



Work Planning and Control Assessment at the Fermi National Accelerator Laboratory Long-Baseline Neutrino Facility Far Site

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Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
CESHP	Construction Environment, Safety and Health Plan
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DOE	U.S. Department of Energy
DPM	Diesel Particulate Matter
DUNE	Deep Underground Neutrino Experiment
EA	Office of Enterprise Assessments
ES&H	Environment, Safety, and Health
Fermilab	Fermi National Accelerator Laboratory
FRA	Fermi Research Alliance, LLC
IH	Industrial Hygiene
ISM	Integrated Safety Management
JHA	Job Hazard Analysis
KAJV	Kiewit-Alberici Joint Venture
LBNF	Long-Baseline Neutrino Facility
LOTO	Lockout/Tagout
MSHA	Mine Safety and Health Administration
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Level
PPM	Parts Per Million
RCS	R.C.S. Construction, Inc.
RFID	Radiofrequency Identification
SDSTA	South Dakota Science and Technology Authority
SOP	Standard Operating Procedure
SURF	Sanford Underground Research Facility
TLV	Threshold Limit Value
WCD	Work Control Documents
WP&C	Work Planning and Control

**Work Planning and Control Assessment
at the Fermi National Accelerator Laboratory
Long-Baseline Neutrino Facility Far Site
August 26-29, 2019**

Summary

Scope:

This assessment evaluated the work planning and control (WP&C) processes and safety requirements flowdown for construction work at the Fermi National Accelerator Laboratory (Fermilab) Long-Baseline Neutrino Facility (LBNF) Far Site, which is managed and operated by Fermi Research Alliance, LLC (FRA), located at the Sanford Underground Research Facility in Lead, South Dakota. This assessment was requested by the Director of Fermilab.

Significant Results for Key Areas of Interest:

Overall, FRA has established a satisfactory construction safety program and has adequately implemented WP&C processes for construction work at the LBNF Far Site with two exceptions with respect to industrial hygiene sampling and monitoring, and some sections of subcontractor Environment, Safety, and Health (ES&H) manuals.

DOE Safety Requirements Flowdown

In most cases, FRA has established effective processes and procurement protocols to identify and ensure that subcontractor programs include applicable U.S. Department of Energy (DOE) and FRA ES&H requirements for sub-tier construction contractors working at the LBNF Far Site. FRA has demonstrated significant improvement in its construction safety program since a 2015 Office of Enterprise Assessments (EA) construction safety special review of other Fermilab projects.

Work Planning and Control Institutional Programs

WP&C institutional program requirements for construction sub-tiered contractors are well designed in the *LBNF Far Site Construction Environment, Safety and Health Plan* (CESHP). However, some sections of subcontractor ES&H manuals lacked sufficient implementation procedures or were not current, contributing to inadequate control of some hazards during work activities (e.g., Lockout/Tagout of hazardous energy).

Work Planning and Control Implementation

The FRA subcontractor WP&C processes are generally effective, with some exceptions with respect to industrial hygiene sampling and monitoring.

Best Practices and Findings

The following best practices were identified as part of this assessment.

- Build plans, requiring the identification of risks and potential injuries as well as prevention plans for each work step, are developed for each discrete construction activity.
- The planned upgrades to the underground emergency escape and evacuation equipment and systems are robust, well defined, and provide state-of-the-art protection for underground workers.
- A radiofrequency identification detector system (i.e., an audible proximity alarm system) is used when certain mobile equipment is operating in the vicinity of workers.

There was one finding. FRA has not ensured that its subcontractors (e.g., Kiewit-Alberici Joint Venture and its sub-tier contractors) have implemented a comprehensive IH program, including initial or baseline surveys and periodic resurveys and/or exposure monitoring, as appropriate, of all work areas or operations to identify and evaluate potential worker health risks as required by 10 CFR 851. A similar IH concern was noted during the 2015 EA construction safety special review.

Follow-up Actions:

EA will conduct a follow-up assessment in 2020.

