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NEW PCN FOR SILO 3 NHASP

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40430-PL-0010	1PCN2	APPROVED	SILO 3 RETREIVAL AND DISPOSITION NUCLEAR HEATH AND SAFETY PLAN	ATT: RAYER, DIANA L Project: 40430

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EFFECTIVE DATE	PCN NO.	REV. NO.	DESCRIPTION
3/23/05	2	1	Changes to: (1) Section 1.4.3, *Silo 3 Material Retrieval and Packaging Activities*, to describe the in-line automatic samplers installed above Packaging Stations A and B; (2) Section 10.4, *Derivation of Safety Basis Requirements*, to make text consistent with PR-3; (3) Appendix B, under *Executive Summary*, and Sections B-3.2.3 and B-3.3, to change facility designation from Radiological to Less Than Nuclear; (4) Section, B-4.0, *Final Hazard Category*, to clarify purpose of Appendix G, and to change facility designation from Radiological to Less Than Nuclear; (5) Appendix F (FHA), on Pages 8, 16, 18, and 21, to remove the word "DELETION" left over from a previous PCN; (6) Appendix G, *Accident Analysis*, under Section G-2.3, *Common Assumptions*, to explain the calculated bulk density of 73 lb/ft^3 used in EBA-4; (7) Section G-3.4, *EBA-4: Breach of Full Package*, to discuss the calculated bulk density of 73 lb/ft^3; (8) Table G.3-4, *Breach of a Full Package Scenario Results*, to provide new dose values; (9) Section G-3.7, *EBA-7: ISO Penetrated*, to clarify ISO staging; (10) Table G.4-1, *Dose for Comparison to Emergency Guideline*, to provide new dose values for EBA-4; (11) Table G.4-2, *Dose for Comparison to Emergency Guideline Using Conservative Assumptions*, to provide new dose values for EBA-4; (12) App. G, Att. 4, *EBA-4 Spreadsheet, EBA-4 Solids Release*, to provide new dose values based on calculated bulk density of 73 lb/ft^3.

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Container Filling and Sampling

PCN1

For both PRS- and MRS-retrieved waste, the final package is a tested and approved DOT (Department of Transportation) IP-2-compliant (Industrial Package Type 2) soft-sided, sturdy-but-flexible, polypropylene bulk bag containing a sealed poly-vinyl choride (PVC) liner. The bulk bag measures 72" x 48" x 48". The containers were certified IP-2 via testing per 49 CFR Part 173 [Ref. 26] and Part 178 [Ref. 27].

The test container was filled with 7,000 pounds (minimum) of surrogate material similar in characteristics to Silo 3 material. Two tests were performed using: (1) a surrogate similar to conditioned Silo 3 material; and (2) a surrogate similar to untreated Silo 3 material. Each test article underwent a series of tests, including a Free Drop Test, a Stacking Test, and a Vibration Test. Both test articles completed the test series, demonstrating no loss of material during or after testing. No splits, tears, rips, or damage were observed after testing.

Each of the two Package Loading Stands is a computer-controlled (PLC), semi-automated system with loading spouts, loading stands, thumper tables, weighing scales, sealers, and motorized roller conveyors for transporting the filled bags away from the station. There is a camera in the area to allow remote viewing of bagging operations.

Material will be dropped through the fill chutes into the PVC liner. Once material flow into the container has been started, an aqueous conditioning solution will be sprayed on the material as it passes through the chute. After the container is full, a small slit will be made in upper region of the container spout. A tube sampler will be manually inserted into the spout to collect a predetermined material volume which will be extracted and placed in a sample jar (the sample will be analyzed at a Silos Project lab outside the Silo 3 facility). The sample slit will then be taped closed (per procedure) so that a slight vacuum can be pulled on the liner to facilitate an RF-sealing and liner perforation process. This proceduralized process makes an upper seal, a perforation, and two lower seals to ensure that none of the powdered waste is released to the adjacent work area (from either the liner or the residual liner spout once the container is disconnected from the chute). PCN1

In-line dry material samplers have been installed underneath the screw feeders for the two drop chutes above Packaging Station A and B. Each sampler includes a PLC controller for setting sampler timers and counters. The sampler will collect numerous grab samples in a 125-ml plastic sample jar. When material flow is verified, the operator will initiate the sampling cycle. The sampler will then perform a number of grab samples, as programmed, with a set time delay between samples. When the sampler has completed the sampling routine, the operator will unscrew the sample jar, place a lid on it, and attach a new jar for the next sampling event. The sample will be handled and analyzed in a manner similar to samples taken from the Silo 3 waste packages. PCN2

After liner sealing, the lower part of the liner neck will be detached from the chute by tearing at the perforation. The container assembly, (container and loading frame) will move away from the fill chute to be closed, surveyed, and labeled. The trimmed-off and sealed upper part of the liner neck will be retained by the fill chute and blown into the next liner bag to be filled. In the event of failure of the RF seal, the liner may be closed using the alternate method approved during container tests [Ref. 65], or an Engineering-approved alternative. PCN1

The PRS baghouse collector has high-level switches to provide alarm at High level and shutdown at High-high level. An interlock associated with the packaging stand weight transmitters will stop the upstream conveyor, which in turn stops other upstream equipment. The operator will also be able to observe bag loading via a miniature camera inside the packaging filling head and associated monitor. The operator will also be able to feel the container as it is filled. The operator can stop the equipment when, by visual and/or touch, the bag is full.

Bag-filling is totally contained. If a bag is overfilled, there will be no release of material. Excess material can be addressed by vibrating the package to lower the level of material. There is a capability (a port) to vacuum excess material if needed. Vacuum activity would make use of containment (plastic bagging), a work plan, and a Radiation Work Permit (RWP).

<u>Filled Container Management and Preliminary Staging</u> PCN1

After a soft-sided container is filled and the PVC liner is sealed, the container assembly is moved to the Package Staging Conveyor where swipe sampling and surveys of the container assembly are performed. If no contamination is found, the container is then transported through an airlock to the Cargo Container Bay, where it is closed and placed on a shipping pallet. The containers are surveyed to meet shipping requirements and staged for labeling inside the Cargo Bay. Equipment and material, including containers of Silo 3 material, will be released from the Silo 3 facility when the exterior of the item meets DOT surface contamination limits. Therefore, it is planned that shipping activities will take place in a Controlled Area.

A labeled soft-sided container will be loaded by forklift into an International Standards Organization (ISO) container on the Interim Staging Area [ISA] (i.e., Silo 3 Pad). Due to anticipated radioactivity variability between soft-sided containers, these bags will undergo preliminary staging on the ISA. This entails placing four bags in an ISO (an ISO can hold up to eight bags). This allows bags to be retrieved from different staged ISOs to create a shipping ISO with eight bags that, as a unit, will meet shipping requirements. Once loaded, ISOs will be handled in one of the following manners: (1) one ISO each will be loaded onto a truck trailer on the ISA using a heavy forklift, and staged for shipment off-site; or (2) the loaded ISO will be moved by heavy forklift to a staging area for shipment off-site. Video cameras allow for remote viewing of the process and personnel. PCN1

If an IP-2 container is rejected because it does not pass the QC check, it can be repaired per an Engineering and Rad-approved process, or the shipping/packaging supervisor can have the package placed in the Excavator Service Room where its contents can later be recycled to a Packaging Station via the Excavator Bin.

<u>On-site Transportation and Staging</u>

The on-site transportation process will be the same used for all FCP operations. The Silo 3 waste shippers will become part of the Silo 3 Project. Silo 3 waste material will be transported to an off-site disposal facility by truck. IP-2 containers of Silo 3 material may need to be moved, by forklift, on a pallet to other areas of the site for various activities such as assay.

Prior to shipping, trucks will be staged. Staging consists of container management, which includes completion of shipping paperwork for waste disposition. Containers meet DOT requirements for shipping and will be handled in accordance with DOT shipping requirements. Between 15 and 20 trucks will leave the site weekly. This is similar to other off-site shipment schedules prior to this project.

Because there may be delays in shipping, plans are being developed and evaluated to stage ISOs on site beyond the time period needed to complete shipping paperwork. If the entire Silo 3 contents need to be staged, as many as 273 ISOs (each containing 7 or 8 filled IP-2 containers) could be staged on site.

Staging is assumed to be in an outdoor location. Maximum duration for staging will be administratively controlled as six months. In addition to the ISA pad, staging areas include, but are not limited to, the former site of Silo 4 (now demolished), the area south of Silo 1, the silos lay-down area along the entry road, and various other on-site areas. All areas where Silo 3 material will be loaded and staged pending the completion of shipment will be within the site fence and provided with appropriate levels of security and lighting. FCP Security monitors site access by using stationary posts and walking/driving/perimeter patrols on a 24-hour basis.

