed. Therefore, conservative assumptions must be made to protect against possible buildup of higher concentration of plutonium in vessels, pumps, and piping. Since no pre-knowledge of how much the uranium to plutonium ratio may be perturbed is available, the most conservative plutonium limits must be followed.

Table 5.4 shows the nuclear criticality safety limits established using the above criteria. Operational requirements for periodic monitoring of gamma radiation from all pumps, and piping is performed to provide trend information to indicate any radioactive material buildup.

Sludge layer limits apply to KW Basin only, even though use of encapsulated canisters in KW has significantly reduced the sludge buildup problem. These limits apply to the storage of 1.25 percent enriched fuel. At the present time, storage of 1.25 percent enriched fuel is limited to the 105-KW Basin.

These limits are very conservative and will ensure safe operation of the equipment and areas analyzed.

8.1.3 Canister Drop

Dropping multiple canisters containing spike fuel from the one over three storage configuration onto a full density storage array of spike fuel, is a minimal perturbation. Such an incident would not raise the k-effective above 0.833. This value is significantly below the k-effective safety limit value of 0.98.

Special criticality concerns associated with capped canister (Mark I and II) storage were evaluated in Reference 3. Based on the analysis in that document, limits on the amount of fuel suspended above a full density array was established at a ratio of 1 over 3.

8.1.4 Broken Fuel Elements

Some of the fuel elements shipped to the facility for storage will be broken and cracked. An estimated quantity of such elements is approximately five percent of the total fuel in storage. Calculations have assumed that one percent of the fuel has gone into solution and remains in the water immediately surrounding the fuel elements. This is a conservative assumption since the water circulates and passes through filters and ion exchangers for removal of radionuclides.

N Reactor spent fuel elements in the KW Basin are encapsulated in either:

(1) The standard N Reactor fuel storage canisters (designated Mark 0) modified by welding a plate on the bottom and installing a sealing cap on the top of the canister to become a Mark I canister, or

(2) The Mark II, a canister of improved design and made entirely of stainless steel. See Figure 2.1.

The KE Facility storage racks currently store fuel in the open Mark 0 canisters. However, fuel in Mark I or Mark II canisters, with or without encapsulation, may also be stored in KE.

Encapsulation of the spent fuel elements in the Mark I and II canisters is intended to prevent the escape of solid and dissolved radionuclides into the K Facility basins. Gaseous fission products are vented from the fuel loaded canisters and dissipated through the building ventilation system. Release of non-gaseous radionuclides into the KW storage basin water can take place only through a leak in a canister or the cap assembly.

SAR CITATIONS RELEVANT TO FUEL IN CLOSED CANISTERS WITH FAILED SEALS ADDENDUM 2 WHC-SD-NR-SEL-001, SAFETY EQUIPMENT LIST

Fuel Storage Canisters: Safety Class #3

The fuel storage canisters that hold the spent reactor fuel are made of either aluminum or stainless steel. The newer type of canisters seal the spent fuel within them from the basin water while the older type of canister is open to the basin water. The sealed canister variety acts as a barrier to separate the fuel which is inside of the canister from the basin water which surrounds the outside of the canister.