Attachment 1

Reduction in HFBR Hazard Category

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INTRODUCTION

Reference 1 re-categorized the HFBR from a Hazard Category 1 reactor to a Hazard Category 1, non-reactor nuclear facility and directed that the HFBR be assessed for downgrading the hazard category to a radiological facility. Reducing the hazard category to that of a radiological facility would result in reducing the surveillance and maintenance costs associated with the many rigorous operational and administrative requirements placed on nuclear facilities.

Attachment 1 to DOE Standard 1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, notes that with respect to the lowest hazard categorization of a nuclear facility, “the definition of a Category 3 threshold is designed to exclude those facilities which cannot have a significant radiological impact outside the facility.” It follows that facilities that do not have significant outside radiological impacts can be categorized as radiological facilities.

Although the HFBR contains gross radionuclide inventories in excess of unadjusted Category 3 threshold levels, an assessment of the form, location, and vulnerability to energy sources that could lead to release of these materials concludes that the quantity of dispersible radionuclides is below these same Category 3 thresholds. This conclusion is supported by the fact that most of the radionuclides are in the form of activated structural materials located within the biological shield. The shield, a massive concrete structure, provides protection from any credible energy source such as fire or natural phenomena. This document develops each of these facility characteristics to demonstrate that categorizing the facility as a radiological facility is appropriate.

NUCLEAR MATERIAL INVENTORIES

The nuclear material contained at the HFBR consists of material stored in the Special Nuclear Material (SNM) vault, Low Enriched Uranium fission plates stored on the Equipment Level, and reactor process system equipment that has been activated and/or contaminated as a result of reactor operations.

Special Nuclear Materials

An assortment of special nuclear material is stored in the SNM vault on the Equipment Level. Table 1 lists the isotopes and their masses for the SNM stored in the vault.

Table 1

Approximate SNM Inventories in SNM Vault

ISOTOPE	MASS
U 235	670 gm
U 233	2 gm
PU 238	7 gm
PU 239	15 gm
PU 242	25 mg

Over half of the U 235 is in the form of a “standard” HFBR fuel element that contains approximately 351 grams of U 235. This element was used for measurement and calibration purposes. The remaining material is in many different forms, such as pellets and foils. With the exception of approximately 3.2 grams of PU-239, less than 1 gram each of U 233, U 235 and several nanograms of Pu-238, all of the SNM is stored in DOT approved 6M shipping containers. As per DOE STD-1027-92, the material stored in these containers need not be counted against the Category 3 thresholds. The 3.2 grams of Pu-239 represents about 40 % of the Category 3 threshold limit for that isotope. The remaining isotopes of SNM combined represent less than 1 % of the Category 3 thresholds. Plans are presently in place to transfer all of the SNM stored in the vault to an appropriate storage facility outside of the HFBR site.

In addition to the SNM stored in the vault, there are twelve Low Enriched Uranium fission plates (LEU) stored on the Equipment Level. These plates were originally intended for use in a new beam shutter to be installed at the Brookhaven Medical Research Reactor (BMRR). The shutter project has been cancelled and the LEU plates are being stored at the HFBR until they can be properly disposed of. These plates each contain about 5 kilograms of uranium enriched to about 20% U-235. Each plate is stored in a separate, DOT approved 6M shipping container, so consistent with DOE 1027-92 guidance, the nuclear material contained in the plates is excluded from the facility's hazard category radionuclide inventory.

Radioactive Material

HFBR spent fuel had been disposed of as part of the tritium remediation project undertaken in 1997. With the recent removal and off-site transfer of tritiated heavy water from the reactor vessel, the existing radionuclide inventory consists mainly of activated metals from the reactor vessel and its internal components, the thermal shield, and the biological shield. Smaller amounts of activity are associated with radioactive auxiliary systems such as the heavy water purification and storage systems and some radioactive waste stored in the building.

Reactor Vessel and Internals

The principal constituents of the radiological inventory at the HFBR are the control rod blades and the transition plate. These components, fabricated from stainless steel, have become highly activated from reactor operations. The principal isotopes of concern are Cobalt 60, a gamma emitter, Nickel 63, a beta emitter, and Fe-55, a hard to detect auger electron and X-ray emitter. Some other steel components, such as the anti-critical grid, are also made of stainless steel but since they were subjected to a much lower neutron flux, they are not nearly as activated as the control rods or transition plate.