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Identification of the required SBRs and PRs was completed by a team of Silos personnel representing Operations, Quality Assurance, Engineering, Project Safety, and Nuclear and System Safety. Although none resulted in significant radiological consequences, each of the seven EBAs described in Appendix G, as well as Environmental and Operational ALARA details, were considered for potential requirements to protect the Hazard Categorization.

Examination of EBA-1 (hose rupture) did not result in any single component or administrative control that required special protection, as the equipment was of rigorous design and construction, and detection of any spill resulting from hose rupture would be immediate in the occupied facility. Examination of EBA-2 (silo failure due to wall cutting) resulted in SBR-1, to ensure that the work plan for cutting into the Silo 3 wall was documented and implemented with the proper rigor. Examination of EBA-3 (material spill from conveyor) also did not result in any single component or administrative control that required special protection. As was the case for EBA-1, the equipment was of rigorous design and construction, and detection of any spill resulting from conveyor failure would be immediate in the occupied facility.

EBA-4 (package failure during transport to pallet) was examined and two PRs were developed for this scenario. Both PR-2 (gross weight at or below 7000 pounds) and PR-3 (bag are sealed before transfer to ISA) describe maintaining the bags within the parameters tested for DOT compliance. PCN2 EBA-5 (filter system failure during retrieval) was examined but did not result in any single component or administrative control that required special protection. This was due to the fact that an abrupt pressure change resulting in filter failure had multiple levels of prevention, and consequences were limited by the immediate loss of ability to pneumatically retrieve.

PRs 1, 4, 5, and 6 were developed to protect parameters outside the EBA scenarios. PR-1 requires capability to measure stack concentration, to meet an environmental release requirement for radon. PR-4 requires a visual inspection of the fabric boot that seals the Silo to the pneumatic retrieval system, because the seal is especially important when pneumatic retrieval is not operating. PR-5 protects the TSR for the Silo dome, as it requires the vacuum relief valve to be set properly to prevent underpressurization of the silo that could cause dome collapse. PR-6 is an administrative control that requires review of an Operation Work Instruction (OWI) package for preliminary pneumatic retrieval and equipment installation.

EBAs 6 and 7 were added when staging of material in the ISA was better defined in the scope of the N-HASP. Two PRs were developed for defense-in-depth of material staging. PR-7 limits sealed bags not contained in an ISO to eight, and PR-8 limits the stacking of the ISOs to two high.

11.0 TRAINING REQUIREMENTS

The *Silos Project Training and Qualification Program (TQP) Description*, TQP-067, [Ref. 69] establishes the training and qualification requirements for Silos personnel. The program's objectives are to:

- ensure that workers understand the potential hazards they may encounter.
- ensure that workers possess the knowledge and skills necessary to perform their work with minimal risk to their health and safety.
- ensure that workers are aware of the safety requirements, including the purpose and limitations of safety equipment.
- ensure that workers can safely avoid or escape from emergencies.

The program ensures that workers meet the minimum requirements of 29 CFR 1910.120, DOE Order 5480.20A [Ref. 70] (applicability as described in RM-0043, *FEMP Training Implementation Matrix* [Ref. 71], and other relevant regulations, as applicable.

Health and Safety Training

Workers will receive the appropriate training based on their scope of work. Workers performing activities which fall under 29 CFR 1910.120 [Ref. 72] will receive a required number of hours of initial and annual-refresher health and safety training for hazardous waste site operations. In addition to the initial health and safety training, workers will receive one to three days of directly-supervised field experience.

All personnel performing work under 29 CFR 1910.120 are required to be trained per RM-0055, *FEMP Access* [Ref. 73], in one of the following categories:

- Occasional Site Worker
- General Site Worker

Workers whose work scope does not require hazardous waste site operations training will receive a level of training that is specific to the type of activities to be performed and the hazards to be encountered. Personnel may not participate in field activities until they have been appropriately trained.

Job and Safety Briefings (all hazards)

Before commencement of field activities, all personnel performing fieldwork will participate in a briefing that will specifically address the activities, procedures, monitoring, and equipment used in the work. The briefing will include a description of the work to be accomplished, known hazards (all types), administrative controls, and PPE requirements. This briefing will also allow field workers to receive clarification of anything they do not understand and to confirm their responsibilities regarding safety and operations for their particular activity.

EXECUTIVE SUMMARY

PCN2

The Silo 3 Retrieval and Disposition Facility is classified as a Less Than Nuclear facility with Low chemical hazards, since the largest potentially releasable inventory does not result in significant localized consequences, due to the low specific activity of the material.

The most severe radiological and chemical hazards from the Integrated Hazards Analysis (IHA), Appendix A, were selected for modeling to determine the hazard category. Several scenarios were analyzed for consequences and the most significant potentially releasable inventory is a result of a silo failure during wall cutting.

The RAD hazard classification was determined after analyzing both radiological and chemical hazards. This is shown in Section B-3.0.

The radiological analysis considered three parameters, total activity of the various radionuclides, total activity that could be reasonably released via bounding scenario, and dose to onsite and offsite personnel.

The chemical analysis considered two parameters, the quantities of the various hazardous chemicals present, and the concentrations that would be generated during the bounding accident. Whereas five hazardous chemicals could be released in quantities exceeding the corresponding Threshold Planning Quantities, the airborne concentrations that would result are lower than the applicable Emergency Response Planning Guides. This is because of the low concentrations of the hazardous components in the bulk material. The "Low" chemical hazard category specified is conservative.

B-1.0 INTRODUCTION

The purpose of this hazard categorization is to ensure that the appropriate level of hazard baseline documentation and approval authority is assigned to the project based on the severity of the hazards that may be encountered.

This document establishes the hazard category designation for the Silo 3 facility in accordance with DOE-STD-1027-92 [Ref. 1] for the following activities:

- Retrieval of material from Silo 3
- Packaging of the material in storage bags for placement into cargo containers
- Staging of cargo containers that are awaiting shipment

The hazard baseline for the activities preceding retrieval has been documented separately in RMR-0445-0056-002, the Silo 3 PHAR [Ref. 2]:

- Continued storage of material in Silo 3
- Routine maintenance and upkeep of Silo 3, support equipment, and surrounding grounds
- Continued design, procurement, construction, and system operability testing of new facilities and/or existing facilities in support of Silo 3 final remediation

B-1.1 Previous Analyses

The preliminary hazard category for Silo 3 storage was first documented in FEMP-2337, *Preliminary Safety Analysis Report (PSAR) for Operable Unit 4* [Ref. 3]. The preliminary hazard categorization of HC-2 was determined by comparing the total inventory of Silo 3 radioactive materials to the threshold quantities listed in DOE-STD-1027-92 [Ref. 4]. In accordance with DOE-STD-1027-92, the PSAR established the final hazard category for Silo 3 as HC-3, based on the hazards analysis.

Subsequent safety basis documents continued to document Silo 3 storage as HC-3, including the *Hazards Analysis Report (HAR) for Operable Unit* 4 [Ref. 5], and the *Preliminary Hazard Analysis Report for Silo* 3 [Ref. 2].

B-1.2 Segmentation

The Silo 3 structure houses the entire inventory of hazardous materials associated with current Silo 3 activities, processes, and operations. Therefore, the "facility" considered for hazard categorization is limited to the Silo 3 structure and its contents. The concept of independent facility segments is applied *within* a facility where facility features preclude bringing hazardous materials together or causing harmful interaction from a common severe phenomenon. Therefore, the Silo 3 structure constitutes a single segment, authorized by the PHAR.

The Hazard Category Calculation documented here establishes that the Silo 3 Retrieval and Disposition Project consists of two additional segments with respect to safety analysis for future project configurations. Therefore, there are a total of three facility segments:

1. Silo 3 - analyzed and authorized in PHAR
2. Process Building - analyzed and authorized in this N-HASP
3. Interim Staging Area (ISA) - analyzed and authorized in this N-HASP

The Process Building consists of a process area containing material handling and bag-out facilities, the Excavator Room, the Excavator Service Room, and the Cargo Container Bay. The building is adjacent to Silo 3, and connects to Silo 3 through the batch type retrieval mechanisms (pneumatic and mechanical). After construction of the building and operation of the pneumatic retrieval system for initial removal of waste material, an opening will be cut in the silo to provide direct access to the remaining contents by mechanical retrieval

Radon Released

The initial radon release from the silo failure during wall cutting is conservatively assumed as 0.0356 Ci, which assumes a maximum headspace concentration, where no silo ventilation was in operation. In addition to the initial radon release, radon would be released from the remaining silo material at a rate of 4.7×10^6 pCi/minute over the next 24 hours.

B-3.2.3 Hazard Categorization Based on Radiological Dose Criteria

To demonstrate no significant localized consequences, dose consequences are determined for workers at 30 m, for comparison to the dose threshold criteria of DOE HC-3 facilities (10 rem over a 24-hour exposure).