Work Planning and Control Assessment at the Fermi National Accelerator Laboratory Long-Baseline Neutrino Facility Far Site

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment on August 26-29, 2019, of work planning and control (WP&C) at the Fermi National Accelerator Laboratory (Fermilab) Long-Baseline Neutrino Facility (LBNF) Far Site, which is managed by Fermi Research Alliance, LLC (FRA). This assessment evaluated the effectiveness of the implementation of the integrated safety management (ISM) core functions (define scope of work, identify and analyze hazards, identify and implement controls, perform work safely within controls, and feedback and improvement) for activity-level work. This assessment also evaluated elements of the DOE safety requirements flowdown from FRA to its sub-tiered contractors.

In accordance with the *Plan for the Office of Enterprise Assessments Assessment of the Work Planning and Control Program at Fermi National Accelerator Laboratory Long-Baseline Neutrino Facility Far Site, August 2019*, this assessment included FRA work activities within facilities at the Sanford Underground Research Facility (SURF) in Lead, South Dakota.

2.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms “best practices, deficiencies, findings, and opportunities for improvement” as defined in DOE Order 227.1A.

As identified in the assessment plan, this assessment considered requirements related to WP&C. The assessment team used sections of DOE Guide 226.1-2A, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*, Appendix D: *Activity-Level Work Planning and Control Criterion Review and Approach Documents with Lines of Inquiry*; Criteria Review and Approach Document EA-32-03, Rev. 0, *Industrial Hygiene Criteria Review and Approach Document*; and applicable Mine Safety and Health Administration (MSHA) standards when reviewing underground work activities. The assessment team also used selected feedback and improvement criteria from within DOE Guide 226.1-2A.

The assessment team observed the planning and implementation of construction work activities occurring aboveground and underground.

The assessment team examined key documents, such as contracts, system descriptions, work packages, job hazard analyses (JHAs) and build plans, standard operating procedures (SOPs), policies, and training and qualification records. The assessment team also interviewed key personnel responsible for developing and executing the associated programs, observed six work activities, and walked down selected portions of FRA subcontracted work at SURF. Appendix A lists the members of the assessment team, the Quality Review Board, and management responsible for this assessment.

EA conducted a Construction Safety Special Review at Fermilab in 2015 at the request of the Director of Fermilab that resulted in recommendations for Fermilab’s consideration. EA also conducted an

assessment of WP&C at Fermilab in February 2019; however, subcontracted construction work was not included in that assessment scope. Therefore, there were no deficiencies or findings for follow-up during this assessment.

3.0 RESULTS

The objective of this assessment was to verify that DOE and FRA safety requirements are properly flowed down to sub-tiered contractors in accordance with 10 CFR 851.1(a), *Worker Safety and Health Program*, and DOE Contract Number DE-AC02-07CH11359, and that FRA manages, and its subcontractors perform, work in accordance with a documented safety management system that (1) defines the scope of work; (2) identifies and analyzes hazards associated with the work; (3) develops and implements hazard controls; (4) performs work within controls; and (5) provides feedback on the adequacy of controls and continues to improve safety management. (48 CFR 970.5223-1(c), *Integration of Environment, Safety, and Health into Work Planning and Execution*, and DOE Contract Number DE-AC02-07CH11359, Clause I.98, *Integration of Environment, Safety, and Health into Work Planning and Execution*)

Overall, FRA has established a satisfactory construction safety program that includes flowing down safety requirements, and has adequately implemented WP&C processes for construction work at the LBNF Far Site with two exceptions with respect to industrial hygiene sampling and monitoring, and some sections of subcontractor ES&H manuals.

3.1 DOE Safety Requirement Flowdown

The objective of this portion of the assessment was to verify that FRA has appropriately flowed 10 CFR 851 and contract safety requirements to its sub-tiered construction contractors and assuring the requirements are implemented.

