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Title: WORK PLAN
EXCAVATION SUPPORT DESIGN
CHEMISTRY AND METALLURGY RESEARCH
REPLACEMENT PROJECT
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO
KLEINFELDER PROJECT NO. 101492
June 22, 2010
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Intended for: Use as reference for CMRR-NF Supplemental Environmental Impact Statement

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REVISION HISTORY

This page is a record of revisions to this document. Each time the document is changed, a change notice may be prepared identifying the change or the entire document may be reissued. For convenience, the nature of the change is noted under the description and/or by vertical revision lines in the document margin.

Revision	Revision By	Effective Date	Pages Revised	Description	Type of Revision (Technical/ Editorial)	Update Required Reading? (Yes/No)
A	A. Kuhn	4/13/10	Initial Issue	Initial issue for internal ARES and Kleinfelder review.	NA	NA
B	A. Kuhn	4/28/10	Initial Issue	Addressed minor internal review comments. Issued for LANS review.	Editorial	NA
C	J. Stoken/A. Kuhn	6/22/10	Most in the Technical Approach section	Addressed LANL review comments. Revised technical approach.	Editorial/ Technical	NA

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ACRONYMS

amsl	above mean sea level
CF	concrete fill
CMRR	Chemistry and Metallurgy Research Replacement
CP	Construction Package
DIT	Design Information Transmittal
DOE	Department of Energy
GM	ground modification
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
PC-3	Performance Category 3
PF-4	Plutonium Facility
PIDADS	Perimeter Intrusion Detection, Assessment, and Delay System
PQAP	Project Quality Assurance Plan
PRT	peer review team
QAPM	Quality Assurance Program Manual
RLUOB	Radiological Laboratory/Utility/Office Building
SME	subject matter expert

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1 INTRODUCTION

Kleinfelder, West Inc. (Kleinfelder) has prepared this Work Plan for development of the conceptual and final designs of the Excavation Support for the Chemistry and Metallurgy Research Replacement (CMRR) Project at Los Alamos National Laboratory (LANL) located in Los Alamos, New Mexico. The work will be performed by Kleinfelder as a subcontractor to ARES Corporation (ARES) in accordance with subcontract agreement 0833300-009. ARES has a prime contract with Los Alamos National Security, LLC, (LANS), which is the operator of LANL for the Department of Energy (DOE). The term LANL will be used to mean both the facility and the operating entity (LANS) from this point forward throughout this document.

This Work Plan addresses both the conceptual and final design of the excavation support system(s) (i.e., soldier pile and lagging with ground anchors) that will be used to provide structural support for the walls of the excavation required for ground modification, foundation construction, and construction of the CMRR building. Conceptual design consisting of one or more support systems will be developed by Kleinfelder for review and approval by LANL, ARES, Sargent & Lundy, and the outside Peer Review Team (PRT). Kleinfelder will develop the final design package of the support system(s), selected by LANL from the conceptual designs, for subsequent inclusion in construction bid documents.

Excavation support design will be closely coordinated with, and draw extensively from, the design of the Ground Modification (GM) also being prepared by Kleinfelder. The GM design will include excavation of the poorly welded volcanic tuff in the lower portion of Bandelier Unit 3 ($Qbt3_L$) and replacement with concrete fill (CF) as prescribed by LANL.

1.1 Background

1.1.1 Geologic and Geotechnical Conditions Requiring Excavation Support

Kleinfelder performed geotechnical investigations of the CMRR site and characterized the geologic strata of the Bandelier Tuff from ground surface to the base of this formation at approximately 700 feet depth (Kleinfelder 2007a, 2007b). The CMRR excavation will be affected by the uppermost units of the Bandelier Tuff:

- Unit 4 (Qbt4), poorly to moderately welded tuff from ground surface to approximately 14 feet depth;
- Upper Unit 3 ($Qbt3_U$), poorly to moderately welded tuff from the base of Qbt4 to approximately 75 feet depth;
- Lower Unit 3 ($Qbt3_L$), poorly to non-welded tuff from approximately 75 feet depth to approximately 125 feet to 130 feet depth. $Qbt3_L$ has upper and lower transition zones of slightly stiffer and slightly more competent (more welded) material; and

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- Unit 2 (Qbt2), moderately to densely welded tuff, underlying $Qbt3_L$ and more than 120 feet thick.

The required excavation will remove all of Qbt4, $Qbt3_U$, and $Qbt3_L$ within the footprint of the CMRR foundation and to 5 feet laterally beyond each side. At total depth the excavation will be up to 130 feet below original grade.

