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APPENDIX C
HUMAN FACTORS EVALUATION

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ACRONYMS

ALARA	as low as reasonably achievable
CAT	construction acceptance testing
CCTV	closed circuit television
DOE	U.S. Department of Energy
FCP	Fernald Closure Project
FMPC	Feed Materials Production Center
HFE	human factors evaluation
HMI	human machine interface
HVAC	heating, ventilation, and air conditioning
I/O	input and output
MRS	Mechanical Retrieval System
MWI	maintenance work instructions
NHASP	Nuclear Health and Safety Plan
OJT	on-the-job-training
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PLC	programmable logic controller
PC	personal computer
P&ID	Piping and Instrument Diagrams
PPE	personal protective equipment
PRS	Pneumatic Retrieval System
RWP	radiological work permit
SSC	Structure, Systems, and Components
STD	Standard
VWMS	vacuum wand management system

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PATH FORWARD

At the beginning of final design for the Silo 3 Project, the design engineers were provided with a Human Factors Engineering Design Checklist and design criteria. Design engineers used the checklist, presented as Attachment 1, to ensure that constraints and recommendations of human factors engineering were included in their design of components and systems. The checklist and criteria assisted design engineers in designing equipment in accordance with human capabilities and limitations.

This Human Factors Evaluation is an appendix in the Nuclear Health and Safety Plan (NHASP) that requests approval to perform Silo 3 operations. A complete and final Human Factors Evaluation requires a thorough review of the human/machine interfaces of all systems within the Silo 3 Project.

As the construction of the Silo 3 progresses, the manufacturer's manuals for major equipment will become available. A system safety analyst will evaluate the Silo 3 operating and maintenance manuals to perform a task evaluation and provide procedure and training guidance regarding human factors concerns. Additional evaluations will be performed following dry-runs, walk-downs, and startup testing, to revise the procedures as necessary. Further refinements can be performed as lessons learned arise from the actual implementation.

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C-1.0 INTRODUCTION

This Human Factors Evaluation (HFE) is an initial assessment of a number of factors important to the safe operation of the Silo 3 Project. The goal of this evaluation is to address stress, ergonomic, procedural, design, and training issues, with a resulting reduction of risk to workers, the public, and the environment caused by operator errors. The adequacy of controls has been evaluated based on specific engineering design details. The HFE focus is on the new facility design and pays particular attention to remote operations. The purpose of this HFE is to demonstrate that human factors are adequately considered for Silo 3 operations.

According to U.S. Department of Energy (DOE)-Standard (STD)-3009-94 (Ref. 1), the primary " emphasis is on human-machine interfaces required for ensuring safety function of safety structures, systems, and components (SSC's) that are important to safety." Hazard Category 3 facilities may have human-machine interfaces with safety-significant SSCs. Silo 3 is a less than Hazard Category 3 Facility. Consequently, the emphasis of this evaluation is shifted to activities that could cause unnecessarily high exposures to hazardous/radioactive materials, but still less than those necessary to cause significant local effects, consistent with the concept of as low as reasonably achievable (ALARA). In addition, emphasis is placed on minimizing physical dangers to personnel (i.e., strains or falls) in the course of performing project activities.

C-1.1 Silo 3 Description

The Fernald Closure Project (FCP) Operable Unit (OU) 4 includes four silos: Silos 1 and 2 (also known as the K-65 Silos), Silo 3, and Silo 4. Silos 1 and 2 contain radium-bearing residues from pitchblende ore processes. Silo 3 contains dry uranium oxide and other metal oxides. Silo 4 is empty and has never been used. Silo 3 was built in 1952 and is a freestanding, pre-stressed concrete, domed silo. It is 80 ft in diameter and the top is about 36 ft above ground level. The floor system is constructed of seventeen inches of compacted clay, a 2-in.-thick layer of asphaltic concrete, and an eight-inch layer of gravel topped by 4 in. of concrete. Approximately 5,088 yd^3 of metal oxide material reside in Silo 3. The predominant radionuclide of concern is thorium-230, which is produced from the natural decay of uranium-238.

Silo 3 contains metal oxide material generated from the operation of the former Feed Materials Production Center (FMPC), now known as the FCP. Raffinate streams from the FMPC's solvent extraction process were dewatered using rotary vacuum filters. The filtrate streams were then processed through evaporators, and the evaporator concentrates were further processed using either a spray calciner or a rotary calciner. From plant startup through the mid-1950s, a spray calciner processed the concentrates. Approximately 35 percent of the Silo 3 material is believed to have come from this process. Because of operational difficulties with the spray calciners, a rotary calciner process was implemented. In this process, the evaporator concentrates were transferred to a drum dryer and, finally, to a rotary calciner. The calciner removed residual liquids and

converted the metal nitrates to metal oxides. The resulting fine powdered metal oxides were pneumatically transferred to Silo 3 for storage. Transfer of all materials into Silo 3 continued until 1957.

C-1.2 Human Factors Evaluation

The primary objective of human factors engineering is to improve human performance through enhancements in the work environment and human-machine interface (HMI) (Refs. 2 and 3). Enhancements to the work environment and HMI reduce human errors and their consequences and lead to the following:

- Increased productivity,
- Lower costs,
- Better product quality,
- Decreased equipment and property damage,
- Improved program schedules,
- Personal job satisfaction, and
- Further improvements in the safe operation and maintenance of project facilities.

Human factors safety guidance provided in DOE-STD-3009-94, Chapter 13 (Ref. 1) refers to the following:

- Allocation of control functions to personnel versus automatic devices;
- Staffing and qualification of operating crews;
- Personnel training;
- Preparation, validation, and use of written procedures to guide operations;
- Surveillance and maintenance; and
- Design of the human-machine interface to build on strengths and protect against the susceptibility to human error in operating crews.

HFEs are performed on project designs, operations, activities, procedures, plans, training programs, and other applicable documents and activities with a graded approach. The extent of the graded approach is determined by the following criteria:

- Requirements of the applicable DOE Orders and implementation guidance documents,

- Magnitude of the risk being addressed,
- Relative importance of the subject matter to the assurance of safety, and
- Risk and cost evaluation.