The control rods are made of neutron poisons matrixed within and clad by stainless steel. The principal poison material in both the main and auxiliary control rod blades is Europium 153. The main blades also contain smaller amounts of dysprosium, another neutron poison. In addition to the activation products attributed to the steel, the control rods contain isotopes formed from neutron absorption reactions with the europium. The following table shows the radionuclide inventories from the control rods and transition plate[2].

TABLE 2

ACTIVATION PRODUCT INVENTORY FROM

CONTROL RODS AND TRANSITION PLATE, CURIES

Activation Product	Eu Section of Main Blade (8 blades)	Auxiliary Blade (8 blades)	Transition Plate	Total	Cat. 3 Threshold
Cr 51	4.3×10^{-9}	4.1×10^{-9}	1.2×10^{-8}	2.08×10^{-8}	2.2×10^{4}
Fe 55	**7.4×10^{3}**	**9.7×10^{3}**	**2.4×10^{4}**	**4.10×10^{4}**	**5.4×10^{3}**
Fe 59	1.3×10^{-5}	3.0×10^{-5}	4.7×10^{-5}	8.89×10^{-5}	6.0×10^{2}
Co 60	**3.7×10^{3}**	**3.9×10^{3}**	**1.2×10^{4}**	**2.0×10^{4}**	**2.8×10^{2}**
Ni 59	3.3	6.3	23.4	34.94	1.2×10^{4}
Ni 63	**7.5×10^{2}**	**1.8×10^{3}**	**5.6×10^{3}**	**8.19×10^{3}**	**5.4×10^{3}**
Zn 65	2.1×10^{-3}	2.1×10^{-2}	2.3×10^{-2}	4.60×10^{-2}	2.4×10^{2}
Mo 93	0.0	2.6×10^{-2}	6.2×10^{-2}	8.78×10^{-2}	2.0×10^{3}
Eu 154	**2.3×10^{2}**	**2.4**	**0.0**	**2.32×10^{2}**	**2.0×10^{2}**
Eu 155	12.9	1.3	0.0	14.21	9.410^{2}
Gd 153	9.1×10^{-2}	0.0	0.0	9.13×10^{-2}	1.0×10^{3}
Tb 160	1.0×10^{-3}	3.1×10^{-3}	0.0	4.13×10^{-3}	5.6×10^{2}

The aluminum portions of the reactor vessel and its internals are also activated. The principal isotopes are Fe-55, an auger electron and X-ray emitter, and the gamma emitter Zn-65[3]. The largest aluminum structure, the reactor vessel, is located away from high flux areas. The combined contribution from activated aluminum components represents only ten percent of the total radionuclide inventory[3].

In the proposed lay-up configuration, the reactor vessel will be drained and dried once the light water is no longer needed for shielding, and the activated internals will remain installed until decommissioning is undertaken. Current plans call for maintaining the system dry in an inert atmosphere to eliminate the hazard of a coolant loss from a vessel or piping failure and to provide a stable environment that minimizes corrosion. This configuration is advantageous from an ALARA point of view because it makes use of the original reactor shielding to maintain surrounding dose rates very low. The shielding, nominally six feet of heavy concrete, also protects the vessel from natural phenomena (tornado, hurricane, earthquake) and fire. The decay heat from the control rods and transition plate is low, approximately 300 watts, so that elevated temperatures during layup of the system are not expected[3].

Thermal Shield and Biological Shield

The thermal shield is a carbon steel and lead structure, of which only the activation of steel is significant. The principal activation products are Fe-55 and Fe-59 of which only Fe-55 is of concern since Fe-59 is relatively short lived. The activity of the thermal shield was estimated to be no greater than 7.2×10^5 Ci.[3] The thermal shield surrounds the spherical and the lower cylindrical portions of the reactor vessel. Like the vessel, it is located in the biological shield cavity, so it too is protected by the heavy concrete from environmental effects that might have sufficient energy to initiate a radiological release. Details of the proposed operations within the facility and the credible energy sources are developed later in this document and will show that although the radionuclide inventory exceeds the unadjusted Category 3 thresholds, there is no credible mechanism that would lead to a radioactive release from the facility (no Material at Risk).