Safety Requirements Flowdown Mechanisms

EA exercises independent oversight of DOE work activities, regardless of the organization having regulatory jurisdiction. DOE work at the LBNF Far Site is conducted in a complex regulatory environment. SURF is managed by South Dakota Science and Technology Authority (SDSTA), a governmental unit of South Dakota. As such, the SDSTA worksite at SURF is exempt from Occupational Safety and Health Administration (OSHA) regulation. However, South Dakota provides safety and health regulation/oversight through its Office of Risk Management. FRA subcontracted construction work in the SDSTA workspace is under regulation by the Office of Risk Management. The subcontracted construction work in these areas primarily includes projects to improve the reliability of the underground infrastructure critical to supporting the Deep Underground Neutrino Experiment (DUNE) construction and operation (i.e., shafts, hoists, and ventilation equipment).

DOE leased underground space for constructing the DUNE project. Within this DOE-leased space, subcontracted construction work falls under the DOE worker safety and health regulatory jurisdiction, in accordance with 10 CFR 851.1(a) and (b). Therefore, all FRA subcontractors working in DOE-leased space at the LBNF Far Site must meet applicable OSHA standards as required by contract and/or 10 CFR 851. FRA contractually requires its subcontractors conducting work in non-DOE leased space at SURF to follow 10 CFR 851 requirements.

FRA developed an *ESH + Security SURF Governance Matrix* that accurately identifies the regulatory structure and environment, safety, and health (ES&H) requirement set for its LBNF Far Site work

conducted in both DOE-leased and non-leased space at SURF. Based on review of contracts and interviews with FRA, sub-tiered contractors, and SDSTA, this matrix is a good tool to document and clearly communicate the regulatory environment for work performed by each organization.

In November 2015, at the request of the laboratory director, EA conducted a *Construction Safety Special Review* of FRA's subcontracted construction projects located at Fermilab. This review resulted in recommendations to improve the overall FRA construction safety program and how DOE and FRA safety requirements (by regulation and/or contract) are flowed down to sub-tiered contractors to ensure that subcontractors fully understand the applicable safety requirements for work at Fermilab. Shortly after the 2015 EA special review, the LBNF/DUNE project began early stages of procuring subcontracted construction services at the LBNF Far Site. FRA effectively used the EA assessment feedback in revising its approach to establishing, documenting, and communicating ES&H requirements in contract documents for LBNF Far Site construction work. FRA has since formalized needed improvements to the construction safety program and construction contracting practices.

Overall, the FRA construction safety program has significantly improved since the EA 2015 special review, including:

- FRA completed a major revision to Fermi Environment, Safety and Health Manual 7010, *Construction ES&H Program*, to better align organizational responsibilities, updated procurement policies for construction, created a new contract *ES&H Requirements for Subcontractors* document (Exhibit 013100), and enhanced FRA contract work oversight activities.
- The construction safety program effectively used SafetyNet Predictive Solutions software for promptly notifying management when construction safety issues arise from FRA safety oversight activities, and for tracking and trending issues to identify adverse trends and opportunities for improving construction oversight.
- ES&H requirements for construction work are now consolidated in standard sets of procurement documents (for both DOE-leased and non-leased facilities) to clearly communicate ES&H expectations to subcontractors.
- ES&H regulatory and contract requirements are communicated and emphasized to subcontractors to ensure that they are aware of ES&H performance expectations (e.g., pre-bid and pre-construction meetings).
- Subcontractors must now certify that they understand when DOE regulatory safety and health requirements (10 CFR 851) apply to their work and must maintain subcontract worker safety-related training records on site.
- Stop-work authority is clearly included in contractual documents and was effectively implemented.

The FRA LBNF/DUNE project team specifically developed an *Integrated Environment, Safety and Health Management Plan* and *LBNF Construction Environment, Safety and Health Plan* (CESHP) to describe, in part, how subcontractors would conduct WP&C. These documents adequately describe how the LBNF/DUNE project will implement DOE ISM Core Functions at SURF.

The assessment team reviewed six FRA sub-tiered contracts (see Appendix B for subcontract flow chart) for the construction manager/general contractor Kiewit-Alberici Joint Venture (KAJV) and R.C.S. Construction, Inc. (RCS) work, and found that DOE/FRA ES&H requirements were appropriate and were clearly flowed down to the subcontractors in all but one sub-tiered contract (i.e., RCS's subcontract with its electrical contractor). FRA first-tier subcontractors interviewed were aware of the ES&H requirements of their subcontracts.