C-1.3 Evaluation Methodology

A generalized checklist, Attachment 1, of human factors requirements and criteria was used to evaluate whether the applicable human factors requirements were being met. This checklist (based upon an HFE performed for the OU4 Hazard Analysis Report) (Ref. 4) was assessed for the Silo 3 Operations Phase (Attachment 1)

This checklist was provided to appropriate design engineering personnel for review and completion. These individuals reviewed the project against the checklist, indicating whether the design incorporated each requirement. A comment column was provided to allow for further explanation. The checklist has been initially completed on the basis of final design information, and the results are shown in Attachment 1. Finalization of the checklist will be performed upon the basis of information gained during construction, procedure development, acceptance testing, and training.

Following receipt of the manufacturer's manuals, a system safety analyst evaluates the manuals to perform a task evaluation and provide procedure and training guidance. Additional evaluations are performed following dry-runs and walk-downs, and prior to startup, to revise the procedures as necessary. Further refinements can be performed as lessons learned arise from the actual implementation.

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C-2.0 SILO 3 PROJECT DESCRIPTION

Access and retrieval of the Silo 3 material will be accomplished by both pneumatic and mechanical systems (Ref. 5). Before material retrieval is initiated, radon concentrations in the silo headspace will be reduced to acceptable levels. In preparation for mechanical retrieval, a reinforced concrete framework will be installed on the east silo wall, and a section of the silo wall will be removed.

Pneumatic retrieval involves vacuuming material through the existing manways on the Silo 3 dome. Material is removed from the eastern side of the silo to allow for wall-cutting activities. Pneumatic retrieval continues from the manways until it is no longer effective or practicable due to either inaccessibility by the pneumatic wand or a reduction in material flowability. The Pneumatic Retrieval System (PRS) then transfers material to the Process Building (Ref. 6).

In addition to pneumatic retrieval, a Mechanical Retrieval System (MRS) is used to access and remove the compacted material from Silo 3. An opening is cut in the silo wall to enable mechanical retrieval. A remotely controlled mechanical excavator transfers Silo 3 material to a bin located in the Excavator Room. The retrieval bin discharge feeder is variable speed, which controls the flow rate of material from retrieval to packaging. All downstream conveyors are single speed, and are designed to operate at capacities equal to or greater than the maximum capacity of the retrieval bin discharge feeder. An inclined conveyor transfers the material to the Process Building. Once the Excavator is in full operation, a water-misting system may be employed for dust suppression and stabilization of the working face of the Silo 3 material (Ref. 6).

The Container Management System allows personnel in the Process Building to perform the following functions:

1. Prepare bags and packaging frames for filling.
2. Dispense Silo 3 material from the Feed Conveyor into bags.
3. Add waste conditioning chemicals.
4. Perform swipe sampling and labeling of bags.
5. Convey filled bags into the Cargo Container Bay for loading.

Lighting will be provided near each of the closed circuit television (CCTV) cameras. Cameras will be provided at the following locations to support access and retrieval, at the Silo 3 north wall, inside the silo dome, on the ceiling above retrieval bin, and in the excavator room. In the Silo 3 Area, a 20-in. color monitor is located on top of Silo 3 to be used by the vacuum wand management system (VWMS) operator. A controller will be used by the vacuum wand operator to control pan/tilt and zoom of the Silo 3 cameras. A 20-in. color monitor will be in the observation room to be used by the excavator operator. The Operations Support Trailer has two 20-in. color monitors that can view any of the cameras (Ref. 7).

All equipment used for the Silo 3 Project includes control system hardware and a control approach typical of those used in conventional industrial material handling and packaging operations. The control philosophy is based on a combination of automated functions (where applicable) and actions by local operators. Many of the operations, particularly in the Packaging Area, require continuous operator actions and control input on a local basis.

Operator interface is based primarily on local operation with input via local push buttons and hand switches. A primary hand control station is provided at each of the two Package Loading Stands. Other control stations are provided as required. These control stations are suitably configured for manipulation by operators who are in a standing position alongside the associated equipment.

All controls and instrumentation are suitable for use in an industrial environment. The devices are conventional, commercially available items with a proven history of performance.

A programmable logic controller (PLC)-based control system is provided to monitor and control the material handling and packaging equipment. All control logic, sequencing, alarm monitoring, and interlocking are performed in the PLCs[1]. All relay logic, timers [non-heating, ventilation, and air conditioning (HVAC)], and other control devices are contained inside the PLC system. Operator push buttons, hand switches, conveyor controls, motion detectors, solenoid valves, etc. are configured as inputs and outputs (I/O) to the PLC control system. Emergency stop controls are hard-wired and have PLC inputs to reset process PLC control functions.

The main PLC processor is located in the Operations Support Trailer. A minimal number of PLC remote I/O racks are located in the Packaging Area and other locations as required to simplify wiring to conveyor controls, material position sensors, instruments, etc. One or more basic alpha/numeric display stations are provided at strategic locations in the Process Building to display process parameters such as motor amps, pressures, differential pressures, and alarm indications.

Two redundant personal computer (PC)-based HMI stations are installed in the Operations Support Trailer. These HMI stations serve as central points for monitoring and control of the process and supporting utilities. Monitoring and alarming capabilities are configured for all systems. The necessary control functions to support unattended systems[2] are incorporated in the HMI stations. Support systems such as the HVAC systems and the Breathing Air System are controlled and alarmed from the HMI stations.

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[1]Exceptions to this are hard-wired emergency stops.

[2]"Unattended" systems are: Process Vent System, Plant and Instrument Air System, Breathing Air System, and all HVAC systems.

C-2.1 Silo 3 Operators

The Silo 3 operators will consist of a staff of approximately 12 operators per shift. Operating shifts will be scheduled 12 hours per day and 4 days per week and only one shift will be used. The operators will undergo extensive training before the operation.

C-2.1.1 Pneumatic Retrieval

Operators at the Package Loading Stands have overall control responsibility for regulation of PRS operations. The packaging operators communicate with the main PRS operator, who in turn communicates with the VWMS operators by radio voice communication. The PRS operator coordinates retrieval operations to supply silo material to the Package Loading Stands, and to halt retrieval when necessary.