The biological shield is a heavy concrete structure that contains 60% by weight of steel punchings. Fe-55 again is the nuclide of concern and amounts to about 360 Ci.[3], insignificant when compared to the activity of the thermal shield.

Other Radioactive Wastes

Other activated waste materials are stored in the HFBR and are awaiting disposal. The most active waste component is the H-6 beam plug stored in a shielded storage structure on the Equipment Level. Based upon previous beam plugs that have been disposed of, it is estimated that this beam plug contains approximately 21 curies of Cobalt 60[4]. This storage structure, called the "cheese box", also contains other activated components that were associated with the experimental beam lines but are not nearly as activated. Material stored in the cheese box is well protected in that it is stored in deep holes within a large steel and concrete structure. Dispersal of the stored material is not credible since the material is comprised mostly of stainless steel and the large, stable structure protects its contents from fire and other energy sources. There are no postulated accidents that lead to dispersal of the materials stored in the cheese box.

Other wastes are stored in shielded pigs or barrels on the Equipment Level that contain miscellaneous small components removed from the vessel that were stored in the canal before it was drained and emptied. Based on characterizations of similar wastes previously disposed of, it is estimated that these containers contain less than a curie of activity from cobalt, nickel, and iron.

Dispersible Materials

The reactor vessel was refilled with approximately 1400 gallons of demineralized light water after the heavy water was drained from it. The light water will provide shielding for personnel working on stabilization activities in the reactor pit area. These activities may include layup of the control rod drives or removal or installation of equipment to facilitate decommissioning. Following completion of these activities, the water will be pumped from the vessel as part of the vessel long-term layup or removal plan. Other than the residual heavy water in the purification system and the light water in the vessel, there are no large amounts of liquid or gaseous radioactive material within the facility. Consistent with experience with these systems, only minor amounts of residual contamination are expected to remain within radioactive piping systems after these systems are drained. For example, purification system piping removed as part of the Suffolk County Article 12 improvements contained only a few micro-curies of Cobalt-60 and Fe-55.

Although the primary coolant has been drained from the reactor and primary system piping, a small amount of heavy water remains in the heavy water purification and storage systems. This liquid, approximately 300 to 500 gallons of high quality D2O, consists of storage tank dregs and residues in purification resin beds, filters, and the connected piping. At a concentration of 1.5 Ci. per liter, that amounts to no more than 3000 curies of tritium, well below the category 3 threshold of 16,000 curies.

There are four ion exchange beds and three filters in the primary system purification system and one identical resin bed in the Experimental Facility Cooling Water System purification system. Previous experience with the resin beds indicates that they each contain small amounts of Cobalt 60, Iron 59, Zinc 65 and several curies of Chromium-51. Based on the characterized activity of resin from past resin bed change outs, it is estimated that the storage and purification systems contain less than one curie of activity of these isotopes except the Chromium-51 for which there is approximately six curies per resin bed. Since the thresholds for Chromium-51, Cobalt-60, Zinc-65, and Iron-59 are 22,000, 280, 240, and 600 curies respectively, resin bed activity will not contribute significantly towards the Category 3 limits. The filter media was replaced about a year ago. Since they have not been in service for very long, and the reactor has not been operated, the radionuclide inventory of the filters is expected to be small. It is planned to dispose of the purification system filters and resin beds during the early stages of stabilization or decommissioning.

SUMMARY OF PLANNED OPERATIONS

In the time since the decision was made to permanently shutdown the HFBR, activities have been undertaken to reduce the hazards associated with the facility and to prepare the facility for eventual decontamination and decommissioning. All new and spent fuel elements have been removed and shipped off site. With the exception of the light water in the reactor vessel that provides temporary shielding and heavy water dregs left in the purification system, the radioactive liquid systems have been drained and placed in an industrially safe condition. Many of the hazardous chemicals associated with the operating facility, such as 2000 gallons of sulfuric acid, several thousand gallons of chemicals used for secondary water treatment, and the five drums of gadolinium nitrate used as a neutron poison have also been disposed of. Efforts to reduce or eliminate the remaining chemical hazards such as the 350 gallons of cadmium nitrate/light water solution are in progress.