The methods used to determine the dose consequence or committed effective dose equivalent (CEDE) for each accident scenario use variations of the following general equation [Ref. 16]:

$$CEDE = \sum (MAR * DCF * DR * BR * ARF \text{ or } ARR * LPF * RF * (\chi/Q) * T)_i$$

where:

MAR	=	amount of a radionuclide available to be acted upon by a physical stress (pCi)
DCF	=	dose conversion factor in mrem/pCi
DR	=	damage ratio or the fraction of the MAR actually impacted by accident conditions
BR	=	breathing rate of a reference person considered = 3.33×10^{-4} m^3/sec
ARF	=	airborne release fraction
ARR	=	airborne release rate
LPF	=	leak path factor or the fraction of material transported through some confinement
RF	=	respirable fraction
χ/Q	=	long-term dispersion factor in sec/m^3
T	=	exposure time in hours
i	=	each radionuclide

The dispersion factor (χ/Q) for a straight line, ground level release, is determined from a Gaussian plume model for continuous point source emission in accordance with Nuclear Regulatory Commission's *Regulatory Guide 1.145* [Ref. 17]. A wind speed of 1.0 m/second and D stability class was used at a distance of 30 m, which is consistent with the recommendations of DOE-STD-1027-92 [Ref. 4], for HC-3 criteria. A wind speed of 4.5 m/sec and D stability class was used at 100 m, which is consistent with the recommendations of DOE-STD-1027-92 for HC-2 calculations. The χ/Q is 1.77×10^{-2} at 30 m and 1.05×10^{-3} at 100m.

For a continuous release, the receptor is assumed to be exposed for 24 hrs at 30 m and 2 hrs at 100 m and 330 m. For an instantaneous release, the material is assumed to be completely released within 1 hour. The receptor is exposed during this hour to the instantaneous release, and for the entire exposure period to resuspended solids that are emitted continuously.

All Silo 3 material is in powder form. For EBA-2, dose resulted from powders impacted by falling objects, radon release, and radon flux. The ARF for powders impacted by a falling object (Page 4-85, HDBK-3010), is 1×10^{-3} and the RF is 0.1.

The DCFs were obtained from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* [Ref. 18]. The Ra226 DCF, lung clearance class Y, is obtained from CAP88-PC Version 2.1, which was determined using the RADRISK code.

The dose from exposure to radon is determined from the Radon Modeling Report [Ref. 19].

Dose results for hazard categorization purposes are presented in **TABLE B.3-2.**

TABLE B.3-2: RADIOLOGICAL DOSE CONSEQUENCES

Receptor Distance	Solids Results	Radon Results for Initial Release	Radon Results for Flux	Total CEDE (rem)
	Dose (mrem)	Dose (mrem)	Dose (mrem)	
Silo Failure During Wall Cutting (EBA-2 Appendix G)				
30 m (HC-3)	273	41	6.8	0.32
100 m (HC-2)	16	8.4	0.1	0.03

The total dose is the sum of the dose from solids, the dose from radon released initially, and the dose from radon released continuously. These results demonstrate no significant localized consequences and therefore support a hazard categorization of Less Than Nuclear for the Silo 3 retrieval and disposition activity. PCN2

B-3.3 COMPARISON OF CHEMICAL CONSTITUENTS TO THRESHOLDS

Less Than Nuclear facilities with inventories of hazardous materials at or above the levels specified in 40 CFR 355, *Emergency Planning and Notification,* shall develop the same safety documentation as required for "non-nuclear" facilities.

TABLE B.3-4: PARAMETERS FOR CALCULATING CHEMICAL CONCENTRATIONS

Parameter	Initial Release	Ferrous Sulfate Spill
MAR (kg)	Chemical specific	32,000 kg (4,500 gal)
Release duration (t in hrs)	1	1
ARF	1E-3	5E-5
RF	0.1	0.8
LPF	0.01	1
DR	1	1
X/Q @ 100 m	9.08E-3	9.08E-3
X/Q @ 350 m	9.0E-4	9.0E-4

The five chemical compounds are released as a result of the silo failure during wall cutting. The ferrous sulfate spill assumes the 4,500 gal. tank ruptures spilling the entire contents into the Cargo Container Bay. The ARF and RF values are obtained from DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* [Ref. 22], for a free fall spill of a liquid. It is conservatively assumed that the structure provides no containment.

TABLE B.3.5 provides the maximum concentrations of chemical compounds from the postulated scenarios at distances of 100 and 350 m for comparison to the ERPG values for those chemicals.

TABLE B.3-5: CHEMICAL CONCENTRATION COMPARISON TO ERPGS

Chemicals	Concentration		ERPG-1 (mg/m^3)	ERPG-2 (mg/m^3)	ERPG-3 (mg/m^3)
	On-site (mg/m^3)	Off-site (mg/m^3)			
Arsenic trioxide	5.61E-02	5.56E-03	0.03	1.4	5
Cadmium oxide	1.96E-03	1.94E-04	0.035	0.05	12.5
Mercuric oxide	9.42E-03	9.34E-04	0.075	0.1	10
Thallium sulfate	1.20E-03	1.19E-04	0.3	2	15
Vanadium pentoxide	9.83E-02	9.75E-03	0.075	0.5	35
Ferrous Sulfate	3.26	0.32	7.5	12.5	350

The on-site concentrations are below ERPG-2 and the off-site concentrations are below ERPG-1. As shown in TABLE B.3.4, these concentrations result in a "Low" chemical hazard classification.

B-4.0 FINAL HAZARD CATEGORY

The results of these analyses demonstrate that the Silo 3 Facility and staging area may be reasonably categorized as a Less Than Nuclear Facility with a Low chemical hazard. Anticipated localized dose consequences are not significant, and anticipated chemical concentrations do not exceed the corresponding ERPG concentrations.

These analyses are appropriate for the development of graded safety analysis required by 10 CFR 830 Appendix A, Table 2 [Ref. 8]. Detailed accident analyses are provided in Appendix G of the Silo 3 Nuclear Health and Safety Plan to validate the hazard categorization and to give a better understanding of the material that can be physically released from the facility and the associated risks to workers, the public, and the environment.

PCN2

EXECUTIVE SUMMARY

The purpose of this document is to establish the design and operating features necessary to manage the risk of fire associated with operation of the systems within the Silo 3 Process Facility. The descriptions and conclusions are based on the preliminary design documentation. The Silo 3 Project is supported by the Fernald Closure Project (FCP) infrastructure services including water supply for fire protection and contracted emergency response.

Potential fire scenarios were analyzed for the Silo 3 Process Facility, including the maximum credible fire loss and the maximum possible fire loss. It was determined that fire suppression systems are not required for the Silo 3 Process Facility. Areas subject to contamination have been provided with a fire detection system to detect a fire in the incipient stage to alert personnel and the Crosby Township Fire Department, thus controlling the spread of fire. Fire detection and fire alarm systems are provided throughout the facility. DOE-STD-1066-99, Section 6.2.5 [Ref. 1], suggests that hose runs from hydrants to all exterior portions of protected buildings be no more than 300 ft. There are areas of the Silo 3 Project that exceed a 300 ft hose run from the closest hydrants; however, water pressure and hose diameter are sufficient to provide adequate protection.

Water supplies, fire reporting, and designated emergency response will likely change over the next few years during operation of the facility. Changes that have occurred include the demolition of the elevated water tank used for firewater and the supplementing of the site Fire Department with contracted services. Neither of these changes should jeopardize the level of protection required for the facility. Generally, except for the loss of the elevated tank, water supplies should be more abundant as existing sprinkler-protected facilities are demolished at the site. As a result of the readiness review, this document may require updating prior to facility operation to ensure that all changes are adequately addressed and that the level of protection is not diminished. Any change in the response times between the contracted services will be reviewed and evaluated, as required during service procurement.

The conclusion of this Fire Hazards Analysis is that the fire risk of the Silo 3 Process Facility are low to moderate and will be adequately controlled by the fire detection/alarms design and operating features provided. The objective of protecting the public and the environment from fire-induced releases is met. The objective of protecting employees from fire is accomplished with detection, notification, and means of egress. The property damage and project downtime risks are acceptable for the duration of this project.

F-1.0 INTRODUCTION

The following fire hazard analysis was prepared to satisfy DOE requirements for the proposed project. This effort was based on performing a fire hazards analysis as required by DOE Order 420.1, *Facility Safety* [Ref. 2]; and DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees* [Ref. 3]. The subject project is located at the DOE FCP at Fernald, Ohio.

The intent of this analysis was to review the proposed project in accordance with the proposed design documents and determine what, if any, design modifications, enhancements, etc., would be necessary to the fire safety and life safety elements of the project.

