Capsule Storage Area Preliminary Design Report (Project W-135)

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Assistant Secretary for Environmental Management

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<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALARA</td>
<td>As Low As Reasonably Achievable</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>CDR</td>
<td>Conceptual Design Report</td>
</tr>
<tr>
<td>CE&amp;I</td>
<td>Control, Electrical, and Instrumentation</td>
</tr>
<tr>
<td>CHPRC</td>
<td>CH2M HILL Plateau Remediation Company</td>
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<tr>
<td>CSA</td>
<td>Capsule Storage Area</td>
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<tr>
<td>CSB</td>
<td>Canister Storage Building</td>
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<td>CSP</td>
<td>Capsule Storage Pad</td>
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<td>CSS</td>
<td>Cask Storage System</td>
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<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
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<tr>
<td>DOE-HQ</td>
<td>U.S. Department of Energy, Headquarters</td>
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<tr>
<td>DOE-RL</td>
<td>U.S. Department of Energy, Richland Operations Office</td>
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<tr>
<td>DSA</td>
<td>Documented Safety Analysis</td>
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<td>FDC</td>
<td>Functional Design Criteria</td>
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<td>FDR</td>
<td>Final Design Report</td>
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<tr>
<td>MCSC</td>
<td>Management of Cesium and Strontium Capsule</td>
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<tr>
<td>MSA</td>
<td>Mission Support Alliance</td>
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<td>NAC</td>
<td>NAC International</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
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<td>PDR</td>
<td>Preliminary Design Report</td>
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<td>PDSA</td>
<td>Preliminary Documented Safety Analysis</td>
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<td>QA</td>
<td>Quality Assurance</td>
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<tr>
<td>SDC</td>
<td>Seismic Design Category</td>
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<tr>
<td>SLF</td>
<td>Storage, Laydown, and Fabrication</td>
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<tr>
<td>SSCs</td>
<td>Structures, Systems, and Components</td>
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<tr>
<td>TMS</td>
<td>Temperature Monitoring System</td>
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<tr>
<td>TSC</td>
<td>Transportable Storage Canister</td>
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<tr>
<td>VCC</td>
<td>Vertical Concrete Cask</td>
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<td>VCT</td>
<td>Vertical Cask Transporter</td>
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<tr>
<td>WESF</td>
<td>Waste Encapsulation and Storage Facility</td>
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<tr>
<td>WIDS</td>
<td>Waste Information Data System</td>
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<tr>
<td>Units</td>
<td>Description</td>
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<td>in.</td>
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<td>kV</td>
<td>kilovolt</td>
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<tr>
<td>mRem/hr</td>
<td>milirems per hour</td>
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<tr>
<td>V</td>
<td>volt(s)</td>
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1.0 INTRODUCTION

The Management of Cesium and Strontium Capsules (MCSCs) Project (W-135) will fill the capability gap for interim storage of cesium and strontium capsules currently stored underwater at the Waste Encapsulation and Storage Facility (WESF). The scope of Project W-135 is consistent with DOE/RL-2012-47, Mission Need Statement for the Management of the Cesium and Strontium Capsules.

The project will provide the capabilities necessary to transfer the capsules from the WESF pool cell to a Cask Storage System (CSS) which will be located in a new Capsule Storage Area (CSA). The CSS will safely and compliantly store the 1,936 capsules until a capsule disposal option is available in the future.

This report addresses the CSA portion of Project W-135, which consists of the following key elements:

- Design and construction of the CSA, including the Capsule Storage Pad (CSP) and other sub-systems to support interim storage of the capsules; and
- Design and construction of transfer roadway and haul path facility access improvements from the WESF to the CSA, as necessary to support transfer of the capsules utilizing the CSS-supplied Vertical Cask Transporter (VCT) and tug.

1.1 Background

From 1974 to 1985, cesium and strontium were removed from the nuclear waste at B-Plant and then encapsulated and stored at the WESF. Removal of the cesium and strontium from the underground tanks allowed for improved management of the underground tanks, enhanced isolation of the tank waste, and provided an opportunity for beneficial use of the encapsulated cesium and strontium.

The WESF is located adjacent to B-Plant in the 200-E Area on the Central Plateau of the Hanford Site. The mission of the WESF is the safe and compliant storage of 1,936 cesium and strontium capsules. As of June 2017, the capsules contain approximately 90 million curies. This activity includes the short half-life daughter products, barium-137m and yttrium-90.

The capsules are stored underwater in pool cells. The WESF is an aging facility operating beyond its design life. The facility relies on active systems for ventilating, maintaining pool cell water levels, and monitoring the capsules. These systems are becoming more expensive and difficult to operate and maintain.

Recognizing the need for continued storage of the capsules, the US Department of Energy, Richland Operations Office prepared the Mission Need Statement. The U.S. Department of Energy, Headquarters (DOE-HQ Office) approved this Mission Need Statement and Critical Decision 0 on November 5, 2015. Project W-135 was created to close the capability gaps identified in the Mission Need Statement.
The statement of mission need is as follows:

- **The Hanford Site needs to provide safe, compliant, and cost-effective storage of the cesium-137 and strontium-90 capsules. This storage capability will be necessary until a disposal path for the capsules is established and implemented.**

- **Fulfillment of this mission need will align management of the capsules with site goals for cleanup of the Central Plateau, including safe management of legacy material and long-term stewardship of the site.**

The approach for managing and controlling all activities necessary to successfully execute all responsibilities inherent to Project W-135 are described in CHPRC-02264, *MCSC Project Execution Plan for the Management of the Cesium and Strontium Capsules (MCSC) Project (W-135).*

### 1.2 Scope

CHPRC-03328, *Capsule Storage Area Conceptual Design Report (Project W-135)* was prepared to document the conceptual design. The conceptual design addresses and reflects the DOE-RL approach that is documented in DOE/RL-2012-47.

The Conceptual Design Report (CDR) defined the following major activities as the scope of Project W-135 to successfully transfer the capsules to a new storage capability:

1. Design and fabricate a storage capability that can safely, compliantly, and cost-effectively store the capsules until a disposal pathway for the capsules is available;
2. Design and construct the equipment necessary to retrieve, load, and transfer the capsules from the WESF pool cells to the storage capability;
3. Design and construct a CSA (including storage pad, fencing, lighting, and road access);
4. Design and construct the WESF modifications needed to support capsule retrieval, load, and transfer to the storage capability;
5. Prepare operational procedures, maintenance procedures, and training;
6. Perform operational startup readiness activities;
7. Prepare required environmental permits and approvals; and
8. Prepare safety basis documents and obtain DOE-HQ approval.

As stated previously, the CSA portion of Project W-135 consists of design and construction of the CSA and the transfer roadway and haul path facility access improvements from WESF to the CSA, as necessary to support transfer of the capsules utilizing the CSS-supplied VCT and tug.

#### 1.2.1 Capsule Storage Area

The designated CSA is the storage site location selected for interim storage of the capsules and consists of several structures, systems, and components (SSCs), including the CSP and other sub-
systems to support interim storage of the capsules until a disposal pathway becomes available. The CSA consists of:

- **The CSP** – A concrete monolith designed and sized to support the fully loaded Vertical Concrete Casks (VCCs) for the duration of interim storage.

- **The Operating Pad and CSA Yard** – The Operating Pad is a concrete monolith adjacent to the CSP. The Operating Pad provides a stable operating area for the maneuvering of the VCCs into designated positions utilizing a combination of a crane and the VCT and tug system previously utilized at the West Valley Demonstration Project’s High-Level Waste Canister Relocation Project for similar purpose. The CSA Yard is the balance of the designated CSA open space that will be cleared, grubbed, and graveled with the gravel being compacted and leveled grade to match with the CSP and Operating Pad.

- **The Security/Property Protection Sub-systems** – These CSA sub-systems consist of fencing, vehicular and personnel access gates, pole-mounted flood lighting, and any other associated equipment as may be required and necessary based upon security assessment, hazard analysis, safety analysis, and housed SSCs quality level designations.

- **The Temperature Monitoring System (TMS) and Control, Electrical, and Instrumentation (CE&I) interfaces and support equipment** – These CSA sub-systems consist of the CE&I interface to the TMS and the TMS protective structure.

1.2.2 **Transfer Roadway and Facility Access Haul Path Improvements**

Transfer roadway and facility access haul path improvements consist of improvements and modifications to Atlanta Avenue and 7th Street from WESF to the CSA, as well as roadway improvements from the truck loading area at WESF to Atlanta Avenue, necessary to support transfer of the capsules in the loaded VCCs utilizing the VCT and tug. This scope also includes extending site fire water lines to provide fire protection to the CSA.

1.2.3 **Design Reviews and Approvals**

The CH2M Hill Plateau Remediation Contract (CHPRC) W-135 Project Team is responsible for review, approval, and end-user acceptance of this Preliminary Design Report (PDR). Final design activities for the CSA scope are expected to be completed by July 2018. Construction is scheduled to begin in mid-fiscal year 2019, and the project is scheduled to be completed by September 2020.

2.0 **DESIGN/PROCESS SELECTION**

The preliminary design for the CSA portion of Project W-135 presented in this PDR has been developed to meet the project requirements as defined in the Project W-135 key requirement documents (CHPRC-02252, Management of the Cesium and Strontium Capsules Project (W-135) Functions and Requirements Document; CHPRC-02623, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135); CHPRC-03275, Capsule Storage Area and WESF Modifications Code of Record (Project W-135); and CHPRC-03328. In addition to development of a design that meets the project requirement documents, the CSA design needs to meet the
technical interface requirements of the CSS, as well as that of multiple CHPRC and other onsite Hanford services organizations. For complete list, see Section 3.1.1 below.

2.1 Summary of Report

This PDR documents the approximate 60% complete design for the CSA portion of Project W-135. This preliminary phase of the design, which continues to evolve from the CDR, is composed of the following primary elements:

- Development of the project drawings. (See Appendix A).
- Development of the project procurement and construction specifications as necessary to ensure all associated project requirements are addressed, including all quality requirements. (See Appendices B and C, respectively).
- Development of the project calculations. (See Appendix D).
- Performance of an operations analysis for the receipt, transportation, interim storage, and permanent storage of the VCCs. This report is complete and the results are incorporated into the design. (See Appendix E).
- Development of other Project Supporting Engineering Design Documents. (See Appendix F for the FDC Compliance Matrix).

This PDR was developed by the ARES Corporation Project Team and is consistent with guidance provided in PRC-STD-EN-40258, Preliminary/Final Design Report.

2.2 Design/Process Options

In addition to numerous “day-to-day” engineering design decisions, formal systems engineering processes were employed to determine significant design decisions/options. Significant design decisions were determined through a series of meetings and analysis; alternatives were developed, refined, and evaluated to support safe and cost-effective approaches for designing and constructing the CSA and the haul path improvements.

2.3 Selection of Design/Process

The successful determination of major design options was completed through the conceptual design process. Modifications/optimizations of the CDR design have been incorporated throughout preliminary design.

All design decisions documented in this PDR were determined in a manner consistent with guidance provided in US Department of Energy (DOE) O 413.3A/B, Program and Project Management for the Acquisition of Capital Assets and DOE G 413.3-1, Managing Design and Construction Using Systems Engineering for Use with DOE O 413.3A. Design decision methods were chosen and implemented to comply with CHPRC-02623, and to ensure that the level of analysis was commensurate with the magnitude of each particular design decision.
2.4 Design Issues

Several key issues are associated with the preliminary design basis, as follows:

- Completing the design of the fire water piping system. This will involve continuing to work with Mission Support Alliance (MSA) to determine hydrant and tie-in locations.

- Obtaining final geotechnical information and ensuring this information is incorporated into the final design. This will involve interfacing with Ojeda Business Ventures (and Shannon and Wilson, Inc.)

- Obtaining final design media associated with the TMS. The line of separation for safety-significant items needs to be clearly delineated, along with wiring connections to VCCs, backup power requirements, annunciator location, and control panel signals. This will involve interfacing with NAC International (NAC).

- Ensuring that any potential dose rate changes are incorporated into the final design documents. This will involve interfacing with NAC.

- Determining the quantity of VCCs (24 ea. or 17 ea.). This will involve interfacing with NAC.

- Incorporating the results of the drop analysis and the tip-over analysis into the final design media.

Note that these issues will be resolved during the course of the final design phase and incorporated into the design media as applicable. All of these items are captured in the Final Design Technical Memo, which is contained in Appendix G.

3.0 DESIGN/PROCESS OVERVIEW

The Functional Design Criteria (FDC) documented in CHPRC-02623 provides the design requirements and technical baseline for the CSA portion of Project W-135. To ensure requirement compliance and consistency is accomplished, an FDC Compliance Matrix was completed and is included in Appendix F.

The design described in this PDR is compliant with the FDC requirements described in Appendix F. This PDR narrative, the design media located in the appendices, and the interpretations identified in Appendix F collectively demonstrate compliance with the FDC at a level of detail commensurate with a preliminary design.

The following subsections provide an overview and summary of the anticipated operations and principal activities of the CSA portion of Project W-135 as they relate to each operable unit of the CSA SSCs, as well as their interface with existing infrastructure. At this stage of the design, there are several elements that will require further development as the design progresses.
3.1 Interfaces with Existing Facilities/Systems

There are multiple interfaces that are necessary for this project. The CSA design needs to meet the technical interface requirements of the CSS, as well as that of multiple CHPRC and other onsite Hanford services organizations. Where applicable, these interfaces have been incorporated into the preliminary design. Interface management is a primary focus area as the final design nears completion. A Design Basis Review Matrix was developed for the CSA portion of Project W-135 design as a working tool to capture and manage the design interfaces.

3.1.1 Organizational Interfaces

The following organizations will interface with the W-135 Project at various points throughout project execution:

- MSA Utilities (Electrical, Telecommunications, Water, and Roads);
- Site Security;
- CHPRC Waste Management Operations;
- CHPRC Quality Assurance (QA), Safety, and Environmental/Permitting; and
- MSA Hanford Fire Department and Hanford Fire Marshal Office.

3.1.2 Existing Facilities and System Interfaces

Project W-135 shall interface with existing Hanford Site utilities and infrastructure, as needed, to support construction, capsule transfer operations, and long-term storage operations. Existing systems shall be used to the maximum extent possible to distribute required utilities. The project-specific interfaces (interfaces related to the CSA portion of Project W-135 design and construction) consist primarily of site electrical power, site fire water, site roads and the WESF. The key interfaces with these existing facilities/systems are:

- Fire water piping and hydrants for protection of the CSA will interface with the existing 200-E Area raw water/fire water piping system; as shown on H-2-837593 (see Appendix B).
- Electrical power for the TMS and lighting at the CSA will interface with the existing 200-E area electrical grid; as shown on drawings H-2-837606, H-2-837608, H-2-837609, and H-2-837610 (see Appendix B).
- Alarm signal from TMS control panel to the Canister Storage Building (CSB) operations base, as shown on drawings H-2-837606 and H-2-837607 (see Appendix B).
- The VCT facility access haul path will interface with existing overhead lines for the 200-E area electrical grid, WESF power distribution, WESF/B-Plant series lighting loop, WESF PAX system, and MSA telecommunications infrastructure, as shown on drawings H-2-837606, H-2-837607, and H-2-837609 (see Appendix B).
- The VCT transfer roadway and facility access haul path improvements will interface with the existing 200-E Area road system and the truck load pad at the WESF, as shown on

3.2 Nuclear Safety

The MCSC Project shall comply with the requirements of Title 10, *Code of Federal Regulations*, Part 830, “Nuclear Safety Management” (10 CFR 830) and DOE-STD-1189, *Integration of Safety into the Design Process*, as implemented by PRC-PRO-NS-700, *Safety Basis Development*. The specific strategy that will be used to ensure compliance is described in CHPRC-02236. Required safety documentation that will be developed by CHPRC includes a Preliminary Documented Safety Analysis (PDSA), and a final Documented Safety Analysis (DSA) at final design.

3.3 Operations Integration

For design efforts associated with the CSA SSCs, two critical aspects of operations integration have been considered and evaluated at some level of detail: Human Factors and Siting.

Human Factors are largely self-explanatory. This element has significant impact on the constructability and operability of operable units, even though many would consider the CSA SSCs to be passive systems.

Siting is evaluated under this category as the locations selected and developed for the CSA and the transfer roadway/haul path are critical to the traffic, logistics, and material handling and control elements of the entire Project W-135.

3.3.1 Human Factors

The majority of the CSA SSCs are of a passive design nature (largely concrete, asphalt, gravel, and security/property protection fencing), which are designed and constructed to support safe transport and placement operations associated with the movement of empty and loaded VCCs utilizing the VCT, as well as the proper level of property protection and controlled access to the MCSC Project SSCs and operable units. Therefore, the primary focus was on the systems and design features associated with the CSA capital asset project SSCs and operable units discussed in the following subsections.

3.3.1.1 VCT and Tug

The VCT and tug are not part of the CSA/CSP; however, they are one of two principal systems/components that drive the design features and requirements for the CSA scope of work.

During this preliminary design phase, human factor aspects considered included the design of CSA SSCs/operable units that interface with the VCT and tug including transport roadway/access haul path improvements to assure that the systems can operate as designed, have less wear and tear placed upon them as a result of not having suitable travel surfaces, and have improvements that accommodate the width of operations during transit that will accommodate personnel accompaniment of the systems within the normal range of a control pendant without having to unnecessarily walk off pavement.
Relative to utilities interface with the VCT and tug, and in particular overhead lines, it is assumed that the crane or equipment designation, as appropriate, has been assigned to the VCT in support of the applicable limited approach boundaries requirements of DOE-0359, *Hanford Site Electrical Safety Program*. This in turn supports human factor aspects associated with work in the vicinity of overhead power lines in a manner that is standard operating procedure.

3.3.1.2 \textbf{VCCs}

The VCCs themselves are also not part of the CSA portion of Project W-135; however, they are the other of the two principal systems/components that drive the design features and requirements for the CSA scope of work. Human factor aspects considered in the design of CSA SSCs/operable units that interface with the VCC include:

- Transfer roadway/facility access haul path improvements, which take into consideration that steering control for the VCT is often accomplished with a pendant control and an operator walking alongside the VCT; and

- Placement position consideration of minimizing pinch points between the VCT and adjacent VCCs.

3.3.1.3 \textbf{CSA/CSP Security and Property Protection Lighting}

Human factor aspects considered in the design of CSA operable units that interface with the lighting and fencing includes:

- Locating lighting poles for security and surveillance lighting outside of and adjacent to the outer fence at the CSA, so maintenance can be performed without needing to enter the controlled area of the CSP. This is also an ALARA measure, as the dose rates within the controlled area of the CSP are expected to be higher than those near the outer fence line; and

- Emergency crash bars on the personnel gates installed in each fence line at the CSP.

3.3.1.4 \textbf{TMS and CE&I Interfaces}

Human factor aspects considered in the design of the TMS and CE&I interfaces include:

- The design allowance for a protective three-sided structure located outside of the northeast corner of the CSA perimeter fence to house the TMS control panel and any operation and maintenance and/or upgrade/system replacement needs during the interim storage period.

- Based upon design information from the CSS contractor with regard to the VCC shielding analysis, an enabling assumption has been established that the design dose rate at the fence line is less than or equal to 0.5 mRem/hr; however, the dose rates within the controlled area of the CSP are expected to be higher than those near the outer fence line. The CSS contractor is responsible for the VCC shielding design and it is expected that a combination of both engineering and administrative controls will be required to minimize
exposure. The CSA portion of Project W-135 will provide some elements of those measures via the fencing for controlled area access limitation. Operations may also need to provide local and/or temporary shielding (e.g., ecoblocks) as needed.

- The current design provides a minimum of 85 ft. from the capsule storage pad to the outer fence line. This was a design input from the CSS contractor.

3.3.2 Siting

Facility siting is a key factor in considering Operations Integration of the SSCs. The siting of the CSA was oriented around the WESF location. The CSA siting has been evaluated multiple times, was the subject of a formal Site Evaluation Study (2E-11-09, *Cesium and Strontium Capsules Dry Storage Project*), considered multiple possible locations, and was finalized when the corner coordinates were established.

Based on Site Evaluation 2E-11-09, the CSA will be located in the 200-E Area approximately 0.12 miles (200m) from the WESF. It is designated as Site 1 Site Evaluation 2E-11-09 Attachment 1. In accordance with the Site Evaluation, Site 1 is reserved for the Project W-135 with no outstanding land-use commitments. Potential interferences noted in the Site Evaluation include buried pipelines (200-E-217-PL and 200-E-161-PL) crossing and parallel to 7th Street. In addition to the known and earlier noted Waste Information Data System (WIDS) associated with UPR-600-20, there are one or more radioactive transfer lines in the area, as well as the likelihood of other WIDS areas as well. These are not fully evaluated and will need further evaluation during the next phase of the design effort. The site walk down and corner staking effort also identified the presence of eco-blocks on the north and east sides of the current site. Select numbers of these eco-blocks will need to be removed and/or relocated in order to support fence line installation and CSA access haul path construction. The current ecology block configuration and installation requirements have been evaluated and modified to ensure that their function is otherwise met.