The major activities associated with the facility stabilization are those that will facilitate decontamination and eventual decommissioning while maintaining the facility in a safe condition. Work has begun on the installation of a stainless steel liner for the spent fuel canal. There are currently no plans to use the canal and it will remain empty. If it is decided to disassemble the reactor vessel and its internal components as part of the facility decommissioning, the canal may be filled, tested, and used to provide shielded storage for highly activated components.

Other planned activities include removal of auxiliary buildings located on the HFBR site that contain no nuclear materials. These structures include the secondary water system pump house, cooling towers, and water treatment house.

Consideration is being given for removing the activated beam plugs that are installed in the biological shield on the Experimental Level and storing them in a beam plug storage area, called the “cheese box”, also located on the Experimental Level. The cheese box is a large steel and concrete structure located on the Experimental Level that contains a series of holes into which activated beam plugs can be safely stored. There is currently only one beam plug stored in the cheese box, an H-6 plug that was removed from the beam line in 1996. Storage in the cheese box will facilitate characterization of beam plugs prior to disposal. The procedure for removing the beam plugs from the biological shield and relocating them to the cheese box is an evolution that has been performed in the past by Reactor Division personnel using established procedures and is considered a maintenance type activity. The hazards associated with plug handling are well characterized as a result of handling operations during reactor vessel ultrasonic testing that has been periodically performed since 1984, most recently in 1996. Plug removal will be evaluated using detailed work planning required by ESH Standard 1.3.6, Work Planning and Controls of Operations.

HAZARDS ANALYSIS

In determining the hazard category of a facility, DOE -STD–1027-92 provides guidance to consider the potential energy sources and initiating events that could lead to dispersal of radionuclides. When the physical form, location and interaction with potential energy sources are considered, categorization of the HFBR as a radiological facility can be justified even though the gross radionuclide inventory at the HFBR exceeds the unadjusted Category 3 thresholds

Material Form

As described previously, the majority of the radionuclides present in the facility are confined to the stainless steel control rods and transition plate. The remainder of the inventory is contained in the aluminum reactor vessel, some internal components in the vessel, the carbon steel portion of the thermal shield, and the activated steel punchings in the biological shield concrete.

Following draining of the heavy water, the vessel was partially refilled to just below the vessel outlet with demineralized light water to provide temporary shielding for transition activities. Once work is completed in the reactor pit, it is anticipated that the vessel will be drained entirely and an inert atmosphere most likely will be maintained within the vessel to minimize corrosion of the vessel and the internal components. Because the activated components of the vessel and its internals are made from corrosion resistant aluminum and stainless steel, and since they will likely be maintained in an inert environment intended to minimize corrosion, there will be no significant amounts of corrosion products available to be released from the vessel.

The activated components of the thermal shield surround the reactor vessel and are confined and protected by the massive concrete biological shield. The activated steel punchings within the biological shield are bound within the concrete and have no mechanism for release unless the concrete itself is somehow penetrated. The discussion of energy sources below shows there are no postulated energy sources that can threaten the integrity of the concrete shield.

The bulk of the dispersible radionuclides is comprised of dregs in the heavy water storage tanks and purification system resin beds and filters. The resins and filters are contained within steel enclosures that are isolated by installed valves. These tanks, resin beds and filters are located in concrete pits below the Equipment Level floor that would contain any leakage. It is planned to dispose of the resins and filters together with the containers early in the stabilization or decontamination and decommissioning plans to minimize the potential for an accidental release of their contents. The tank dregs will be removed from the tanks before the tanks are disposed.

Energy Sources

Natural Phenomena

The reactor and auxiliary systems were constructed within a confinement structure designed to withstand the most severe natural phenomena that could be reasonably expected to occur during its life span. Major structural components, most importantly the building shell and the central shield structure are designed to withstand a 0.2 g ground acceleration seismic event without experiencing significant damage. [5,6] The building is also designed to withstand 120 mile per hour hurricane winds. Analysis of the effects of 270-mph tornado winds on the facility revealed that while the domed portion of the confinement building might be vulnerable to penetration by missiles generated by a tornado, the reactor shield would not be affected.[7] Components found to be vulnerable in the tornado analysis, such as poison water and cover gas piping, are no longer required for reactor safety and would no longer result in radioactive release if damaged. The Equipment Level, where the bulk of the remaining heavy water and purification system resin beds are located, is surrounded by a ten inch thick concrete wall which will not be penetrated by tornado induced missiles. Therefore, there are no conceivable natural phenomena that would lead to release of radioactive materials from within the biological shield.