The purpose of a fire hazards analysis is to comprehensively and qualitatively assess the risk from fire within individual fire areas in a DOE facility to ascertain whether the DOE fire safety objectives delineated in Order 420.1 and Order 440.1A are met.

F-1.1 Purpose

The purpose of this document is to establish the design and operating features necessary to manage the risk of fire associated with operation of the Silo 3 Process Facility for the retrieval and packaging of the Silo 3 material.

The potential fire hazards associated with the processes, structures, facilities, and equipment are identified, and the fire prevention and protection strategies are outlined.

F-1.2 Approach and Assumptions

The descriptions and conclusions in this document are based on the design documentation. The Silo 3 Process Facility is supported by the FCP infrastructure services including fire protection and contracted emergency response.

A sprinkler system was not included in the design of the building for three chief reasons. First is the lack of combustibles. The main buildings are constructed primarily of steel and concrete. The combustible materials, e.g., insulation in the walls, roofing, and the membrane-covering meet code for fire resistance or are self-extinguishing. Most of the contents of the building are not combustible either. The few combustibles, listed in Section F-1.3 are widely dispersed so that the likelihood of fire spread is low. Second, in many areas contamination may be present and activation of a sprinkler head would cause its spread, greatly increasing the cost of recovery. Third is the duration of the project, scheduled for completion in less than 9 months from start to finish.

The packaged air conditioning units for the Process Building and the Cargo Container Bay Air Handling Unit have smoke detectors installed in their supply air plenums. The air conditioning units and air-handling unit will be shut down when a fire is detected by the fire detection system by a signal sent from the fire detection system. The Silo Enclosure and the Process Building have exhaust fans that will also be shut down when a signal is received from the fire detection system. Motorized fire dampers are located in the ductwork for the corridors and the air locks. See Section F-4.5 for a description of a fire-induced radiological dispersal. A detailed description of the strategy and equipment used for the heating, ventilation and air conditioning (HVAC) of the facilities is described in the HVAC Sequences of Systems Operations drawings [Refs. 18 and 19].

Process Equipment

A detailed description of the strategy and equipment used to remove the material contained in Silo 3 is found in the project *Access and Retrieval Strategy for the Silo 3 Project*, Document No. 40430-PL-0002 [Ref. 7] and the *Process Description for the Silo 3 Project*, Document No.40430-RP-0003 [Ref. 8]. From a fire protection standpoint, none of the processes or equipment pose a combustible materials loading hazard.

The Process and Excavator Buildings contain process equipment, including pumps and motors that create a low risk of a localized fire. The buildings also contain hydraulic, pneumatic, and electrical systems, creating a small potential for localized fires. The hydraulic oil is a combustible liquid with a flash point of 350°F or greater. An electric motor could fail and become an ignition source for other combustibles including hydraulic fluids. However, the likelihood of an ignition of hydraulic oil is low because of the high ignition energy required and the need for a second failure (motor failure). No other significant ignition sources (e.g., heated surfaces) are in proximity of the hydraulic systems. An electrical or hydraulic fluid fire would render the affected equipment inoperative until repairs could be made. The amount of combustible materials is not adequate to create a fire capable of causing structural damage to the buildings.

Operations Support and Change Trailer

The Operations Support and Change Trailer presents a moderate fire risk due to the electronic equipment located in the Control Room in the northeast corner and storage in the southwest corner. Walls of the trailer are fabricated using combustible materials. The Change Room in the northwest corner is standard light hazard occupancy and presents no significant fire risk. This area (Fire Area 2) is separated from the Silo 3 Process Building by an enclosure of approximately 14 ft by 25 ft dimensions. The enclosed area is an extended exit corridor from the Silo 3 Building. The trailer is positioned 3 ft 9 in away from the tension frame fabric structure over Silo 3. The trailer is a temporary structure (having non-rated walls and being un-sprinklered) and therefore does not need to meet Table 600 of the Ohio Building Code for fire separation. The fabric on the tension structure is flame retardant, self-extinguishing, and does not propagate flame. The structure design also allows the self-venting release of heat.

F-4.3 Analysis of Potential Fire Scenarios

- Fire Area 1 – Process, Excavator, and Cargo Container Buildings: The Process, Excavator, and Cargo Container Buildings have been constructed of noncombustible materials and contain a very limited amount of combustible materials. The worst-case fire in this building would be in the packaging/filling area of the process building due to the presence of packaging materials, conveyors, and motors in proximity to each other. An uncontrolled fire in this area could create significant damage to the equipment and the building, thus impacting the operation of the facility.

- Fire Area 2 – Operations Support Area: The fire scenario in this area involves the Operations Support and Change Trailer, which are considered to have a moderate hazard occupancy. A fire could do significant damage to the trailer because of the equipment inside. Building materials for stairs and decks that meet applicable codes are used to minimize the potential for a fire to propagate from the trailer to the process building. In addition, the trailer is normally occupied during operations, so that personnel would be immediately available to fight an incipient fire. The enclosed area between the trailer and Process Building is rated for one-hour construction.

  A fire in the Operations Support and Change Trailer might propagate to the tension support structure covering Silo 3. However, structure ventilation, a flame retardant fabric, fire alarms, and the time required for a fire to breach the Operations Support and Change Trailer's outer envelope would provide for sufficient worker safety and minimize equipment damage. The fabric cover for the tension support structure is self-extinguishing PVC with a Flame Spread Rating of 25 or less and a Flame Resistance of 2 seconds or less.

F-4.4 Explosives

None of the materials handled or used in the Silo 3 Process Facility Project in any measurable quantities create an explosive hazard based on the hazard category calculation in Appendix B of this N-HASP.

F-4.5 Potential for Radiological, Biological, or Toxic Incident

- Radiological Hazards: The major radiological hazard from a fire would be the potential release of radon from the packaging area. The calculation of the worst-case dose to a worker or a member of the public in the event of a spill of material from equipment failure due to a fire is based on the assumed complete release of the radon present in the spilled material. Radon in the spilled material void spaces, radon generated over the next 24 hours, and some of the solids are released to the ventilation system. The filter system fails to remove the material and all materials are passed through the ventilation system and released from the 125 ft stack. The calculated dose at 350 m downwind was found to be 12 mrem. Therefore, a fire in the packaging area of the process building should not be considered to be "safety-significant."

- Biological Hazards: There are no biological hazards created by any fire scenario.

- Chemical and Toxic Hazards: Two chemicals will be used in the process, ferrous sulfate and sodium lignosulfonate. Both chemicals will be supplied as aqueous solutions and will remain in solution (in an even more diluted form) during use. Ferrous sulfate is not combustible, and sodium lignosulfonate will only burn if dried out. With the detection/alarm systems provided, none of the fire scenarios should involve the release of hazardous or toxic chemicals.

F-4.6 Fire Protection Water Run-Off

Water for fire fighting would only be used in the non-contaminated areas of the facility. Therefore, this should not create a contaminated water run-off problem greater than normal storm water run-off, since no breach of contaminated areas would occur.

F-4.7 Natural Hazards (Earthquake, Flood, and Wind)

Wind is the only natural hazard that could exacerbate a fire by allowing a fire to propagate between the trailer and the Process Building (Section F-6.4, MPFL). Earthquake and flood potentials do not affect the fire risks.

F-5.0 FIRE PROTECTION

F-5.1 Water Supply

An adequate fire-protection water supply is available from the FCP site (Section F-1.4). Fires in areas that cannot be handled with portable fire extinguishers will be suppressed manually by the subcontracted fire department. The Silo 3 Civil Utility Plan, Drawing No. 94-X-3900-G-01299 [Ref. 10], outlines the site plan and the fire hydrant locations.

F-5.2 Fire Suppression

The Implementation Guide for DOE Orders 420.1 and 440.1 (paragraph 9.7) [Ref. 20] states that DOE has an obligation to provide protection for its facilities so that a fire will not result in an unacceptable program delay or property loss. Consequently, DOE considers any facility in excess of 5,000 ft^2 in ground floor area and any facility with a maximum possible fire loss (MPFL) of $1 million ($10 million approved at FCP via DOE memorandum, DOE-0320-99 [Ref. 21], J. Craig to G.L. Denver, January 22, 1999, *Change in Maximum Possible Loss Criteria at the Fernald Environmental Management Project*) as warranting protection by an automatic fire suppression system. The packaging area of the Silo 3 Process Building has a ground floor area of 5,700 ft^2 and Occupancy Classification of Group F-2 (Low Hazard). Group F-2 Occupancies do not require that an automatic sprinkler system be provided. On Feb. 1, 2000, a DOE memorandum provided FCP with a fire suppression system exemption [Ref. 22]. A fire detection and alarm system has been installed throughout the Silo 3 facility to assure occupant notification of emergencies. Fire extinguishers are provided throughout the Silo 3 facility. They are located external to the fire hazard areas and near access ways so that incipient fires can be extinguished.