The CSA north boundary is located 20 ft. from the existing overhead medium voltage power lines to comply with Hanford Electrical Utilities’ Right of Way requirements.

3.4 Technical Design Changes that Differ from CDR

The following provides a listing of major design items that have changed since the time the conceptual design was performed:

- Elimination of the need for the Storage, Laydown, and Fabrication (SLF) area.
- The inclusion of a fire water line and associated fire hydrants.
- The size and thickness of the CSP and Operations Pad (less volume of concrete).
- Quantity of casks (16 ea. for CDR).
The requirement for a weathertight enclosure (building) for the TMS changed to a threesided protective shelter.

4.0 DESIGN

The following sections of this PDR and the design media contained in the appendices constitute the preliminary design for the CSA portion of Project W-135. The preliminary design includes the CSA, including the CSP, operating pad, fencing, lighting, and support devices for the TMS; haul path improvements between the WESF truck loading pad and Atlanta Avenue; and haul path improvements on 7th Street.

The remainder of Section 4.0 and its subsections describe the civil/structural, geotechnical and electrical engineering and design approach associated with the CSA portion of Project W-135. The subsections are organized by discipline and reflect the preliminary design approach implemented for each discipline-based portion of the design.

4.1 Civil/Structural Engineering

The civil/structural design for the CSA portion of Project W-135 addresses design of the CSA, including the CSP and operating pad; haul path improvements between the WESF truck loading pad and Atlanta Avenue; and haul path improvements on 7th Street. These design topics are described and detailed in the following subsections.

4.1.1 CSA (Including CSP and Operational Pad)

The CSA layout, as shown on the drawings contained in Appendix A, is adequate to support the delivery and receipt of the VCCs, Transportable Storage Canisters (TSCs), and VCC lids, including storage of this equipment on the operating pad and CSP. There is sufficient remaining space available on the operating pad for manipulation and assembly of the VCCs, TSCs, and VCC lids. As the VCCs are assembled, they will be relocated to the north end of the operating pad in order to provide access to the CSP for placement of the full VCCs.

The design of the CSA yard calls for it to be cleared, grubbed, and graveled with the gravel being compacted and graded to allow for runoff away from the CSP and operating pad. Eight-foot high security fencing around both the CSA and the CSP has been designed to provide a safe and secure area. The fencing also includes vehicular and personnel access gates to facilitate safe and efficient work efforts in the area. The personnel access gates are equipped with crash bars.

The need for fire hydrants to supply fire water to the CSA will be incorporated into the design as dictated by MSA. The current design calls for fire water to be provided via 12-in buried piping that is tied in to existing piping near the WESF and the CSB. Two fire hydrants will be installed to provide fire protection to the CSA.

Design of the CSP has been performed using Seismic Design Category (SDC)-2, Limit State (LS) C loading conditions, as defined in PRC-PRO-EN-097, Engineering Design and Evaluation (Natural Phenomena Hazard), loading data for the VCCs, VCT and tug provided by the CSS contractor, and loading data for a typical crane that will be used for moving the VCCs within the
CSA. The operating pad is not required to meet the SDC-2 requirements, but will be used for storage of empty canisters. It is therefore being designed to the same standards as the CSP.

4.1.2 Transfer Roadway and Haul Path Improvements

An assessment was performed of the transfer roadway and facility access haul path between the WESF and the CSA for transfer of the VCCs (see Appendix E). Several areas have been identified for improvement based upon multiple site walk downs and field measurements, meetings with MSA and CHPRC, review of marked up and annotated drawings from MSA (see CHPRC-03328), and review of VCT documentation. These areas include widening of Atlanta Avenue at the WESF turn off, and the widening of 7th Street from Atlanta Avenue to the CSA haul path turn off. As the design evolves, it is possible other necessary improvements may emerge.

An evaluation has been performed to assess the need to remove, relocate, and/or protect existing below- and above-grade utilities. This evaluation is documented on several drawings contained in Appendix A (H-2-837591, H-2-837593, H-2-837594, H-2-837596, H-2-837606, H-2-837607, and H-2-837608). Multiple buried water (e.g., raw, sanitary), electrical, and radioactive lines were identified throughout the project area. Of particular note are the lines in the WESF access path to Atlanta Avenue and electrical and radioactive liquid lines on the north side of the CSA/CSP location along 7th Street. Overhead lines are located in the vicinity of the WESF access path and on the north side of the CSA/CSP location along 7th Street.

4.2 Geotechnical

CHPRC engaged the services of a geotechnical contractor to perform the geotechnical investigation of the CSA site. At the time this preliminary design report was being issued, the geotechnical investigation had not been completed; only a preliminary geotechnical Report, No. 22-1-40034-002, Preliminary Geotechnical Design Recommendations Report for the W-135 Project Capsule Storage Area, has been provided as input into the design. The design recommendations from this report are included in this preliminary design.

4.3 Electrical Engineering

4.3.1 Power Distribution

Power for the CSA lighting and TMS will be provided from a new pole-mounted utility transformer supplied by the nearby existing 13.8kV overhead line. Service equipment, metering, and power distribution panelboard will be installed in the TMS protective structure. Convenience receptacles will be installed in the protective structure and in each lighting pole.

4.3.2 Lighting

Pole-mounted LED floodlights will be installed at the CSA outside of the outer fence line so most maintenance can be performed without entering either property protection fence. A maintenance road will be installed to the lighting poles. An integral convenience receptacle will be installed in each lighting pole above the handhole.
Lighting fixture selection will consider energy efficiency guidance documents including DOE O 436.1, *Departmental Sustainability*; DOE G 413.3-6A, *High Performance Sustainability Building Requirements*; and, Executive Order 13693, *Planning for Federal Sustainability in the Next Decade*.

### 4.3.3 Access Control

There are no access control requirements that require power, signal, or video.

### 4.3.4 Temperature Monitoring System

Conduit and cabling for the TMS will be provided from the CSS interface locations to the TMS control panel in the TMS protective structure. An annunciator panel will be installed at the CSB Operations Base to mimic alarms in the TMS control panel.

### 4.3.5 Lightning Protection

A lightning risk assessment has been performed in accordance with NFPA 780-2014, *Standard for the Installation of Lightning Protection Systems*, Annex L. Since the tolerable lightning frequency is less than the annual threat of occurrence, a lightning protection system is not recommended and has not been included in the scope of this effort.

### 4.4 Functional Elements

CHPRC-02623 provides the design requirements and technical baseline for the CSA portion of Project W-135. The following sections describe the Project W-135 functional elements and their applicable requirements.

#### 4.4.1 Fire Protection

The draft preliminary Fire Hazards Analysis for Project W-135, CHPRC-03299, *Preliminary Fire Hazards Analysis for the Management of the Cesium and Strontium Capsules Project [W-135]*, lists the need for crash bars as a recommendation. CSA personnel entry gates should have crash bars for egress. Crash bars would ensure that occupants would not be locked inside the CSA. For preliminary design, personnel entry gates with crash bars for all protection fences at the CSA have been identified as a requirement.

It was initially determined that since it is unlikely that the CSA will need a fire hydrant water supply since the amount of combustible material stored will be minimal and wildland exposure fire separation distances appear to be adequate. Upon further evaluation, the fire protection engineer has re-evaluated the need for fire hydrant water supply and determined that it is required at the CSA.

#### 4.4.2 Worker Health and Safety

Project W-135 follows PRC-MP-SH-32219, *Worker Safety and Health Program Description*, which complies with Title 10, *Code of Federal Regulations*, Part 851, “Worker Safety and Health Program” (10 CFR 851), which invokes applicable parts of the following:
• Title 29, Code of Federal Regulations, Part 1926, “Safety and Health Regulations for Construction” (29 CFR 1926); and


Project W-135 will use the CHPRC Integrated Safety Management System described in PRC-MP-MS-003, Integrated Safety Management System/Environmental Management System Description, to identify specific hazards associated with any given task.

As noted previously, the CSA personnel entry gates should have crash bars for egress. Crash bars would ensure that occupants would not be locked inside the CSA. For preliminary design, personnel entry gates with crash bars for all protection fences at the CSA have been identified as a requirement.

During preliminary design, all items that can be removed or relocated without undue impact on other site operations have been identified and plans developed to facilitate that removal/relocation effort.

For preliminary design, it is assumed that the crane or equipment designation, as appropriate, has been assigned to the VCT in support of the applicable limited approach boundary requirements of DOE-0359.

4.4.3 Radiological Control

ALARA is the project’s approach to radiation protection management. Controlling exposures (both individual and collective) to the work force and to the general public is paramount to successful implementation of any project. Fundamentally, ALARA is not a dose limit; it is a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable.

As a general approach, the ALARA principles will be incorporated into the design and will include the requirements of Title 10, Code of Federal Regulations, Part 835, “Occupational Radiation Protection” (10 CFR 835) Subpart K, “Design and Control.” The basic requirements concerning the use of ALARA aspects related to this design are imposed in CHPRC-00072, CHPRC Radiation Protection Program, CHPRC-00073, CHPRC Radiological Control Manual, and PRC-PRO-RP-1622, CHPRC Radiological Design Review Process.

Physical design features (distance) will be the primary method used to maintain exposures ALARA. The security/property protection fencing is the primary feature of the CSA in providing exposure control via access control to the CSA and CSP and sufficient distance to the CSA outer fence line to meet exposure limitation requirements. Based upon conceptual design information from the CSS contractor with regard to VCC shielding analysis, an enabling assumption has been established that the design dose rate at the fence line is less than or equal to 0.5 mRem/hr. however, the dose rates within the controlled area of the CSP are expected to be higher than those near the outer fence line. The CSS contractor is responsible for the design of the VCC’s shielding to meet these exposure limits at the fence line and within the CSA. The design of the CSS VCCs had not yet been completed by NAC at the time of completion of this
preliminary design. It is expected that a combination of both engineering and administrative controls will be required to minimize exposure. The CSA design will provide some elements of those measures via the fencing for controlled area access limitation.

Another example of physical design features is locating the flood lamp/security lighting poles outside of the outer fence line so that maintenance can be performed without the need of entering the controlled area of the CSP. This is also an ALARA measure as the dose rates within the controlled area of the CSP are expected to be higher than those near the outer fence line. These design features are specifically identified in the discipline-based subsections (i.e., civil/structural and electrical) of Section 5.0 and the corresponding design media (appendices) contained in this PDR. Optimization methods will be used to ensure that occupational exposure is maintained ALARA in developing and justifying the facility design and controls.

The method of connecting TMS wiring and conduit to the VCCs is unknown at this time and will be determined during final design based on the final VCC design documents provided by the CSS contractor. Every effort will be made to minimize workers’ time near the VCCs during installation and connection of TMS wiring and conduit.

4.4.4 Environmental

The CSA portion of Project W-135 will conform to applicable Federal and State regulations. Project demolition and decommissioning will be accomplished in accordance with Hanford Site and CHPRC waste management, waste minimization, and demolition and decommissioning requirements.

Initial assessment has identified that the CSA siting location and at least two of the transport road/haul path road improvement/widening areas are adjacent to or co-located with known and documented WIDS sites as noted below:

- The CSA siting location is adjacent to UPR-600-20.
- The CSA Access Roadway is adjacent to UPR-600-20 and possibly UPR-200-E-64.
- The WESF access roadway is adjacent to UPR-200-E-64 and possibly UPR-200-E-54, as well as 216-B-64.

CHPRC instructed ARES to proceed with preliminary design based on the following:

- ARES to base preliminary design on the assumption that the CSA site is free of contamination;
- ARES to ensure that the CSA construction footprint does not encroach on adjacent WIDS sites; and
- ARES to ensure that CSA works do not encroach on existing groundwater wells.

There are no known issues in the designated CSA site; however, the site radiological investigation is limited based upon Site Evaluation 2E-11-09. Further review is required of an
area of contaminated soil (UPR-600-20) in the vicinity of the CSA site. CHPRC is planning to perform a radiological survey of the CSA footprint prior to completion of final design.

4.4.5 Safeguards and Security

Fence lines will be provided at the CSA for property protection per the security assessment. There will be two fence lines, one around the CSA and one around the CSP. The fences are designed as 8-ft. high chain link fence with outriggers and 3-strand barb wire. There will be a single vehicular gate in each fence. There will be two personnel gates in each fence; these gates will have emergency crash bars. All gates will have security lock capability.

4.4.6 Criticality

There are no fissile materials associated with the cesium and strontium capsules; therefore, criticality is not a concern and criticality control measures are not a requirement of Project W-135.

4.4.7 Quality Assurance

Project activities have been performed in accordance with the ARES approved Quality Assurance (QA) Program and implementing procedures. This program meets the requirements of American Society of Mechanical Engineers (ASME) NQA-1-2008, Quality Assurance Requirements for Nuclear Facility Applications, with the ASME NQA-1a-2009 addenda. ASME NQA-1 is the implemented standard endorsed by DOE O 414.1D, Quality Assurance; and 10 CFR 830, Subpart A, “Quality Assurance Requirements.” Application of QA requirements of 10 CFR 830.122, “Quality Assurance Criteria,” were applied to items and activities using a graded approach as defined in PRC-PRO-QA-259, Graded Approach; and PRC-PRO-NS-700. Quality requirements of CHPRC-00189, CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan, were applied.

5.0 PRELIMINARY DESIGN DOCUMENT INVENTORY


6.0 APPLICABLE REQUIREMENTS

Applicable requirements will be passed down to sub-tier contractors as applicable and implementation of those requirements will be verified. The specific technical and quality requirements, material certifications, qualification and certification of personnel, inspections, examinations/testing and applicable QA records will be established during the final design and included in the final design documents. Contractors will have an effective program preventing the introduction of suspect/counterfeit items through the design, procurement, fabrication, and modification process, as described in DOE G 414.1-3, Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements and DOE O 414.1B, Quality Assurance, and DOE O 414.1D.
6.1 Cost Estimate and Project Schedule

A Construction Cost Estimate and Schedule have been prepared which contain all cost and schedule activities associated with procurement and construction.

A Work Breakdown Structure was used to organize the cost estimate and construction schedule.

The cost estimate was prepared utilizing the design media contained in this PDR as the technical basis. The CDR Project Cost Estimate was also used as a reference. Given the level of current detail, costs were derived using a quantity-based cost estimating approach by developing costs for each estimate detail at the cost element level (examples of cost elements are labor, material, equipment, etc.). Appropriate mark-ups, from labor productivity factors to sales tax, have also been applied to arrive at a total cost for each estimate detail. A Cost Estimate Basis, which explains the technical basis, organization, methodology, and assumptions used to create the estimate, was also prepared. The Cost Estimate will be updated during final design.

The Construction Cost Estimate is provided under separate cover. See ARES Report No. 046414.17.01-006, Cost Estimate Package for Project W-135 Capsule Storage Area.

7.0 DESIGN COMPLETION STRATEGY/CONSTRUCTION ACQUISITION PLAN

CHPRC will continue to direct the Architect/Engineer in the final design phase, and will obtain construction contractors, equipment vendors, and independent inspectors as required to execute the CSA portion of Project W-135. CHPRC will provide the project management and engineering support to effectively and efficiently manage the work scope. This includes management of all contractors (including cost, schedule, and technical baselines), providing technical direction, reporting performance, preparation, and maintenance of required project documentation, permitting, and QA-related activities.

After the PDR is issued for review and comment, final design activities will commence. Final design activities include maturing the design presented in the PDR, along with initiating the development of several other design scopes.

CHPRC will utilize the final design to assemble bid packages to competitively solicit a contract in order to perform all construction activities for the project.

CHPRC will also perform all construction management activities supporting the project. It is anticipated that CHPRC will retain the same Architect/Engineer who prepared the final design to perform engineering support during construction activities.

8.0 REFERENCES


### APPENDIX A

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<td>Capsule Storage Area Instrumentation Connection Diagram</td>
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<td>Capsule Storage Area Instrumentation Connection Elementary Diagram</td>
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### Parts List/Material List

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<td>Protective Structure</td>
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### General Notes
- Drawings are not to scale and are for orientation only.
- All dimensions are in feet unless otherwise noted.
- See 30.3.1, 30.3.2, 30.3.5, and 30.3.7.1 for additional notes.
- Refer to 30.3.3 for additional information.
- All sections are to be completed by the responsible engineer.

### PRELIMINARY DESIGN
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<td>Data 4</td>
<td>Data 5</td>
<td>Data 6</td>
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**GENERAL NOTES**

1. See drawing No.2 for additional details and area notes.
2. Electrical distribution shall be in accordance with the NEC and NFPA 70, 1997 Edition and local codes. All electrical equipment shall be UL listed and/or tested to UL standards.
3. All electrical equipment, cables, and conduit shall be installed as shown on this drawing. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
4. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
5. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
6. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
7. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
8. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
9. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.
10. All electrical equipment, cables, and conduit shall be installed in accordance with the NEC and NFPA 70, 1997 Edition and local codes.

**PREFACE**

Preliminary design not for construction.
APPENDIX B

PROCUREMENT SPECIFICATION

<table>
<thead>
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<tbody>
<tr>
<td>CHPRC-02540</td>
<td>W-135 Capsule Storage Area Procurement Specification for Aluminum Cantilever Slide Gates</td>
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TABLES

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TERMS

ASCE  American Society of Civil Engineers
ASTM  ASTM International
AWS  American Welding Society
CFR  Code of Federal Regulations
CSA  Capsule Storage Area
DOE  U.S. Department of Energy
IBC  International Building Code
QA  Quality Assurance
SEI  Structural Engineering Institute

UNITS

ft  foot/feet
in.  inch(es)
mph  miles per hour
oz.  ounce
psf  pounds per square foot
sq. ft.  square foot
1.0 INTRODUCTION

This Specification provides technical requirements for purchase of manually operated aluminum cantilever slide gates to be used at the 200-East Area Capsule Storage Area (CSA) located at the Hanford Site.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of the Basis of Design to the extent indicated by subsequent references. Reference documents are those current as of the date of this Specification unless otherwise indicated. If any conflict occurs between the codes and standards and the drawings and specifications, the codes and standards are to govern. This does not relieve the Seller of complying with any requirements as defined by the Engineer concerning the plans and specifications that are in excess of the codes and regulations.

2.1 Government Documents

The government documents listed in Table 2-1, including others referenced therein, form part of this Specification to the extent designated herein and/or as applicable.

<table>
<thead>
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<th>Document Number</th>
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<tr>
<td>DOE O 414.1D</td>
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</table>
2.2 Non-Government Documents

The non-government documents listed in Table 2-2, including others referenced therein, form part of this Specification to the extent designated herein and/or as applicable.

Table 2-2. Non-Government Documents.

<table>
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<tr>
<td>ASCE/SEI 7-2010</td>
<td>Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI), Reston, Virginia.</td>
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<tr>
<td>AWS D1.2</td>
<td>Structural Welding Code – Aluminum, American Welding Society (AWS), Miami, Florida.</td>
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3.0 TECHNICAL REQUIREMENTS

3.1 Product Requirements

The Seller provided aluminum cantilever slide gates shall consist of the following basic design requirements:

A. Design and Fabrication

1. Gates shall be fabricated in compliance with ASTM F1184.

2. The cantilevered sliding gates shall be designed and fabricated to meet the structural requirements of the following codes:

   a. IBC 2012, Chapter 16.

   b. ASCE/SEI 7-2010.

3. The site-specific values listed in Table 3-1 shall be used in designing the gate.
### Table 3-1. Site-Specific Values.

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<td>Exposure Category = C</td>
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<td></td>
<td>( S_1 = 0.15 )</td>
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<tr>
<td>Load Combinations</td>
<td>ASCE/SEI 7-2010</td>
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4. Dimensional requirements are as follows:
   a. Gate 1: Double-span with a clear opening of 90 ft and a height of 8 ft.
   b. Gate 2: Double-span with a clear opening of 90 ft and a height of 8 ft.

5. Aluminum members: Gates frames and tracks shall be fabricated from aluminum meeting the requirements of ASTM B221.

6. Fasteners: All fasteners shall be stainless steel.

7. Chain Link Fabric: ASTM A392, Class 1, zinc coated (1.2 oz.), steel wire/fabric, 2 in. mesh size, 9-gage coated wire size, galvanized before weaving, with twisted barbed selvages top and bottom.