In addition to being surrounded by a concrete wall around the Equipment Level, most of the radioactive piping and storage systems are contained within the biological shield or in concrete vaults below the Equipment Level floor. This arrangement prevents exposure to environmental conditions associated with natural phenomena that could lead to release of the contamination.

Fire Hazards

The relative fire hazard in Building 750 is extremely low since the combustible loading is very limited and will be reduced further during facility stabilization. In addition, fire detection and suppression systems exist on each level to mitigate fires if they occur.

The potential fire hazards and fire loading in this building are those typical of an industrial occupancy. The operating equipment contains small amounts of oil (less than 5 gallons). High voltage, 2400 volts ac, is used in standard industrial applications. Small amounts of other combustibles such as paints, solvents, and cleaners are stored in approved fire cabinets near the areas where they are used.

Fire protection

The Fire Protection Systems at the HFBR, Building 750, provide fire detection, alarm, and suppression capabilities to minimize hazards from fire and smoke to HFBR personnel and plant equipment. The fire protection system will be maintained throughout the stabilization project and during the surveillance and maintenance period that follows. Changes to the fire protection system will be reviewed by a fire protection engineer prior to implementation.

The Fire Protection System for the reactor complex is a composite of multiple detection and suppression sub-systems that automatically initiates suppression system action and provides a remote means for determining the location of a fire or smoke hazard. The system also can warn if fire protection supervisory equipment has malfunctioned or has been disabled.

The sprinkler system protects the entire 750 building and office annex, except the machine shop and lobby area. Certain other areas within the building confinement were deliberately not covered by the sprinkler system, to exclude light water from critical areas to prevent contaminating heavy water systems with light water. These areas are primarily protected by the manually operated CO_2 hose systems. The excluded areas are:

a. The two primary heat exchanger cells and shutdown heat exchanger cell.
b. Over the D_2O storage tanks and the primary purification system on the Equipment Level.
c. The central portion of the confinement dome area over the reactor vessel on the Operations Level.
d. Within the greenhouse on the Operations Level.

The sprinkler system is a dry pipe pre-action type, which fills normally dry piping with water from the domestic water system when activated by its detection system. The water in the system is not sprayed out until a sprinkler head is fused locally as a heat source occurs. This type of system was installed to prevent the inadvertent release of water onto exposed equipment should a sprinkler head or system piping be damaged.

Three manually operated fire suppression systems also serve Bldg. 750. These manual systems are the carbon dioxide hose system, and Ansul dry chemical hose system, and a fire standpipe system. The carbon dioxide and Ansul systems consist of fixed mounted containers with attached hose reels.

Two carbon dioxide systems are located on both the equipment and operations levels. Each carbon dioxide hose station consists of two 50-pound carbon dioxide cylinders, 100 feet of hose with a discharge horn, and valves for operating the system.

The two Ansul Dry Chemical Hose Systems located on the experimental level, provide a dry chemical agent that is used for fire suppression. This agent is used on fires where it is deemed more effective than carbon dioxide.

The fire standpipe system has hose connections in the north and south stairwells, which are provided for use with hose brought in by the BNL Fire/Rescue Group. None of these systems have detection systems associated with them.

Water supplies for the automatic sprinkler and manual fire standpipe systems are available from two sources: the BNL domestic water system and the building siamese connections. The water supplied to the siamese connections may be provided either from a fire pump truck or from fire hoses that are run to external fire hydrants that are fed from the BNL domestic water system. The fire hydrants that are in and around the reactor complex may be used by the Fire/Rescue Group for connection of their hoses to fight fires.

The complex contains a number of portable fire extinguishers containing such agents as CO_2, water, dry and chemical.

Fire dampers are installed in ducts and openings that pass through fire walls and floors. Fire doors, which are normally closed, are installed throughout the complex to prevent the spreading of fire from one fire zone to another. Some fire doors in the lobby area and control room of Bldg. 750 are held opened by magnetic latches for ease of passage. When any fire detector is activated, or upon operation of any manual fire alarm pull station, all the magnetic latches are released allowing all the fire doors with magnetic latches to close.