FRA proactively recognized that 29 CFR 1926.800(k), *Underground Construction*, ventilation standards required by 10 CFR 851.23(a)(7), *Safety and health standards*, are not feasible when it starts future

construction work in DOE-leased underground space. As documented in a January 2019 letter to the Fermi Site Office, FRA notes that while the Oro Hondo fan, when upgraded, will be capable of providing the air flow required by 29 CFR 1926.800(k), air flow in the narrower drifts leading to the area of excavation would be excessive and create additional hazards. A recognized mine safety expert assisted FRA in identifying alternative standards to protect workers when excavating the caverns. The assessment team discussed with FRA that a variance to 10 CFR 851/29 CFR 1926.800(k), in accordance with 10 CFR 851, Subpart D, *Variances*, may be required before performing this work.

Safety Requirement Flowdown Conclusions

FRA has generally flowed down applicable ES&H and WP&C requirements in subcontracts for LBNF Far Site work. The assessment team observed that FRA ES&H and LBNF project staff and construction coordinators assigned to the LBNF Far Site are effectively engaged in oversight of the LBNF Far Site subcontractors and sub-tiered contractors to ensure requirements are implemented. WP&C implementation by sub-tiered construction contractors generally improved since the 2015 special review.

3.2 Work Planning and Control Institutional Programs

The objective of this portion of the assessment was to verify that FRA and its sub-tiered construction contractors have developed and approved WP&C processes to enable the safe performance of work.

Overall, the LBNF/DUNE Integrated Environment, Safety and Health Management Plan provides a useful structure for how ES&H requirements, and the DOE ISM core functions and guiding principles, are to be incorporated into WP&C at the LBNF/DUNE project.

Construction Subcontractor Work Planning and Control Institutional Programs

The FRA CESHP identifies the minimum requirements for FRA construction subcontractors and their sub-tiered subcontractors to perform construction activities at the SURF, and vicinity, during the construction of the LBNF/DUNE project. The CESHP provides a clear and well-written set of ES&H requirements, defines roles and responsibilities for the project, and establishes expectations and procedures for incident reports and stop-work authority.

FRA employs three primary subcontractors in the performance of construction work at the LBNF/DUNE project: KAJV, RCS, and SDSTA. KAJV serves as the construction manager and general contractor to provide construction management services, and to execute the conventional facilities construction scope of work at SURF. On occasion, RCS may serve as a subcontractor to KAJV, as well as in a direct subcontractor relationship with FRA. SDSTA manages SURF, operates and maintains the facility conveyances, and provides support for FRA's subcontractors, as needed. In turn, these subcontractors may employ second- and third-tier subcontractors to provide specific construction services such as lead and asbestos abatement, electrical, and other construction-specific work activities.

The assessment team observed construction and support services work performed by each of the FRA primary subcontractors, as well as four of their sub-tiered construction subcontractors. Each subcontractor had established similar WP&C processes that, overall, met the requirements and expectations of the FRA CESHP and ES&H contract requirements, including detailed build plans, hazard analyses, and pre-job briefings. When addressing specific construction safety hazards, such as electrical hazards, confined space hazards, etc., subcontractors typically relied on procedures within their own ES&H manuals. In some cases, these ES&H manuals lacked sufficient procedures or current requirements, were not in compliance with OSHA requirements, or did not meet the requirements of 10

CFR 851 when working on FRA-tasks construction projects contributing to inadequate control of some hazards during work activities (see **Deficiency D-FRA-1**). For example:

- RCS workers occasionally perform lockouts on potentially energized and/or de-energized systems that other companies initially locked out or that their subcontractors locked out, without an adequate written lockout/tagout (LOTO) procedure; indicated that they have worked under an LOTO without applying their own personal locks; and have not received adequate LOTO training, which is contrary to the requirements of 29 CFR 1926.417, *Lockout and tagging of circuits*, and 29 CFR 1910.147, *The control of hazardous energy (lockout/tagout)*.
- The RCS respiratory protection program does not meet the requirements for a written respiratory protection program as defined in 29 CFR 1910.134(c), *Respiratory Protection*.
- Section 2.DD of the KAJV Manual on Silica Exposure and Section K of the RCS Safety Handbook on Silica Exposure Control Program, have not been updated to reflect the lower American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 0.25 milligrams per cubic meter for respirable silica, which was incorporated into the requirements of 10 CFR 851 with an implementation date of January 17, 2019.