8. Barbed Wire: ASTM A121 metallic coated steel, Type Z zinc coating strand wire, 2 1/2 gage (0.099 in.) steel wire, 4 barb points, 14 gage (0.080 in.) spaced on 5 in. centers.

9. Latching/Locking: Manufacturer’s standard latching/locking catch hardware meeting the requirements of ASTM F1184.

10. All welding of aluminum components shall be performed in accordance with AWS D1.2.

11. Items subject to corrosion or weathering (e.g., carbon steel) shall be hot dipped galvanized to ASTM A123, provide hot-dipped, zinc-coated accessories of ferrous material with weight of zinc coating not less than 1.2 oz. per sq.ft.

12. Gate rolling system shall be of internal wheel construction. Gate truck assemblies shall be swivel type, shall be tested for continuous duty and shall
have precision ground and hardened components. Bearings shall be pre-lubricated sealed type and contain shock-resistant outer races and captured seals.

3.2 **Experience**

Seller shall have a minimum of five (5) years of experience manufacturing and installing aluminum cantilever slide gates.

3.3 **Warranty**

Seller shall provide a manufacturer’s standard limited warranty covering cantilever slide gate and truck assembly against failure resulting from normal use for a period of ten (10) years from date of purchase. Failure is defined as any defect in manufacturing that prevents the gate from operating in a normal manner.

3.4 **Suggested Vendors**

Tymetal Corporation, Master Halco or approved equal.

4.0 **QUALITY ASSURANCE**

The Seller shall have in place a Quality Assurance (QA) Program that ensures that the preparation and testing of the product are performed in accordance with this Specification and applicable Seller’s-approved procedures. These procedures shall ensure that the preparation and testing of the product meet the quality and functional requirements of this Specification. Seller shall comply with the following QA requirements in addition to those in the Contract Statement of Work.

The Seller is responsible for maintaining quality and shall perform in-process and final inspection of its work and all sub-tier contractors’ work as required within this Specification.

4.1 **Submittals**

The Master Submittal List, Submittal form, and other associated information can be found in the Contract Documents and the Statement of Work. The Seller shall provide the following information:

1. A copy of their QA Program manual(s) with proposal.

2. A schedule showing design, fabrication, and shipment of the units within ten (10) working days after receipt of the order.

3. A complete set of shop drawings detailing the design. This information shall be submitted and approved prior to fabrication.

4. Calculations showing conformance with Table 3-1, and in support of lifting and installation, if applicable, shall be submitted and approved prior to fabrication. This shall include anchorage instructions.
5. Catalog data on the packaged assembly including weights, capacities, ratings, and gauges and finishes of materials shall be submitted prior to shipment.

6. Warranty shall also be submitted prior to shipment.

7. Installation, operation, and maintenance data shall be submitted prior to shipment.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping

1. Unless otherwise specified by the purchaser, all materials shall be prepared for standard commercial shipment.

2. Materials that do not comply with the requirements of this Specification and the listed codes and standards or that are damaged when received shall be replaced by the supplier at their expense.

END OF SPECIFICATION
APPENDIX C

CONSTRUCTION SPECIFICATION

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<th>Title</th>
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CERTIFICATION
I certify that the indicated sections of this Specification were prepared by me or under my direct supervision and that I am a registered architect/professional engineer under the laws of the State of Washington.

Civil/Structural Sections
Sections 03 15 00, 03 30 00, 05 50 00, 07 92 00, 09 91 00, 10 14 53, 31 20 00, 32 11 23, 32 12 00, 32 17 23, 32 31 13, 33 10 00

Electrical
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SECTION 03 15 00

POST-INSTALLED CONCRETE ANCHORS

PART 1  GENERAL

1.1  SUMMARY OF WORK

A. Purchasing and installing post-installed concrete anchors.

1.2  REFERENCES

The following documents, and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Hanford Documents

Form A-6004-239 Expansion Anchor Installation Report (or company-approved equivalent)

B. International Code Council (ICC)

ESR-1917 Hilti®¹ Kwik Bolt®¹ TZ Carbon and Stainless Steel Anchors in Concrete

ESR-2322 Hilti HIT-RE 500-SD Adhesive Anchors in Cracked and Uncracked Concrete

IBC, 2012 International Building Code®²

1.3  SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required


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¹ Hilti and Kwik Bolt are registered trademarks of Hilti Corporation, Schaan, Liechtenstein.
² International Building Code is a registered trademark of International Code Council, Inc., Brea, California.
4. Installation Reports (Paragraph 3.3.A): Within ten days after work is complete.

C. Approval Not Required
   1. Drawings, Diagrams, Templates, and Instructions: Within ten days after work is complete.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Manufacturer’s representative shall train post-installed anchor installers to the anchor manufacturer’s installation instructions, design document requirements, and the anchor installation report. Contractor shall deliver installer training records to the Company.

B. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.

C. Post-Installed Anchor Special Inspector Qualifications.
   1. Two years’ experience in concrete inspection and/or certification from American Concrete Institute, ICC, International Conference of Building Officials, or other recognized concrete inspection agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

PART 2 PRODUCTS

2.1 SUBSTITUTES

A. See Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Post-installed anchors (PC-2, PC-1, and PC-0): Industry standard having a published evaluation report (by ICC Evaluation Services, Inc.), with anchor descriptions, tables of allowable tension and shear loads (including seismic and wind qualifications), and test findings.

B. Hilti Corporation or approved equal:
   2. HIT-RE 500-SD Adhesive Anchor.
C. Anchors located in dry interior locations may be carbon steel unless otherwise noted. All other anchors shall be stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where expansion anchors are to be installed and notify the CHPRC Field Work Supervisor, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Do not install anchors in concrete or grout prior to 28 days after placement unless it can be shown by testing (via field-cured test cylinders) that the concrete design strength has been obtained.

3.3 INSTALLATION

A. Anchor Installation

1. Install anchors shown on the Drawings in accordance with training.

2. Metal embedded in existing concrete may be cut when drilling for installation of anchors. Notify the CHPRC Field Work Supervisor if metal is encountered when drilling for evaluation.

3.4 FIELD INSPECTIONS

A. Special Inspection is required for all anchor bolt installations. This shall be done in accordance with Section 4 of the applicable ICC Evaluation Report. The Special Inspector shall be on the jobsite during anchor installation to verify anchor type, anchor dimensions, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, drill bit size, anchor embedment and tightening torque.

Special Inspection Services referenced herein will have to be provided by an offsite testing and inspection agency who possess personnel with proper certification as noted in Paragraph 1.4.

1. Complete inspections shall be documented by the inspector on Expansion Anchor Installation Report (Form A-6004-239) (or CHPRC-approved equivalent) and submitted to the Buyer for approval.

END OF SECTION 03 15 00
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1   GENERAL

1.1   SUMMARY OF WORK

A. Formwork. 
B. Reinforcement. 
C. Cast-In-Place Items. 
D. Concrete. 
E. Non-shrink grout. 

1.2   REFERENCES

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated. 

A. American Concrete Institute (ACI)
   117 Tolerances for Concrete Construction and Materials
   301 (2016) Specification for Structural Concrete
   305.1 Standard Specification for Hot Weather Concreting
   306.1 Standard Specification for Cold Weather Concreting
   308 Standard Practice for Curing Concrete
   315 Details and Detailing of Concrete Reinforcement
   318 (2014) Building Code Requirements for Structural Concrete and Commentary
   347 Recommended Practice for Concrete Formwork
   CP-1 Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade 1
B. ASTM International (ASTM)

<table>
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<tr>
<th>Standard Number</th>
<th>Specification Title</th>
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<tr>
<td>A108</td>
<td>Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished</td>
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<tr>
<td>A185</td>
<td>Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete</td>
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<tr>
<td>A615</td>
<td>Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement</td>
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<td>Standard Specification for Steel Wire, Carbon, for General Use</td>
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<tr>
<td>C31</td>
<td>Standard Practice for Making and Curing Concrete Test Specimens in the Field</td>
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<td>C33</td>
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<td>C39</td>
<td>Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens</td>
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<td>C150</td>
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<td>C231</td>
<td>Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method</td>
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<tr>
<td>C260</td>
<td>Standard Specification for Air-Entraining Admixtures for Concrete</td>
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<tr>
<td>C1077</td>
<td>Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation</td>
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<td>C1107</td>
<td>Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)</td>
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<tr>
<td>D1751</td>
<td>Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)</td>
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<tr>
<td>F593</td>
<td>Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs</td>
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<tr>
<td>F594</td>
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</table>
C. National Ready Mixed Concrete Association (NRMCA)

QC Manual – Section 3 Certification of Ready Mixed Concrete Production Facilities

D. American Welding Society (AWS)

D1.1/D1.1M Structural Welding Code-Steel

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

B. Approval Required.

1. Concrete Data: Before mixing, submit concrete materials, mix design, and mix proportions, in accordance with ACI 301, Section 4.1.2. Identify each material to be used in concrete, including amount, by weight, to be utilized in each cubic yard of plastic mix.


3. Reinforcement Shop Drawings: Prior to fabrication of reinforcement, submit placement drawings that detail fabrication, bending, and placement. Include bars sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

4. Setting drawings, diagrams, templates, and instructions: Prior to fabrication, submit information for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, to be embedded in concrete.

5. Detailed plan for cold weather placements including curing and protection of concrete placed and cured in ambient temperature below 40°F.

6. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80°F.

7. Concrete Placement drawings: Prior to setting of forms, submit placement drawings indicating planned pouring sequence and locations of any planned joints, including those not shown on the Contract drawings.

8. Concrete repair methods and materials.

9. Submittals shall include the documentation listed in Paragraph 1.4.
1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. The concrete supplier shall be currently certified by the NRMCA’s “Certification of Ready Mixed Concrete Production Facilities” with compliance to ASTM C94 requirements for production facilities and equipment.

B. Qualification of Concrete Inspection/Testing Laboratory: The laboratory including equipment, personnel, and procedures shall meet the requirements of ASTM C1077 and shall be currently accredited by an independently recognized authority.

C. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to CHPRC Document Control in accordance with Contract Documents.

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<th>Paragraph</th>
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<td>Concrete Test Results</td>
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D. Perform work in accordance with the applicable sections of ACI 117, ACI 301, and ACI 318.


1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

1.6 QUALIFICATION OF CONCRETE INSPECTORS

A. Personnel performing field testing of concrete shall be ACI Concrete Field Testing Technicians, Grade 1, who have received formal certification in accordance with ACI CP-1 or equivalent. Equivalent certification programs shall include requirements for written and performance examination as stipulated in ACI 301, Section 1.6.2.
B. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade I.

PART 2 PRODUCTS

2.1 SUBSTITUTION

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Concrete

1. Cement: ASTM C150, Type II.

   a. Thermal expansion: No greater than $1\times10^{-6}$ mm/mm/°C (tangent in temperature range of 20°C to 38°C [70°F to 100°F]) or be one of the following minerals: limestone, dolomite, marble, basalt, granite, gabbro, or rhyolite.

3. Admixtures: Furnish from one manufacturer.
   a. Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
   c. Water-reducing admixture: ASTM C494, Type A or Type D.
   d. High-range water reducing admixture (superplasticizer): ASTM C494, Type F or Type G.

4. Properties (if not specified on drawings):
   a. Minimum allowable compressive strength: 5000 psi at 28 days.
   b. Slump range at site:
      i. 4.5 in. minimum, 8 in. maximum for concrete with a high range water reducing admixture.
      ii. 3 in. minimum, 5 in. maximum for concrete without a high range water reducing admixture.
c. Air content: Four to six percent when tested in accordance with ASTM C231.

d. Proportions: In accordance with ACI 301, Section 4.2.3, and ASTM C94.

e. Time of discharge: In accordance with ASTM C94, Section 12, and ACI 301, Sections 4.1.2.12 and 4.3.2.2, unless otherwise approved based on trial batch test results.

5. Measuring, Mixing, and Delivery: In accordance with ASTM C94.

B. Controlled Density Fill (CDF): Portland cement based, minimum compressive strength of 100 psi at 28 days, maximum compressive strength of 300 psi at 28 days.

C. Reinforcing Steel

1. Steel bars: ASTM A615 or ASTM A706, deformed, Grade 60.


D. Cast-in-place sleeves for electrical stub-ups: ASTM A53 steel pipe, Calpico Model C-SWS or approved equal.

E. Embedded conduit couplings: Stub-EASE™ by CSUE Technologies or approved equal.

F. Embedded Plates: See Section 05 50 00, “Metal Fabrications.”

G. Headed Weld Stud Anchors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

H. Post-Installed Anchors: See Section 03 15 00, “Post-Installed Concrete Anchors.”

I. Expansion joint filler: ASTM D1751; asphalt impregnated fiberboard or felt, 1/2-in. thick.

J. Joint sealants: See Section 07 92 00, “Joint Sealants.”

K. Forms: Wood, steel, plywood or Masonite Corporation “Concrete Form Presdwood,” as required for various specified finishes.

L. Bonding Agent: Epoxy resin emulsion appropriate for bonding fresh concrete to existing set concrete.

M. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of
developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

PART 3 EXECUTION

3.1 PREPARATION

A. Form Construction

1. Install formwork in accordance with ACI 301, Section 2.3. Interior shape and rigidity shall be such that finished concrete will meet requirements of Drawings and approved shop drawings within tolerances specified in ACI 117, Section 4.

2. Prepare form surfaces in accordance with ACI 301, Section 2, using specified form coating materials, or as described below.

3. Forms for surfaces which will be permanently concealed from view may be saturated with water, before placing concrete, instead of other treatment. In freezing weather, forms shall be treated with oil or stearate.

4. Clean forms of foreign material before placing concrete.

B. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, embedded plates, and miscellaneous items having integral anchors, to be embedded in concrete.

3.2 INSTALLATION

A. Reinforcing Steel

1. Fabricate and place bars to dimensions shown on Contract drawings, within tolerances shown in ACI 117, Sections 2.1 and 2.2.

2. Tie to prevent displacement during placement of concrete.

3. Do not force into concrete after initial set has started.

4. Provide concrete cover for reinforcement protection per dimensions given in ACI 301, Section 3.3, except where shown otherwise on Contract drawings or approved shop drawings.

5. Reinforcement shall be supported and fastened together to prevent displacement by construction loads, or placement of concrete beyond specified tolerances. Reinforcement supported from ground shall rest on precast, square concrete blocks, with a minimum surface area of 4-in² and having a compressive strength equal to specified compressive strength of concrete being placed. Other means of support require prior approval.
B. Verify that reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Document inspection on the Pre-Pour Inspection Checklist.

C. Concrete

1. Before placing:
   a. Approve “Pre-Pour Inspection Checklist,” including identification of sections of structure to be placed, maximum size of coarse aggregate, and design strength.
   b. For each truck load, collect “Trip Ticket.” “Trip Tickets” shall contain information listed in ASTM C94, Paragraphs 14.1.1 through 14.1.10, and water to cementitious material ratio.
   c. Discharge concrete rinsate at Company-approved location.
   d. Place in accordance with ACI 301, Section 5.3. Do not drop more than 5 ft.
   e. Slump field adjustment only as permitted in ACI 301, Section 4.3.

2. Placing concrete against subgrade/base material: Place on or against firm, damp surfaces free of frost, ice, and free water. Obtain required earth compaction in accordance with Section 31 20 00, “Earth Moving,” before concrete placement. Dampen earth surfaces to receive fresh concrete.

3. Consolidation: Consolidate concrete in accordance with ACI 301, Section 5.3.2.5. Avoid contact between vibrator head and forms, reinforcement, or embedded items.

4. Construction joints: Make in accordance with ACI 301, Section 5.3.2.6. Coat joints with epoxy resin, in accordance with manufacturer’s recommendations.

5. Form Removal and Concrete Repair:
   a. Form removal: Remove in accordance with ACI 301, Section 2.3.2.
   b. Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by the Project/System Engineer.
   c. Place concrete repair mortar within one hour after mixing. Do not re-temper mortar.
d. Repair surface defects in accordance with ACI 301, Section 5.3.7. Cure concrete repairs same as new concrete.

6. Concrete Finishes and Tolerances
   a. Measuring for tolerances shall be performed in accordance with ACI 301, Section 5.3.4.3.
   b. Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with ACI 301 Section 5.3.3.
      i. Surfaces exposed to earth backfill; rough form finish.
      ii. Exterior surfaces exposed to weather.
   c. Unformed surfaces: Finish in accordance with ACI 301, Section 5.3.4.
      i. Exterior slabs.

D. Place non-shrink grout where shown on Contract drawings, in accordance with manufacturer’s recommendations.

3.3 CONCRETE PROTECTION AND CURING
   A. Weather conditions: Protect concrete in accordance with ACI 301 and ACI 305.1 or ACI 306.1, if weather conditions so dictate.
   B. Cure concrete in accordance with ACI 301, Section 5.3.6. Clear curing compounds shall be tinted or applied to surfaces marked to show extent of spraying.
   C. Protect concrete during adverse weather conditions in accordance with ACI 301, Section 1.8.
   D. Protect concrete from mechanical damage in accordance with ACI 301, Section 1.8.

3.4 FIELD INSPECTIONS AND TESTS
   A. Pre-Pour Inspection: The concrete Pre-Pour Inspection Checklist shall be prepared and signed off prior to any concrete pouring. The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, re-bar, anchor bolts, chamfer of exposed concrete edges, subgrade, embedments, and other items that may need inspection.

Ensure rebar is correctly located, supported, and tied. Document on Pre-Pour Inspection Checklist along with other required attributes.
B. Sample and test concrete in accordance with ACI 301, Sections 1.6.3.2 (d) and (e). Record results. Engage a qualified independent testing agency to perform material evaluation tests.

C. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade I.

END OF SECTION 03 30 00
PART 1  GENERAL

1.1 SUMMARY OF WORK

A. Miscellaneous metal fabrications.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Mechanical Engineers (ASME)
   B&PVC, 2013  Boiler and Pressure Vessel Code
   Section IX  Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations

B. American Society for Nondestructive Testing (ASNT)
   SNT-TC-1A  Personnel Qualifications and Certification in Nondestructive Testing

C. ASTM International (ASTM)
   A36  Standard Specification for Carbon Structural Steel
   A53  Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   A106  Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
   A181  Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
   A307  Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A513 Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing

A563 Standard Specification for Carbon and Alloy Steel Nuts

A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A992 Standard Specification for Structural Steel Shapes

F844 Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

D. American Welding Society (AWS)

D1.1/D1.1M Structural Welding Code - Steel

D1.3/D1.3M Structural Welding Code - Sheet Steel

QC1 Certification of Welding Inspectors

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required.

1. Welding personnel qualifications: Five days minimum before start of fabrication, submit Welder Performance Qualification Records and Welder Continuity Logs as required by Paragraph 1.4.B.1.

2. Welding procedure qualifications: Five days minimum before first use, submit Weld Procedure Specifications and Procedure Qualification Records as required by Paragraph 1.4.B.1.

3. Examination personnel qualifications: Five days minimum before first use, submit examination personnel qualification as required by Paragraph 1.4.B.2.

4. Examination procedures: 5 days minimum before start of fabrication, submit examination procedures as required by Paragraph 1.4.B.3.

5. Carbon Steel Weld Examination as required by Paragraph 3.5.A.1.
6. Weld Examinations (PT, MT) as required by Paragraph 3.5.A.4.

7. Shop drawings and production travelors.

C. Approval Not Required: None.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.

B. Qualifications of Welding Personnel and Procedures

1. Personnel and procedures for welding structural steel shall be qualified in accordance with AWS D1.1/D1.1M for steel structures and AWS D1.3/D1.3M for sheet steel before welding. Qualification of welding personnel and procedures in accordance with ASME B&PVC, Section IX, may be substituted for components welded in accordance with AWS D1.1/D1.1M and D1.3/D1.3M. Maintain copy of welding procedure specifications, procedure qualification records, and welder performance qualification test results and renewal of qualification documentation. Where stainless steel materials are welded to carbon steel, AWS D1.1/D1.1M procedures shall govern, unless ASME B&PVC, Section IX, was substituted.

2. Qualification of examination personnel: Maintain copies of examination personnel certifications and written examination performance procedures.
   a. Personnel performing visual examinations shall be Certified Welding Inspectors (CWIs) or Certified Associate Welding Inspectors (CAWIs) who have received certification (current or previous certification) in accordance with AWS QC1.
   b. Personnel performing other nondestructive examinations (NDEs) shall be certified in accordance with approved procedure, which shall meet the requirements of ASNT SNT-TC-1A. Use Level II or III personnel to interpret results.

3. Examination procedures: Examination procedures shall be in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and this Specification. Maintain copies of examination procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.
1.6 PROJECT CONDITIONS

A. General: Every item shipped is to arrive at the job site in the same condition it was in when it passed all quality control inspections and tests.