Controls for the PRS are located in the Process Building near the Packaging Area. The VWMS operators manipulate the vacuum wand using hand controls. The wand operator inserts, manipulates, or retracts the wand, as required, to retrieve Silo 3 material at a rate appropriate for packaging operations and to minimize buildup in the Pneumatic Retrieval Collector.

The Pneumatic Retrieval Collector has a high level switch that triggers an alarm at the VWMS station and in the Process Building. When this level is reached in the collector, the PRS operator either reduces or stops the retrieval rate.

CCTV cameras are installed in the silo and at the VWMS stations on the silo dome. Associated monitors and camera controls are located in the Process Building. The CCTV system allows the PRS operator to view the silo material and the wand movement and to control material retrieval.

C-2.1.2 Mechanical Retrieval

The Excavator is an electrically powered remote operated machine. Operator control and machine status monitoring are by radio-frequency-based (or "umbilical" hard-wired as an emergency alternative) remote control and telemetry. A remote control operator station allows the Excavator to be controlled from an observation room adjacent to the Excavator Room. This operator station is capable of initiating and performing all machine surface travel and silo material removal functions. An excavator emergency stop is also provided.

The silo material is raked, carried, or pushed out of the silo to the Retrieval Bin. The Retrieval Bin Discharge Feeder is speed-controlled to feed the material onto the Inclined Conveyor. Material in the Inclined Conveyor is transported to the Transfer Conveyor, which then deposits the material onto the Feed Conveyor. This conveyor has two outlets, leading to two Package Loading Stands. These conveyors are started manually by the packaging operators. Each conveyor is interlocked with the upstream conveyor(s).

A local indicator panel is provided to communicate Inclined Conveyor operation, packaging equipment activities, and other equipment status to the Excavator operator. The operator is required to access and retrieve material at a rate suitable for the packaging operators and to halt excavation if material starts to build up in the MRS conveyors. CCTV cameras

are provided in the silo interior, on the Excavator, and near the Retrieval Bin to allow the Excavator operator to view the silo material and the Excavator operation.

C-2.1.3 Training

Operator training is designed to meet the requirements of DOE Order 5480.20A (Ref. 8) that apply to the operation of nuclear facilities. The Fluor Fernald Project Training and Qualification Program (TQP-067) (Ref. 9) will incorporate the training and qualification requirements for Silo 3 activities. Training specific to startup engineers, supervisors, and other personnel is delineated in TQP-067. Continuing training and operator requalification requirements are described in TQP-067.

The Silo 3 training program will include training on systems overview, facility operations, and field training. Field training will consist of system walkdowns, on-the-job training (OJT), training evaluation standards, completion of operator qualification cards, and assisting in the Silo 3 Construction Acceptance Test (CAT), where possible. Operators who are not able to participate in the CAT will receive OJT where they work side-by-side with experienced, qualified operators.

The Silo 3 operations and field training courses will provide training on the Silo 3 computer terminal and each of the PC screens. Nomenclature and labels on the screens will be coordinated with training materials and procedures to ensure that ergonomic and human factors engineering are implemented as designed. Operator aids will also be built into the PC screens as appropriate to assist the operators in their timely, reliable performance of safety functions.

C-2.2 Silo 3 Maintenance

Human factors engineering principles (see Attachment 1) have been incorporated into the design of Silo 3 equipment and its maintenance. The Silo 3 final design has been reviewed to examine the provisions for maintenance of Silo 3 equipment. Adequate space for accessing and performing maintenance on each piece of Silo 3 equipment has been verified. In addition, adequate space is available to implement radiation protection practices developed pursuant to the radiological work permit (RWP) program, for example, containments, step-off pads, and temporary shielding.

Maintenance personnel will be qualified in accordance with their craft Training and Qualification Program Description that includes practical evaluation. Maintenance personnel will receive pre-job and RWP briefings as required.

The manuals for each piece of Silo 3 equipment requiring maintenance will serve as the starting point for development of Silo 3 maintenance procedures. Maintenance Work Instructions (MWIs) are then prepared and approved. MWIs will be validated and verified by a systematic walk through with as-built equipment. Maintenance personnel will be briefed for each maintenance task, including equipment specifications, maintenance requirements, maintenance instructions, the need for special tools, and safety precautions. Radiation dose rates and potential radioactive contamination will be considered in

preparing the MWI for each task to ensure that the work can be done while wearing the needed personal protective equipment (PPE). Specific requirements for dosimetry, shielding, and stay time limitations will be provided through the RWP process.

Physical stress factors in the work environment for maintenance personnel are not expected to be unusual. Noise, temperature, and humidity within the Silo 3 Process Building should not cause any discomfort to workers that could affect their ability to perform maintenance work. PPE, such as protective clothing and respirators, will be provided as necessary and as specified by RWPs.

C-2.3 Human Factors Evaluation Results

A systematic and thorough evaluation of the HMI related to the construction, operation, and maintenance of equipment and facilities associated with the Silo 3 Project was performed based on the specific engineering design details available at this time. Each of the following four important elements are incorporated into the design, with the requirements proportional to their importance to safety:

- provisions for communication and operator aids to support timely, reliable performance of safety functions;
- layout and design of controls and instrumentation, and provisions for labeling that apply the principles of ergonomics and human engineering;
- work environments including physical stress, need for protective clothing and equipment, noise levels, temperature, humidity, distractions, and other factors bearing upon the physical comfort, alertness, and fitness of workers; and
- staffing considerations (e.g., minimum staffing levels, overtime restrictions, facility status turnover between shifts, procedures, and training).

Attachment 2 lists the industrial safety and human factors requirements applicable to the Silo 3 Project.

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C-3.0 CONCLUSIONS

A preliminary HFE has been performed based on the available design information. As construction is completed and the procedures are ready for issue, the procedures will be re-evaluated. The finalized procedures will be incorporated into the training program and the HMI will be fully evaluated. In the meantime, placeholders for required information are addressed in the attachments, and additional HFE scenario information will be included as it becomes available. Prior to operations, the HFE for the Silo 3 will be completed and resubmitted as a new revision.