Fire suppression for the trailer emphasizes manual fire fighting. Normally-occupied areas have been provided with fire detection and alarm systems to assure prompt notification of emergencies to both occupants and to subcontracted emergency response. Portable fire extinguishers have been provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers* [Ref. 23]. Because of the lack of continuity of combustibles and the provisions of the fire detection system (see Section F-5.3), credible fires will be incipient in nature and can be suppressed using portable extinguishers. Because of the limited size and low or moderate hazard use, no automatic sprinkler protection is required. A trailer fire that is not controlled with portable extinguishers will require hose lines operated by the subcontracted fire department. The water supply distribution system to the Silo 3 area is a dead end run hydrant. This dead end run hydrant is within 290 ft of the supply tie-in point. There are parts of the Silo 3 Project that exceed the suggested maximum hose run distance of 300 ft distance from a hydrant, as specified in DOE STD 1066-99, Section 6.2.5 [Ref. 1]. However, water pressure and hose diameter are sufficient to provide adequate protection. The parts of the facility that fall outside this suggested hydrant support area are the Operations Support and Change Trailer, and the north and northwest sides of the Silo 3 Enclosure.

F-5.3 Protective Signaling System

Fire Detection

The Silo 3 Process Facility has been provided with fire detection and alarm systems to assure prompt notification of fire emergencies to both building occupants and emergency responders.

Detectors have been installed in accordance with NFPA 72, *National Fire Alarm Code* [Ref. 24], and are connected to the Silo 3 Process Building Fire Alarm Control Panel.

Fire Alarm System

The fire alarm system has a central Fire Alarm Control Panel in the Silo 3 Process Building. A fire or trouble alarm will be sent to the Savannah River Facility Communication Center, which will relay the alarm to the FCP site. Manual pull boxes have been installed in accordance with NFPA 72 and the IBC. Notification devices consist of horns and strobes and are installed in all areas in accordance with NFPA 72.

Smoke Detection System

Industrial-grade duct smoke detectors powered by 24V with battery back-up have been installed in the facility. Photoelectric spot type smoke detectors have been installed in the Cargo Container Bay, Packaging Area, Storage Area, Waste Water Area, Electrical Building, Operations Support and Change Trailer, Corridors, Air Locks, supply air plenums for the air conditioning units and the Cargo Container Bay Air Handling Unit. Each device

PCN1

is wired to the central Fire Alarm Control Panel (FACP). Upon activation, the FACP activates Silo 3 Project fire alarm horns/strobes, sends a fire alarm message to the Savannah River Facility Communication Center via telephone outlets, and send applicable output signals to the Silo 3 Process Control System. The Silo 3 Project also has numerous voice-message speakers that are connected to the site Emergency/Evacuation message system. PCN1

Heat Detection System

Combination rate-of-rise/fixed temperature type heat detectors have been installed above potentially dusty areas (i.e., rubber belt conveyors, within the air handling system, and in the Excavator Room). Each heat detector has a discrete address, will sound a general alarm, and automatically notify the communication center when activated.

F-5.4 Fire Department Response

Fire pre-plans have been developed for each fire area to outline the fire-fighting strategies and precautions required for the Silo 3 Process Facility. These pre-plans have been developed and reviewed with the Crosby Township Fire Department. Selected Silo 3 Process Facility project employees will receive incipient fire training regarding portable extinguishers and the alarm system.

F-6.0 FACILITIES, EQUIPMENT, AND PROGRAM PRESERVATION

F-6.1 Essential Safety Class Systems

No systems are considered essential safety class systems for this project as determined per the Silo 3 accident analysis in Appendix G of this N-HASP.

F-6.2 Vital and Critical Program

Vital Program Impact

A fire in the Process Building would be local and involve only one piece of equipment due to the lack of combustibles and their separation. As a result, recovery would not be more damaging to cost and schedule than other events such as the failure of containment (and the spread of contamination) or equipment failure. Areas where there are combustibles are areas where there is usual occupancy so that personnel would likely be available to mitigate the incipient fire immediately. In addition, the fire detection devices and alarms provided in these areas would alert others to help minimize damage and downtime.

Primary Equipment

All components involved with the retrieval, conveyance, and packaging of silo material are primary equipment. The fire detection system reduces the significance of a fire involving any of these components.

F-6.3 High-Value Equipment

The following values were obtained from estimates and procurements to date:

• Inclined conveyor:	$125,000
• Packaging system bag loaders:	$400,000
• Package heat sealers:	$320,000
• Excavator:	$450,000
• Pneumatic Retrieval - Vacuum Blower Skid:	$100,000
• Pneumatic Retrieval Collector:	$120,000
• Pneumatic Retrieval Cartridge Filter:	$65,000
• Motor control centers:	$125,000
• 480-volt feeder:	$81,000
• Control System:	$200,000
• Continuous emissions monitor:	$90,000
• Personnel contamination monitors:	$90,000
• Tennelec counting systems:	$90,000
• Process Vent System Collectors:	$90,000
• HVAC:	$275,000
• Trailer:	$135,000
• Tanks:	$90,000

F-6.4 Facility Fire Loss Potential

The maximum credible fire loss (MCFL) and MPFL potential in each fire area includes the cost of property loss, recovery, cleanup, and replacement.

Maximum Credible Fire Loss

- Fire Area 1 – Process, Excavator, and Cargo Container Buildings, and Silo 3 Enclosure: The MCFL is a fire in the packaging area of the Process Building that would result in damage to one of the two Container Management and Packaging Systems. The property damage would be approximately $800,000. Because of the redundant container management and packaging systems this MCFL would have little programmatic impact on the project.

- Fire Area 2 – Operations Support Area: The MCFL is a fire in the Operations Support and Change Trailer. An electrical fire could do significant damage to the trailer and control systems because of the trailer's frame construction. The property damage would be approximately $900,000. This MCFL would have a programmatic impact on the project.

Maximum Possible Fire Loss

- Fire Area 1 –Process, Excavator, and Cargo Container Buildings, and Silo 3 Enclosure: The MPFL is a fire in the packaging area of the Process Building that would result in the loss of the Container Management and Packaging Systems, as well as all ancillary equipment. The property damage would be approximately $2,500,000. This MPFL would have a programmatic impact on the project because the majority of the equipment is not readily replaceable.

- Fire Area 2 – Operations Support Area: The MPFL is an unmitigated fire in the trailer during high wind conditions and is the same as the MCFL for this area. The resulting damage would include the trailer with similar property damage of approximately $900,000. This MPFL would have a programmatic impact on the project, but these facilities and associated equipment are more readily replaceable than those associated with Fire Area 1.

F-6.5 Emergency Planning

The Silo 3 Process Facility Project emergency planning will be integrated with PL-3020, the FCP Emergency Plan [Ref. 25], EM-0030, *Silos Area Emergency Procedure* [Ref. 26], and EM-0020, *Building Emergency Procedure* [Ref. 27].

F-7.0 CONCLUSION

The conclusion of this Fire Hazards Analysis is that the fire risk of the Silo 3 Process Facility are low to moderate and is adequately controlled by the fire detection/alarms design and operating features provided. The objective of protecting the public and the environment from fire-induced releases is met. The objective of protecting employees from fire is accomplished with detection, notification, and means of egress. The property damage and project downtime risks are acceptable for the duration of this project.

A small, localized fire in the contamination areas (see Section F-1.3) will be detected in the incipient stage and can be controlled with portable fire extinguishers and/or the ventilation system to isolate the areas.

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LIST OF TABLES

ACRONYMS

ARF = Airborne release fraction

ARR = Airborne release rate

ASR = Auditable safety record

CEDE = Committed effective dose equivalent

Ci = Curie

DAC = Derived air concentration

DCF = Dose conversion factor

DOE = U.S. Department of Energy

EBA = Evaluation basis accident

EG = Evaluation guideline

ERPG = Emergency Response Planning Guide

FCP = Fernald Closure Project

HC = Hazard category

HEPA = High-efficiency particulate air

MOI = Maximally exposed off-site individual

OU = Operable unit

pCi = Picocurie

PHAR = Preliminary Hazard Analysis Report

RF = Respirable fraction

STD = Standard

TPQ = Threshold planning quantity

UCL = Upper confidence level

WL = Working level

WLM = Working level-month

G-2.3 Common Assumptions

The accident scenarios were analyzed using several common assumptions:

- The Silo 3 material is assumed to contain 3,870 pCi/g of ^{226}Ra and its progeny are in complete equilibrium unless otherwise noted in the scenario.