Work Planning and Control Institutional Programs Conclusions

FRA construction subcontractors have developed WP&C institutional programs that are generally effective and commensurate with their construction activities, with a few exceptions in which elements of their ES&H manuals did not reflect current OSHA or DOE 10 CFR 851 requirements, or were not of sufficient detail such that those requirements could be fully implemented.

3.3 Work Planning and Control Implementation

The objective of this portion of the assessment was to assess FRA's implementation of its institutional WP&C program for subcontracted construction activities. The assessment team observed six aboveground and underground construction activities and three work planning meetings. Observed work was conducted by SDSTA, KAJV, two KAJV sub-tiered contractors, and RCS.

Defining the Scope of Work

Work control documents (WCDs) for each of the six construction activities observed were complete, and each WCD included a well-defined work scope. A build plan is the cornerstone of each set of WCDs used by RCS, KAJV, and KAJV subcontractors; build plans provide step-by-step instructional guidance for the completion of the work activity. The assessment team identified a number of positive and unique attributes of the build plans, which collectively identify the use of build plans as a **Best Practice**. For example:

- Each step of a build plan is typically accompanied by a detailed sketch or drawing depicting the desired outcome.
- The build plan includes a series of three questions for each step: "What is the Worst that Could Happen?"; "How are You Most Likely to get Hurt?"; and "Other Risks to be Aware Of?" A prevention plan is documented for each question, as well as a prevention plan for each response.
- Build plans are intended for discrete activities, and each construction work activity typically consists of a series of build plans, contrary to large construction WCDs observed by the assessment team at most construction sites.

Identifying and Analyzing Hazards Associated with the Work

For FRA subcontractors, the expectations and requirements for the identification of hazards and performance of a hazard analysis for each definable construction activity are well documented in Section 4 of the FRA CESHP and in the ES&H requirements of their contracts. A hazard analysis, which met these expectations and requirements, was prepared by the subcontractors for each of the six construction activities observed by the assessment team, with a few exceptions as described below. For construction work performed by RCS and KAJV, and their observed subcontractors, each work activity and associated hazards were sufficiently documented in a build plan and an accompanying hazard analysis. For construction work performed by SDSTA, work hazards were typically well documented in either an SOP or on a JHA form.

The hazard analysis processes observed were generally effective in identifying and communicating workplace hazards to the workforce. The hazard analyses were detailed and descriptive of the work activity, and a number of the hazard analyses were annotated with sketches or drawings. The mini JHA process, used in all observed work activities, was useful in focusing the workers on the specific hazards and controls of the day's work activity.

An exception to a generally robust hazard analysis process was observed in the identification and analysis of industrial hygiene (IH) hazards, including the application of IH controls and instrumentation to mitigate these hazards. KAJV has not implemented a comprehensive IH program that includes initial or baseline surveys and periodic resurveys and/or exposure monitoring, as appropriate, of all work areas or operations to identify and evaluate potential worker health risks, as required by 10 CFR 851, Appendix A(6)(a). The following five IH hazards observed by the assessment team (i.e., hazardous chemicals, noise, silica, diesel particulate and gaseous emissions) were not identified and/or sufficiently analyzed (see **Finding F-FRA-1**).