This HFE demonstrates that the essential elements are, or will be, in place to ensure that the important human factors issues have been addressed for the operation and maintenance of the Silo 3 Project.

By the incorporation of these concepts into the project design, plans, procedures, and training, the potential for human error resulting in adverse safety consequences is minimized.

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C-4.0 REFERENCES

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1. DOE-STD-3009-94, *Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components,* Change Notice No. 2, April 2002.

2. *Handbook of Human Factors*, edited by G. Salvendy, 1987, John Wiley & Sons, Inc., New York.

3. Woodson, Wesley E., Barry Tillman, and Peggy Tillman, *Human Factors Design Handbook*, 1992, McGraw-Hill, Inc., New York.

4. *Hazard Analysis Report for Operable Unit 4 (OU4) Silos*, HAR-97-0028, Appendix D.

5. Jacobs, *Access and Retrieval Strategy for the Silo 3 Project*, 40430-PL-0002, Rev. 0, Jacobs Engineering Group, July 2002.

6. Jacobs, *Process Description for the Silo 3 Project*, 40430-RP-0003, Rev. 0, Jacobs Engineering Group, July 2002.

7. Jacobs, *Process Control Plan for the Silo 3 Project*, 40430-PL-0003, Jacobs Engineering Group, August 2002.

8. DOE Order 5480.20A, *Personnel Selection, Qualification, and Training, Requirements for DOE Nuclear Facilities*, November 1994.

9. Fluor Fernald, *AWR Project Training and Qualification Program (TQP-067)*, Fernald Environmental Management Project, Fernald, Ohio, 2000.

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ATTACHMENT 1 – HUMAN FACTORS EVALUATION CHECKLIST

Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
A. Housekeeping and General Work Environment			
1	Are adequate signs posted near maintenance, cleanup, or staging areas to warn workers of special or unique hazards associated with the areas?	Yes	Project-Specific Health and Safety Plan; additional posting requirements will be identified through routine health and safety inspections
2	Are adequate barriers erected to limit access to maintenance, cleanup, or staging areas?	Yes	Project-Specific Health and Safety Plan; additional barrier requirements will be identified through routine health and safety inspections
3	Are working areas generally clean?	Yes	Project-Specific Health and Safety; routine health and safety inspections
4	Are provisions in place to limit the time a worker spends in an extremely hot or cold area?	Yes	Project-Specific Health and Safety Plan
5	Is noise maintained at a tolerable level?	Yes	Project-Specific Health and Safety Plan; noise surveys conducted in out-of-tolerance cases; site noise limit of 85 dB is enforced
6	Are alarms audible above background noise both inside the control room and in the process area?	Yes	System testing; Contingency Plan and Emergency Response
7	Are normal and emergency lighting sufficient for all area operations?	Yes	Final design documents/reports and drawings; System testing

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
8	Is there adequate backup power for emergency lighting?	Yes	UPS system; Battery powered emergency lighting
9	Is the general environment conducive to safe job performance?	Yes	Operations and Maintenance Safe Work Plans; Project-Specific Health and Safety Plan
B. Accessibility/Availability of Controls and Equipment			
1	Are adequate supplies of protective gear readily available for routine and emergency use?	Yes	Project-Specific Health and Safety Plan
2	Are workers able to perform both routine and emergency tasks safely while wearing protective equipment?	Yes	Project-Specific Health and Safety Plan
3	Is emergency equipment accessible without presenting further hazards to personnel?	Yes	Operations and Maintenance Safe Work Plans; Project-Specific Health and Safety Plan; operator training
4	Is communications equipment adequate and easily accessible?	Yes	Project-Specific Health and Safety Plan; Final design documents/reports
5	Would others quickly know if a worker is incapacitated in a process area?	Yes	Project-Specific Health and Safety Plan; Final design documents/reports; buddy system
6	Are the right tools (including special tools) available and used when needed?	Yes	Operations and Maintenance Safe Work Plans; Final design documents/reports; Maintenance and operating procedures

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
7	Is the workplace arranged so that workers can maintain a good working posture while performing necessary movements to conduct routine tasks?	Yes	Project-Specific Health and Safety Plan; Final design documents/reports
8	Is access to all controls adequate?	Yes	Final design documents/reports
9	Can operators and maintenance workers safely perform all required routine and emergency actions, considering the physical arrangement of equipment (e.g., access to the equipment, or proximity of required tasks to rotating equipment, hot surfaces, or points where hazardous material can be vented or discharged to the atmosphere)?	Yes	Final design documents/reports
10	Are valves that require urgent manual adjustments (e.g., emergency shutdown) easily identifiable and readily accessible?	Yes	Final design documents/reports
C. Labeling			
1	Is all important equipment (e.g., vessels, pipes, valves, instruments, controls) legibly, accurately, and unambiguously labeled?	Yes	Final design documents/reports
2	Does the labeling program include components (e.g., small valves) that are mentioned in the procedures even if they are not assigned an equipment number?	Yes	Labeled per the final design requirements; Final design documents/reports

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
3	Has responsibility for maintaining and updating labels been assigned?	Yes	Configuration Management
4	Are emergency exit and response signs adequately visible and easily understood?	Yes	Project-Specific Health and Safety Plan; Final design documents/reports; worker training
5	Are signs that warn workers of hazardous materials or conditions adequately visible and easily understood?	Yes	Project-Specific Health and Safety Plan; Final design documents/reports; worker training
D. Feedback/Displays			
1	Is adequate information about normal and upset process conditions clearly displayed in the control room?	Yes	Final design documents/reports
2	Are the controls and displays arranged logically to match operators' expectations?	Yes	Final design documents/reports
3	Are the displays adequately visible from all relevant working positions?	Yes	Final design documents/reports
4	Do separate displays present similar information in a consistent manner?	Yes	Final design documents/reports
5	Are automatic safety features provided when a process upset requires rapid response?	Yes	Final design documents/reports