- Sample data shows that the Silo 3 material bulk density ranges from 29 to 58 lb/ft^3. The average bulk density is 42.4 lb/ft^3 (0.68 g/cm^3). A bulk density of 50 lb/ft^3 was used in most of the analyses. However, EBA-4 used a calculated density of 73 lb/ft^3. This was done in order to estimate the maximum potential release based on two easily-measured parameters (bag weight and bag volume). These two parameters drove a calculated material density of 73 lb/ft^3, which, although outside the range of the sample data, is conservative for consequence analysis purposes (i.e., it reflects the absolute physical limits of the container). This ensures that an operational condition does not occur in which the safety basis may be inadequate, or results in a "potential inadequacy of the safety analysis". PCN2

- All Silo 3 material is in powder form. The airborne release fraction (ARF) and respirable fraction (RF) of the solid powder material is obtained from DOE-HDBK-3010-94 [Ref. 2]. The inputs are summarized in **TABLE G.2-1.** The bounding ARF for a free-fall spill of uncontained powders, page 4-77 of DOE-HDBK-3010-94, is 2 x 10^{-3}. An RF of 0.3 was used for free fall spill of powders. These values were obtained from experiments performed using up to 1,000 g. TiO_2, material density 4.2 g/cm^3, from a spill height of 3 m. Recalculation of EBAs where free-fall spills were modeled was performed with more conservative bounding values, as discussed in SECTION G-3.0.

- The ARF for powders impacted by a falling object is 1 x 10^{-3} and the RF is 0.1. DOE-HDBK-3010-94, page 4-85, provides a basis for choosing an ARF and RF from impacts due to large falling objects and induced air turbulence. Tests were performed on a variety of materials to simulate the release of powders. All the tested materials were free-flowing (non-cohesive) powders, the most dispersible of which was Al_2O_3, with an ARF of 1 x 10^{-3}. The nature of this release scenario is to provide some confinement of its inner volume. DOE-HDBK-3010-94 also considers other material configurations in which some material protection is available. Additional tests were performed by dropping heavy objects on cans of powder. The highest RF value from the contained set was 0.07. DOE-HDBK-3010-94 concludes that, in cases where some material protection is afforded, the appropriate bounding ARF*RF is the highest ARF from the uncontained data set (1 x 10^{-3} for uncontained Al_2O_3) used in conjunction with the largest RF from the contained experiments (rounded to 0.1). As a result, an ARF of 1 x 10^{-3} with a RF of 0.1 was assessed to be appropriate for this release scenario.

- The summation of CEDEs for each radionuclide results in a CEDE for Silo 3 material of 19.8 rem/g inhaled (without radon and daughters). This is shown in **TABLE G.2-2.** The DCFs were obtained from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation,* *Submersion, and Ingestion* [Ref. 10], which is based on ICRP 30. The selected lung clearance class was based on the presence of oxides. The Ra226 DCF, lung clearance class Y, is obtained from CAP88-PC Version 2.1, which was determined using the RADRISK code. Short-lived radionuclides are not included because of the negligible dose contribution.

Radon will continue to emanate from silo material that is involved in spills or is open to the environment. The radon emanation rate from a solid material is 35 percent of the generation rate, based on experimental studies [Ref. 11 and 12]. The measured values for emanation fraction are derived or measured from mill tailings, which are similar to Silo 1 and 2 material in terms of composition, particle size, density, and porosity. However, Silo 3 contains calcined material that has a significantly different porosity, density, and particle size distribution. Since an experimentally determined emanation rate does not exist for Silo 3 material, 35 percent was used. The 35 percent emanation rate is the best experimentally based value available, although it may not be conservative.

TABLE G.2-1: DISPERSION ANALYSIS INPUTS

Release Mode or Type	Distance (m)	Application	Wind Speed (m/sec)	Stability Class	ARF	RF
Gaussian Ground Level Solids Release	30	HC-3	1.0	D	2E-3	0.3
	100	HC-2	4.5	D		
	350	MOI	1.0	F		
Gaussian Ground Level Solids Release (High Wind)	30	HC-3	31	A	1E-3	0.1
	100	HC-2				
	350	MOI				
Gaussian Stack Solids Release	30	HC-3	1.0	D	2E-3	0.3
	100	HC-2	4.5	D		
	350	MOI	1.0	F		
Radon Release	30	HC-3	1.8	F	1	1
	100	HC-2				
	350	MOI				

Note:
1. An ARF of 1×10^{-3} and an RF of 0.1 is used for EBA-2.

TABLE G.3-2: SILO WALL FAILURE SCENARIO RESULTS

Receptor Distance	Solids Results			Radon Results for Initial Release		Radon Results for Flux		Total[1] CEDE (mrem)	Total[2] CEDE (mrem)
	X/Q	Dose[1] (mrem)	Dose[2] (mrem)	Conc. (pCi/L)	Dose (mrem)	Conc. (pCi/L)	Dose (mrem)		
30 m (HC-3)	1.77E-2	273	983	488	41	3.4	6.8	321	1031
100 m (HC-2)	1.05E-3	16	58	101	8.4	0.7	0.1	25	67
350 m (MOI)	9.0E-4	14	50	20	1.6	0.1	<0.1	16	52

Chemicals	Concentration				ERPG-1 (mg/m³)	ERPG-2 (mg/m³)	ERPG-3 (mg/m³)
	On-site [1] (mg/m³)	On-site [2] (mg/m³)	Off-site [1] (mg/m³)	Off-site [2] (mg/m³)			
Arsenic trioxide	6.62E-02	2.38E-01	6.56E-03	2.36E-02	0.03	1.4	5
Cadmium oxide	2.31E-03	8.32E-03	2.29E-04	8.24E-04	0.03	0.05	12.5
Mercuric oxide	1.11E-02	4.00E-02	1.10E-03	3.96E-03	0.025	0.1	10
Thallium sulfate	1.42E-03	5.11E-03	1.40E-04	5.04E-03	0.3	2	15
Vanadium pentoxide	1.16E-01	4.18E-01	1.15E-02	4.14E-02	0.15	0.5	35

1 Based on ARF of 1E-3, RF of 0.1 from DOE-HDBK-3010-94. See SECTION G-3.0 for explanation.
2 Based on RF of 0.36, bounding. See SECTION G-3.0 for explanation.

Of the chemical constituents in the waste, five exceed the threshold planning quantity (TPQ) values in 40 CFR 355 [Ref. 15]. After further evaluation of these five compounds, none exceed the criteria for a "low" chemical hazard classification based on Emergency Response Planning Guide (ERPG) values. The criteria for "low" chemical hazard on-site is less than ERPG-3 and off-site is less than ERPG-2.

G-3.3 EBA-3: Spill Of Material From Conveyor Failure

In this accident scenario, there is a total break in conveyor containment while removing material with the excavator at the intersection of the inclined conveyor and the transfer conveyor. The conveyed material is released directly into the interior of the process building packaging area for 15 minutes before action is taken to stop the conveyor. The transfer rate for the conveyor is 10 yd³ per hour; therefore, 2.5 yd³ or 3,375 lb of material is released. The solids that become airborne are released to the ventilation system. It is conservatively assumed that the filter system fails to remove the material and all materials are passed through the ventilation system and released from the 125-ft stack.

Radon present in the spilled material void spaces and radon generated over the next 24 hours is released to the ventilation system. The 2.5 yd^3 spilled material contains 0.0059 Ci Ra^{226}. Assuming 35 percent of the radon generated emanates to the void spaces, the spill will result in a release of 2.07 x 10^{-3} Ci instantaneously. The radon emanation from the remaining solids will be 260,000 pCi/min over the next 24 hours.

The solids dispersion is modeled using the Gaussian plume model for stack releases, with stability class G and wind speed of 0.5 m/second. The radon release is significantly lower than that released in EBA-1; therefore, the radon dose is negligible. **TABLE G.3-3** summarizes the scenario results; the spreadsheets are provided in ATTACHMENT 3.

TABLE G.3-3: SPILL OF MATERIAL FROM CONVEYOR SCENARIO RESULTS

Receptor Distance	Solids Result			Total [1] CEDE (mrem)	Total [2] CEDE (mrem)
	X/Q	Dose [1] (mrem)	Dose [2] (mrem)		
30 m (HC-3)	2.75E-2	167	1002	167	1002
100 m (HC-2)	7.8E-3	47.4	284	47	284
350 m (MOI)	2.24E-3	13.6	81.6	14	82

1 Based on ARF of 2E-3, RF of 0.3 from DOE-HDBK-3010-94. See SECTION G-3.0 for explanation.
2 Based on ARF of 0.01, RF of 0.36, bounding. See SECTION G-3.0 for explanation.

G-3.4 EBA-4: Breach Of Full Package

In this accident scenario, a bridge crane or forklift is assumed to be transferring a full soft-sided package. The package is either not sealed, or gets caught on a sharp edge and is ripped open. The material in the soft-sided container spills out and lands in a pile on the floor.