- Potential worker exposures to chemical reproductive toxins when applying a lead paint stripping compound (Multi-Strip) had not been identified in hazard analysis documents or adequately analyzed and sampled. In addition, the respirator used by workers from Horsley Specialty, Inc. (a subcontractor to KAJV) at the time of the observation provided protection for airborne lead particulates but not for the chemical constituents of the Multi-Strip compound used by Horsley for lead abatement in the Ross Headframe. Section 13.3.1.3 of the CESHP *Exposure Assessment* requires that subcontractors shall perform monitoring as necessary to document employee exposures to chemical hazards.
- Worker exposures to noise (above and below ground) have not been sufficiently analyzed, and not all areas requiring hearing protection have appropriate postings (underground and at the SURF Oro Hondo Fan rebuild worksite). Although KAJV has monitored sound levels in the underground, KAJV has not conducted sound level surveys to identify areas of elevated sound levels requiring hearing protection, and noise dosimetry measurements have not been performed and documented to assess workers' exposures to elevated noise levels. The assessment team observed areas of elevated noise underground in which some workers wore hearing protectors and others did not. Section 12.3.2 of the CESHP *Noise Evaluation* requires subcontractors to survey and evaluate suspected high noise areas and work efforts, and to control employee exposures when noise levels exceed 85 decibels as an eight-hour time weighted average.
- Worker exposures to silica have not been sufficiently identified and analyzed. Silica controls are not identified in build plans and hazard analyses. KAJV sampling of airborne respirable silica has been limited to a few area samples in the underground. However, sampling for respirable silica in workers' breathing zones during excavation, mucking, or concrete pouring operations has not been

performed. Furthermore, in several of the observed work activities involving excavation or concrete pouring, the potential respirable silica hazard was not identified in either the build plans or the hazard analysis. Section 13.3.10 of the CESHP *Silica Exposure* requires that subcontractors monitor employee exposures to airborne free silica dust (i.e., breathing zone samples) to ensure that control techniques are effective.

- Worker exposures to diesel particulate emissions in the underground have not been sufficiently analyzed and/or controlled. Worker exposures to diesel particulate matter (DPM), a known carcinogen, have not been sufficiently analyzed. In July 2019, KAJV obtained five area samples for DPM in the underground at the 4,850-foot elevation, one of which was above the MSHA permissible exposure level (PEL) for DPM. Breathing zone DPM sampling for workers has not been performed to determine the significance of the elevated DPM area sampler readings with respect to potential worker overexposures.
- Diesel equipment gaseous emissions (carbon monoxide or CO, nitrogen dioxide or NO₂, nitric oxide or NO) are routinely monitored in underground areas by KAJV, but in some cases only through area monitoring and not through sampling of a worker's breathing zone as required by OSHA and 10 CFR 851.21. Area monitoring instrument data provided by KAJV for diesel emissions during a recent mucking operation in the Ross Ore Pass Excavation site identified concentrations of NO₂ at 3-5 parts per million (ppm), which is well above the ACGIH TLV of 0.2 ppm, on numerous occasions during a work shift and on multiple days during a three-week period. The results were also occasionally above the OSHA PEL (NO₂ Ceiling) of 5 ppm. The possibility of worker overexposures to NO₂ during this period is plausible, but unanalyzed. Furthermore, alarm set points for CO, hydrogen sulfide (H₂S), and NO₂ for the six-channel multi-gas monitor are set above current ACGIH and/or OSHA regulatory limits, and do not provide adequate worker protection from potential overexposures to these gases. WCDs identify "bad air" as a potential hazard, but they do not define the term "bad air" or document the expected worker responses. Section 13.3.1.2 of the CESHP *Control Measures* states that a "subcontractor's industrial hygiene program shall require that controls are implemented to eliminate or reduce employee exposures below recognized occupational exposure limits (PEL's & TLV's)."

Neither FRA or KAJV has an onsite industrial hygienist, which is a contributing cause for some of the aforementioned industrial hygiene sampling and monitoring concerns.

Developing and Implementing Hazard Controls

Overall, the build plans and SOPs, and associated hazard analyses, provide an adequate description of hazard controls for construction activities observed at the SURF site. A few exceptions were noted with IH hazards and associated controls, as discussed in the previous section. Two best practices were also observed.