B. Preservation and Packaging: All items shall be dried and cleaned to protect against rust and corrosion. Do not wrap the assemblies in shrink wrap or other substance that can cause condensation to collect inside the wrapper. All items shall be protected from dirt, soil, and moisture and packaged for long-term storage in an unprotected exterior environment. All items shall be boxed or crated or otherwise packaged to eliminate damage during shipping, handling, and storage.

C. Marking: Packages shall be suitably marked on the outside to facilitate identification of the purchase order, the procurement specification, the package contents, and any special handling instructions.

1.7 PERMITS

A. Obtain and conspicuously post the following permits before starting work under this Section.


PART 2 PRODUCTS

2.1 SUBSTITUTES

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

Use the following materials unless otherwise shown on Contract drawings:

A. Rolled Steel Shapes, Plates, and Bars: ASTM A36 or ASTM A992, Gr. 50.

B. Flanges: ASTM A181, Class 60.

C. Steel Pipe: ASTM A53 (black) Type E or S, Grade B or ASTM A106 Grade B, standard weight, Schedule 40 or ASTM A513, Alloy 1010 or 1020, 0.25-inch wall thickness.

D. Hollow Structural Sections: ASTM A500, Grade B.

E. Sheet Steel: ASTM A653
F. Fasteners

1. Bolts:
   a. ASTM A307, Grade B.

2. Nuts:
   a. ASTM A563, Grade C, plain, heavy hex.


4. Concrete Anchors: See Section 03 15 00, “Post-Installed Concrete Anchors.”

5. Weld studs: Nelson Stud Welding Co. Type H4L or approved substitute.

G. Welding Electrodes/Filler Metal:

1. Carbon steel – Matching filler metal with $F_u = 70,000$ psi (minimum).

H. Coating: See Section 09 91 00, “Painting.”


J. Supports: Channels, channel spring nuts, bolts, and fittings for any one support type shall be galvanized and from the same manufacturer. Cooper B-Line® channels and fittings, or approved substitute.

1. Channels: 1-5/8 in. wide by 1-5/8 in. deep, or as shown on Drawings.

2. Channel spring nuts: Manufacturer’s standard.

3. Bolts (for use with channel spring nuts): Manufacturer’s standard.


2.3 FABRICATION

A. General

1. Verify measurements, including field measurements, before fabrication. Provide miscellaneous bolts and anchors, supports, braces, and connections necessary for completion of metal fabrications. Cut, reinforce, drill, and tap metal fabrications shown to receive finish

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3 Zinc Clad is a registered trademark of SWIMC, Newark, Delaware.
4 Z.R.C. is a registered trademark of Norfolk Corporation, Marshfield, Massachusetts.
5 B-Line is a registered trademark of Cooper Technologies Company, Houston, Texas.
hardware and similar items. Weld or bolt connections as shown on the Drawings.

2. Perform welding of steel connections in accordance with AWS D1.1/D1.1M and sheet steel in accordance with AWS D1.3/D1.3M.

B. Miscellaneous Steel Items: Supply required clips, frames, equipment supports, and other fabrications not shown on the Drawings. Fabricate parts from standard structural sections or shapes, to sizes required. Wherever miscellaneous parts are exposed, grind edges, corners, and rough cuts smooth and free of snags. Shop paint parts except those to be embedded in concrete or those that require other specific finishes.

C. Finishes

1. Prime and paint ferrous metal in accordance with Section 09 91 00, “Painting.” Do not coat members to be embedded in concrete, surfaces and edges to be field welded, or items to be galvanized. Shop paint may extend into embedded areas where impractical to remove.

2. Touch up damaged zinc surfaces with zinc-rich coating. Apply in accordance with manufacturer’s instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where metal fabrications are to be installed and notify CHPRC Field Work Supervisor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, to be embedded in concrete. Coordinate with CHPRC Field Work Supervisor for delivery of items to Site.

3.3 INSTALLATION

A. Concrete Anchor Installation: See Section 03 15 00, “Post-Installed Concrete Anchors.”

B. Install metal fabrications plumb, level, or as shown on the Drawings.
C. Make field connections as neatly as possible with joints flush and smooth. Grind smooth exposed field welds before field painting. Repair welds in galvanized work with two coats of zinc-rich coating.

D. Assemble and install interchangeable channel supports in accordance with manufacturer’s recommendations. Torque bolts used with channel spring nuts in support channels and clamps per manufacturer instructions (B-Line torque requirements shown).

<table>
<thead>
<tr>
<th>Bolt size, in.</th>
<th>Torque, ft-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>6 – 9</td>
</tr>
<tr>
<td>5/16</td>
<td>11 – 17</td>
</tr>
<tr>
<td>3/8</td>
<td>19 – 30</td>
</tr>
<tr>
<td>1/2</td>
<td>50 – 75</td>
</tr>
</tbody>
</table>

Unless specified on the design drawings, torque bolts in accordance with manufacturer’s instructions.

E. Weld Studs: Installation, testing and welder qualification shall be in accordance with the manufacturers’ written instructions and AWS D1.1/D1.1M, Section 7, for carbon steel.

3.4 APPLICATION

A. After installation has been completed, clean and paint connections with primer. Touch-up shop prime coat wherever damaged. Repair breaks in galvanized coating with zinc-rich coating.

3.5 FIELD INSPECTIONS AND TESTS

A. Weld Examination

1. Perform visual examination of carbon steel welds in accordance with AWS D1.1, Sections 6.5.5 and 6.9 (statically loaded structures). Record examination results.

Perform visual examination for sheet steel in accordance with AWS D1.3/D1.3M, Section 6.1. Record examination results.

END OF SECTION 05 50 00
SECTION 07 92 00

JOINT SEALANTS

PART 1  GENERAL

1.1  SUMMARY OF WORK

A. Clean and prepare joint surfaces.
B. Apply sealant and backing materials.

1.2  REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Code of Federal Regulations (CFR)


B. ASTM International (ASTM)

C920   Elastomeric Joint Sealants
C1330   Standard Specification for Cylindrical Sealant Backing Use with Cold Liquid Applied Sealants

C. Underwriters Laboratory (UL)

1479   Standard for Fire Tests of Through-Penetration Firestops

1.3  SUBMITTALS

A. Submit the following in accordance with the Contract Statement of Work.

1. Catalog Data: Manufacturer’s data sheets on each product to be used, including, preparation instructions and recommendations, storage and handling requirements and recommendations, as well as installation methods. Additional information to include Material Safety Data Sheet, shelf life, and temperature range of storage and application.
1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Installer qualifications: Trained and/or experienced in the application of sealants to be used.

B. Source limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Contract Statement of Work.

B. Store products in manufacturer’s unopened packaging, with labels intact, until ready for installation.

C. Store products off ground; if stored on roof, do not exceed structural capacity of deck.

D. Store materials at minimum of 68°F for at least 24 hours prior to installation, regardless of temperature at location.

E. Do not allow materials to freeze prior to application.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. General: Provide exterior sealants that comply with the following limits for volatile organic compound content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants for Nonporous Substrates: 250 g/L.

2. Sealants for Porous Substrates: 775 g/L.

B. Sealant: Single component, traffic-grade, neutral-curing silicone joint sealant: ASTM C920, Type S, Grade NS or P, Class 100/50.

2.3 ACCESSORIES

A. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint-forming materials.
B. Joint Filler: ASTM C1330 or ASTM D994; round, type as recommended by sealant manufacturer; oversized 30 to 50 percent.

C. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to installation, ensure that joint dimensions and physical and environmental conditions are suitable for application of joint sealers.

B. By beginning the Work of this Section, Subcontractor warrants it has examined and verified that existing conditions are in accordance with provisions of Paragraph 3.1.A.

3.2 PREPARATION

A. Clean, prepare, and size joints in accordance with manufacturer’s instructions. Remove any loose materials and other foreign matter that might impair adhesion of sealant.

B. Verify that joint-shaping materials and release tapes are compatible with sealant.

C. Examine joint dimensions and size materials to achieve required width/depth ratios.

D. To allow sealants to perform properly, use joint filler to achieve required joint depths.

E. Use bond breaker where required.

3.3 INSTALLATION

A. Install sealant per manufacturer’s instructions.

B. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.

C. Tool joints as indicated on Drawings.

D. Joints: Free of air pockets, foreign embedded matter, ridges, and sags.

E. Coverage: Replace sealants that fail because of loss of cohesion or adhesion onto surfaces applied or that do not cure. If the sealant can be detached from a surface by rubbing the surface contact point with a finger, than the surface adhesion is inadequate.

F. Follow manufacturer’s recommended cure time before painting or over coating.

END OF SECTION 07 92 00
SECTION 09 91 00

PAINTING

PART 1   GENERAL

1.1 SUMMARY OF WORK

Painting of miscellaneous metals.

1.2 REFERENCES

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Master Painters Institute (MPI)
   Architectural Painting Manual

B. Steel Structures Painting Council (SSPC)
   SP 2 Hand Tool Cleaning
   SP 3 Power Tool Cleaning

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. List of materials: Before delivery, submit complete list of materials, colors, and location to be used. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material and the conversion factors to determine dry film thickness from applied wet film thickness. Submit Material Safety Data Sheets for materials proposed for use.

2. Film thickness test results as required by Paragraph 3.6.A.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Use manufacturers and products as listed under the Approved Product List section of the MPI Painting Manual unless otherwise specified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements. Store materials indoors.

1.6 PROJECT CONDITIONS

A. General: Ensure that surfaces are dry and have attained required temperatures and conditions before starting work or continuing previously started work.

B. Weather: No exterior work shall be performed on unprotected surfaces if rain or moisture from other sources is present or expected before applied finishes can dry or attain proper cure.

C. Dust: No finishes shall be applied if dust is being generated at worksite.

D. Temperature:

1. Unless recommended otherwise by paint manufacturer, apply coatings when the following temperatures exist.

<table>
<thead>
<tr>
<th>Coating</th>
<th>Ambient Temperature</th>
<th>Surface Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-thinned paints</td>
<td>50 to 90°F</td>
<td>50 to 90°F</td>
</tr>
<tr>
<td>Other paints</td>
<td>45 to 95°F</td>
<td>45 to 95°F</td>
</tr>
<tr>
<td>Epoxy</td>
<td>As recommended by manufacturer</td>
<td></td>
</tr>
</tbody>
</table>

2. If necessary, provide temporary heat until specified temperatures exist for required time periods. Maintain temporary heat for 24 hours after paint application.

E. Humidity: Follow manufacturer’s directions for extremes.

F. Ventilation: Provide ventilation recommended for extremes.
CHPRC-02537, Rev. 0

PART 2 PRODUCTS

2.1 SUBSTITUTIONS
A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS
A. Furnish materials identified in MPI Architectural Painting Manual.
B. Furnish ready-mixed materials.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, permanence, and quality of work, and which cannot be corrected through specified preparation.
B. Report in writing to CHPRC Field Work Supervisor conditions that may affect proper application of finish. Correct unsuitable conditions before beginning surface preparation or coating application.

3.2 PREPARATION
A. Protection
1. Provide and install drop cloths, shields, and other protective devices to protect surfaces adjacent to areas being painted. Keep spatter, smears, droppings, and over-run of paint materials to a minimum and remove as painting work progresses.
2. Promptly remove spills, splashes and splatter. Use removal methods which do not damage surfaces being cleaned or painted.
3. Repair or replace surfaces damaged by painting work as directed by CHPRC Field Work Supervisor.
4. Remove electrical outlet and switch plates, mechanical diffusers, escutcheons, registers, surface hardware, fittings, fastening, and similar items before starting work.

B. Surface Preparation
1. Prepare surfaces for scheduled finish systems in accordance with recommendations of finish material manufacturer, MPI Architectural Painting Manual, and SSPC-SP 2 or SSPC-SP 3.
2. Obtain written approval from CHPRC Field Work Supervisor before using dry or liquid abrasive blasting.

C. New Surfaces

1. Remove mildew by scrubbing with trisodium phosphate, bleach, or detergent solution, then rinse with potable water and let dry.

2. Ferrous Metals and Carbon Steel
   a. For shop-primed surfaces, apply phosphoric acid etch solution at field welded or abraded spots and let set for time recommended by acid etch manufacturer.

3. Prepare in accordance with SSPC-SP 2 or SSPC-SP 3. Prime within 4 hours after preparation.

3.3 APPLICATION

A. Perform work in accordance with manufacturer’s instructions, PDCA Architectural Specification Manual, and this Section.

3.4 CLEANING

A. Furnish and maintain at Site, closed metal containers for disposal of waste materials. Collect materials spotted or soaked with paint, oil, or solvents and place in containers.

B. At completion of coating work, remove materials, containers, rags, cloths, brushes, tools, and equipment from site.

3.5 SCHEDULES

A. Paint and Finish
   1. Exterior Ferrous Metals and Carbon Steel: Light and ordinary exposures (not galvanized)
      a. MPI Painting Manual EXT 5.1C, Water Based light industrial semi-gloss coating over alkyd primer, Color – Gray
      OR
      b. MPI Painting Manual EXT 5.1D, Alkyd semi-gloss finish over alkyd primer, Color – Gray
3.6 FIELD INSPECTIONS AND TESTS

A. Measure the Wet Film Thickness (WFT) of each coat of material with a notched WFT gage (Nordson® 790-015) at a minimum of five evenly spaced points for each 100 ft² of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness. Document results.

B. Meet requirements of MPI Architectural Painting Manual for “Custom” Material and work, unless otherwise specified.

END OF SECTION 09 91 00

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6 Nordson is a registered trademark of Nordson Corporation, Westlake, Ohio.
PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Traffic signs.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)

D6.1 Manual on Uniform Traffic Control Devices for Streets and Highways

B. Washington State Department of Transportation (WSDOT)

M41-10 Standard Specifications for Road, Bridge, and Municipal Construction

QPL Qualified Product List

1.3 SUBMITTALS

A. See contract Statement of Work for submittal procedures.

B. Approval Required.

1. Before delivery, submit complete list of materials and location to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Contract Statement of Work.

B. Store products in manufacturer’s unopened packaging, with labels intact, until ready for installation.

C. Store materials in accordance with manufacturer’s recommendations.
PART 2  PRODUC TS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Signs: Reflectorized aluminum in accordance with WSDOT M41-10, Section 9-28 using WSDOT QPL-listed manufacturer.

B. Posts: Perforated steel, square in accordance with WSDOT M41-10, Section 9-06.16.

PART 3 EXECUTION

3.1 INSTALLATION

A. Placement and installation of signs shall be in accordance with ANSI D6.1, WSDOT M41-10, Section 8-21 and the Drawings.

END OF SECTION 10 14 53
PART 1  GENERAL

1.1 SUMMARY OF WORK

A. This section covers the Work required in conjunction with other Division 26 specifications necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test the electrical systems.

1.2 REFERENCES

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Contractors Association (NECA)
   National Electrical Installation Standards

B. National Electrical Manufacturers Association (NEMA):
   250 Enclosures for Electrical Equipment (1000 Volts Maximum).
   Z535.4 Product Safety Signs and Labels.

C. National Fire Protection Association (NFPA)
   70® National Electrical Code® (NEC®)

D. Underwriters Laboratories (UL)

1.3 SUBMITTALS

A. Approval Required Prior to Work Submittals:

   1. Provide manufacturers’ data for the following:
      a. Electrical metering components.
      b. Electrical service-disconnect switch and panelboard.

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7 NFPA 70, National Electrical Code, NEC and NFPA 70E are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Provide the Work in accordance with the NEC. Electrical material and equipment shall be accepted, certified, listed, labeled, or otherwise determined safe by a Nationally Recognized Testing Laboratory (NRTL) and indicated by an NRTL label applied by the manufacturer or labeled by an NRTL representative following an NRTL field evaluation to provide basis for approval under NEC.

B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc., shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to the Authority Having Jurisdiction for Class, Division, and Group of hazardous area indicated.

D. Electrical inspection shall be performed by personnel that are certified to perform NEC inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

See Statement of Work.

1.6 PROJECT CONDITIONS

A. The following areas are nonhazardous (nonclassified) and wet locations. Use materials and methods required for such areas.

1. Outdoors above and below grade.

2. In electrical protective shelter.

1.7 UTILITY / FACILITY INTERFACE POINT

A. For aerial systems, the interface point that separates the utility distribution system from the facility electrical power system is the incoming line termination connection at the weatherhead. Where there is no weatherhead, the interface point shall be the secondary terminals of the utility transformer.

B. For underground systems, the interface point that separates the utility distribution system from the facility electrical power system is the secondary terminal of the utility transformer serving the facility.
PART 2  PRODUCTS

2.1 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40°F to 104°F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of -25°F to 115°F.

D. Equipment panels installed outdoors in direct sun should be equipped with sun shields.

E. Electrical ratings of materials and equipment that are reduced by increased elevation shall be derated as required for Site elevation.

2.2 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by Buyer’s Technical Representative (BTR).

2.3 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment:

1. NEMA 4 and 4X Enclosures: One-Part Clear Room Temperature Vulcanizing (RTV) adhesive.

2. All Other Enclosures: Stainless steel screws.

C. Color: White, engraved to a black core.

D. Letter Height: As indicated on Drawings.

2.4 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.
PART 3 EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of BTR.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify BTR in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of BTR. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.2 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:

1. Analog control circuits from devices in same general area to same destination.
   a. No power circuits shall be combined in same conduit with analog circuits.
   b. No Class 2 or Class 3 circuits shall be combined with power or Class 1 circuits.
   c. Analog circuits shall be continuous from source to destination. Do not splice or combine into a multi-pair cable without authorization of BTR.
   d. Raceways shall be sized per General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.
Changes shall be documented on record drawings.

2. Discrete control circuits from devices in the same general area to the same destination.
   a. No power circuits shall be combined in same conduit with discrete circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
   c. Raceways shall be sized per the General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.
   d. Changes shall be documented on record drawings.

3. Power circuits from loads in same general area to same source location.
   a. Lighting Circuits: Combine no more than three circuits to a single raceway. Provide a separate, identified neutral conductor for each 120-volt and 277-volt circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate identified neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   c. All Other Power Circuits: Do not combine power circuits without authorization of BTR.

3.3 NAMEPLATES, SIGNS, AND LABELS

   A. Arc Flash Protection Warning Signs:
      1. Field mark switchboards and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
      2. Use arc flash hazard boundary, energy level, PPE (personal protective equipment) level and description, shock hazard, bolted fault current, and equipment name from BTR as basis for warning signs.
B. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including tap cabinets, switchboards, panelboards, motor starters, adjustable speed drives, transformers, terminal junction boxes, disconnect switches, light switches, control stations, receptacles, and lights.

2. Switchboards, panelboards, and motor control centers shall include equipment designation, service voltage, phases, power source, and circuit number.

3. Transformer and disconnect switch shall include equipment designation, power source, and circuit number.

4. Motor starter and adjustable speed drive shall include equipment designation and power source. Include circuit number when power source is a switchboard or panelboard.

5. Lighting switch and receptacles shall include power source and circuit number.

6. Control station shall include controlled equipment designation.

7. Pad mount utility transformer shall include equipment designation, primary and secondary voltages, and power source.

8. Tap cabinet shall include equipment designation, service voltage, phases, and power source.

9. Provide a nameplate to label HVAC and plumbing equipment including electric heaters, heat pumps, air handling and makeup units, water heaters, exhaust fans, supply fans, and freeze-proof safety showers. Include equipment designation, power source, and circuit number.

3.4 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement. Obtain BTR approval prior to relocating or reconnecting loads.
3.5 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes, and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.

2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to BTR.

3.6 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor’s convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to BTR.

END OF SECTION 26 05 02
SECTION 26 05 05
CONDUCTORS

PART 1  GENERAL

1.1  SUMMARY OF WORK

A. This Section covers the Work necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test conductors.

1.2  REFERENCES

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

B3  Standard Specification for Soft or Annealed Copper Wire

B8  Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B33 Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

B172 Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

C2  National Electrical Safety Code (NESC)

C. National Electrical Manufacturers’ Association (NEMA)

WC 58  Portable and Power Feeder Cables for Use in Mines and Similar Applications

WC 70  Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
D. National Fire Protection Association (NFPA)
   70® National Electrical Code®

E. Underwriters Laboratories (UL)
   83 Thermoplastic-Insulated Wires and Cables
   486A-486B Wire Connectors
   486C Splicing Wire Connectors
   510 Standard for Polyvinyl Chloride Polyethylene, and Rubber Insulating Tape
   1650 Outline of Investigation for Portable Power Cable
   2277 Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable

1.3 SUBMITTALS

A. Approval Required Prior to Work Submittals:
   1. Wire and cable descriptive product information.
   2. Wire and cable accessories descriptive product information.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Authority Having Jurisdiction (AHJ):
   1. Ensure the Work is performed in accordance with NFPA 70 and IEEE C2. Electrical material and equipment shall be accepted, certified, listed, labeled, or otherwise determined safe by a Nationally Recognized Testing Laboratory (NRTL) and indicated by an NRTL label applied by the manufacturer or labeled by an NRTL representative following an NRTL field evaluation to provide basis for approval under NFPA 70.
   2. Materials and equipment manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark.

