IMPLEMENTING 10 CFR 830 AT THE FEMP SILOS:
NUCLEAR HEALTH AND SAFETY PLANS AS DOCUMENTED SAFETY ANALYSIS

Authors: Patricia Fisk and Lavon Rutherford
Contributors: Tulanda Brown and William Klein

Fluor Fernald, Inc.*
P.O. Box 538704
Cincinnati, Ohio 45253

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Abstract

Note: After the submission of this EFCOG discussion topic, the Fernald Environmental Restoration Project (FEMP) was renamed the Fernald Closure Project (FCP). The document title was retained for conference continuity. However, “FCP” is used within the document.

The objective of the Silos Project at the Fernald Closure Project (FCP) is to safely remediate high-grade uranium ore residues (Silos 1 and 2) and metal oxide residues (Silo 3). The evolution of Documented Safety Analyses (DSAs) for these facilities has reflected the changes in remediation processes. The final stage in silos DSAs is an interpretation of 10 CFR 830 Safe Harbor Requirements that combines a Health and Safety Plan with nuclear safety requirements. This paper will address the development of a Nuclear Health and Safety Plan, or N-HASP.

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1.0 Introduction

The objective of the Fernald Closure Project (FCP)\(^1\) is to safely complete the environmental restoration of the Fernald site by 2006. This objective includes the Silos Project, which involves three large inventories of high-grade uranium ore residues (Silos 1 and 2) and metal oxide residues (Silo 3). DSAs for the Silos facilities have gone through a process of simplification, from a single site-wide Authorization Basis containing nuclear facility Bases for Interim Operations (BIOS) to individual project Preliminary Hazard Analysis Reports (PHARs) and Hazard Analysis Reports (HARs), each addressing the changing remediation plans. The final stage in Silos DSAs is an interpretation of 10 CFR 830 Safe Harbor Requirements that combines a Health and Safety Plan (HASP) with nuclear safety requirements. 10 CFR 830 cites three alternative methods for conducting environmental restoration activities under DOE-STD-1120-98. Fluor Fernald’s graded approach to Silos safety documentation implements one of these methods by using OSHA and construction requirements in lieu of the safety management requirements in the nuclear safety orders.

The evolution of FCP DSAs reflects the course of environmental restoration of the site. As the facilities transitioned from operations to active shutdown (in which hazardous materials are sorted, packaged, and removed), the hazards to the public, and particularly to the workers, changed. Safety documentation that previously addressed operational safety issues needed to focus on a different type of work and a different type of worker to ensure that appropriate hazards were addressed. A more integrated site-wide approach was needed to address both the oversight audience and the direct supervisory/worker audience. The solution was to combine the project-specific HASP with the project DSA(s), resulting in a document that addresses hazard categorization, OSHA safety concerns, and implementation requirements.

Fluor Fernald personnel from both the Silos Project and Nuclear and System Safety presented evidence to DOE, and to their own internal Safety Review Committee, demonstrating that the traditional safety analysis/authorization basis model was not appropriate or efficient for Silos remediation. Traditional approaches address health risks from proposed activities; however, this underestimates the true cost/benefit equation, because legacy wastes present real-time health hazards regardless of whether DOE authorizes new activities. The result is the application of resources to continuously justify remediation work that has already been established by a Record of Decision. Fluor Fernald successfully argued that the most suitable path for Silos remediation could be found within the safe harbor provisions of DOE-STD-1120-98, because Silos work meets the two conditions specified: an environmental restoration activity, and an activity involving work not done within a permanent facility.

Fluor Fernald’s first example of an alternative DSA written for Silos was the project-specific Radon Control System Nuclear Health and Safety Plan (RCS N-HASP). This N-HASP identified hazards and controls to support safe operation of Phase 1 of the Radon Control System and met the requirements of 10 CFR 830 and 29 CFR 1910.120. The format of this document is well-suited to addressing worker safety issues seen in environmental restoration activities, and includes elements for emergency response, training, conduct of operations, management of change, and maintenance.