To prevent the spreading of smoke from its point of origin to other areas, duct smoke detectors are installed in the ductwork of most of the large air handling units in Bldg. 750. Sensing smoke, a duct smoke detector transmits a signal, which sounds the building alarms, alerts the Fire/Rescue Group, and shuts down all the air handlers in the same sprinkler zone that are provided with duct smoke detectors. The Fire and Rescue Group is manned 24 hours to respond to site wide fire alarms.

Explosive Hazards

During operation of the Cold Neutron Facility, hydrogen gas was condensed and used as a moderator. Since the decision to permanently shut down the reactor, all hydrogen has been removed from the facility. A small amount of acetylene gas is used at the facility for incidental welding and cutting. Controls on the allowable amounts and proper storage are in place so that the acetylene is considered only a standard industrial hazard. Substitution of propylene gas in place of acetylene is being encouraged because propylene gas presents a smaller explosive hazard.

A 1000 gallon storage tank for propane fuel used for the standby generator is located 300 feet north of the facility. The top of the tank is buried approximately 24 inches below grade, making it highly unlikely that the tanks will be impacted by vehicle traffic or exposed to an ignition source. The tanks are periodically inspected to ensure compliance with state and local regulations. For these reasons, explosion of the propane tanks is not considered credible.

The propane generator is located in a room outside of the confinement and adjacent to the Equipment Level. Ignition or explosion of propane that has accumulated in the generator room could damage the confinement building, but since the reactor vessel and primary piping are protected by thick concrete and /or steel shields, they would not be damaged.

To prevent such an accident from occurring, the generator room is continually ventilated and is provided with a propane detection system. The generator room is also checked by facility personnel making routine inspection rounds. For these reasons, the probability of an explosion in the generator room is considered remote.

Compressed gas cylinders are used throughout the facility. The largest source of compressed gas is helium used in the vessel cover gas system. Helium is supplied from a tube trailer located outside of the confinement building. A backup supply is available from a bank of cylinders on the Equipment Level that is secured within a seismically

qualified rack. The individual cylinders are not usually handled, and are only removed from the rack for periodic hydrostatic pressure testing. These cylinders are recharged from the normal helium supply trailer through installed valving. Both the trailer and backup helium systems are supplied with pressure relief systems to protect against over pressurization. All compressed gas cylinders undergo periodic hydrostatic testing.

Both the helium trailer and the backup helium cylinders are located at the elevation of the Equipment Level. This is below the level of the reactor vessel and most of the highly activated materials. Since the primary system piping is protected by the five foot thick concrete heat exchanger cell walls, the missile hazard from a ruptured cylinder will not lead to damage to the reactor vessel or primary system piping. In addition to the concrete shield, the helium tubes from the trailer would also have to penetrate the concrete base wall of the confinement building before damaging the primary system piping.

Smaller amounts of compressed gas are used throughout the building for water level instrument bubbler tubes, tank sparging, and other miscellaneous uses. These sources are usually a single compressed gas cylinder provided with approved restraining devices. Handling, use, and storage of compressed gas cylinders are controlled through formal procedures.

Chemical Hazards

There are several chemical hazards associated with the HFBR that represent worker and environmental hazards, but are not associated with the release of radionuclides to the environment.

Lithium chromate or lithium arsenite are used as corrosion inhibitors in the two absorption refrigerators that produce chilled water for the facility air conditioning. The Carrier brand unit uses lithium chromate and low pressure steam (15 psig) while the Trane unit uses lithium arsenite and higher pressure steam (about 120 psig). Both inhibitors are hazardous and occur in amounts above regulatory threshold limits.

In both machines, the corrosion inhibitor is completely contained within the machine. Release to the environment could occur through leakage of the inhibitor from the machine or from over-pressurization of the steam tubing within the units leading to a blow out of protective rupture discs. Dispersal of the lithium arsenite from a steam rupture is limiting because it has the largest energy source available (steam at 120 psig) and through atomization of the fluid could create an inhalation hazard to workers in the facility. Calculations show that the off site consequences of a release of the total inventory of lithium arsenite to the building are negligible since the Equipment Level floor is sealed to prevent leakage to the ground and airborne emissions are filtered before being released from the building.