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8 NFPA 70 and National Electrical Code are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
PART 2 PRODUCTS

2.1 TRANSFORMER PRIMARY CONDUCTORS

A. Conductors:
   1. Conform to requirements of ASTM B3.
   2. Soft drawn copper, solid, black 110-mil polyethylene cover.
   3. Size as shown on drawings.
   4. Manufacturers:
      a. General Cable®.
      b. Southwire®.
      c. Essex® Wire & Cable.
      d. Or equal.

2.2 CONDUCTORS 600 VOLTS AND BELOW

A. General:
   1. Power Conductors and Cable: Conform to applicable requirements of NEMA WC 70.
   2. Conductor Type:
      a. 120-Volt Circuits, 10 AWG and Smaller: Solid copper.
      b. All Other Circuits: Stranded copper.
   3. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

B. Data/Instrumentation Cables:
   1. To be determined.

2.3 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type THHN/THWN, insulation.

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9 General Cable is a registered trademark of General Cable Technologies Corporation, Highland Heights, Kentucky.
10 Southwire is a registered trademark of Southwire Company, Carrollton, Georgia.
11 Essex Wire is a registered trademark of Essex Group, Inc., Atlanta, Georgia.
2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Insulating Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch®\textsuperscript{12}, Brand Super 33+®, rated for 90°C minimum, meeting requirements of UL 510.


B. Identification Devices:

1. Sleeve:
   a. Compatible for use on conductor being identified.
   b. Permanent, PVC, white, with legible machine-printed black markings.
   c. Manufacturers and Products:
      i. Tyco Electronics®\textsuperscript{13} (TE Connectivity); Type D-SCE or ZH-SCE.
      ii. Brady, Type 3PS.
   d. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
   e. Tie-On Cable Marker Tags:
      i. Chemical-resistant white tag.
      ii. Size: 1/2 in. by 2 in.
      iii. Manufacturer and Product: Tyco Electronics (TE Connectivity); Type CM-SCE.


\textsuperscript{12} Scotch and Super 33+ are registered trademarks of 3M Company, St. Paul, Minnesota.
\textsuperscript{13} Tyco Electronics is a registered trademark of Tyco International Services GmbH, Switzerland.
C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      i. Thomas & Betts\textsuperscript{14}; Sta-Kon\textsuperscript{14}.
      ii. Burndy\textsuperscript{15}; Insulug.
      iii. ILSCO\textsuperscript{16}.

2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75\textdegree{}C wire at full NFPA 70, 75\textdegree{}C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      i. Thomas & Betts; Sta-Kon.
      ii. Burndy; Insulink.
      iii. ILSCO; ILSCONS\textsuperscript{15}.

3. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturers:
      i. 3M\textsuperscript{17} Co.
      ii. Thomas & Betts.
      iii. Marrette\textsuperscript{14}.

\textsuperscript{14} Thomas & Betts, Marrette, Color-Keyed, SHRINK-KON, Locktite, and Sta-Kon are registered trademarks of Thomas & Betts International, Inc., Wilmington, Delaware.
\textsuperscript{15} Burndy and Cable Grip are registered trademarks of Hubbell Incorporated, Shelton, Connecticut.
\textsuperscript{16} ILSCO is a registered trademark of Ilsco Corporation, Cincinnati, Ohio.
\textsuperscript{17} 3M is a trademark of 3M Company, St. Paul, Minnesota.
D. Cable Lugs:
   1. Rated 600 volts of same material as conductor metal.
   2. Uninsulated Crimp Connectors and Terminators:
      a. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.
      b. Manufacturers and Products:
         i. Thomas & Betts; Color-Keyed®.
         ii. Burndy, Hydent.
         iii. ILSCO.
   3. Uninsulated, Bolted, Two-Way Connectors and Terminators:
      a. Manufacturers and Products:
         i. Thomas & Betts; Locktite®.
         ii. Burndy; Quiklug.
         iii. ILSCO.
E. Cable Ties:
   1. Nylon, adjustable, self-locking, and reusable.
   2. Manufacturer and Product: Thomas & Betts; TY-RAP.
F. Heat Shrinkable Insulation:
   1. Thermally stabilized cross-linked polyolefin.
   2. Single wall for insulation and strain relief.
   3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
   4. Manufacturers and Products:
      a. Thomas & Betts; SHRINK-KON®.
      b. Tyco Electronics (TE Connectivity); RNF-100 and ES-2000.
G. Instrumentation and Control Cable Accessories: Terminators, connectors, and junctions necessary for a complete system.
2.5 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:
   1. IDEAL®\textsuperscript{18} Industries.
   2. Polywater, Inc.
   3. Cable Grip®\textsuperscript{15} Co.

PART 3 EXECUTION

3.1 GENERAL

A. Conductor installation shall be in accordance with manufacturer’s recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer’s recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate all conductors and cables, unless otherwise indicated. Verify and document Conductors have been installed from and to the locations indicated by Contractor drawings.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

\textsuperscript{18} Ideal is a registered trademark of Ideal Industries, Inc., Sycamore, Illinois.
3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1 1/2 in. to 2 in. wide.

2. 8 AWG and Smaller: Provide colored conductors.

3. Colors:

<table>
<thead>
<tr>
<th>System</th>
<th>Conductor</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Systems</td>
<td>Equipment Grounding</td>
<td>Green</td>
</tr>
<tr>
<td>240/120 Volts Single-Phase, Three-Wire</td>
<td>Grounded Neutral One Hot Leg Other Hot Leg</td>
<td>White Black Brown</td>
</tr>
<tr>
<td>480Y/277 Volts Three-Phase, Four-Wire</td>
<td>Grounded Neutral Phase A Phase B Phase C</td>
<td>White Red Yellow Blue</td>
</tr>
</tbody>
</table>

NOTE: Phase A, B, and C implies direction of positive phase rotation.

4. Tracer: Outer covering of white with an identifiable colored strip, other than green, in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.

C. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at supply end of circuit, include panel, circuit number, and phase.

2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
D. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.

2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.

3. Taped-on markers or tags relying on adhesives not permitted.

3.4 TRANSFORMER PRIMARY CONDUCTORS

A. Install in accordance with the Drawings and IEEE C2.

3.5 CONDUCTORS (RATED 2000 VOLTS AND BELOW)

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Buyer’s Technical Representative.

C. Connections and Terminations:

1. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.

2. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.

3. Install uninsulated crimp connectors and terminators for power circuit conductors 4 AWG through 2/0 AWG.

4. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.

5. Install crimp connectors with tools approved by connector manufacturer.

6. Install terminals and connectors acceptable for type of material used.

7. Compression Lugs:
   a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
   b. Do not use plier type crimpers.
D. Do not use soldered mechanical joints.

E. Splices and Terminations:
   1. Insulate all uninsulated connections.
   2. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
   3. Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
   4. Leave pig tails of adequate length for bundled connections.
   5. Cable Protection:
      a. Maintain integrity of shielding of instrumentation cables.
      b. Ensure shorts to ground do not occur because of damage to jacket over the shield.

H. Extra Conductor Length: For conductors to be terminated by Others, provide minimum 2 feet of extra conductor length.

END OF SECTION 26 05 05
PART 1    GENERAL

1.1 SUMMARY OF WORK

A. This Section covers the Work necessary to procure, detail, manufacture, deliver to
   the jobsite, install, startup, and test the grounding and bonding system specified
   herein.

1.2 REFERENCES

Drawings and general provisions of the Contract Statement of Work, including
Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the
extent designated in this Section. Referenced documents are those current as of the date
of this Section unless otherwise indicated.

A. Institute of Electrical and Electronics Engineers (IEEE)
   C2 National Electrical Safety Code (NESC)

B. National Electrical Contractors Association (NECA)
   1 Standard Practices for Good Workmanship in Electrical
   Contracting

C. National Fire Protection Association (NFPA)
   70®19 National Electrical Code®19 (NEC®19)

D. Underwriters Laboratories (UL)

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19 NFPA 70 and National Electrical Code are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
1.3 SUBMITTALS

All submittal information shall be provided in English.

A. Approval Required Prior to Work Submittals:
   1. Shop Drawings: Product data for the following:
      a. Mechanical connectors.
      b. Compression connectors.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Authority Having Jurisdiction (AHJ):
   1. Provide the Work in accordance with NFPA 70, Electrical material and equipment shall be accepted, certified, listed, labeled, or otherwise determined safe by a Nationally Recognized Testing Laboratory (NRTL) and indicated by an NRTL label applied by the manufacturer or labeled by an NRTL representative following an NRTL field evaluation to provide basis for approval under NEC.
   2. Materials and equipment manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect, and handle products according to NECA 1.

PART 2 PRODUCTS

2.1 GROUND ROD

A. Material: Copper-clad steel.

B. Diameter: Minimum 5/8 inch.

C. Length: 8 feet.

2.2 GROUND CONDUCTORS

A. As specified in Section 26 05 05, “Conductors.”
2.3 CONNECTORS

A. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.

2. Single indentation for conductors 6 AWG and smaller.

3. Double indentation with extended barrel for conductors 4 AWG and larger.

4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.

5. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.
   c. ILSCO.

B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

PART 3 EXECUTION

3.1 GENERAL

A. Grounding shall be in compliance with the NEC.

B. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

C. Bond together system neutrals, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

D. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
E. Shielded Instrumentation Cables:
   1. Ground shield to ground bus at power supply for analog signal.
   2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
   3. Do not ground instrumentation cable shield at more than one point. Ground shields at source panel, not field end, in accordance with Drawings.

3.2 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
C. Connect ground conductors to raceway grounding bushings.
D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
E. Connect enclosure of equipment containing ground bus to that bus.
F. Bolt connections to equipment ground bus.
G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.
B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
C. Motors Less than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.
D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.
E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.4 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point 6 inches below finished grade, unless otherwise shown.

C. Space multiple ground rods by a minimum of 6 feet.

3.5 CONNECTIONS

A. General:

1. Above grade Connections: Install mechanical or compression-type connectors; or brazing.

2. Below grade Connections: Install compression type connectors.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

4. Notify Buyer’s Technical Representative (BTR) and NEC inspector prior to backfilling ground connections. NEC inspection and approval is required before backfilling.

B. Compression Type:

1. Install in accordance with connector manufacturer’s recommendations.

2. Install connectors of proper size for grounding conductors and ground rods specified.

3. Install using connector manufacturer’s compression tool having proper sized dies.

C. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.

2. Install in accordance with connector manufacturer’s recommendations.

3. Do not conceal mechanical connections.
3.6 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.7 LOW VOLTAGE TRANSFORMER GROUNDING

A. Bond neutrals of low voltage transformers to nearest common grounding conductor and/or grounding electrode per Drawings.

3.8 FIELD QUALITY CONTROL

A. General: Perform on-site verification, certification, and acceptance testing of the grounding installation during construction. Verification and testing will be witnessed by the designated NEC AHJ.

B. Notify the BTR ten working days in advance of the expected completion of a grounding system installation. Verification and testing can be scheduled in parts or by area depending on the system and construction schedule.

C. Before work is concealed, verify and certify that the following grounding installations have been made correctly:

1. Ground plates and grounding bars.

2. All other underground grounding installations.

Acceptance Testing: Perform acceptance testing and submit written reports to the BTR in accordance with the requirements of Division 01 Specification Sections. Tests will be witnessed by designated NEC AHJ.

END OF SECTION 26 05 26
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1  GENERAL

1.1  SUMMARY OF WORK

A. This Section, in conjunction with other Division 26 Sections, covers the Work necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test hangers and supports for electrical systems.

1.2  REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Manufacturers’ Standardization Society (MSS)
   SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
   SP-69 Pipe Hangers and Supports – Selection and Application

B. ASTM International (ASTM)
   A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

C. Metal Framing Manufacturers Association (MFMA)
   4 Metal Framing Standards Publication
   102 Guidelines for the Use of Metal Framing
   103 Guidelines for the Use of Metal Framing

D. National Electrical Contractors Association (NECA)
   1 Standard Practices for Good Workmanship in Electrical Contracting
E. International Code Council (ICC)
   IBC, 2012 International Building Code
F. National Fire Protection Association (NFPA)
   70®20 National Electrical Code ®20 (NEC®20)
G. Underwriters Laboratories (UL)
   486A-486B Wire Connectors

1.3 SUBMITTALS

A. Submit the following in accordance with the provisions of the Contract Statement of Work.

B. Catalog Data: Submit catalog data for each type of product specified. Include information substantiating equivalent corrosion resistance to zinc coated steel of alternative treatment, finish, or inherent material characteristic.

C. Test Reports: Submit ICC Evaluation Service, Inc., evaluation report for each post-installed concrete or masonry anchor product showing that it complies with the current edition of the IBC and the intended conditions of use.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Furnish and install hangers and supports that conform to the requirements of the following codes and standards:

   1. NEC.
   3. NECA 1.
   4. MFMA-4.
   5. MFMA-102

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20 NFPA 70, National Electrical Code, and NEC are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
B. Where a Nationally Recognized Testing Laboratory (NRTL) has requirements for such products, provide products that are NRTL listed and labeled for the application, installation condition, and the environment in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products according to NECA 1.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work. Any substitution must be submitted to engineering for approval before procurement of alternate products.

2.2 COATINGS AND MATERIALS

A. Furnish products for use indoors protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

B. Furnish products for use outdoors or in damp or corrosive indoor locations with hot-dip galvanized coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or material such as stainless steel with inherent corrosion resistant characteristics.

2.3 RACEWAY SUPPORTING DEVICES

A. Furnish supports as described below for the installation of raceway systems.

B. Use pressed steel, single bolt hangers to support individual conduits from threaded rods or beam clamps. Manufacturer: Steel City®21 “6H Series.”

2.4 FASTENERS

A. Post-Installed Concrete Anchors:

1. Furnish post-installed concrete anchors as shown on the Drawings.

2. Each post-installed anchor shall have an ICC-ES evaluation report stating that the product is compliant with the current edition of the IBC and the intended conditions of use.

3. For applications in outdoor, damp, or corrosive locations furnish stainless steel post installed anchors.

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21 Steel City is a registered trademark of Steel City Electric Co., Pittsburgh, Pennsylvania.
2.5 FRAMING CHANNEL SYSTEMS

A. Furnish galvanized U-channel framing systems that conform to MFMA-4 and are fabricated using minimum 12-gage steel.

B. Furnish galvanized fittings and accessories that mate and match with U-channel and are of the same manufacturer. Use two-piece, single bolt type conduit straps on U-channel supports.


2.6 FABRICATED SUPPORTING DEVICES

A. Furnish shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Furnish steel brackets fabricated from angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 EXECUTION

3.1 GENERAL

A. Install hangers and supports according to the NEC, IBC, NECA 1, the requirements in this Section, and specific supporting requirements in other Sections.

B. Conform to manufacturer’s instructions and recommendations for selection and installation of hangers and supports.

C. Do not use wire or perforated strap for permanent supports.

3.2 EXAMINATION

A. Examine surfaces to receive hangers and supports for compliance with installation tolerances and other conditions affecting performance of the system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 FASTENERS

A. Post-installed concrete expansion anchors: Install in accordance with Section 03 15 00, “Post-Installed Concrete Anchor Bolts,” and the product’s ICC-ES report conditions of use.

B. Use beam clamps or machine bolts, nuts, and washers for fastening to metal.

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22 Unistrut is a registered trademark of Unistrut International Corporation, Wayne, Michigan.
C. The use of lead-cinch drop in anchors is not allowed.
D. Torque threaded fasteners as recommended by the manufacturer’s instructions.

3.4 BOXES AND CABINETS
A. Install surface-mounted cabinets as shown on the Drawings or as required.

3.5 FRAMING CHANNEL SYSTEMS
A. Select and install framing channel systems in accordance with MFMA-103.
B. Provide cold galvanizing protection on all cut ends and all holes drilled into galvanized framing channel.

END OF SECTION 26 05 29
SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Section, in conjunction with other Division 26 Sections, covers the Work necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test raceways and boxes for electrical systems.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ANSI/National Electrical Manufacturers Association (NEMA)
   FB1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   OS1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

B. ANSI/Society of Cable Telecommunications Engineers (SCTE)
   77 Specification for Underground Enclosure Integrity

C. National Electrical Contractors Association (NECA)
   1 Standard Practices for Good Workmanship in Electrical Construction
   101 Standard for Installing Steel Conduits (Rigid, IMC, EMT)
   111 Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)

D. National Electrical Manufacturers Association (NEMA)
   C80.1 Electrical Rigid Steel Conduit (ERSC)
OS 3      Selection and Installation Guidelines for Electrical Outlet Boxes

RN 1      PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

E.     National Fire Protection Association (NFPA)
   70®       National Electrical Code® (NEC®)

F.     Underwriters Laboratories (UL)
   1       Flexible Metal Electrical Conduit
   6       Rigid Metal Electrical Conduit
   50      Enclosures for Electrical Equipment, Non-Environmental Considerations
   360     Liquid-Tight Flexible Steel Conduit, Electrical
   498     Attachment Plugs and Receptacles
   514A    Metallic Outlet Boxes
   514B    Fittings for Conduit and Outlet Boxes
   514C    Non-Metallic Fittings for Conduit and Outlet Boxes
   651     Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
   797     Electrical Metallic Tubing - Steel

1.3     SUBMITTALS

A.     See Statement of Work.

1.4     QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A.     Comply with the NEC for components and installation.

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23 NFPA 70, National Electrical Code, and NEC are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect, and handle products according to NECA 1.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit:
   1. Meet requirements of NEMA C80.1 and UL 6.
   2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):
   1. Meet requirements of NEMA C80.3 and UL 797.
   2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. PVC Schedule 40 Conduit:
   1. Meet requirements of NEMA TC 2 and UL 651.
   2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90°C insulated conductors.

D. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of NEMA RN 1.
   2. Material:
      a. Meet requirements of NEMA C80.1 and UL 6.
      b. Exterior Finish: PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
      c. Interior finish: Urethane coating, 2 mils nominal thickness.
   3. Threads: Hot-dipped galvanized and factory coated with urethane.
   4. Bendable without damage to either interior or exterior coating.
E. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105°C insulated conductors.


2.2 FITTINGS

A. Rigid Galvanized Steel:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.

2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150°C.
   b. Manufacturers and Products:
      i. Appleton; Series BU-I.
      ii. O-Z/Gedney; Type HB.

3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150°C, with solderless lugs.
   b. Manufacturers and Products:
      i. Appleton; Series GIB.
      ii. O-Z/Gedney; Type HBLG.

4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
c. Manufacturers and Products:
   i. Appleton, Series HUB-B.
   ii. O-Z/Gedney; Series CH.
   iii. Meyers; ST Series.

5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products (for Normal Conditions):
      i. Appleton; Form 35 threaded unilets.
      ii. Crouse-Hinds; Form 7 or 8 threaded condulets.
      iii. Killark; Series O electrolets.
      iv. Thomas & Betts; Form 7 or 8.
   c. Manufacturers (for Hazardous Locations):
      i. Appleton.
      ii. Crouse-Hinds.
      iii. Killark.

6. Couplings: As supplied by conduit manufacturer.

7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      i. Appleton; Series SCC Bolt-On Coupling or Series EC Three-Piece Union.
      ii. O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.

8. Drain Seal Manufacturers and Products:
   a. Appleton; Type EYD.
   b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers and Products:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.

10. Expansion Fitting Manufacturers and Products:
   a. Deflection/Expansion Movement:
      i. Appleton; Type DF.
      ii. Crouse-Hinds; Type XD.
   b. Expansion Movement Only:
      i. Appleton; Type XJ.
      ii. Crouse-Hinds; Type XJ.
      iii. Thomas & Betts; XJG-TP.
   c. Cable Sealing Fittings:
      i. To form watertight nonslip cord or cable connection to conduit.
      ii. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
      iii. Manufacturers and Products:
           • Appleton; CG-S.
           • Crouse-Hinds; CGBS.

B. Electric Metallic Tubing:
1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Electro zinc-plated inside and out.
4. Raintight.
5. Coupling Manufacturers and Products:
   a. Appleton; Type 95T.
   b. Crouse-Hinds.
   c. Thomas & Betts.