The Qbt4 and $Qbt3_U$ units are extensively fractured. These fractures are mostly non-planar and non-systematic, apparently resulting from shrinkage from cooling soon after deposition of the volcanic ash. Some of these fractures are deeply weathered and infilled with clay from weathering or deposition of detritus. As a result, although Qbt4 and $Qbt3_U$ display intact properties of soft rock, rock mass performance will be dominated by the tendency of the rock to separate and displace along weathered fractures.

$Qbt3_L$ displays properties more typical of slightly cemented, non-plastic medium to dense silty sand. The apparent cementation is actually weak welding caused by vapor-phase minerals that form fragile connections between the volcanic ash particles that constitute the matrix of this unit. This weak welding is easily broken by even slight disturbance.

Qbt2 displays increasing welding, density, and strength with depth through and below its transition with the overlying $Qbt3_L$. Below this transition, Qbt2 has the geomechnical properties of rock. Qbt2 will not be excavated as part of the GM work but may be penetrated by components of the excavation support system.

Viewed as a composite vertical section, the excavation face will expose approximately 75 feet of soft rock underlain by 50 to as much as 60 feet of poorly welded tuff with soil-like properties, the inverse position of materials typically encountered in deep excavations. Either rock- or soil-type ground support systems are suitable for the upper 75 feet, while soil-type support will be required below 75 feet to the top of Qbt2. Regardless of the ground support systems chosen for the upper and lower tuffs, the entire system must act in unison to provide rigid support of the entire excavation height.

1.1.2 Design Concerns Arising from Ground Conditions

Excavation support functionality is required during excavation and CMRR construction until backfill is complete. Excavation support has a temporary function but must be robust enough to perform for an extended period of time without deterioration. Specific design objectives include:

<u>Protection of Adjacent Facilities</u>

As a top priority, the foundations of PF-4 must be protected to prevent detectable settlement and lateral displacement. The new Perimeter Intrusion Detection, Assessment, and Delay System (PIDADS) will be located as close as five feet

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horizontally from the edge of the excavation on the west and north side, so the excavation support design must provide protection against excessive displacements of the PIDADS system. The excavation support must also provide protection against excessive displacements of the Radiological Laboratory/Utility/Office Building (RLUOB) structure to the east of CMRR and PC-3 utilities north of the north wall of the excavations.

Safety

The excavation support must provide protection to workers within the excavation against rock falls originating in the excavation walls. Although construction equipment will operate within the excavation, the excavation support must be able to support static and live loads of equipment located above the supported excavation walls near the edge of the excavation. In particular, the construction ramps on the east and south sides of the excavation must provide safe ingress and egress for workers, equipment and materials.

Constructability

The excavation support design must take into account the limited space available on all sides of the CMRR excavation. Lateral limits are set on the west and north by the PIDADS, by RLUOB on the east, and by Pajarito Road on the south side. Because of these limits, excavation support construction must be performed from within the excavation.

Two construction ramps will be used for access to the foundation subgrade level at elevation 7,227 feet above mean sea level (amsl). Equipment used for excavation support construction must be able to move up and down these ramps or be hoisted directly into and out of the excavation.

The excavation support must be designed so that the support components can be installed before or during excavation and staged to be in sequence with excavation.

Coordination with PIDADS Ground Support

As much as possible, the excavation support will incorporate, or at least not conflict with, the ground support designed for the PIDADS construction of the Nuclear Materials Safeguards and Security Upgrades Project at PF-4. Kleinfelder will coordinate its excavation support design with that of the slope support for the PIDADS to attempt to integrate the latter into the overall excavation support design.

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2 QUALITY ASSURANCE

Quality-impacting work performed for this project will be conducted in accordance with the ARES Corporation Quality Assurance Program Manual (QAPM) and the ARES Project Quality Assurance Plan for the Chemistry and Metallurgy Research Replacement Nuclear Facility Design Support Project (PQAP-01). Quality Assurance activities will be performed under the general oversight of ARES' corporate Director of Quality Assurance. Personnel will be trained to all applicable quality procedures and subsequent revisions of this Work Plan.

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3 SCOPE AND TECHNICAL APPROACH

3.1 Conceptual Design

The design of the excavation support will be completed in two stages – conceptual and final design. The overall design will support two major construction packages (CP) – CP 34, Site Excavation, and CP 35, Soil Stabilization. The following activities will be performed in parallel as part of the conceptual design of the excavation support system.