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\(^1\) Until recently, the Fernald Environmental Management Project (FEMP).
2.0  FCP Site and Silos Description

The FCP is located in southwestern Ohio, approximately twenty miles northwest of downtown Cincinnati near the communities of Miamitown and Ross, Ohio. The total site area is 1050 acres. FCP is owned by the DOE and is operated by Fluor Fernald, Inc.

The facility was built beginning in 1950; full operation started in 1953. The facility was an in-house integrated production complex for processing uranium and its compounds from natural uranium ore, ore concentrates, and recycled uranium. The mission was to produce uranium metal for use in government defense programs. A wide variety of chemical and metallurgical process steps were used to support the production of uranium metal products.

The Silos Project involves three large inventories of high-grade uranium ore residues (Silos 1 and 2) and metal oxide residues (Silo 3). The silos were constructed in the 1950s to store these residues. They are cylindrical, above-ground, domed concrete tanks with post-tensioned steel reinforcing. They are 80 feet in diameter and 36 feet high to the center of the dome.

Silos 1 and 2 residues contain high-activity concentrations of naturally-occurring radionuclides, including radium and thorium. These radionuclides contribute to: (1) an elevated direct-penetrating radiation field in the vicinity of the silos; and (2) the chronic emission of radioactive radon gas to the atmosphere. Berms were constructed around the Silos in 1963-64 to provide lateral support to the silos walls and, as a secondary benefit, to provide radiation shielding.

Radon-222 is generated by Silos 1 and 2 residues at a rate in secular equilibrium with its radium-226 parent. Radon is continually released from the residues into the headspace of the silos. The actual quantity of radon present in the headspaces is determined by production and loss rate. Primary loss mechanisms are: (1) the natural decay of the radon gas; (2) the escape of the gas from cracks and openings in the concrete silo structure; and (3) diffusion of the radon gas through the concrete.

Various engineered systems were applied to the silos from the mid-1980s to 1998 in an attempt to reduce the escape of radon gas to the atmosphere, and to reduce the radiation levels in the headspaces. A new Radon Control System (RCS) was constructed recently, and is part of the Accelerated Waste Retrieval Project to remediate Silos 1 and 2. The RCS consists of four carbon beds vaults, and two chilling/condensing vaults (which contain desiccant drying units, hold-up tanks, and condensate transfer pumps). Contaminated gases are drawn through the RCS, chilled by cooling coils, dried with a desiccant dryer, and adsorbed on the carbon beds.

The RCS N-HASP is the current DSA for Phase I operation of the system. The N-HASP is now being revised and expanded to incorporate sluicing retrieval of the Silo 1 and 2 waste and transfer to interim storage tanks.
3.0 Justification for Alternative DSAs

To provide an alternative method for environmental restoration activities, 10 CFR 830 relies on the use of DOE-STD-1120-98, *Integration of Environment Safety and Health into Facility Disposition Activities*, which allows certain nuclear facility remediation activities to be conducted using 29 CFR 1910.120 and 29 CFR 1926.65 requirements in lieu of the safety management requirements in the nuclear safety orders. DOE-STD-1120-98 further requires continuation of the QA rule (10 CFR 830.120) and the DOE Occurrence Reporting Processing System (ORPS). The contractor is required to submit to DOE documents generated under the alternative regulations for review and approval prior to work (in this case, Health and Safety Plans [HASPs]).

DOE-STD-1120-98 specifies that the DOE safety management orders applicable to the “in lieu of” alternative process include: SAR, USQ, TSR, Training and Certification, Conduct of Operations, and Maintenance. It further states that the Health and Safety Program and HASPs, which include elements for emergency response, training, conduct of operations, and maintenance, may be used in lieu of the nuclear safety orders.