6. Connector Manufacturers and Products:
   a. Appleton; Type ETP.
   b. Crouse-Hinds.
   c. Thomas & Betts.

C. PVC Conduit:
   1. Meet requirements of NEMA TC-3.
   2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of UL 514B.
   2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
   3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
   5. Overlapping pressure-sealing sleeves.
   7. Manufacturers:
      a. Robroy Industries.
      b. Ocal.
   8. Expansion Fitting Manufacturer and Product: Ocal; OCAL-BLUE XJG.
E. Flexible Metal, Liquid-Tight Conduit:
   1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105°C.
   2. Insulated throat and sealing O-rings.
   3. Manufacturers and Products:
      a. Thomas & Betts; Series 5331.
      b. O-Z/Gedney; Series 4Q.

F. Watertight Entrance Seal Device:
   1. New Construction:
      a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
      b. Manufacturer and Product: O-Z/Gedney; Type FSK or WSK, as required.

2.3 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:
   1. Box: Malleable iron.
   2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
   3. Hubs: Threaded.
   4. Lugs: Cast Mounting.
   5. Manufacturers and Products, Nonhazardous Locations:
      a. Crouse-Hinds; Type FS or FD.
      b. Appleton; Type FS or FD.
      c. Killark.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or EAJ.
   b. Appleton; Type GR.

C. PVC-Coated Cast Metal:
   1. Type: One-piece.
   2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
   3. Coating:
      a. Exterior Surfaces: 40-mil PVC.
      b. Interior Surfaces: 2-mil urethane.
   4. Manufacturers:
      a. Robroy Industries.
      b. Ocal.

2.4 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Sheet Steel Box:
   1. NEMA 250, Type 1.
   3. Cover: Full access, screw type.

D. Large Cast Metal Box:
   1. NEMA 250, Type 4.
   2. Box: Cast malleable iron or ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
   3. Cover: Hinged with clamps.

5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.

6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.

7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.

8. Manufacturers and Products, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O-Z/Gedney; Series YR.

9. Large Stainless Steel Box:
   a. NEMA 250 Type 4X.

10. Box: 14-gauge, ASTM A240/A240M, Type 304 stainless steel, with white enamel painted interior mounting panel.


13. Manufacturers:
   b. Robroy Industries.
   c. Wiegman.

E. Large Steel Box:

1. NEMA 250 Type 1 or 3R.

2. Box: 14-gauge steel minimum, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide gray finish as approved by Buyer’s Technical Representative (BTR).

3. Cover: Hinged with clamps.

5. Manufacturers:
   b. Robroy Industries.
   c. Wiegman.

2.5 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:
   1. Separate connection point for each conductor entering or leaving box.
   2. Spare Terminal Points: 25 percent, minimum.

2.6 METAL WIREWAYS

A. General:
   1. Meet requirements of UL 870.
   2. Cover: Removable, screw type.
   3. Knockouts: Without knockouts, unless otherwise indicated.

B. Ratings:
   1. NEMA Type 1 and 12: Steel-enclosed, lay-in type with rust inhibiting phosphatizing primer and grey baked powder coat finish and plated hardware. NEMA 12 shall have overlapping cover and neoprene gasketing.
   2. NEMA Type 3R: Steel-enclosed, lay-in type with rust inhibiting phosphatizing primer and grey baked powder coat finish, plated hardware, and overlapping cover edges.
   3. NEMA 4X: ASTM A167, Type 304 stainless steel, feed-through type with Type 316 stainless steel hardware.
C. Manufacturers:
   1. Hoffman.
   2. Square D.
   3. Circle AW.

2.7 ACCESSORIES

A. Identification Devices:
   a. Raceway Tags:
   b. Material: Permanent, polyethylene.
   c. Shape: Rectangular.
   d. Raceway Designation: Pressure stamped, embossed, or engraved.
   e. Tags relying on adhesives or taped-on markers not permitted.

2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge with detectable strip.
   b. Color: Red.
   c. Width: Minimum 3 inches.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.
   f. Manufacturers and Products:
      i. Panduit; Type HTDU.
      ii. Reef Industries; Terra Tape.

B. Heat Shrinkable Tubing:
   2. Semi-flexible with meltable adhesive inner liner.
4. Manufacturers:
   a. Raychem.
   b. 3M.

PART 3 EXECUTION

3.1 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors.
B. All installed Work shall comply with NECA Installation Standards.
C. Crushed or deformed raceways not permitted.
D. Maintain raceway entirely free of obstructions and moisture.
E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
H. Group raceways installed in same area.
I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.
J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
L. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.
M. Install watertight fittings in outdoor, underground, or wet locations.
N. Paint threads and cut ends before assembly of fittings, galvanized conduit, and PVC-coated galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
P. Do not install raceways horizontally in concrete equipment pads.

Q. Do not install raceways in foundations or beams without structural approval and detail.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.2 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including all fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by BTR.

E. Slabs and Walls:
   1. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
   2. Install within middle two-fourths of slab or wall.
   3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
   4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
   5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1-inch.
   6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.

F. Columns and Beams:
   1. Trade size of conduit not to exceed one-fourth of beam thickness.
   2. Conduit cross-sectional area not to exceed four percent of beam or column cross section.
3.3 CONDUIT APPLICATION


B. Exterior, Exposed (except on Power and Lighting Poles):
   1. Rigid galvanized steel.
   2. PVC-coated rigid galvanized steel.

C. Exterior, On Power and Lighting Poles
   1. As shown on Drawings

D. Direct Earth Burial:
   1. PVC-coated rigid galvanized steel.

E. Embedded in Concrete or Under Slab-on-Grade:
   1. PVC-coated rigid galvanized steel.

F. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.


3.4 FLEXIBLE CONNECTIONS

A. For motors, electrically operated valves, instrumentation, and other locations approved by BTR where flexible connection is required to minimize vibration:
   3. Wet or Corrosive Areas: Flexible, nonmetallic liquid-tight.

B. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

3.5 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members not permitted.
3.6 **SUPPORT**

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Application/Type of Conduit Strap:
   1. Rigid Steel or EMT Conduit: Zinc coated steel, pre-galvanized steel or malleable iron.
   2. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
   3. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   5. Location/Type of Hardware:
      a. Dry, Noncorrosive Areas: Galvanized.
      b. Wet, Noncorrosive Areas: Stainless steel.
      c. Corrosive Areas: Stainless steel.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.7 **BENDS**

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Install with symmetrical bends or cast metal fittings.

C. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
D. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

E. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

F. PVC Conduit:
   2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
   3. Use manufacturer’s recommended method for forming smaller bends.

G. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.8 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 25°F maximum temperature variation.

C. Install in accordance with manufacturer’s instructions.

3.9 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.
3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer’s instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating. Coating repairs require approval by BTR.

C. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer’s instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.

2. Stainless steel wireway in indoor wet, outdoor, and corrosive locations.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer’s premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:

   a. Install insulated bushing on ends of conduit where grounding is not required.

   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.

   d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.

   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.


4. Flexible Metal Conduit: Provide one or two screw type, insulated, malleable iron connectors.

5. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

6. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.

7. PVC Schedule 40 and 80 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

3.13 SWITCHBOARD AND FREE-STANDING ENCLOSURES:

1. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

2. Terminate PVC conduit entering bottom with bell end fittings.

3.14 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts. Provide survey coordinates on final routing.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
G. Transition from Underground to Exposed: Rigid galvanized steel or PVC-coated or rigid steel conduit.

H. Installation with Other Piping Systems:
   1. Crossings: Maintain minimum 12-inch vertical separation.
   2. Parallel Runs: Maintain minimum 12-inch separation.
   3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints, apply wraparound duct band with one-half tape width overlap to obtain two complete layers or apply heat shrinkable tubing.

J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.

K. Provide deflectional/expansion fittings in conduit runs that exit building or structure below grade. Conduit from building wall to fitting shall be PVC-coated rigid steel.

L. Maintain minimum 4 inches of cover below building slabs and structural beams for underground conduit installations to allow for compaction requirements.

M. Backfill:
   1. As specified in Section 31 23 00, Trench Backfill. Controlled low strength fill is an acceptable bedding and pipe zone material and backfill material to within 12 inches of the surface.

      a. Do not backfill until inspected by electrical inspector.

3.15 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:
   1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.

C. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.

D. Switch and Receptacle: Minimum 2-inch by 4-inch device box.
3.16 LOCATIONS

1. Drawing locations are approximate.

2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by BTR.

3. Light Switch: Install on lock side of doors.

4. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

B. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference. Do not straddle CMU block or other construction joints. Coordinate new locations with BTR.

2. Light Switch: 48 inches above floor.

3. Convenience Receptacle:
   a. Outdoor, All Areas: 48 inches above finished grade.

4. Special-Purpose Receptacle: 48 inches above floor or as shown.
   a. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

C. Install plumb and level.

D. Support boxes independently of conduit by attachment to building structure or structural member.

E. Install galvanized mounting hardware in industrial areas.

F. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

G. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
3.17  JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. At or Below grade:
   1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
   2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   3. Obtain BTRs written acceptance prior to installation in paved areas, roadways, or walkways.
   4. Use boxes and covers suitable to support anticipated weights.

J. Mounting Hardware:
   1. Noncorrosive Dry Areas: Galvanized.
3.18 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.
B. Provide PVC plug with pull tab for underground raceways with end bells.
C. Provide nylon pull cord.
D. Identify, as specified in Section 3.19, Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.19 IDENTIFICATION DEVICES

A. Raceway Tags:
   1. For exposed raceways, install tags at each terminus, near midpoint, of runs less than 10 feet.
   2. Install tags at each terminus for concealed raceways.
   3. Provide two nylon straps for attachment.
   4. Locate conduit tags such that they are visible from the floor or grade.
B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

3.20 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.
B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.
C. Touch up painted conduit threads after assembly to cover nicks or scars.
D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers’ instructions until time of use.

END OF SECTION 26 05 33
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Section, in conjunction with other Division 26 Sections, covers the Work necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test identification for electrical systems.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Code of Federal Regulations (CFR)

29 CFR 1910.145 Danger and Caution Specifications

B. American National Standards Institute (ANSI)

Z535.1 Safety Color Code
Z535.2 Environmental and Facility Safety Signs
Z535.3 Criteria for Safety Symbols and Labels
Z535.4 Product Safety Signs and Labels
Z535.5 Safety Tags and Barricade Tapes (for Temporary Hazards)

C. Hanford Documents

CHPRC-02426 Permanent Load Calculation

D. International Standards Organization (ISO)

3864 Graphical Symbols Package
E. National Fire Protection Association (NFPA)

   70®\(^{24}\) National Electrical Code®\(^{24}\) (NEC®\(^{24}\))

   70E®\(^{24}\) Standard for Electrical Safety in the Workplace

F. Underwriters Laboratories (UL)

   969 Marking and Labeling Systems

1.3 SUBMITTALS

See Statement of Work.

1.4 QUALITY ASSURANCE

See Statement of Work.

1.5 DELIVERY, STORAGE, AND HANDLING

See Statement of Work.

1.6 PROJECT CONDITIONS

See Statement of Work.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of the NEC, NFPA 70E, and 29 CFR 1910.145.


PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted, as approved by the Buyer’s Technical Representative (BTR).

2.2 COMPONENT IDENTIFICATION TAGS

A. Furnish component identification tags as specified and scheduled on the Drawings.

B. Provide tags made of materials shown on the drawings.

\(^{24}\) NFPA 70, National Electrical Code, NEC, and NFPA 70E are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
2.3 EQUIPMENT NAMEPLATES
   A. Furnish equipment nameplates as specified or scheduled on the Drawings.

2.4 WIRE MARKERS
   A. Provide wire markers for power and control circuit wires.
   B. Furnish split sleeve, heat-shrinkable sleeve.
   C. Locate a wire marker on each conductor at each pull box, junction box, and each load connection.
   D. Manufacturer: LEM Products, Inc., Brady®\textsuperscript{25}, Panduit®\textsuperscript{26}.

2.5 VOLTAGE MARKERS
   A. Furnish voltage markers for each pull box and cabinet.
   B. Provide flexible pressure sensitive vinyl markers with minimum 1-in. x 4-in. orange background and black letters.
   C. Provide voltage markers with lettering indicating the highest voltage present:
      1. 480Y/277V and 480V systems: 480V.
      2. 120/240V and 240V systems: 240V.
   D. Manufacturer: Electromark®\textsuperscript{27}, LEM Products, Inc.

2.6 WORKING SPACE LABELS
   A. Provide labels indicating required working clearance at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.
   B. Material:
      1. Use polyester label stock that is NRTL-recognized to UL 969 and has a high-adhesion adhesive back.
      2. Use printing ribbon recommended by the label stock manufacturer.

\textsuperscript{25} Brady is a registered trademark of Garmeuse Lime, Inc., Pittsburgh, Pennsylvania.
\textsuperscript{26} Panduit is a registered trademark of Panduit Corporation, Tinley Park, Illinois.
\textsuperscript{27} Electromark is a registered trademark of Brady Worldwide, Inc., Milwaukee, Wisconsin.
3. Use a suitable thermal transfer process label-printing machine to generate labels and enter the application-specific information.

4. Outdoor labels shall be suitable for a high-UV environment.

C. Minimum dimensions: 3-1/2 x 1-1/4 in.

D. Use the following label design:

   ![Label Design]

1. Signal word: “NOTICE” in 24-point minimum white italic letters on safety blue panel.

2. Word message: 16-point minimum black or safety blue letters on white background.
   a. Word message for 480V and 480Y/277V equipment with exposed live parts on one side of the working space and no live parts on the other side of the working space: “Keep area in front of this electrical equipment clear for 3-1/2 feet. OSHA-NEC regulations.”
   b. Word message for 480V and 480Y/277V equipment with exposed live parts on both sides of the working space: “Keep area in front of this electrical equipment clear for 4 feet. OSHA-NEC regulations.”
   c. Word message for 120/240V equipment with exposed live parts on both sides of the working space: “Keep area in front of this electrical equipment clear for 3 feet. OSHA-NEC regulations.”

E. Manufacturer: Brother, Seton®28, Brady.

2.7 UNDERGROUND WARNING TAPE

A. Furnish underground warning tape for underground cables and conduits.

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28 Seton is a registered trademark of Seton Name Plate Corporation, New Haven, Connecticut.
B. Use 6-in. wide, 0.004-in. thick, polyethylene detectable underground warning tape black lettering and the following background colors:
   1. Electric: Red

C. Provide lettering that indicates the type service buried below.
   1. Electric: “CAUTION ELECTRIC LINE BURIED BELOW”

D. Manufacturer: Utility Safeguard®29, LLC.

2.8 CONDUIT LABELING
A. Conduit metal tags shall be affixed to all numbered conduit. Conduit numbers are shown on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine surfaces to receive identification products for compliance with installation tolerances and other conditions affecting performance of the identification products. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL
A. Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Install electrical identification products only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

D. Clean surface where electrical identification product is to be placed.

E. Use manufacturer’s recommended adhesive for engraved tags and nameplates.

F. Place electrical identification products centered and parallel to equipment lines.

29 Utility Safeguard is a registered trademark of Full Source LLC, Jacksonville, Florida.
3.3 COMPONENT IDENTIFICATION TAGS

A. Install component identification tag as indicated on the Drawings on the front of each piece of electrical equipment.

B. Position tags so they can be read from ground.

3.4 EQUIPMENT NAMEPLATES

A. Install equipment nameplate or nameplates as indicated on the Drawings on the front of each piece of electrical equipment.

B. Position nameplates so they can be read from floor or ground.

3.5 WIRE MARKERS

A. Install wire markers on power and control conductors at each appearance in locations such as control cabinets and load connections.

B. Position markers so they can be read from the front of the enclosure.

3.6 WORKING SPACE LABELS

A. Install working space labels on any equipment likely to require examination, adjustment, servicing, or maintenance while energized.

B. Position labels so they can be read from floor or ground.

3.7 UNDERGROUND WARNING TAPE

A. Install underground warning tape in trench above underground conduit, 6-in. minimum below ground surface.

END OF SECTION 26 05 53
PART 1  GENERAL

1.1 SUMMARY OF WORK

A. This Section covers the Work necessary to commission the electrical system. Work in this Section is the responsibility of the Contractor and the qualified testing firm.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Institute of Electrical and Electronics Engineers (IEEE)


C2 National Electrical Safety Code

B. InterNational Electrical Testing Association (NETA)

ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (ATS)

C. National Fire Protection Association (NFPA)

70® National Electrical Code®

70E® Standard for Electrical Safety Requirements for Employee Workplaces

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30 NFPA 70, National Electrical Code, NFPA 70E, and NFPA 101 are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
1.3 SUBMITTALS

A. For Information Only Submittals:
   1. Submit 30 days prior to performing inspections or tests:
      a. Schedule for performing inspection and tests.
   2. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
   3. Operation and Maintenance Data:
      a. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

1.5 DELIVERY, STORAGE AND HANDLING

A. See Statement of Work.

1.6 PROJECT CONDITIONS

A. See Statement of Work.

1.7 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment herein listed has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment shall be:
   1. Scheduled with CH2M HILL Plateau Remediation Company (CHPRC) prior to de-energization.
   2. Minimized to avoid extended period of interruption to the operating plant equipment.
D. Notify CHPRC at least 48 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS

See Statement of Work.

PART 3 EXECUTION

3.1 GENERAL

A. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer’s tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer’s recommendations.

C. Adjust mechanisms and moving parts of equipment for free mechanical movement.

D. Verify nameplate data for conformance to Contract Documents and approved Submittals.

E. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer’s recommendations, or as otherwise specified in NETA ATS.

F. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

G. Provide proper lubrication of applicable moving parts.

H. Inform Buyer’s Technical Representative (BTR) of working clearances not in accordance with NFPA 70.
I. Investigate and repair or replace:
   1. Electrical items that fail tests.
   2. Active components not operating in accordance with manufacturer’s instructions.
   3. Damaged electrical equipment.

J. Electrical Enclosures:
   1. Remove foreign material and moisture from enclosure interior.
   2. Vacuum and wipe clean enclosure interior.
   3. Remove corrosion found on metal surfaces.
   4. Repair or replace, as determined by BTR, door and panel sections having dented surfaces.
   5. Repair or replace, as determined by BTR, poor fitting doors and panel sections.
   6. Repair or replace improperly operating latching, locking, or interlocking devices.
   7. Replace missing or damaged hardware.
   8. Finish:
      a. Provide matching paint and touch up scratches and mars.
      b. If required due to extensive damage, as determined by BTR, refinish entire assembly.

K. Identify and inform BTR of fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.2 CHECKOUT AND STARTUP

A. Voltage Field Test:
   1. Check voltage at point of supply system to project when installation is essentially complete and is in operation.
B. Equipment Line Current Tests:

1. Check line current in each phase for each panelboard.

2. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.3 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer’s instruction manual.

3. Check panelboard mounting, area clearances, and alignment and fit of components.

4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer’s instructions for proper torque values.

5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer’s instruction:

1. Insulation Resistance Tests:
   
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   
   b. Each phase of each bus section.
   
   c. Phase-to-phase and phase-to-ground for one minute.
   
   d. With breakers open.
   
   e. With breakers closed.
   
   f. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.4 **LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM**

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 4 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer’s minimum allowable bending radius.
   d. Color coding conformance with Specifications.
   e. Proper circuit identification.

2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.

3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.

4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.

B. Electrical Tests for Conductors No. 4 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
b. Test each conductor with respect to ground and to adjacent conductors for one minute.

c. Evaluate ohmic values by comparison with conductors of same length and type.

d. Investigate values less than 50 megohms.

2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low voltage cable tests may be performed by installer in lieu of independent testing firm. Record all results and include on final report.

3.5 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.

2. Proper operation of switch operating handle.

3. Adequate mechanical support for each fuse.

4. Proper contact-to-contact tightness between fuse clip and fuse.

5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.

6. Proper phase barrier material and installation.

7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.

8. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:

   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

   b. Phase-to-phase and phase-to-ground for one minute on each pole.

   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.6 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection for all circuit breakers.

B. Visual and Mechanical Inspection:
   1. Proper mounting.
   2. Proper conductor size.
   3. Feeder designation according to nameplate and one-line diagram.
   4. Cracked casings.
   5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
   6. Operate breaker to verify smooth operation.
   7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
   8. Verify that terminals are suitable for 75°C rated insulated conductors.

3.7 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:
   1. Visually check current, potential, and control transformers for:
      a. Cracked insulation.
      b. Broken leads or defective wiring.
      c. Proper connections.
      d. Adequate clearances between primary and secondary circuit wiring.
2. Verify mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Verify proper primary and secondary fuse sizes for potential transformers.

3.8 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard for proper connection and tightness.