Preventive measures such as high steam pressure trips and periodic tube inspections provide assurance that such a release in not likely to occur.

Approximately 3300 pounds of cadmium nitrate is dissolved in water and stored in a 400 gallon stainless steel tank located on the Operations Level. An additional 100 pounds of cadmium nitrate powder is also stored on the Operations Level. The cadmium nitrate was intended as a neutron absorbing reactor poison used during certain reactor emergencies. The poison water solution is no longer needed, owing to the permanent removal of fuel from the facility. Cadmium nitrate does not have threshold or reporting quantities associated with it but it is recognized as a serious health hazard. As noted earlier, efforts are already underway to drain the poison water tank and dispose of the cadmium nitrate solution and powder.

Postulated initiators of cadmium nitrate releases are a rupture of the storage tank or a fire on the Operations Level that leads to rapid decomposition of the cadmium nitrate powder. Since the Poison Water tank is normally depressurized and is provided with a relief valve, rupture from over-pressurization is unlikely. Rupture from tornado induced missiles is postulated, however, the area surrounding the tank is bermed to minimize the spread of liquid. The poison water solution would eventually be directed to the

Equipment Level, which complies with Suffolk County Sanitary Code Article 12 to prevent leakage to the underlying ground.

The cadmium nitrate powder is stored in an approved chemical storage locker in accordance with its Material Safety Data Sheet in an area with no large combustible loading. Efforts are underway to dispose of the cadmium powder and solution.

CONTROLS

Because reducing the hazard category is reliant on limiting the material at risk to below Category 3 thresholds, controls will be put in place to identify work activities that have the potential to involve Category 3 threshold or higher amounts of activity. The majority of the facility radionuclide inventory resides within the activated components of the reactor vessel, its internals, and the surrounding thermal and biological shields. Because the biological shield protects the highly activated components from energy sources with the potential to disperse the activity to the environment, planned activities with the potential to compromise the biological shield's ability to protect the vessel and its internals will also have to be identified so that appropriate controls can be put into place. Work controls appropriate to the hazards will be developed in accordance with Integrated Safety Management principles and evaluated for their ability to prevent unintended radiological consequences outside of the facility.

CONCLUSION

Although the gross radionuclide inventory at the HFBR exceeds the Category 3 thresholds defined in DOE STD-1027, almost all of this material consists of activated structural materials associated with the reactor vessel and its internal components. These components are well protected by a massive steel and concrete shield structure. There are no credible energy sources with the potential to disperse these activated materials from the facility. Table 3 summarizes the material at risk at the HFBR. With the removal of the spent fuel and most of the tritiated heavy water, the amount of material with the potential to be released from the facility, dispersible radioactive material, falls well below Category 3 thresholds. Therefore, recategorization of the HFBR from a Hazard 1, non-reactor nuclear facility to a radiological facility is appropriate.

TABLE 3

SUMMARY OF MATERIAL AT RISK AT HFBR

ISOTOPE	PRINCIPAL SOURCE	INVENTORY	CATEGORY 3 THRESHOLD	CATEGORY 3 FRACTION
U-233	SNM not stored in 6M container	< 1 gm	440 gm	.0023
U-235	SNM not stored in 6M container	< 1 gm	1.9×10^{6} gm	5.5×10^{-7}
Pu-238	SNM not stored in 6M container	5.7×10^{-9} gm	0.036 gm	1.6×10^{-7}
Pu-239	SNM not stored in 6M container	3.2 gm	8.4 gm	0.38
H-3	Approximately 550 gallons of heavy water @ 1.4 Ci./liter	2910 curies	16000 curies	0.18
Co-60	Primary and Experimental Purification System resin beds	< 1 curie	280 curies	0.004
Fe-59	Primary and Experimental Purification System resin beds	1 curie	600 curies	0.002
Zn-65	Primary and Experimental Purification System resin beds	2 curies	240 curies	0.008
Cr-51	Primary and Experimental Purification System resin beds	30 curies	22000 curies	0.0014
Ni-63	Activated wastes from vessel and canal	<1 curie	5,400 curies	1.9×10^{-4}
Fe-55	Activated wastes from vessel and canal	< 1 curie	5,400 curies	1.9×10^{-4}
			TOTAL	**0.58**

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