To mitigate the potential of mobile equipment struck-by hazards (a significant hazard in mining and construction activities), KAJV has implemented a proximity detection system in mobile equipment. Radio Frequency Identification (RFID) technology is placed within worker's hard hats, and an antenna is installed in equipment to communicate with the RFID tags. When an operator reverses a piece of equipment installed with an antenna, the operator will be alerted inside the cab with a visual and audible alarm when a ground worker (wearing an RFID) is behind them. The loud audible alarm outside of the cab also alerts the ground worker of their interference of the detection zone behind the equipment. Observation of equipment with this system, and the acceptance and endorsement of protected workers, validated the successful implementation of this technology to enhance safety. These systems are not common at similar operations in the DOE complex. The use of an RFID system (i.e., an audible

proximity alarm system) when certain KAJV mobile equipment is operating in the vicinity of workers, below and above ground, is identified as a **Best Practice**.

Overall, FRA has provided adequate escapeways and emergency resources for working underground. The FRA site has two shafts (Yates and Ross) that may be used as escapeways from the underground to the surface. However, the Ross Shaft hoist lacks some required safety devices for routine personnel hoisting but could be used in an emergency, recognizing that all the necessary safety features are not present. SDSTA also provides an underground refuge chamber capable of housing 75 people in the event of an emergency, and two well-marked escape routes provide direction to each egress shaft. Workers are provided, and required to carry, self-rescuers or emergency escape respirators for use in the event of an underground fire. KAJV provides their workers with Ocenco M20 Self Rescuers and places larger Ocenco Self Contained Self Rescuers at predetermined locations near the underground working places. These stored units were examined and found to be well maintained, properly inspected, and stored in a manner that exceeds the National Institute for Occupational Safety and Health/MSHA requirement for these emergency escape respirators.

While the current underground refuge chamber is inadequate in that it does not fully comply with National Fire Protection Association 520, *Standard on Subterranean*, an upgrade is currently being installed that will provide state-of-the-art protection and is considered a **Best Practice**. The designed system specifications for breathing air purification, with the addition of air monitoring systems for CO, carbon dioxide, and oxygen levels both inside and outside the chamber, exceed the design standards set for refuge chambers for use in coal mines, which are tested and approved by MSHA, as well as internationally recognized standards for refuge chambers.

Performing Work Within Controls

For the six construction subcontractor work activities observed by the assessment team, work was performed within controls documented in build plans, SOPs, and hazard analyses.

Worker involvement in the identification and resolution of safety concerns was also evident in work observations, pre-job planning meetings, and interviews. For example, KAJV requires a mini JHA for all work activities. A mini JHA focuses on the job tasks and hazards or work about to be performed, is prepared by the foreman and/or superintendent conducting the task, and is reviewed and concurred by all work task members prior to initiating the work. SDSTA uses a five-point card to involve workers in the preparation of work activities and identification of hazards and controls. Each subcontractor conducts a weekly safety meeting to review any potential safety issues, as well as to obtain worker feedback on actions taken to resolve safety concerns. The assessment team observed several of these mechanisms for involving workers in the planning and execution of construction work activities and found them to be effective.

Each subcontractor ES&H Manual includes a discussion on a worker's stop-work authority. Interviews with workers affirmed that workers were aware of their requirement and authority to stop work if an unsafe condition was evident, and workers are not hesitant to pause/stop work if needed.

Feedback and Improvement

The assessment team observed as KAJV and RCS provided real-time feedback on improving work processes and safety controls, and documenting these improvements in the field on the WCDs. These field improvements were formally changed in the corresponding WCDs. All subcontractor hazard analyses are required to be reviewed by FRA, while KAJV sub-tiered contractors' hazard analyses

required a KAJV review as well, with comments provided for resolution prior to starting work. The assessment team observed a FRA ES&H specialist mentoring a subcontractor superintendent during the morning safety meeting on how to improve a specific hazard analysis for work that was starting, as well as ideas to improve the hazard analysis and build plans in general.

Work Planning and Control Implementation Conclusions

Overall, the WP&C institutional programs are adequately implemented for FRA construction work at SURF. The workers are effectively integrated into the WP&C processes and are not hesitant to pause/stop work if needed. Hazards and controls are effectively identified and analyzed, and hazard controls are described in build plans, SOPs, and hazard analyses. Three best practices were also identified. One finding was identified in that FRA subcontractors' IH sampling and monitoring programs do not meet the IH requirements of the FRA CESHP or 10 CFR 851, particularly with respect to noise, silica, diesel emissions, and hazardous chemicals.