2. Ground bus connections in panelboard for proper termination and tightness.

3. Effective dry-type transformer equipment grounding.

4. Accessible connections to grounding electrodes for proper fit and tightness.

5. Accessible compression connections grounding connections to verify that proper bonding was obtained.

B. Electrical Tests:

1. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1, for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

2. Neutral Bus Isolation:
   a. Test each neutral bus individually with neutral bonding jumper removed at separately derived system.
   
   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
   
   c. Investigate values less than 50 megohms.

END OF SECTION 26 08 00
PART 1 GENERAL

1.1 SUMMARY OF WORK
A. This Section covers the Work necessary to procure, detail, manufacture, deliver to the jobsite, install, startup, and test the wiring devices specified herein.

1.2 REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

B. Federal Specifications (FS)
   W-C-596 General Specification for Connector, Electrical, Power
   W-S-896F/GEN Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification)

C. National Electrical Manufacturers Association (NEMA)
   250 Enclosures for Electrical Equipment (1000 Volts Maximum)
   WD 1 General Requirements for Wiring Devices

D. National Fire Protection Association (NFPA)
   70®31 National Electrical Code®31 (NEC®31)

31 NFPA 70, National Electrical Code, and NEC are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.
E. Underwriters Laboratories (UL)

498 Standard for Attachment Plugs and Receptacles
508 Standard for Safety for Industrial Control Equipment
943 Standard for Ground-Fault Circuit-Interrupters
1449 Standard for Transient Voltage Surge Suppressors

1.3 SUBMITTALS

A. Approval Required Prior to Work Submittals: Manufacturer’s product data for wiring devices.

1.4 QUALITY ASSURANCE

A. See Statement of Work.

PART 2 PRODUCTS

2.1 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F/GEN.

2. Totally enclosed, ac type, with quiet tumbler switches and screw terminals.

3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contacts.

4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.


6. Color:

   a. Other Areas: White.

7. Automatic grounding clip and integral grounding terminal on mounting strap.
8. Manufacturers and Products, Industrial Grade:
   a. Arrow Hart; 2221 Series.
   b. Bryant; 4901 Series.
   c. Hubbell; 1222 Series.
   d. Leviton; 1221 Series.
   e. Or equal.

B. Switch, Motor Rated:
1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. Enclosure/Mounting and Rating:
   a. General Purpose:
      i. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. UL 508 listed.
      ii. General Purpose Rating: 30 amperes, 600V ac.
      iii. Minimum Motor Ratings:
         - 2 hp for 120V ac, single-phase, two-pole.
         - 3 hp for 240V ac, single-phase, two-pole.
         - 15 hp for 480V ac, three-phase, three-pole.
      iv. Screw-type terminals.
      v. Provide enclosure suitable for location with provisions for locking switch handle in the OFF position.
3. Manufacturers:
   a. General Purpose:
      i. Bryant.
      ii. Hubbell.
      iii. Leviton.
      iv. Or equal.
2.2 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596.

2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.

3. Impact resistant nylon cover and body.

4. One-piece mounting strap with integral ground contact (rivetless construction).

5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.


7. Size: For 2-in. by 4-in. outlet boxes.

8. Outdoor receptacles shall be listed as “Weather Resistant”

9. Industrial Grade:
   a. Color:
      i. Other Areas: White.
   b. Manufacturers and Products:
      i. Arrow Hart;
      ii. Bryant;
      iii. Hubbell;
      iv. Leviton;

B. Receptacle, Ground Fault Circuit Interruption:

1. Meet requirements of general-purpose receptacles.

2. Listed Class A to UL 943, tripping at 5 mA.


4. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.

6. Outdoor receptacles shall be listed as “Weather Resistant”

7. Manufacturers:
   a. Bryant.
   b. Hubbell.
   c. Arrow Hart.
   d. Leviton.
   e. Or equal.

C. Receptacle, Special-Purpose:
   1. Rating and number of poles as indicated or required for anticipated purpose.
   2. One matching plug with cord-grip features for each special-purpose receptacle.

2.3 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:
   1. Material: Specification grade, one-piece, 0.040-in. nominal thickness stainless steel.
   3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:
   1. Material: Malleable ferrous metal, with gaskets.
   2. Screw: Oval-head stainless steel.

D. Sheet Steel:
   1. Finish: Zinc electroplate.
E. Weatherproof:

1. Receptacles, Weatherproof Type 1:
   a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
   b. Mounting Screw and Cap Spring: Stainless steel.
   c. Manufacturers and Products:
      i. Crouse-Hinds; Type WLRD-1.
      ii. Appleton; Type FSK-WRD.

2. Switches:
   a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
   c. Manufacturers and Products:
      i. Crouse-Hinds; DS-181 or DS-185.
      ii. Appleton; FSK-1VTS or FSK-1VS.

F. Raised Sheet Metal: 1/2-in. high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

G. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast metal boxes.

PART 3 EXECUTION

3.1 SWITCHES

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, “Raceways and Boxes for Electrical Systems.”

2. Install with switch operation in vertical position.

3. Install single-pole, two-way switches so toggle is in up position when switch is on.
B. Switch, Motor Rated:
   1. Mounting Height: See Section 26 05 33, “Raceways and Boxes for Electrical Systems.”
   2. Install with switch operation in vertical position so toggle is in up position when ON.
   3. Install within sight of motor when used as a disconnect switch.

3.2 RECEPTACLES
A. Duplex Receptacles:
   1. Install with grounding slot up, except where horizontal mounting is shown, in which case install with neutral slot up.
   2. Ground receptacles to boxes with grounding wire only.
   3. Weatherproof Receptacles:
      a. Install in cast metal box.
      b. Install such that hinge for protective cover is above receptacle opening.
   4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.
   5. Special-Purpose Receptacles: Install in accordance with manufacturer’s instructions.

B. Multioutlet Surface Raceway System:
   1. Install in accordance with manufacturer’s instructions.
   2. Wire alternate outlets to each circuit where two-circuit, three-wire supply is shown.

3.3 DEVICE PLATES
A. Securely fasten to wiring device; ensure a tight fit to box.
B. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.
C. Install with alignment tolerance to box of 1/16 in.
D. Types (Unless Otherwise Shown):

1. Exterior:
   a. Switch: Weatherproof.
   b. Receptacle in DAMP location: Weatherproof Type 1.
   c. Receptacle in WET location: Weatherproof Type 2.

2. Interior:
   a. Flush Mounted Boxes: Metal.
   b. Surface Mounted, Metal Boxes:
      i. General Purpose Areas: Sheet Steel.
      ii. Other Areas: Cast.
   c. Surface Mounted, Aluminum Boxes:
      i. General Purpose Areas: Stamped.
      ii. Other Areas: Cast.
   d. Surface Mounted, Sheet Steel Boxes: Raised sheet steel.
   e. Surface Mounted, Nonmetallic Boxes: Manufacturer’s standard.
   f. Receptacle shown as Weatherproof on Drawings: Weatherproof Type 1.

END OF SECTION 26 27 26
PART 1   GENERAL

1.1 SUMMARY OF WORK

A. Earthwork operations associated with construction of the CSA and haul road improvements.

1.2 REFERENCES

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

D653   Standard Terminology Relating to Soil, Rock, and Contained Fluids

D1557   Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

D2922   Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

D6938   Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Code of Federal Regulations (CFR)

29 CFR 1926   Safety and Health Regulations for Construction

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. Qualifications for Soils Technician (field inspector).
C. Approval Not Required

1. Competent person: Before excavation and in writing, submit identity of individual designated Competent Person as defined in 29 CFR 1926.650 and as required by the approved safety and health program.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to CH2M HILL Plateau Remediation Company (CHPRC) Document Control.

<table>
<thead>
<tr>
<th>Document</th>
<th>Paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Place Density Tests</td>
<td>3.7.A</td>
</tr>
<tr>
<td>Soil Compaction Test Report</td>
<td>3.7.A</td>
</tr>
</tbody>
</table>

1.5 DELIVERY, STORAGE, AND HANDLING

See Statement of Work.

1.6 PROJECT CONDITIONS

A. Do not place backfill or fill on frozen ground.

1.7 PERMITS

A. Obtain and conspicuously post the following permits before starting work under this Section.


2. Excavation Permit: In accordance with Contract Statement of Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Use materials free of frozen particles, lumps, organic matter, and trash for backfill and fill, bedding, and stabilization.

B. Backfill and Fill: Obtain from excavation or locations designated by the Company.

1. Backfill using excavation (in-situ) material or 5/8 minus crushed rock.
2. Use of any other imported material will require CHPRC Field Work Supervisor approval.

C. Bedding for Underground Piping, Tubing, Conduit, and Utility Lines: Sand as defined in ASTM D653 or excavated sandy material having less than 20% gravel particles. Gravel particles shall have a maximum dimension of 1/2-in.

D. Location Marker: 3-in.-wide, detectable plastic tape imprinted with warning such as “CAUTION - BURIED INSTALLATION BELOW” at maximum 4-ft intervals. “Terra Tape Sentry Line 620” with “Terra Clips,” both by Reef Industries, or approved substitute.

E. Stabilization: Crushed rock with maximum fragment size of 3/4 in.

**PART 3 EXECUTION**

3.1 EXCAVATION

A. Excavation includes any operation in which earth, rock, or other materials below original grade is moved, removed, or otherwise displaced by means of any hand tools, mechanical equipment, or explosives. These requirements constitute the need for an “Excavation Permit” (Form A-7400-373). If an excavation permit is not required, this section does not apply.

B. Notify CHPRC Field Work Supervisor before excavation.

C. Locate and expose underground utilities using subsurface scanning and hand tools, or other methods if approved by the CHPRC Field Work Supervisor.

D. If cultural properties (e.g., bones and artifacts) are encountered, stop excavation and notify the Buyer. Obtain approval before resuming excavation.

E. If unexpected debris is encountered, stop excavation, clear personnel to 30 ft from debris, and notify the CHPRC Field Work Supervisor. Obtain approval before resuming excavation.

F. Excavation of contaminated soil will be administered in accordance with contractor procedures and programs.

G. Excavate earth and establish protective systems in accordance with the approved safety and health program.

3.2 CONTOURS AND ELEVATIONS

A. Excavation for Utility Trenches: Excavate to contours and elevations shown on Drawings. Excavate deep enough to allow laying utility lines at line and grade shown on the Drawings after placement and compaction of bedding. If excavation will be in undisturbed sand or if utility lines will be encased in
concrete, excavate to line and grade shown on the Drawings. Make trench wide 
enough to permit connection of utility lines. Excavate with near vertical sides 
from bottom of trench up to 12 inches above top of utility lines. Correct 
over-excavation by placing and compacting backfill and fill. Pare holes in trench 
bottoms for pipe couplings so pipe will bear full length of pipe barrel or 
pipe section.

B. Excavation for foundations and slabs: Excavate to depth shown on the Drawings. 
Make excavation wide enough to permit construction of forms and bracing. Make 
excavation bottom compact, level, true and free of loose material. Correct 
over-excavation by extending concrete down to undisturbed earth at time of 
concrete placement or by placing and compacting backfill and fill.

C. Excavation for Common Earthwork: Excavate as needed for general purpose, or 
as shown on Drawings.

D. In-Situ Soils

1. Salvage excavated soil for use as backfill and fill material.

2. Using nuclear density gauge, conduct in-place density tests or use existing 
testing laboratory reports (proctors) if backfill and compaction is to be 
completed via approved control procedure. Record results for use as 
standard density during backfill compaction (see Paragraph 3.6).

3. Dispose of contaminated and excess soil in accordance with Contract 
Documents.

4. If stabilization is required because of excavation, finish subgrade 3 in. 
below elevations shown on Drawings.

3.3 BACKFILL AND FILL PREPARATION

A. Remove debris and organic material from area to be backfilled or filled.

B. Do not backfill by sluicing or flooding unless written approval is obtained from 
CHPRC Field Work Supervisor.

3.4 BACKFILL AND FILL

A. Perform backfilling and filling in accordance with an approved soil compaction 
procedure (for example, Attachment 2).

B. Place specified common or native backfill in even, loose layers not more than 
8-in. deep.

C. Perform initial backfilling and filling in presence of CHPRC Field Work 
Supervisor.
D. Obtain test results (as applicable) and adjust compaction method, if required.

E. Obtain CHPRC Field Work Supervisor approval before proceeding with backfilling and filling.

3.5 BACKFILL AND FILL – FOUNDATIONS AND SLABS

A. Place loose layers of specified structural backfill and fill. Limit each layer that is 24-in. below finish grade to 8-in. depth. Limit each layer in top 24 in. to 4-in. depth.

B. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests in Paragraph 3.7.

3.6 BACKFILL AND FILL - UTILITY LINES

A. Before laying utility lines, place specified bedding in a 4 inch layer. Compact layer uniformly to 95% of maximum density as determined by specified compaction tests.

B. Keep trenches free of standing water during laying of utility lines.

C. After laying utility lines, ensure that lines have been pressure tested before backfilling and filling. Place loose 8 inch layers of specified bedding under haunches, around sides and up to 12 inches above top of utility line. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests. Exercise care during compaction to avoid pipe misalignment and to provide uniform bearing along pipe barrel.

D. Place loose 4 inch layers of backfill and fill in remaining trench depth. Use specified structural backfill and fill under foundations. Use specified common backfill and fill at other locations. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests.

E. Place specified location marker continuously and directly over buried utility lines at depth of 12 inches below finish grade. Place marker continuously and directly over each outside line of multiple lines and if spacing between outside line markers exceeds 4 feet place sufficient intermediate markers to maintain 4 feet maximum spacing between adjacent markers.

F. Prohibit passage of heavy construction equipment over buried utility lines until at least 24 inches of backfill and fill have been placed over lines and compacted or until bridging approved by Company has been placed across trenching.

3.7 FINISH GRADING AND STABILIZATION

A. Grade each area disturbed by work to blend into existing contours. Slope area to drain away from structures.
B. Rake each area to remove surface cobbles larger than 3 in. Dispose of excess material and debris as directed by the Buyer.

C. Stabilize area with minimum of 1-in. and maximum of a 3-in. course of specified stabilization material.

D. After finish grading and stabilization, remove surface markers and flags.

3.8 FIELD INSPECTIONS AND TESTS

A. Compaction Testing:

1. Test compacted backfill and fill at the following intervals.
   a. Backfill and fill: one test of each layer, each layer shall not exceed 8 in.

2. Perform compaction testing in accordance with the following standards. Provide report required by each standard.
      i. In-place density: ASTM D6938. Each layer shall be as dense as the existing soil density (Paragraph 3.1.H.2) and compacted uniformly to 95% of maximum density as established by compaction tests (per ASTM D1557).
      ii. Prior to completion of backfill, perform random surveillance to verify buried utility marker tape has been installed and record results.
SECTION 31 20 00 – ATTACHMENT 1

BACKFILL PERMIT FORM

Key to Backfill Permit Form

<table>
<thead>
<tr>
<th>Block Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Permit No. – Sequential number, developed by the Project; i.e., “5-0001.”</td>
</tr>
<tr>
<td>Project or Task Order No.</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td>Title</td>
<td>Project title.</td>
</tr>
<tr>
<td>Contract No.</td>
<td>Example – “22337 Release 5.”</td>
</tr>
<tr>
<td>Description of Backfill Work</td>
<td>Describe location of the backfill; i.e. “Conduit run 001, between Handhole-005 and Handhole-006.”</td>
</tr>
<tr>
<td></td>
<td>– Enter the applicable drawings that show the backfill location.</td>
</tr>
<tr>
<td></td>
<td>– Enter any other reference documents.</td>
</tr>
<tr>
<td>Approvals</td>
<td>– Discipline Foreman signature, signifying that their work in the excavation to be backfilled is complete. “N/A” will be entered if given discipline is not applicable to the specified backfill area.</td>
</tr>
<tr>
<td></td>
<td>– Quality Signature, signifying that all the quality requirements for the backfill area have been met prior to backfill and backfill may commence.</td>
</tr>
<tr>
<td></td>
<td>– Field Work Supervisor signature, signifying that all contract requirements for the backfill area have been met and backfill may commence.</td>
</tr>
<tr>
<td>Backfill Requirements</td>
<td>Enter backfill requirements, typically construction specification reference.</td>
</tr>
<tr>
<td>Authorization to Proceed</td>
<td>“Construction Representative,” this signature would be from the Construction Group, signifying that they agree that all of the requirements for the backfill area have been met and permission to proceed with backfill is granted.</td>
</tr>
<tr>
<td></td>
<td>– Date that “Construction Representative” signed off the form.</td>
</tr>
<tr>
<td></td>
<td>– Date that the applicable discipline foreman, Quality and Field Work Supervisor signed the form.</td>
</tr>
<tr>
<td>Description of Backfill Work</td>
<td>Approvals</td>
</tr>
<tr>
<td>------------------------------</td>
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<tr>
<td>Electrical -</td>
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<td>Piping -</td>
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<td>Carpentry -</td>
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<td>Concrete -</td>
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<td>Layout -</td>
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<td>Other ( )</td>
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<td>Other ( )</td>
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<tr>
<td>Quality Control -</td>
<td></td>
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<tr>
<td>Superintendent -</td>
<td></td>
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<thead>
<tr>
<th>Backfill Requirements</th>
<th>Authorization to Proceed</th>
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<tr>
<td>[ ] Nonstructural</td>
<td></td>
</tr>
<tr>
<td>[ ] Structural</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Construction Engineer</th>
<th>Date</th>
</tr>
</thead>
</table>
SECTION 32 11 23
AGGREGATE FOR GRAVEL BASE

PART 1  GENERAL

1.1  SUMMARY OF WORK

A. Aggregate base course under asphalt.

B. Aggregate for ground surface.

1.2  RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

The following documents and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM D1557  Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort

ASTM D2922  Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

B. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10  Standard Specifications for Road, Bridge, and Municipal Construction

1.3  SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

1.4  QUALITY ASSURANCE

A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Document Control in accordance with Contract Documents.

<table>
<thead>
<tr>
<th>Document</th>
<th>Paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate grading results</td>
<td>2.2.A; 2.2.B</td>
</tr>
</tbody>
</table>
1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

PART 2 PRODUCTS

2.1 SUBSTITUTION

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Aggregate for base and top courses under asphalt surface: WSDOT M 41.10, Section 9-03.9(3), Crushed Surfacing and 9-03.10, Aggregate for Gravel Base.

B. Aggregate for gravel-surfaced parking lots and general areas: WSDOT M 41.10, Section 9-03.9(4), Maintenance Rock (5/8 minus).

PART 3 EXECUTION AGGREGATE BASE COURSE

A. Hauling and Placing: Transport aggregate to the work site, add water to obtain proper moisture content, and place on prepared surface.

B. Thickness and Number of Layers

1. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.

2. If the required compacted depth of the base course exceeds six inches, construct in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed six inches.

C. Compacting and Shaping

1. Compact each layer of material placed in shoulder and base areas by rollers. Produce a uniform texture and firmly key the aggregates. Apply water over the materials for proper compaction. Continue compaction until there is no reaction or yielding observed under the compactor.

2. Compact each lift to a minimum of 95 percent of maximum dry density as determined by ASTM D1557.

3. Measure in-place density of compacted aggregate base course in accordance with ASTM D2922.

4. Surface Tolerance: The finished top of base course, when tested with a Contractor-furnished 12-foot straightedge, must not vary from the testing edge by more than 0.08 foot at any point, and must be within 0.08 foot of specified grade.
3.2 PARKING LOT AND GENERAL AREA GRAVEL

A. Hauling and Placing: Transport aggregate to the work site, add water to obtain proper moisture content, and place on prepared surface.

B. Placing and Compacting

1. Place each layer in spreads as wide as practical and to the full width of the course.

2. Compact with rollers or tampers to produce a uniform surface at the specified grade and firmly key the aggregates. Apply water over the materials for proper compaction. Continue compaction until there is no reaction.

C. Surface Tolerance: The finished top of base course, when tested with a Contractor-furnished 12-foot straightedge, must not vary from the testing edge by more than 0.08 foot at any point, and must be within 0.08 foot of specified grade.

3.3 FIELD INSPECTIONS AND TESTS

A. Perform testing required by Paragraphs 3.1 and 3.2.

3.4 PROTECTION

A. Traffic Control: Institute and maintain in accordance with WSDOT M41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 11 23
SECTION 32 12 00
HOT MIX ASPHALT PAVING

PART 1  GENERAL

1.1  SUMMARY OF WORK

A.  Asphalt roadways.

1.2  RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the contract, including General and Supplementary
Conditions and Division 01 Specification Sections apply to this Section.

The following documents, and others referenced herein, form part of the Contract to the
extent designated in this Section.  Referenced documents are those current as of the date
of this Section unless otherwise indicated.