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
6	Are automatic safety features provided when a process upset may be difficult to diagnose because of complicated processing of various information?	Yes	Final design documents/reports
7	Are the alarms displayed by priority?	Yes	Final design documents/reports
8	Are critical safety alarms easily distinguishable from control alarms?	Yes	Final design documents/reports; distinctive site alarms; worker training
9	Is an alarm summary permanently on display?	Yes	Final design documents/reports
10	Are nuisance alarms corrected and redundant alarms eliminated as soon as practical to help prevent complacency toward alarms?	Yes	Final design documents/reports
11	Have charts, tables, or graphs been provided (or programmed into the computer) to reduce the need for operators to perform calculations as part of the operation?	Yes	Operating procedures; Final design documents/ reports
12	If operators are required to perform calculations, are critical calculations independently checked?	Yes	Operating procedures; Final design documents/ reports
13	Does the computer check that values entered by operators are within a valid range?	Yes	Operating procedures; Final design documents/ reports
14	Do the displays provide an adequate view of the entire process as well as essential details of individual systems?	Yes	Final design documents/reports

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
15	Do the displays give adequate feedback for all operational actions?	Yes	Operating procedures; Final design documents/ reports
16	Are instruments, displays, and controls promptly repaired after a malfunction?	Yes	Operating procedures; Final design documents/ reports; Maintenance procedures
17	Do administrative features exist that govern when instruments, displays, or controls are deliberately disabled or bypassed and that govern their return to normal service at the appropriate time?	Yes	Operating procedures; Final design documents/ reports
18	Does a formal mechanism exist for correcting human factors deficiencies identified by the operators (e.g., modifications to the displays, controls, or equipment to better meet operators' needs)?	Yes	Operating procedures; Project Quality Control procedures; daily safety briefings
E. Controls			
1	Is the layout of the consoles logical, consistent, and effective?	Yes	Final design documents/reports
2	Are the controls distinguishable, accessible, and easy to use?	Yes	Final design documents/reports
3	Do all controls meet standard expectations (e.g., color, direction of movement)?	Yes	Final design documents/reports

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
4	Do the control panel layouts reflect the functional aspects of the process or equipment?	Yes	Final design documents/reports
5	Does the control arrangement logically follow the normal sequence of operation?	Yes	Final design documents/reports
6	Can operators safely intervene in computer-controlled processes?	Yes	Final design documents/reports
7	Can process variables be adequately controlled with the existing processes?	Yes	Final design documents/reports
8	Do operators believe that the control logic and interlocks are adequate?	Yes	Final design documents/reports; Operating procedures; operator training/feedback
9	Does a dedicated emergency shutdown panel exist? If so, is it in an appropriate location?	Yes	Final design documents/reports
F. Workload and Stress Factors			
1	Is the control room always occupied (i.e., assigned duties do not require the control room operator to be absent from the control room)?	Yes	Operating procedures; two operators are assigned to each shift

Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
2	Are the number and frequency of manual adjustments required during normal and emergency operations limited so that operators can make the adjustments without a significant chance of mistakes as a result of overwork or stress?	Yes	Operating procedures; operator training
3	Is the number of manual adjustments during normal operations sufficient to avoid mistakes as a result of boredom?	Yes	Operating procedures; operator training
4	Have the effects of shift duration and rotation been considered in establishing workloads?	Yes	Operating procedures; Labor agreements
5	Is the number of extra hours an operator must work if his or her relief fails to show up sufficiently limited so that worker safety is not adversely affected?	Yes	Operating procedures; Labor agreements
6	Is the number of hours an operator or maintenance worker must work during startup or turnarounds sufficiently limited so that worker safety is not adversely affected?	Yes	Operating procedures; Labor agreements
7	Can additional operators (e.g., from other areas or from off- site) be called in quickly to help during an emergency?	Yes	Contingency Plan and Emergency Response; Labor agreements; Labor utilization planning; operator training
8	Is the staffing level appropriate for all modes of operation (e.g., normal, emergency)?	Yes	Labor agreements; Labor utilization planning; operator training

Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
G. Procedures			
1	Do written procedures exist for all operating phases (i.e., normal operations, temporary operations, emergency shutdown, emergency operation, normal shutdown, and startup following a turnaround or after an emergency shutdown)?	Yes	Comprehensive operating and maintenance procedures
2	Are safe operating limits documented providing consequences of deviating from limits and actions to take when deviations occur?	Yes	Comprehensive operating and maintenance procedures; Operator and maintenance training
3	Are procedures current (i.e., are they revised when changes occur)?	Yes	Document Control Plan
4	Do operators believe that the procedure format and language are easy to follow and understand?	Yes	Operator training; daily safety meetings; feedback
5	Are the procedures accurate (i.e., do they reflect the way in which the work is actually performed)?	Yes	Start-up tests; Operator training; daily safety meetings; feedback; Document Control Plan
6	Is responsibility assigned for updating the procedures, distributing revisions of the procedures, and ensuring that workers are using current revisions of the procedures?	Yes	Document Control Plan

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Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
7	Are temporary notes or instructions incorporated into revisions of written operating procedures as soon as practical?	Yes	Document Control Plan
8	Do procedures address the personal protective equipment required when performing routine and/or nonroutine tasks?	Yes	Conduct of Operations; Radiological Work Permits
H. Training (Subcontractor)			
1	Are new employees trained in the hazards of the processes?	Yes	Project-Specific Health and Safety Plan; Operations and Maintenance Safe Work Plans; site training; Quality Assurance Program Plan.
2	Do operators and maintenance workers receive adequate training in safely performing their assigned tasks before they are allowed to work without direct supervision?	Yes	Project-Specific Health and Safety Plan; Operations and Maintenance Safe Work Plans; Operations and maintenance training; site training
3	Does operator and maintenance worker training include training in appropriate emergency response?	Yes	Operations and maintenance worker training; site training
4	Do operators practice emergency response while wearing emergency protective equipment?	Yes	Performed by Emergency Response Teams
5	Do operators practice emergency response during extreme environmental conditions (e.g., at night or when it is very cold)?	N/A	Performed by Emergency Response Teams

Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
6	Are periodic emergency drills conducted?	Yes	Contingency Plan and Emergency Response; Operator training
7	Are emergency drills witnessed by observers and critiqued?	Yes	Contingency Plan and Emergency Response
8	Does a periodic refresher training program exist?	Yes	Project-Specific Health and Safety Plans; Operations and Maintenance Safe Work Plans; Operations and maintenance training; site training; daily safety meetings; Quality Assurance Program Plan.
9	Is special or refresher training provided in preparation for an infrequently performed operation?	Yes	Project-Specific Health and Safety Plans; Operations and Maintenance Safe Work Plans; Operations and maintenance training; site training; daily safety meetings; Quality Assurance Program Plan.
10	When changes are made, are workers trained in the new operation, including an explanation of why the change was made and how worker safety can be affected by the change?	Yes	Project-Specific Health and Safety Plans; Operations and Maintenance Safe Work Plans; Operations procedures; Operations training; Quality Assurance Program Plan
11	Are operators and maintenance workers trained to request assistance when they believe they need it so safely perform a task	Yes	Operations and maintenance training; Quality Assurance Program Plan

Fernald Silo 3 Project Operational Phase (Systems Operability Testing, Readiness Assessment, Retrieval)			
Item No.	Question	Response*	Comment/Governing Document
12	Are operators and maintenance workers trained to report near misses as part of the incident investigation program?	Yes	Operations and maintenance training; Safety Incident Report Program
13	Are operators trained to shut down the process when in doubt about whether it can continue to operate safely?	Yes	Operations training; Quality Assurance Program Plan, stop work authority

* A Yes response indicates a commitment)

Attachment 2 – Silo 3 Operations/Maintenance Task List and Human Factors Hazards Matrix

Task	Location	Hazards[1,2]	PPE[3]	Frequency	Human Factors Features
Operations					
Routine					
Startup	Control Stations, top of dome, excavator room.	Human error impacts on Silo 3 operational safety	None	<Monthly	Remote cameras, alarms, indicators, computer monitors, procedures, training, controls layout, displays, labeling, staffing, work environment (noise, distraction, temperature, etc.)
System Monitoring	Control Stations, top of dome, excavator room.	Human error impacts on Silo 3 operational safety	None	Daily	Remote cameras, alarms, indicators, computer monitors, procedures, training, controls layout, displays, labeling, staffing, work environment (noise, distraction, temperature, etc.)
Shutdown	Control Stations, top of dome, excavator room.	Human error impacts on Silo 3 operational safety	None	<Monthly	Remote cameras, alarms, indicators, computer monitors, procedures, training, controls layout, displays, labeling, staffing, work environment (noise, distraction, temperature, etc.)
Emergency					
Manual valve ops, equipment control.	Silo dome, excavator room, Process Building	RA	HH, SS, SG	Not expected	Equipment labeling, alarms, indicators, training, controls layout.

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Task	Location	Hazards[1,2]	PPE[3]	Frequency	Human Factors Features
Maintenance					
Equipment Maintenance					
Pneumatic Retrieval System	Dome, fabric structure	RA, CA	HH, SS, SG, HP, WG, Anti-Cs	Monthly	Access outdoors, work at heights, adequate space, training.
Mechanical Retrieval System	Excavator room	RA, CA	HH, SS, SG, WG, Anti-Cs	Monthly	Access from floor, adequate space, training.
Packaging/Loading System	Process Building	RA, CA	HH, SS, SG, HP, WG, Anti-Cs	Monthly	Access from floor, adequate space, training.
Process Vent System	Process Building	RA, CA	HH, SS, SG, HP, WG, Anti-Cs	Monthly	Access from floor, adequate space, training.
Plant/Breathing Air System	Process Building	RBA	HH, SS, SG, HP, WG	Monthly	Access from floor, adequate space, training.
Wastewater System	Process Building	RBA	HH, SS, SG, HP, WG	Monthly	Access from floor, adequate space, training.
Waste Additive System	Process Building	RBA	HH, SS, SG, WG, HP	Monthly	Access from floor, adequate space, training.
HVAC System	RCS Bldg. 2nd Fl. Platform	RBA	HH, SS, SG, WG, HP	Monthly	Access from floor, adequate space, training.
Electrical Building	Equipment pad platform	RBA	HH, SS, SG, WG, HP	Monthly	Access from floor, adequate space, training.
Repairs					
Miscellaneous	Any equipment location	Same as for equipment	Anti-Cs, RP determined by RWP	Infrequent	Planning on a case-by-case basis

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Task	Location	Hazards[1,2]	PPE[3]	Frequency	Human Factors Features
Health Physics					
Routine					
Surveys	Outside RA	RBA	HH, SS, SG, G, HP	Daily	Site housekeeping
Job Coverage					
Miscellaneous	Any equipment location	Same as for equipment maintenance	Same as for equipment	Same as maintenance activities	Same as for equipment maintenance

[1]Standard industrial hazards not listed

[2]RA = Radiation Area (5 to 100 mrem/hr), HRA = High Radiation Area (>100 mrem/hr), CA = Contamination Area (20 to 2000 dpm/100 cm^2 alpha); RBA = Radiological Buffer Area; ARA = Airborne Radioactivity Area

[3]Abbreviations, HH=hard hat, SS=safety shoes; SG=safety glasses, WG = leather work gloves, G = surgeon gloves, FS=face shield, RP = respiratory protection, HP = hearing protection, Anti-Cs includes coveralls, shoe covers and rubber gloves.