DOE-STD-1120-98 recognizes the potential for remediation workers to be exposed to short-term, temporary increases in risk, but these risks are not likely to exceed the risks accepted by DOE authorization for operation of the nuclear facility that produced the legacy hazard. The standard correctly allows ever-shrinking resources to be directed to activities where risk-reduction potential is the highest, namely, the remediation work. This can be achieved by authorizing an alternative package to manage the risk that: (1) omits requirements for analysis and documentation designed to support a past decisions [i.e., remediation]; and (2) allows management to focus resources directly at the physical handling and disposition of the hazardous material. After all, physical activity is the most critical point where hazard analysis, work planning, and risk reduction provide the most benefit. The proposed alternative allows a method that more logically fits the situation.

Regardless of the logical benefits of an alternative approach, the Silos had to meet the two conditions that DOE-STD-1120-98 specifies for use of this alternative approach: (1) it must be an environmental restoration activity; and (2) it must involve work not done within a permanent structure:

"Definitions" in 10 CFR 830.3, states: "Environmental restoration activities means the process(es) by which contaminated sites and facilities are identified and characterized and by which contamination is contained, treated, or removed and disposed." The Silos remediation involves retrieval, necessary treatment, packaging, and disposal of contaminated waste. This clearly meets the definition of an environmental restoration activity.

10 CFR 830, Subpart B, Appendix A, Table 2, Item 6, states the activity must involve "...work not done within a permanent structure..." The purpose of Silos 1 and 2 structures was for temporary storage of K-65 raffinate. The structures were filled with the material in the 1950s and the inventory has remained virtually untouched pending final disposition. The interim monitored storage that has persisted while awaiting a suitable remediation path forward for disposition of the material does not reflect the original intent of the structures. Once emptied, the Silos will be
of no further use and will be demolished. Given the above factors, the Silos do not qualify as permanent structures.

As for the "...work not done within..." aspect of the condition, the intent appears to be directed to worker safety and the originally-bounded facility accident analysis. In the case of the Silos, the structures are basically large "tanks" which, like confined spaces, were not designed for human occupancy. Removing the stored wastes does not present the typical spectrum of hazards encountered in facilities designed for occupation and operation (e.g., electrical systems, plumbing, gas, hydraulics, machinery, production processes, hold-up material, and asbestos). Furthermore, structures will be demolished upon completion of the remediation activity.

The intent of the Silos environmental restoration activities (at least while the Silos possess greater than DOE-STD-1027-92, Table A.1, HC-3 dispersible inventory) is simply to "empty the tanks" of their low-density, compacted and free-flowing calcined powders and ore concentrates, and safely dispose of the material. This will reduce the inventory below HC-3. Based on the DSAs, removal of the tanks' contents does not involve human occupancy within the structure, only remote access and bulk retrieval of the materials. The remediation process does not require operation of active installed systems, removal of any installed or temporary equipment or systems, or hazardous activities typically associated with remediation of permanent process facilities.

In summary, the "environmental restoration activities" projected for the Silos is not "work done within a permanent structure." The maximum amount of material that could be released during retrieval is bounded by the currently-approved DSAs. Retrieval will not expose workers to the spectrum of hazards typical of work within structures designed for permanent/continuous worker occupancy because there will be no worker occupancy within the silo structures. The workers are protected through compliance with 10 CFR 835, 29 CFR 1910.120, and 29 CFR 1926.65 code requirements.

4.0 Existing Silos Hazard Analyses

A thorough analysis of the Silos hazards (both proposed activities and material at risk) is fundamental to support the argument presented above. Indeed, the Silos Project has an extensive collection of hazard analyses that thoroughly document a wide range of potential hazards for both current and future activities.