The cargo container bay is effectively open to the environment so that what little radon is present and the airborne solids leak from the room. Using the package volume of 96 ft^3, and the tested package weight limit of 7000 lb., the calculated bulk density of the material is 73 lb/ft^3. This calculated bulk density is conservative because sample data for Silo 3 material was in the range of 29-58 lb/ft^3. Therefore, a spill of 7000 lb. is very conservative. PCN2

The solids dispersion is modeled using the Gaussian plume model for ground-level releases. The radon release is significantly lower than that released in EBA-1; therefore, the radon dose is negligible. The same accident could be postulated for the ISA, with identical consequences (but less likely because bags meet DOT requirements [are sealed] before transfer to the ISA). The same scenario with more than one bag, although extremely unlikely, would have consequences that increase linearly (i.e. two bags would double the consequence). **TABLE G.3-4** summarizes the results; the spreadsheets are provided in ATTACHMENT 4.

TABLE G.3-4: BREACH OF A FULL PACKAGE SCENARIO RESULTS

Receptor Distance	Solids Result		
	X/Q	Dose [1] Total CEDE (mrem)	Dose [2] Total CEDE (mrem)
30 m (HC-3)	1.77E-2	223	1338
100 m (HC-2)	1.05E-3	13	78
350 m (MOI)	9.0E-4	11	66

PCN2

1 Based on ARF of 2E-3, RF of 0.3 from DOE-HDBK-3010-94. See SECTION G-3.0 for explanation.
2 Based on ARF of 0.01, RF of 0.36, bounding. See SECTION G-3.0 for explanation.

G-3.5 EBA-5: Failure Of Collectors In Pneumatic Retrieval System

Ordinarily, the material collected by the Pneumatic Retrieval System is removed from the airstream using several unit operations in series. First is the Pneumatic Retrieval Collector consisting of a bag-house. The collector is followed by a cartridge filter and a filter housing, which contains a high-efficiency particulate air (HEPA) filter, two graded prefilters, and an ultra-low-penetrating air filter.

During extraction, an abrupt pressure change causes a blowout of the downstream filters and disables the Pneumatic Retrieval Collector. The extracted material flows directly to the stack and is emitted to the atmosphere. The material and associated radon are released at the design flow-rate of 1,200 ft^3/minute of air containing 0.188 lb solids/ft^3.

$$50 \text{ lb/ft}^3 \times 10 \text{ yd}^3\text{/hr} \times \text{min}/1200 \text{ ft}^3 \times 27\text{ft3/yd3} \times \text{hr}/60\text{min} = 0.188 \text{ lb/ft}^3$$

The accident is unmitigated for 15 minutes, resulting in a release of 3,384 lbs of solids.

The initial radon release is conservatively assumed as 0.105 Ci, which is the headspace inventory based on 1,000,000 pCi/L and a volume of 3720 ft^3. In addition to the initial radon release, radon will be released from the remaining silo material at a rate of 6.26 x 10^6 pCi/minute over the next 15 minutes. The total radon release is 0.048 Ci.

The solids dispersion is modeled using the Gaussian plume model for stack releases, with stability class G and wind speed of 0.5 m/second. The radon dispersion is modeled with the Fernald radon model. **TABLE G.3-5** summarizes the scenario results; the spreadsheets are provided in ATTACHMENT 5.

TABLE G.3-5: FAILURE OF PRS COLLECTORS SCENARIO RESULTS

Receptor Distance	Solids Results			Radon Results for Initial Release		Total [1] CEDE (mrem)	Total [2] CEDE (mrem)
	X/Q	Dose [1] (mrem)	Dose [2] (mrem)	Concentration (pCi/L)	Dose (mrem)		
30 m (HC-3)	2.75E-2	167	1002	652	54.3	221	1056
100 m (HC-2)	7.8E-3	47.5	285	135	11.3	59	296
350 m (MOI)	2.24E-3	13.6	81.6	26.3	2.2	16	84

1 Based on ARF of 2E-3, RF of 0.3 from DOE-HDBK-3010-94. See SECTION G-3.0 for explanation.
2 ased on ARF of 0.01, RF of 0.36, bounding. See SECTION G-3.0 for explanation.

G-3.6 EBA-6: ISO Falls

This accident scenario addresses packaged material staged in the Interim Staging Area (ISA) or elsewhere. The material is packaged in sealed IP-2 soft-sided packages, and these soft-sided packages are then contained in steel International Standards Organization (ISO) containers. No more than 8 sealed bags should be staged without being in an ISO. The Silo 3 inventory packaged in this manner would number no more than 273 ISOs, each containing an average of 30,000 pounds of Silo 3 material, which (collectively) is considered the Material at Risk. The ISOs are stacked two high.

In the event of an earthquake, the ISO containers on the top row may be vulnerable to toppling to the ground. Half of the containers are on the top row (136), and it is estimated that 10% of them (14) fall the height of one container (eight feet). This scenario bounds any other toppling scenario that may be initiated by human error in stacking.

It is anticipated that the majority of the force from the fall will be absorbed by the ISO itself, with little impact on the soft-sided packages contained inside. Fluor Fernald has used these steel ISO containers for many years and there is confidence in their ability to withstand damage. The soft-sided package is certified to meet the same test criteria as metal containers [Ref. 16]. Nonetheless, if a conservative assumption is made that half of the ISOs that fall are damaged to the extent that the soft-sided packages are impacted, and 1% of the inventory is released, the result will be a ground level spill of 2100 pounds of material. Assuming untreated material has a density of 50 lb/ft^3, the Silo 3 material comprises 89 percent of the total treated material mass. Therefore, the mass of silo 3 material released is 1969 lb. **TABLE G.3-6** summarizes the scenario results; the spreadsheets are provided in ATTACHMENT 6.

TABLE G.3-6: ISO FALLS SCENARIO RESULTS

Receptor Distance	Solids Result			Total [1] CEDE (mrem)	Total [2] CEDE (mrem)
	X/Q	Dose [1] (mrem)	Dose [2] (mrem)		
30 m (HC-3)	1.77E-2	62.7	376	62.7	376
100 m (HC-2)	1.05E-3	3.72	22.3	3.72	22.3
350 m (MOI)	9.0E-4	3.19	19.4	3.19	19.4

1 Based on ARF of 2E-3, RF of 0.3 from DOE-HDBK-3010-94. See SECTION G-3.0 for explanation.
2 Based on ARF of 0.01, RF of 0.36, bounding. See SECTION G-3.0 for explanation.

G-3.7 EBA-7: ISO Penetrated

This accident scenario addresses packaged material staged in the ISA or elsewhere. The material is packaged in sealed IP-2 soft-sided packages, and these soft-sided packages are then contained in steel ISO containers. No more than 8 sealed bags should be staged without being in an ISO. The Silo 3 inventory packaged in this manner would number no more than 273 ISOs staged on site, each containing an average of 30,000 pounds of Silo 3 material, which (collectively) is considered the Material at Risk. The ISOs are stacked two high.. The 273 number easily represents the maximum for staged ISOs given that the EPA has directed the maximum on-site staging time to be 14 days. PCN2

The probability of tornadoes and high winds decreases with severity ranking. For example, the probability per year per square mile for an F-2 tornado (113-157 mph) is 2.83E-5. This is a relatively unlikely event. Although such an event may cause damage to an ISO, the damage will probably not be significant. Nevertheless, such a scenario was analyzed to be present a comprehensive evaluation of hazards.

In the event of a tornado or high wind event, the ISO containers may be vulnerable to toppling or penetration by projectiles. Toppling is addressed in EBA-6. Although tornado winds will result in more destruction, a high wind event will result in a higher airborne concentration of hazardous material. Therefore, a conservative scenario is modeled that assumes projectiles from a tornado impact the stacked ISOs. The resulting material release is dispersed by high winds.

Following the models from other DOE Natural Phenomena Hazards analyses, various projectiles were considered (car, telephone pole, two-by four, etc.). The smaller projectiles are more probable to be airborne, but less likely to penetrate the ISO containers. Therefore, a telephone pole was postulated as a likely projectile. It was assumed that a 12" diameter pole penetrates the ISO (8 feet tall, 8 feet wide, 20 feet long) from end to end. It displaces 15.7 ft^3 of material (20 feet long by .785 ft^2). Of the possible 273 ISO containers, a conservative assumption was made that 10% were penetrated (27 ISOs). Therefore, 424 ft^3 of material (27 x 15.7) or 16 yd^3 will be released.

Radon is present in the spilled material void spaces and will be generated over the next 24 hours. The 16 yd^3 spilled material contains 0.04 Ci Ra^{226}. Assuming 35 percent of the radon generated emanates to the void spaces, the spill will result in a release of 0.014 Ci instantaneously. The radon emanation from the remaining solids will be 1.73E6 pCi/min over the next 24 hours.