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ATTACHMENT 3 – INDUSTRIAL SAFETY AND HUMAN FACTORS REQUIREMENTS

The following industrial safety and human factors concerns are standard for industrial operations. Silo 3 Project personnel from multiple disciplines evaluated Silo 3 activities in terms of these concerns, and used a graded approach to determine the appropriate implementation.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
Procedures/Safe Work Plans		
1	Written procedures are developed, reviewed by all applicable disciplines including operations and safety, and issued for all operating phases (i.e., normal operations, temporary operations, emergency shutdown, emergency operation, normal shutdown, and startup following a significant change/modification shutdown or after an emergency shutdown).	The procedures were developed, reviewed, and approved per Fluor Fernald site requirements documented in MS-2001.
2	Safe operating limits are determined and documented providing consequences of deviating from limits and actions to take when deviations occur.	Safe operating limits are established. Automatic action is taken by the PLC when parameters start to go outside those limits. In order to change a setpoint, an engineering evaluation, including safety impact, is required.
3	A procedure change control process/system is implemented to ensure that all procedures remain current and accurate (i.e., they reflect the way in which the work is actually performed).	Procedures are maintained per Fluor Fernald site requirements documented in MS-2001.
4	A formal mechanism is implemented for correcting human factors deficiencies identified by the operators (e.g., modifications to controls or equipment to better meet operators' needs).	Design changes are completed per the DCN/RCI process.
5	Procedure format and language is reviewed and revised to ensure that they are easy to follow and understand.	Procedures were drafted by the subject matter expert, and formatted and edited by a technical writer to ensure clarity. Procedure development included walkthroughs with affected personnel.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
6	A process/system for document control, updating procedures, distributing revisions of procedures, and ensuring that workers are using current revisions of procedures is implemented.	Procedure maintenance is done per site requirements documented in MS-2001. A training program and required reading program have been established.
7	Procedures and/or work permits will prescribe the personal protective equipment (PPE) required when performing routine and/or non-routine tasks.	FCP Work Permits and Radiation Work Permits, which include a PPE sheet, are established for routine activities and developed prior to any new activity.
8	Before initial implementation and any subsequent significant revision of the project procedures, they are evaluated by a qualified System Safety Analyst for human factors concerns and modified as necessary to ensure accordance with the requirements of this HFE.	The project uses a multi-disciplined team to review and evaluate procedures. This includes a qualified System Safety Analyst who evaluates for human factors concerns and ensures implementation of human factors requirements.
Training (Employees and Subcontractors)		
1	Training is developed, implemented, and evaluated according to the applicable requirements of DOE Order 5480.20A and implemented in training policies, requirements, and procedures.	The training is developed, implemented, and evaluated per site training requirements.
2	Pre-job briefings, safety meetings, and tool box discussions are conducted in addition to, not in lieu of, the required training.	In addition to training, pre-job briefings, safety meetings, and tool box discussions have been conducted and documented with rosters.
3	To qualify as training, an activity requires a method of evaluation and/or performance demonstration to be successfully completed by the trainee(s).	All training has been conducted per site training requirements.
4	Employees and subcontractors are trained in the hazards of the processes, conditions, and equipment used in the work they are to perform.	All workers have trained per site training requirements. In addition, briefings have been performed addressing project-specific hazards.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
5	Operators and maintenance workers receive adequate training in safely performing their assigned tasks before they are allowed to work without direct supervision, including requesting assistance when they believe they need it and reporting near misses or accidents.	All workers have trained per site training requirements, which include direct supervision during the qualification process.
6	Operator and maintenance worker training includes training in appropriate emergency response.	The emergency response briefing is conducted during the briefing on the N-HASP.
7	Where applicable, operators practice emergency response while wearing emergency protective equipment.	When drills are scheduled, some operators will wear the prescribed protective clothing.
8	Periodic emergency drills are conducted, witnessed by observers, and critiqued.	The project will plan and conduct periodic emergency drills per site requirements.
9	Special or refresher training is provided in preparation for an infrequently performed operation.	When infrequent operations are performed, dry runs or mock-ups will be conducted, as necessary.
10	When changes are made, workers are trained in the new operation, including an explanation of why the change was made and how worker safety can be affected by the change.	Workers will be trained in procedure changes and new operations. The workers will be trained in the basis of changes and new hazards.
11	Before initial implementation and any subsequent significant revision of the project training units, they are evaluated by a qualified System Safety Analyst for human factors concerns and are modified as necessary to ensure accordance with the requirements of this HFE.	The training is developed, implemented, and evaluated per site training requirements. Training is reviewed by a qualified System Safety Analyst for human factors concerns.
Controls and Equipment		
1	Adequate supplies of personal protective clothing and equipment are readily available for routine and emergency use.	Radiological and hazardous material PPE is staged and readily available.
2	Workers are able to perform both routine and emergency tasks safely while wearing the required protective equipment.	Workers are trained and experienced in wearing PPE and are able to perform tasks in PPE.
3	Emergency equipment is accessible without presenting further hazards to personnel.	Emergency equipment is located in areas that are accessible during emergencies.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
4	Communications equipment is adequate and easily accessible. For situations where workers are wearing anti-contamination clothing and respirators, and especially where noise levels make clear communication difficult, it is recommended that the information concerning equipment available for communications in high-noise environments and communications while wearing respiratory protective equipment be evaluated for implementation.	A means of communication is available in all work areas. Radio communications will be utilized as necessary.
5	Means or methods are provided so that others can quickly know if a worker is incapacitated in a process/activity area.	The buddy system will be maintained for work activities in areas presenting hazards. When the situation for workers is not ALARA, a combination of radios for communication and cameras will be deployed.
6	The right tools (including special tools) are available and used when needed.	Routine and special tools are staged for all anticipated maintenance activities.
7	The workplace is arranged so that workers can maintain a good working posture while performing necessary movements to conduct routine tasks.	The facility configuration is conducive to minimizing injuries due to uncomfortable body positions.
8	The workplace is arranged so that equipment and workers will not tread on nor interfere with the free movement of airlines.	No temporary airlines will be present on the floor or ground areas.
9	Controls, including such things as manual valves, power sources, and controls on portable equipment, are easily identified, readily accessible, and conform to cultural norms (e.g., right is tight, left is loose; up is on, down is off).	All manual valves, circuit breakers, switches, etc. are accessible and labeled in accordance with standard industrial norms.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
10	Operators and maintenance workers are able to safely perform all required routine and emergency actions, considering the physical arrangement of equipment (e.g., access to the equipment, or proximity of required tasks to rotating equipment, hot surfaces, sharp corners, or points where hazardous material can be vented or discharged to the atmosphere).	All equipment can be safely accessed. No routine or emergency actions are required in high radiation areas.
11	The layout of the consoles and control panels, whether automated or manual equipment is logical, consistent, and effective.	The control room layout is in accordance with 40430-PL-0003.
12	Controls, whether automated or manual, are distinguishable, accessible, and easy to use.	The controls are in accordance with 40430-PL-0003.
13	Controls meet standard expectations (e.g., color, direction of movement).	The controls are in accordance with 40430-PL-0003.
14	Control panel layouts reflect the functional aspects of the process or equipment and, as applicable, logically follow the normal sequence of operation.	The controls are in accordance with 40430-PL-0003.
15	Where applicable, such as for electrical systems and equipment, a dedicated emergency shutdown panel or equivalent grouped emergency shutdown arrangement is provided and appropriately located for ease of access and use in an emergency response situation.	All work on electrical systems will be conducted per site electrical requirements.
Labeling		
1	Important equipment (e.g., vessels, pipes, valves, instruments, controls) is legibly, accurately, and unambiguously labeled.	The labeling is in accordance with 40430-PL-0003.
2	Equipment labels are maintained and updated, as necessary, and are referenced in the applicable operating and emergency procedures as written.	Operator and management surveillances will identify label deficiencies. Equipment labels are identified in operating and emergency procedures.
3	Emergency exit and response signs are adequately visible and easily understood.	Signs are in compliance with OSHA requirements.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
4	Signs that warn workers of hazardous materials or conditions are adequately visible and easily understood.	Signs are posted in compliance with OSHA and 10 CFR 835 requirements.
5	Safety features, automatic where feasible, are provided when a process/activity upset requires rapid response or when a process upset may be difficult to diagnose because complicated processing of various information.	Automatic safety features are provided (e.g., automatic shutdown for under- and over-pressure).
6	Charts, tables, or graphs are provided (or programmed into a computer) to reduce the need for operators to perform calculations as part of the operation.	Operator aids are provided to minimize the need to perform calculations. For example, aids are provided for determination of carbon bed inventory.
7	Instruments, equipment, and controls are promptly repaired after a malfunction and are tested as appropriate to ensure normal function is restored before being restored to service.	The established maintenance procedures require malfunctioning items to be repaired and tested.
8	Archive samples are characterized and labeled in accordance with Fluor Fernald requirements.	Archive samples are properly labeled and stored per RCRA requirements.
Housekeeping and General Work Environment		
1	Signs are posted near maintenance, cleanup, or staging areas to warn workers of special or unique hazards associated with the areas.	Signs are posted in compliance with OSHA and 10 CFR 835 requirements.
2	Barriers are erected to limit inappropriate access to controlled areas as well as maintenance, cleanup, or staging areas.	Barriers are posted in compliance with OSHA and 10 CFR 835 requirements.
3	Measures are implemented to ensure that working areas are generally clean, and slip, trip, and fall hazards are minimized.	Routine health and safety inspections, as well as worker training, will ensure the areas are clean and free of debris.
4	Provisions are implemented to limit the time a worker spends in an extremely hot or cold area, with adequate break facilities provided.	Safety and Health oversight, safe work plans, the Health and Safety Plan, and worker training will support stay time limits to prevent heat and cold stress.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
5	If noise levels exceed Occupational Safety and Health Administration (OSHA) limits (85 dB) or a tolerable level (as determined by the Health and Safety Officer), adequate hearing protection will be provided.	Safety and Health oversight, postings, safe work plans, and worker training will ensure hearing protection is utilized.
6	Alarms are audible above background noise both inside and outside of working areas.	System testing ensures alarms are audible.
7	Normal and emergency lighting are sufficient for all area operations, with special attention given to the conditions inside structures, maintaining at least the following levels: • 5 foot-candles: General site/indoor corridors, hallways and exitways, • 10 foot-candles: General shop, when work is being performed, and • 1 foot-candle: Emergency lighting egress paths.	System testing, Safety and Health inspections, and routine surveillances will identify lighting deficiencies and areas requiring corrective action.
8	Backup power for emergency lighting is provided for outdoor work areas and will be provided for indoor work areas when natural daylight is or can be expected to be unavailable.	Back-up power is provided indoors, and is provided outdoors as necessary.
9	Tripping hazard areas, with special concern inside structures, where air lines, electrical cables, and uneven footing could lead to frequent incidents and near misses, are identified.	No tripping hazard areas are currently present.
10	For potentially high-tripping hazard areas (as applicable): On level, but uneven, ground, spread small gravel on the walking surface for proper footing; no large rocks to cause a stumbling point for limited vision operators. An Occupational Safety and Health specialist is consulted and concurs with the acceptability of the walking surface before work is begun.	Safety and Health oversight is available on all work activities to ensure walking surface hazards are eliminated.