During the past 10-12 years, the Silos Project has reviewed and analyzed various design proposals for remediation. Development of the existing DSAs (i.e., OU4 HAR, Silo 3 PHAR, and AWR PHAR) included the generation of Integrated Hazards Analyses (IHAs). Potential accident scenarios from these IHAs were identified for further analysis, and although not required for an HC-3 facility, 29 potential worst-case accidents were quantitatively analyzed for dose consequences, controls, and mitigators, using a graded approach. Of those 29 accidents, the only accidents that showed significant localized consequences under HC-3 criteria were tied to Silo structural failure. Silos structures will therefore remain HC-3, and the remediation activities can logically be segmented from the Silos and categorized as Radiological activities.
Additionally, the following analyses were performed, within the DSAs, as remediation approaches evolved: Occupational ALARA Analysis, Environmental ALARA Analysis, Fire Hazards Analysis, Human Factors Evaluation, and Failure Modes and Effects Analysis. Radiological risk associated with construction, operation, decontamination, and decommissioning of the Silos will be minimized through appropriate radiological control requirements per 10 CFR 835, *Occupational Radiation Protection*, as identified in the controls and mitigators from the above analyses.

Existing analyses show that the predominant radiological risk results from the uncertainties in Silos structural life expectancy (i.e., probability of failure) and the vast amount of radiological materials presently stored. The potential for release exists via catastrophic failure from Natural Phenomena Hazards (NPHs) or structural degradation, for which significant localized consequences can only be appropriately mitigated through Silos remediation. Therefore, the operational risks are bounded by the risk arising from on-going Silos storage operations. Clearly, retrieval, treatment, and disposal of Silos materials reduces overall radiological risks at the FCP.

### 5.0 Developing a New DSA, the N-HASP

A graded SAR approach is provided as an alternative in 10 CFR 830 Subpart B, Appendix A, Table 2, Item 8. Another alternative method for developing a DSA is to use a Health and Safety Program and a project-specific HASP. The Health and Safety Program and project-specific HASP are developed using 29 CFR 1910.120 for operations, and 29 CFR 1926.65 for construction. In addition, 10 CFR 830 requires elements for emergency response, conduct of operations, training and qualification, and maintenance. Also, the QA requirements of 10 CFR 830.120 and the Occurrence Reporting Processing System (ORPS) per DOE O 232.1 must be implemented.

DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*, provided additional guidance on HASP content for environmental restoration activities. The guide stated “for environmental restoration activities the normal HASP that examines radiological issues is the appropriate DSA with the addition of Nuclear Hazard Classification.” In addition, the guide stated the following topics could be addressed in the hazard analysis section of the HASP, or as an appendix: potential hazards affecting the public, controls for these hazards, and corresponding TSRs or administrative controls that may be required.

10 CFR 830 Subpart B also allows use of a graded SAR (Appendix A, Table 2, Item 8). Table 1 is a comparison summary of the traditional SAR and the alternative HASP-based Safe Harbor Approach that FCP chose. In comparing the traditional SAR to the alternative HASP approach, the following points can be noted: the requirements for integrating the health and safety programs into the DSA are the same; and the identification of nuclear safety requirements is the same. The HASP is meant to provide more emphasis on the worker safety hazards seen in environmental restoration activities (e.g., industrial, chemical, and radiological hazards) than the higher-level, traditional DSA supporting a production-based nuclear facility.
The benefit of the HASP-based alternative process is that it not only ensures a focus on worker safety, but reduces the number of safety documents from three to one. Instead of a SAR, TSR, and HASP, the Silos Project has developed an N-HASP that contains the important elements of the SAR and TSR documents. This N-HASP also addresses all tiers of project safety, thus reducing administrative work and freeing up the ever-shrinking pool of safety personnel for direct involvement in project safety. This format simplifies training and safety briefings, and is simpler to revise, approve, and update when project scope changes (as opposed to multiple overlapping safety documents).

DOE-STD-1120-98 calls for a Management of Change (MOC) process that evaluates all proposed activities, changes, and discoveries that may affect facility or worker safety. Although DOE-STD-1120-98 discusses using multiple-screening processes, including the existing USQ process, the Silos Project utilized an existing MOC process that integrates the functional disciplines into the change evaluation for both worker safety and nuclear safety. This process uses a “USQ like” screening process for nuclear safety requirements, and functional area sign-off for health and safety issues.