4.0 BEST PRACTICES

Best practices are safety-related practices, techniques, processes, or program attributes observed during an assessment that may merit consideration by other DOE and contractor organizations for implementation. The following three best practices were identified as part of this assessment.

- Build plans, requiring the identification of risks and potential injuries as well as prevention plans for each work step, are developed for each discrete construction activity.
- The planned upgrades to the underground refuge chamber, which include an engineered air purifying system and air monitoring systems for CO, carbon dioxide, and oxygen levels both inside and outside the refuge chamber, will provide state-of-the-art protection for underground workers.
- An RFID system (i.e., an audible proximity alarm system) is used when certain KAJV mobile equipment is operating in the vicinity of workers, below and above ground.

5.0 FINDINGS

Findings are deficiencies that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public, or national security. DOE line management and/or contractor organizations must develop and implement corrective action plans for EA appraisal findings. Cognizant DOE managers must use site- and program-specific issues management processes and systems developed in accordance with DOE Order 227.1A to manage these corrective action plans and track them to completion.

Fermi Research Alliance, LLC

Finding F-FRA-1: FRA has not ensured that its subcontractors (i.e., KAJV and KAJV sub-tier subcontractors) have implemented a comprehensive IH program, including initial or baseline surveys and periodic resurveys and/or exposure monitoring, as appropriate, of all work areas or operations to identify and evaluate potential worker health risks as required by 10 CFR 851, Appendix A(6)(a); 10 CFR 851.21, *Hazard identification and assessment*; and the IH requirements of the FRA CESHP Section 13. A similar IH concern was noted during the 2015 EA construction safety special review.

6.0 DEFICIENCIES

Deficiencies are inadequacies in the implementation of an applicable requirement or standard. Deficiencies that did not meet the criteria for findings are listed below, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

Fermi Research Alliance, LLC

Deficiency D-FRA-1: FRA and its subcontractors have not ensured that subcontractor ES&H manuals provide sufficient instructions/procedures to meet and implement the requirements for written programs for LOTO, silica, and respiratory protection as described in 29 CFR 1926, 29 CFR 1910, and 10 CFR 851. Section 2.3.1, *Site Specific Construction ES&H Plan*, of the CESHP requires that each subcontractor performing work at SURF develop a site-specific safety and health plan that provides for the implementation of all ES&H requirements listed in the contract.

7.0 OPPORTUNITIES FOR IMPROVEMENT

There were no opportunities for improvement identified as part of this assessment.

Appendix A

Supplemental Information

Dates of Assessment

Onsite Assessment: August 26-29, 2019

Office of Enterprise Assessments (EA) Management

Nathan H. Martin, Director, Office of Enterprise Assessments

April G. Stephenson, Deputy Director, Office of Enterprise Assessments

Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments

Kevin G. Kilp, Deputy Director, Office of Environment, Safety and Health Assessments

C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments

Charles C. Kreager, Acting Director, Office of Worker Safety and Health Assessments

Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

April G. Stephenson

Steven C. Simonson

Thomas R. Staker

Michael A. Kilpatrick

EA Assessors

Kevin G. Kilp – Lead

Terry E. Krietz

James R. Lockridge

Peter M. Turcic

Appendix B
LBNF Project Far Site Subcontractor Flow Chart

DOE Prime Contract DE-AC02-07CH11359 with FRA



LBNF Far Site Subcontractors to FRA

Kiewit-Alberici Joint Venture (KAJV)
(Construction Manager/
General Contractor)

R.C.S. Construction*
(Ventilation Rehabilitation)

**South Dakota Science and
Technology Authority
(SDSTA)**
(Ventilation Rehabilitation)



Sub-tiered Subcontractors

United Global Group (UGG)
Horsley Specialties
Anderson Environmental Services
R.C.S. Construction*

Muth Electric

EA did not review SDSTA
Subcontracts.

(No SDSTA subcontractor
work was observed while
onsite.)

*R.C.S. Construction is contracted as a first-tier subcontractor to FRA and as a sub-tiered subcontractor to KAJV for different scopes of work.