Fernald Silo 3 Project Industrial Safety and Human Factors		
Item	**Requirements**	**Implementation**
11	For potentially high-tripping hazard areas (as applicable): Airlines and electrical cables are protected from inadvertent interference by personnel (i.e., tripping hazard) and by vehicles (i.e., running over or parking on); mats, overhead rails, and highly visible conduits are used.	In the event airlines, hoses, or extension cords are temporarily run on the floor or ground for maintenance activities, precautions are taken to minimize the hazards.
12	For potentially high-tripping hazard areas (as applicable): Spread out equipment and activities to the extent possible to decrease noise intensity levels, to provide adequate, uncluttered work areas, to reduce tripping hazards, and to reduce potential for interfering with airlines.	Work activities will be spread out, as practicable with other priorities, to minimize hazards.
13	For potentially high-tripping hazard areas (as applicable): Include in all work plans awareness of and ways to avoid contact with the over-head power line behind Silo 3 near the fence line.	Caution statements will be included in work plans if the hazard is present. A safe working distance will be maintained from power lines in accordance with OSHA.
Workload and Stress Factors		
1	The number and frequency of manual adjustments required during normal and emergency operations are limited so that operators can make the adjustments without a significant chance of mistakes as a result of overwork or stress.	The controls are in accordance with 40430-PL-0003. The facility operation requires a low frequency of manual adjustments. Operator training minimizes the potential for mistakes.
2	The effects of shift duration and rotation is considered and evaluated before establishing workloads.	The shift duration is limited, crew rotation is utilized, and labor agreements require limited workloads.
3	Staffing levels are appropriate for all modes of operation (e.g., normal, emergency).	Sufficient personnel have been trained and staffed to facilitate all modes of operation.