3.1.1 Design Criteria Development

Kleinfelder will develop one or more conceptual designs that satisfy the following design criteria:

- Limiting settlement or lateral displacement at PF-4 to acceptable levels;
- Limiting values of settlement and lateral displacement for PIDADS and RLUOB;
- Minimum plan dimensions of excavation support components consistent with GM construction and subsequent CMRR construction space demands;
- Ability to support live and static loads on the ramps and at edges of the excavation;
- Ability to withstand design earthquake loads and peak ground acceleration; and
- Worker protection against rock fall.

The numeric values for the foregoing design criteria will be conveyed from ARES, LANL, and Sargent & Lundy to Kleinfelder through Design Information Transmittals (DITs).

3.1.2 Constructability

Constructability will be evaluated in consultation with ARES and LANL. Factors will include:

- Work space needed for support component installation;
- Accommodation of ramps, construction equipment, and hoisting equipment;
- Logistical requirements for staging, movement, and application of materials;
- Sequencing and coordinating with other construction, especially the GM activities; and
- Ability to modify the system with time in the event adverse deflections are detected.

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3.1.3 Calculations and Analyses

Using the design criteria developed in Section 3.1.1, engineering analyses and numerical modeling will be performed to support design.

Evaluation of lateral pressures and stability of excavation slopes

In order to estimate the lateral pressures that must be resisted by the excavation support system, limit-equilibrium stability analyses of the full excavation height will be performed. The stability analysis will identify the critical potential failure surfaces (the failure surface of a factor of safety of 1 and the lateral restraint pressures that must be provided to stabilize the ground (increase the factor of safety along the critical potential failure surface). The estimated lateral restraint pressures and location of the critical failure surfaces will be used to design the size and spatial arrangement of the structural support elements in the subsequent design. To confirm that the results of the limit-equilibrium stability analyses are reasonable, a lateral earth pressure solution based on simpler "hand-calculation" methods will be performed.

In addition to the calculations described above, limit-equilibrium analyses will be used to evaluate the stability of the slopes along the east and south sides of the excavation. Above the basemat foundation level, these slopes have a wide range of slope inclinations due to the geometry of the excavation and the presence of access ramps. The stability analyses will help determine what, if any, support system will be required for these slopes.

Design of structural support system

Once the lateral pressures and critical potential failure surfaces have been estimated, the results will be used to select the structural support components and to develop the conceptual spatial arrangements and dimensions of the components. The shoring wall design and analysis program, Shoring Suite, will be used to facilitate this process.

Modeling of supported excavation

FLAC 2D analyses will be performed for critical cross-sections of the excavation support system to estimate stresses and deflections in the supported ground mass. The FLAC 2D model will be run with the design structural components and spatial arrangements to confirm that, if properly installed, these support components can carry the design loads while limiting the ground deflections to acceptable levels. Of particular concern will be deflections near the PF-4 facility. If FLAC 2D analyses indicate that the current support system design allows unacceptable levels of deflection, the support system will be redesigned and FLAC 2D analyses will be performed until sufficiently low deflections are attained.

Volumes and sizing of materials needed

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Following the successful modeling of the selected support components, Kleinfelder will calculate the volumes and sizes of materials needed for the support system(s) selected. These calculations will be used to support the subsequent cost estimate.

Installation rates

Kleinfelder will confer with LANL and industry sources to estimate the rates of excavation support system installation under the one or more scenarios that are consistent with the GM design and construction, which are yet to be determined

3.1.4 Drawings

Conceptual design drawings will be prepared to present the excavation support design approach(es) recommended by Kleinfelder and to support LANL's decision of the excavation support system for final design. The drawings will be prepared in accordance with LANL Drafting Standards Manual Section 100 - General Requirements and Section 200 - Drafting Requirements, Rev. 4, 10/27/06. Drawings will be checked and reviewed per the requirements of ARES QAP-3.6 "Design Controls." The preliminary list of drawings is:

- Cover Sheet – general, design criteria information, list of drawings;
- Plan View(s) – one or more sheets including plan views before construction, after construction of excavation support, sequencing of activities, and instrumentation locations for performance verification;
- Elevations – one or more of each excavation wall, individual excavation support systems, sequencing of activities, and instrumentation locations for performance verification; and
- Details – sufficient to describe components configuration and function.

All drawings are expected to be Discipline Code B (Geotechnical).