The solids dispersion is modeled using the Gaussian plume model for ground release, with stability class A and wind speed of 31 m/second. An ARF of 1E-3 and and RF of 0.1 were assumed. **TABLE G.3-7** summarizes the scenario results; the spreadsheets are provided in **ATTACHMENT 7.**

TABLE G.3-7: ISO PENETRATED SCENARIO RESULTS

Receptor Distance	Solids Results			Radon Results for Initial Release		Radon Results for Flux		Total[1] CEDE (mrem)	Total[2] CEDE (mrem)
	X/Q	Dose[1] (mrem)	Dose[2] (mrem)	Conc. (pCi/L)	Dose (mrem)	Conc. (pCi/L)	Dose (mrem)		
30 m (HC-3)	2.53E-4	1.61E0	5.79E0	9.92	.83	1.85E-1	3.69E-1	2.81	7.00
100 m (HC-2)	2.73E-5	1.73E-1	6.24E-1	2.05	.17	3.82E-2	6.37E-3	.35	.80
350 m (MOI)	2.11E-6	1.34E-2	4.82E-2	0.4	.03	7.43E-3	1.24E-3	.04	.08

1 Based on ARF of 1E-3, RF of 0.1 from DOE-HDBK-3010-94.
2 Based on RF of 0.36, bounding. See SECTION G-3.0 for explanation.

G-4.0 CONCLUSIONS

Analysis of seven accident scenarios produced the radiological dose estimates for workers, co-located workers, and off-site populations that are presented in **TABLES G.4-1** and **G.4-2**. Workers are defined as any personnel performing work on the Silo 3 project within the boundaries of the facility (30 m receptor). Co-located workers are defined as other workers located within the boundaries of the FCP site, but not performing work on the Silos 3 project (100 m receptor). The off-site population is defined as all non-workers who reside or are otherwise located outside the FCP site boundaries. The nearest off-site point for the MOI is approximately 350 m west of the silos. **TABLE G.4-1** provides calculated internal dose estimates for individuals located at 30, 100, and 350 m from the point of the release. The offsite dose estimate is compared to the 25 rem EG established by DOE-STD-3009-94 [Ref. 1].

TABLES G.4-1 and G.4-2 provide calculated internal dose estimates for individuals located at 30, 100, and 350 m from the point of the release. The offsite dose estimate is compared to the 25 rem EG established by DOE-STD-3009-94. TABLE G.4.1 presents the dose estimates using ARF and RF values from DOE-HDBK-3010-94 [Ref. 2], and **TABLE G.4-2** presents the dose estimates using the more bounding ARF and RF values. As expected, the bounding ARF and RF factors resulted in higher dose consequences; however both sets of dose estimates support the conclusion that the final hazard categorization of Radiological is appropriate, and no safety-class structures, systems, and components (SSC) or technical safety requirements are needed.

Of the chemicals present, five exceed the TPQ values in 40 CFR 355. Further evaluation of these five compounds determined that none exceed the on-site and off-site criteria for a "low" chemical hazard classification based on ERPG values.

TABLE G.4-1: DOSE FOR COMPARISON TO EMERGENCY GUIDELINE

Event	Radiological Dose CEDE at various distances (mrem)		
	30 m	100 m	350 m*
EBA-1	63	11	2
EBA-2	321	25	16
EBA-3	167	47	14
EBA-4	223	13	11
EBA-5	221	59	16
EBA-6	62.7	3.72	3.19
EBA-7	2.81	.35	.04

* Nearest off-site location is 350 m, which is the MOI. DOE-STD-3009-94 Public EG is 25 rem.

PCN2

TABLE G.4-2: DOSE FOR COMPARISON TO EMERGENCY GUIDELINE USING CONSERVATIVE ASSUMPTIONS

Event	Radiological Dose CEDE at various distances (mrem)		
	30 m[a]	100 m[a]	350 m[b]
EBA-1	64	11	2
EBA-2	1031	67	52
EBA-3	1002	284	82
EBA-4	1338	78	66
EBA-5	1056	296	84
EBA-6	376	22.3	19.1
EBA-7	7.00	0.80	0.08

[a] ARF = 0.01 and RF = 0.36 for free fall spill of powders
[b] Nearest off-site location is 350 m, which is the MOI. DOE-STD-3009-94 Public EG is 25 rem.

PCN2

The conclusion that can be drawn from the analyses is that none of the accident scenarios analyzed yield consequences that would require "safety-class" controls as DOE-STD-3009-94, since the off-site EGs are not challenged.

Dose Calculation:

EBA-4 Solids Release

Solids Activity (pCi/cc) equals solids activity (pCi/g) x solids density
Source Term (MAR) equals solids activity (pCi/cc) x solids volume
Airborne Source Term (Q) equals the MAR x ARF x RF x DR x LPF
The DCF is listed for each isotope.
DOSE = Q * X/Q * BR * DCF * t

Dry Solid Density 1.17 g/cm^3
wt % solids 100 g solid/g slurry
Solid Density = 73.0 lb/ft^3
Solid Volume = 2.7 m^3 1 sacks
96 cf

ARF =	2.00E-03	
RF =	0.3	
DR =	1.0	
LPF =	1.0	
BR =	3.33E-04	m^3/s

Distance (m)	Stability Class	Wind Spd (m/s)	X/Q (s/m3)	Time (hours)
30	D	1	1.77E-02	1
100	D	4.5	1.05E-03	1
350	F	1	9.00E-04	1

PCN2

Radionuclide	Solids activity pCi/g	Solids activity pCi/cc	Source Term (MAR) pCi	Airborne Source Term (Q) pCi/s	DCF (mrem/pCi)	Dose @ 30 (mrem)	Dose @ 100 (mrem)	Dose @ 350 (mrem)
Ac-227	925	1.08E+03	2.94E+09	4.91E+02	1.29E+00	1.34E+01	8.00E-01	6.83E-01
Ac-228	406	4.75E+02	1.29E+09	2.15E+02	1.25E-04	5.70E-04	3.40E-05	2.90E-05
Bi-210	3,480	4.07E+03	1.11E+10	1.85E+03	1.96E-04	7.66E-03	4.57E-04	3.90E-04
Fr-223	13	1.52E+01	4.14E+07	6.89E+00	6.22E-06	9.08E-07	5.42E-08	4.63E-08
Pa-231	627	7.34E+02	2.00E+09	3.33E+02	8.58E-01	6.04E+00	3.61E-01	3.08E-01
Pa-234	2	2.34E+00	6.36E+06	1.06E+00	8.14E-07	1.83E-08	1.09E-09	9.31E-10
Pb-210	3,480	4.07E+03	1.11E+10	1.85E+03	1.36E-02	5.32E-01	3.17E-02	2.71E-02
Po-210	3,480	4.07E+03	1.11E+10	1.85E+03	8.58E-03	3.35E-01	2.00E-02	1.71E-02
Ra-223	925	1.08E+03	2.94E+09	4.91E+02	7.84E-03	8.15E-02	4.86E-03	4.15E-03
Ra-224	367	4.29E+02	1.17E+09	1.95E+02	3.16E-03	1.30E-02	7.77E-04	6.63E-04
Ra-226	3,870	4.53E+03	1.23E+10	2.05E+03	1.40E-01	6.09E+00	3.63E-01	3.10E-01
Ra-228	406	4.75E+02	1.29E+09	2.15E+02	4.77E-03	2.18E-02	1.30E-03	1.11E-03
Th-227	925	1.08E+03	2.94E+09	4.91E+02	1.62E-02	1.68E-01	1.00E-02	8.57E-03
Th-228	747	8.74E+02	2.38E+09	3.96E+02	3.42E-01	2.87E+00	1.71E-01	1.46E-01
Th-230	60,200	7.04E+04	1.92E+11	3.19E+04	2.62E-01	1.77E+02	1.06E+01	9.02E+00
Th-231	117	1.37E+02	3.72E+08	6.20E+01	8.77E-07	1.15E-06	6.88E-08	5.87E-08
Th-232	842	9.85E+02	2.68E+09	4.47E+02	1.15E+00	1.09E+01	6.49E-01	5.54E-01
Th-234	1,780	2.08E+03	5.66E+09	9.44E+02	3.50E-05	7.00E-04	4.18E-05	3.56E-05
U-234	1,730	2.02E+03	5.50E+09	9.17E+02	1.32E-01	2.57E+00	1.53E-01	1.31E-01
U-235/236	117	1.37E+02	3.72E+08	6.20E+01	1.23E-01	1.62E-01	9.65E-03	8.23E-03
U-238	1,780	2.08E+03	5.66E+09	9.44E+02	1.18E-01	2.36E+00	1.41E-01	1.20E-01
TOTAL	8.62E+04	1.01E+05	2.74E+11	4.57E+04	4.47E+00	**2.23E+02**	**1.33E+01**	**1.13E+01**

PCN2

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