Other important features such as Quality, Readiness Reviews and Reporting Processes are performed in the same manner for the N-HASP as were performed for the traditional DSAs. The hazard analyses and work processes in support of worker safety are the same for the traditional DSA as for the N-HASP. The only difference is that the documentation of controls and mitigators is now in one document instead of two.
### TABLE 1
Summary Comparison Traditional vs. Alternate

<table>
<thead>
<tr>
<th>ISMS(^{[1]})</th>
<th>TRADITIONAL</th>
<th>ALTERNATIVE</th>
<th>BENEFIT OF ALT.</th>
<th>EFFECTIVENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2,3</td>
<td>Safety Analysis Report (SAR); Technical Safety Requirements (TSR); 10 CFR 830; DOE-STD-3009-94</td>
<td>Health and Safety Plan, including Nuclear Safety Requirements (e.g., SBRs, PRs); 10 CFR 830; DOE-STD-1120-98</td>
<td>One document instead of three, saving development, review, approval, and annual update costs.</td>
<td>Retains current effectiveness.</td>
</tr>
<tr>
<td>2,4,5</td>
<td>Unreviewed Safety Question (USQ); 10 CFR 830</td>
<td>Management of Change using existing Silos Project Safety Basis Impact Screen; DOE-STD-1120-98</td>
<td>Ensures changes are evaluated from both a nuclear safety and an occupational safety level.</td>
<td>Improved: Silos MOC process ensures integration at all levels.</td>
</tr>
<tr>
<td>3,4,5</td>
<td>Quality program part of 17-chapter SAR; 10 CFR 830.120</td>
<td>Existing site Quality program referenced in the HASP; 10 CFR 830.120</td>
<td>Allows for the Quality program relationship to be documented once instead of twice.</td>
<td>Retains current effectiveness.</td>
</tr>
</tbody>
</table>
| 2,3,         | Worker Safety  
1) Design (e.g., ALARA, FHA)  
2) Job Safety Analyses  
3) Work Permits  
4) Work Processes | Worker Safety  
1) Design (e.g., ALARA, FHA)  
2) Job Safety Analyses  
3) Work Permits  
4) Work Processes | Same level of benefit. | Retains current effectiveness. |
| 4,5          | Reporting Process  
1) EDRs  
2) ORPS  
3) PAAA-NTS | Reporting Process  
1) EDRs  
2) ORPS  
3) PAAA-NTS | Same level of benefit. | Retains current effectiveness. |

\(^{[1]}\)Integrated Safety Management System Core Functions:  
1) Define the Scope  
2) Analyze the Hazard  
3) Develop and Implement Hazard Controls  
4) Perform Work within Controls  
5) Provide Feedback and Continuous Performance Improvement
6.0 Conclusion

The N-HASP provides a comprehensive document that supports remediation activities at FCP while maintaining the safety basis and meeting OSHA and DOE criteria. The N-HASP concept is a vital part of Fluor Fernald’s effort to realign its safety documentation to reflect the realities of remediation, and to apply rigor and discipline to the safety aspects of remediation work. The N-HASP combines the project safety basis, occupational safety, industrial hygiene, fire safety, radiological, and other safety-related requirements, along with project-specific controls and implementation methods. This consolidation of requirements via the N-HASP has several benefits, including:

- increased emphasis on project-specific hazards.
- improved worker access to project-specific safety-related requirements.
- reduced costs associated with document upkeep and revision.
- enhanced consistency between project and safety documentation.
- a simplified comprehensive document for workers briefings.

If there are any questions, please feel free to contact Patricia Fisk.

Ms. Patricia Fisk  
Silos Lead, Nuclear & System Safety  
Fluor Fernald, Inc.  
P.O. Box 538704  
Cincinnati, Ohio 45253

Office: 513-648-3889 or -7242  
E-mail: patricia.fisk@fernald.gov