3.1.5 Specifications

At the conceptual design level, specifications will be performance-based specifications. A preliminary list includes:

- Material requirements for the various support components, based on minimum properties;
- Installation requirements (e.g.; sequence, timing versus excavation); and
- Monitoring and quality control requirements, including instrumentation.

The specifications will also incorporate:

- Identification of safety classification of the items and activities (provided by LANL);

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- For safety class or safety significant items, identification of the critical characteristics and acceptance criteria;
- Inspection and test requirements and acceptance criteria;
- Quality assurance program requirements;
- Identification of applicable codes, standards, and/or regulations;
- Requirements for the control, handling, storage, and shipping of material and instruments; and
- Documentation submittal requirements.

Specifications will be prepared, checked, and reviewed per the requirement of ARES QAP-3.6 "Design Process." To facilitate subsequent preparation of final specifications, the conceptual design specifications will be prepared in the same format, where possible, as that preferred by LANL for the final design and construction specifications.

3.2 Conceptual Design Package

Kleinfelder will prepare a draft conceptual design package of drawings, specifications, cost estimates, and calculations for submittal to ARES and LANL. The preliminary design package outline is:

- Narrative
- Drawings
- Performance Specifications
- Calculations

3.3 Final Design

Final design of the excavation support will be developed by Kleinfelder based on the conceptual design and input from ARES, LANL, Sargent & Lundy, and the PRT. The final design will include only those support components selected by LANL.

3.3.1 Calculations

Final calculations and engineering analyses will be based on those performed for the conceptual design, and only those calculations that require revision will be repeated for final design. However, other calculations may be required if additional or different support components are identified in the review of the conceptual design.

3.3.2 Drawings

Drawings prepared for the final design will be revisions and additions (if needed) to the conceptual drawings, providing the details necessary for bidding and construction of the work. The drawings will be prepared in accordance with LANL Drafting Standards Manual Section 100 - General Requirements and Section 200 - Drafting Requirements, Rev. 4, 10/27/06. The list of drawings includes:

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- Cover Sheet – general, design criteria information, list of drawings;
- Plan View(s) – one or more sheets including plan views before construction, after construction of excavation support, sequencing of activities, instrumentation locations for performance verification, and security constraints;
- Elevations – one or more of each excavation wall, excavation support component locations and orientations, sequencing of installation activities with GM activities, and instrumentation locations for performance verification;
- Details – sufficient to describe materials, configuration, function of each support component, and instrumentation;
- Details of the construction ramps (from Sargent and Lundy);
- Plan of possible materials-handling arrangements; and
- Plan of quality control measuring and sampling locations.

3.3.3 Specifications

Kleinfelder will prepare technical specifications of the selected excavation support components that will be sufficient in detail to support the construction contract procurement process and the performance of the excavation support construction. The specifications will be prepared in the format directed or preferred by LANL, expanding on the conceptual design specifications as presented in 3.1.5.

Kleinfelder expects to prepare these specifications as primarily performance-based specifications, clearly describing the excavation support system components in terms of configuration and performance, but leaving the selection of specific materials and brands of equipment to the discretion of the construction contractor. However, the specifications will state that LANL has the right to accept or reject materials and equipment proposed by the construction contractor.

3.3.4 Design Package

A design package for final excavation support design will be assembled in support of CP34 and CP35. The design package will have two separable parts:

- Construction bid documents including the specifications and drawings, and
- Design and quantity take-off information including calculations and analyses.

The second part will have a brief narrative describing the contents, roles of the contributing parties, and the process for revisions. Following the submission of the draft final design package, one round of review will be performed by LANL, ARES, Sargent & Lundy, and the PRT. Kleinfelder will address and incorporate changes from the review comments into a final design package.

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4 PERFORMANCE SCHEDULE

The activities described in Section 3 will be performed according to the schedule shown in the CMRR Integrated Project Schedule.

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5 PERSONNEL

The task will be performed under the guidance of Dr. Alan Kuhn, P.E. All personnel associated with activities on this task will be qualified and trained in the appropriate procedures. Once appropriate qualification and training have been established, all personnel involved with this project will read, understand, and abide by the instructions and procedures indicated herein.

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6 REFERENCES

ARES Corporation, “ARES Corporation Quality Assurance Program Manual.”

ARES Corporation, “ARES Project Quality Assurance Plan for the Chemistry and Metallurgy Research Replacement Nuclear Facility Design Support Project.”

ARES Corporation, “Technical Reports,” QAP-3.4.

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