A.  ASTM International (ASTM)

ASTM D977   Standard Specification for Emulsified Asphalt
ASTM D2041  Test Method for Theoretical Maximum Specific
            Gravity and Density of Bituminous Paving Mixtures
ASTM D2397  Standard Specification for Cationic Emulsified
            Asphalt
ASTM D2950  Standard Test Method for Density of Bituminous
            Concrete in Place by Nuclear Methods

B.  Asphalt Institute (AI)

AI MS-22   Construction of Hot Mix Asphalt Pavements

C.  Washington State Department of Transportation (WSDOT)

WSDOT M 41-10   Standard Specifications for Road, Bridge, and
                Municipal Construction

1.3  SUBMITTALS

A.  See Contract Statement of Work for submittal procedures.

B.  Approval Required

1.  Product data for each type of product listed in Paragraph 2.2.
2. Inspector qualifications: Before performance of any work, submit inspector qualifications in accordance with Section 1.4 of this Specification.

3. Traffic control: Before use, submit sketches showing traffic control, including temporary signing and routing.

1.4 QUALITY ASSURANCE

A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Document Control in accordance with Contract Documents.

<table>
<thead>
<tr>
<th>Document</th>
<th>Paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-emergent herbicide</td>
<td>2.2.A</td>
</tr>
<tr>
<td>Mix design of asphalt mixture</td>
<td>2.2.B</td>
</tr>
<tr>
<td>Asphalt mix test reports</td>
<td>2.2.B</td>
</tr>
<tr>
<td>Field inspection results</td>
<td>3.5.A</td>
</tr>
</tbody>
</table>

B. Pre-emergent herbicide must be applied by applicator certified in the State of Washington.

C. Qualification of Inspectors: A certified independent testing agency shall perform all required inspections and testing and shall meet the requirements set forth in the respective Sections of WSDOT M 41-01 and M 41-10.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

PART 2 PRODUCTS

2.1 SUBSTITUTION

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Pre-emergent herbicide: Selective-type control chemical meeting the requirements of WSDOT M41-10. Section 5-04.3(5)D.

B. Asphalt: In accordance with WSDOT M41-10, Section 5-04 and Section 9-02. Grade of paving asphalt for use in asphalitic concrete paving (ACP) mixture shall be performance grade (PG) 70-28.
C. Tack Material: Emulsified asphalt meeting requirements of ASTM D977, Grade SS-1h or ASTM D2397, Grade CSS-1h.

D. Aggregate: Hot mix asphalt, class 1/2 inch, in accordance with WSDOT M41-10, Section 9-03.8.

2.3 MIXES

A. Mix Design: The contractor shall use a previously approved WSDOT mix design. The asphalt mix shall be in accordance with WSDOT M41-10, Section 5-04.3(7)A.

B. Proportioning of Materials: Hot mix asphalt, class 1/2 inch, in accordance with WSDOT M41-10, Section 9-03.8(6).

PART 3 EXECUTION

3.1 APPLICATION

A. After obtaining submittal approvals, verify top course elevations and begin ACP placement. Perform work in accordance with the following sections of WSDOT M41-10.

- Asphalt mixing plants: Section 5-04.3(1)
- Existing surface conditioning: Section 5-04.3(5)
- Asphalt material heating: Section 5-04.3(6)
- Aggregate preparation: Section 5-04.3(7)
- Mixing: Section 5-04.3(8)
- Spreading and finishing: Section 5-04.3(9)
- Compaction: Section 5-04.3(10)
- Joints: Section 5-04.3(12)
- Samples: Section 5-04.3(11)
- Surface smoothness: Section 5-04.3(13)
- Weather limitations: Section 5-04.3(16)

3.2 FIELD QUALITY CONTROL

A. Site tests:

1. When tested with a 12-foot straightedge, surface of completed work shall not contain irregularities in excess of ¼ inch.

2. Conduct in-place density testing using a nuclear gauge in accordance with ASTM D2950.
B. Laboratory tests:

1. Perform one test series for every 5000 square feet of paving, unless otherwise directed by the Field Engineer. Test reports will show compliance by examining depth and density of paving and materials used. Test procedures will be included with the test results.

2. Replace and compact hot mix asphalt where core tests were taken.

3. Remove and replace or install additional hot mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.3 PROTECTION

A. Traffic Control: Institute and maintain in accordance with WSDOT M41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 12 00
PART 1  GENERAL

1.1  SUMMARY OF WORK

A. Pavement markings.

1.2  REFERENCES

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

The following documents, and others referenced herein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)
   ANSI D6.1 Manual on Uniform Traffic Control Devices for Streets and Highways

B. Washington State Department of Transportation (WSDOT)
   M41-10 Standard Specifications for Road, Bridge, and Municipal Construction

   WSDOT QPL Qualified Product List

1.3  SUBMITTALS

A. See contract Statement of Work for submittal procedures.

B. Approval Required.

   1. Pavement marking: Before delivery, submit complete list of materials, colors, and location to be used. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material.

   2. Traffic control: Before use, submit sketches showing traffic control, including temporary signing and routing.
1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Contract Statement of Work.

B. Store products in manufacturer’s unopened packaging, with labels intact, until ready for installation.

C. Store materials in accordance with manufacturer’s recommendations.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Pavement Marking: Low volatile organic compound solvent-based paint in accordance with WSDOT M41-10, Section 9-34.2(4), or low volatile organic compound waterborne paint in accordance with WSDOT M41-10, Section 9-34.2(5), using WSDOT QPL-listed manufacturer. Glass beads in accordance with WSDOT M41-10, Section 9-34.4, using WSDOT QPL-listed manufacturer.

PART 3 EXECUTION

3.1 APPLICATION


3.2 PROTECTION

A. Traffic Control: Institute and maintain in accordance with WSDOT M41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 17 23
PART 1       GENERAL

1.1 SCOPE OF WORK

   A. Fence framework, fabric, and accessories.
   B. Gates.
   C. Electrical grounding.

1.2 REFERENCES

   Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

   The following documents, and others referenced herein, form a part of the contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

   A. American Society of Testing and Materials (ASTM)

      A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
      A123 Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
      A392 Standard Specification for Zinc-Coated Steel Chain Link Fence Fabric
      B8 Standard Specification for Concentric-Lay Stranded Copper Conductors
      F626 Standard Specification for Fence Fittings
      F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

   B. American National Standards Institute

      ANSI/BHMA A156.3 American National Standard for Exit Devices
C. Underwriters Laboratory

UL 305 Standard for Panic Hardware

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. Panic hardware: Data sheets.

1.4 QUALITY ASSURANCE

A. The Seller is responsible for maintaining quality and shall perform in-process and final inspection of his work and all sub-tier contractors’ work as required within this Specification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle structural materials without damaging finish.

B. Deliver manufactured materials in original unopened packages, containers, or bundles with manufacturer’s label intact and legible.

C. Store materials off ground, under cover, and away from damp surfaces.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fabric: ASTM A392, Class 1, zinc coated (1.2 oz), steel wire/fabric, 2-in. mesh size, 9-gage coated wire size, galvanized before weaving, with twisted barbed selvages top and bottom.

B. Posts, Rails & Braces: ASTM F1083 galvanized steel pipe.

C. Galvanizing: ASTM A123, unless otherwise indicated, provide hot-dipped, zinc-coated accessories of ferrous material with weight of zinc coating not less than 1.2 oz per sq/ft.

D. Barbed Wire: ASTM A121 metallic coated steel, Type Z zinc coating strand wire, 2-1/2 gage (0.099 in.) steel wire, 4 barb points, 14 gage (0.080 inches) spaced on 5 in. centers.

E. Fence Fittings: ASTM F626, Standard Specification for Fence Fittings, type and components as noted.
F. Panic Hardware: Outdoor rated touchbar type with panic shield, key cylinder, key box, and lever style handle meeting the requirements of UL 305 and ANSI/BHMA A 156.3.

2.2 BASIC FENCE SYSTEM COMPONENTS

A. Terminal Posts (Angles, corners, ends, and pull posts): 2-1/2 in. Schedule 40 for fence height up to 8 ft and 3 in. Schedule 40 for fence height over 8 ft and equal to or under 16 ft.

B. Line Posts: 2-in. Schedule 40 for fabric height up to 8 ft; 2-1/2 in. Schedule 40 for fabric height over 8 ft and equal to or under 16 ft.

C. Braces at Terminal or Gateposts: 1-1/4 in. Schedule 40.

D. Tension Rods: 3/8 in. diameter galvanized steel with turnbuckle end-fitting-type tighteners.

E. Tension Wire: 7-gage coil spring, hard tempered carbon steel wire.

F. Tension Bars: 3/4 x 1/4-in. thick galvanized steel.

G. Tension Bands: 3/4 x 1/10 in. (nominal) galvanized steel offset bands.

H. Brace Bands: 3/4 x 1/10-in. (nominal) thick galvanized steel.

I. Brace Ends: Cupped fittings of formed steel or cast iron with ears for attaching horizontal braces to brace bands and for connecting diagonal tension rods.

J. Wire Ties: Galvanized steel with a diameter of at least 0.148 in.

K. Post Caps: Formed steel, malleable cast iron, or aluminum, sized to post diameter, with set screw retainer.

L. Barbed Wire Extension Arms: Galvanized pressed steel, type as specified.

M. Gate Posts:
   1. Gate leaf-widths up to 6 ft: 2-1/2 in. Schedule 40.

N. Gate Frames:
   1. Gate leaf-widths less than 10 ft: 1-1/2 in. Schedule 40.

O. Provide non-lift-off type gate hinges sized for gate of adequate strength with large rearing surface for clamping in position so that hinges do not easily twist or turn with gate action.
2.3 FENCE GROUNDING

A. Grounding Cable: No. 4/0 AWG bare, stranded, soft temper copper cable conforming to ASTM B8, Standard Specification for Concentric-Lay Stranded Copper Conductors.

B. Flexible Braid: Tinned copper braid with tinned copper ferrules; minimum 250 ampere rating; 12 in. minimum length. O-Z/Gedney Type FB.

C. Cable to Pipe Clamps: National Recognized Testing Laboratory (NRTL) listed copper alloy connectors with silicon bronze hardware for making cable to pipe connections. O-Z/Gedney Type ABG 1-1/2 in. and smaller, Type CG 2 in. and larger pipe diameter.

D. Flexible Braid to Pipe Clamps: NRTL listed copper alloy connectors with silicon bronze hardware for making braid or copper bar to pipe connections. O-Z/Gedney Type RG.

2.4 CONCRETE

A. Concrete: Concrete for fence posts shall have a minimum specified 28 day compressive strength of 3000 psi. Testing is not required.

PART 3 EXECUTION

3.1 PREPARATION

A. Notify Buyer’s Technical Representative (BTR) ten working days prior to start of construction to identify known utilities and stake and flag locations.

B. Before installing chain-link fence, perform site clearing and grading as noted on Drawings.

C. Allow footings to cure minimum three days before installing fabric and other materials.

3.2 POSTS

A. Space line posts equidistant at intervals not exceeding 10 ft. Measure interval parallel to grade of proposed fence and in line of fence from center to center of post.

B. Set terminal posts (end, corner, and gate) at beginning and end of each continuous length of fence and at abrupt changes in vertical and horizontal alignments.

C. Set fence and gate posts in concrete in holes of diameter and depth as follows:

1. Minimum Diameter: Four times outside diameter of post.
2. Minimum Depth: 36 in. plus an additional 3 in. for each 1 ft increase in fence height over 4 ft.

D. Set posts in a vertical position, plumb and in line. Backfill concrete into excavation and extend 2 in. above grade. Crown concrete at top to shed water and extend minimum of 2 in. below bottom of post.

E. Provide tension offset bands fitted around terminal posts at maximum 15 in. intervals to attach tension bars to posts.

F. Provide brace center band to secure brace ends and tension rods to post.

3.3 FABRIC

A. Place chain-link fabric on outside of area enclosed. Locate posts, bracing, and other structural members on inside of secured perimeter.

B. Place fabric by securing one end, applying sufficient tension to remove slack before making attachment elsewhere. Tighten fabric to provide smooth uniform appearance free from sag.

C. Cut fabric by untwisting a picket and attach each span independently at terminal posts. Use stretcher bars with tension bands at maximum 15 in. intervals or any other approved method of attachment.

D. Install fence fabric 2 in. maximum above ground level. Fasten fabric to line posts at intervals not exceeding 15 in. Fasten fabric to rail or tension wire at intervals not exceeding 24 in.

E. Join rolls of wire fabric by weaving a single picket into ends of rolls to form continuous mesh.

F. Provide continuous length tension bars equal to fence height and located wherever chain link fabric end attaches to terminal post. Thread bars through fabric ends for full height, and attach to posts by tension bands.

G. Provide wire ties for attaching chain link fabric to tension wires at maximum 18 in. centers and fence posts at maximum 24 in. centers.

3.4 TENSION WIRE AND RAIL

A. Provide bottom tension wire and stretch wire from end to end of each stretch of fence at height that will enable it to be fastened to fabric.

B. Stretch tension wire taut (not to exceed 6 in. sideways deflection) between terminal posts for securing fence fabric within 2 in. of bottom with hog rings at 18 in. on center, secure with wire ties to every third post minimum.
C. Provide top rail and support at each post so that a continuous brace from end to end of each stretch of fence is formed. Securely fasten top rail to terminal posts and join with sleeves or coupling to allow for expansion and contraction. Secure fabric to top rail.

3.5 BARBED WIRE

A. Fencing: Top fencing with three strands of barbed wire on each outrigger. Provide single 45-degree outriggers. Angle single outrigger away from secured area.

B. Pull taut to remove sag, firmly install barbed wire in slots of extension arms, and secure to post or terminal arm.

C. Gate: Install barbed wire strands at 6 in. on center between extended gate frame members above gate fabric.

3.6 GATES

A. Install gates true to opening and plumb in closed position. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation.

B. Gate posts shall be spaced according to the manufacturers’ gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application, weight, height, and number of gate cycles. The manufacturers’ gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer’s recommendations.

C. Hang gates so that bottom of gate is as close to ground as practical (2 in. max.) while allowing sufficient clearance for free operation through at least 90 degrees in one direction from closed position.

D. Fasten gate fabric to vertical (end) gate frame members using tension bars and bands as for fence fabric. Fasten fabric to top and bottom gate frame members and to intermediate braces with 11-gage wire ties or clips at minimum spacing of 14 in. on center.

E. Extend end frame members 18 in. vertically above top member of gate frame to support barbed wire.

F. Provide tension rods as diagonal braces on gates and secure rods at gate corner only.
3.7 **LATCHES**

A. Single gates less than 10-ft wide may use forked type latches.

B. Arrange plunger bars and rods so that they engage gate stops and cannot be raised when locked.

C. Rigidly weld brackets for plunger bars holders to inactivate leaves.

D. Arrange latching mechanisms at double gates so one padlock can lock both gate leaves at center latch integral to gate.

E. Install keepers consisting of a mechanical device for securing free end of gate when in full open position.

3.8 **GENERAL REQUIREMENTS**

A. Once in place, peen or spot-weld fence hardware to prevent easy removal.

B. Coat damaged galvanized finish with zinc-enriched paint.

C. Leave area of installation neat and free of debris caused by erection of fence.

3.9 **ELECTRICAL GROUNDING**

A. Bond gateposts on both sides of gate openings using direct buried grounding cable and cable to pipe clamps. Bond gateposts to gates using flexible braid and flexible braid to pipe clamps. Ground posts on both ends of gates; steel posts set in concrete will be considered as adequately grounded.

B. Ground permanent metallic fences crossed by overhead power at every third post for a distance of 50 ft from the crossing; chain link fences with steel post set in concrete will be considered as adequately grounded.

3.10 **EXCAVATION, BACKFILL, AND COMPACTION**

A. Refer to Section 31 20 00, “Earth Moving.”

3.11 **SIGN INSTALLATION (GFE)**

A. Install government furnished property signs or no trespassing signs in areas as indicated by the BTR.

B. Signs will generally be 24 in. x 24 in. or smaller and shall be attached to the wire fabric by the use of, as specified, hog rings.

C. General sign locations will be located on all gates, 25 ft each side of gates, trail crossings, and at visible distances along the fence line, not to exceed 300 ft.
3.12 TESTING

A. The complete gate systems shall be adjusted to assure they are performing properly. Test gate through a minimum of ten full cycles and adjust to ensure operation without binding, scraping or uneven motion.

END OF SECTION 32 31 13
PART 1  GENERAL

1.1 SUMMARY OF WORK

A. Raw/fire water.

1.2 RELATED DOCUMENTS, CODES, AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents, and others referenced herein form part of Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)
   ANSI Z535.1 American National Standard for Safety Colors

B. American Society for Testing of Materials (ASTM)
   ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   ASTM A865 Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for use in Steel Pipe Joints
   ASTM A234 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
   ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation
   ASTM C552 Specifications for Cellular Glass Thermal Insulation
ASTM D3034  Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings


C.  American Water Works Association (AWWA)

C104  Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

C110  Ductile-Iron and Gray-Iron Fittings

C111  Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

C151  American National Standard for Ductile-Iron Pipe, Centrifugally Cast

C153  Ductile-Iron Compact Fittings

C223  Fabricated Steel and Stainless Steel Tapping Sleeves

C509  Resilient-Seated Gate Valves for Water Supply Service

C600  Installation of Ductile-Iron Water Mains and Their Appurtenances

C800  Underground Service Line Valves and Fittings

D.  Factory Mutual Engineering Corporation (FM)

E.  International Association of Plumbing and Mechanical Officials (IAPMO)

Uniform Plumbing Code (UPC)

F.  National Fire Protection Association (NFPA)

NFPA 24  Standard for the Installation of Private Fire Service Mains and Their Appurtenances

G.  Underwriters Laboratories (UL)

H.  Washington State Department of Ecology (WSDOE)

WSDOE ST-4511  State Water Discharge Permit Number ST-4511
1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. Catalog data for items in Paragraph 2.2.

2. Flushing:
   
   a. Procedure for pipe flushing and disinfection required by Paragraph 3.3.B.
   
   b. Documentation of pipe flushing required by Paragraph 3.3.B.

3. Pressure Testing:
   
   a. Procedure for piping pressure testing required by Paragraph 3.4.
   
   b. Documentation of pipe pressure testing required by Paragraph 3.4.

1.4 QUALITY ASSURANCE

A. See the Contract Statement of Work for general requirements.

B. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.

C. Qualifications


2. Qualification of Inspectors: A certified independent testing agency shall perform all required inspections and testing.

1.5 PERMITS

A. Obtain and conspicuously post the following permits before starting work under this Section.

1. Excavation Permit: See the Contract Statement of Work and Section 31 23 00, “Excavation and Fill.”

1.6 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for requirements.
PART 2  PRODUCTS

2.1  PRODUCT OPTIONS AND SUBSTITUTIONS

A.  See the Contract Statement of Work for substitution approvals.

2.2  MATERIALS

A.  Raw/Fire Water Pipe and Fittings:

1.  Ductile Iron Pipe (3-inch diameter and greater): AWWA C151, Class 150.
   a.  Joints: Flanged per AWWA C110 or push-on joints, AWWA C111 rubber gaskets.
   b.  Fittings: AWWA C110, Ductile-Iron or Gray-Iron, Class 250 or AWWA C153, Ductile-Iron Compact Fittings, Class 250 or XTRA FLEX® restrained joint high-deflection fittings.
   c.  Pipe and Fittings: Cement-mortar lining and asphalt seal coat in accordance with AWWA C104.

   b.  Fittings: ASTM A865, threaded and galvanized.

B.  Valves

1.  Gate Valves over 2 in.: AWWA C509, UL listed or FM approved, Class 250, non-rising stem, open left, mechanical joint inlet and outlet with mechanical joint unassembled accessories or Mueller AquaGrip® System.

C.  Tapping Sleeve: AWWA C223, fabricated steel, suitable for PVC, steel, ductile iron, and cast iron pipe, outlet flange size and sleeve O.D. to suit piping system.

D.  Valve Boxes: Cast-iron with top section and cover with lettering “WATER” cast on the cover, bottom section with base of size to fit over valve, barrel approximately 5 in. in diameter, adjustable cast-iron extension of length required.

32 XTRA FLEX is a registered trademark of Manuli Rubber Industries, Milano, Italy.
33 AquaGrip is a registered trademark of Hillerich & Bradsby Co., Louisville, Kentucky.
E. Pipe Casing

   a. Spacers: Calpico Inc., Model M-Series Casing Insulators or equivalent.
   b. End Seals: Calpico Inc., Model W End Seals or equivalent.

F. Gaskets: Gaskets containing asbestos are not permitted.

G. Pipe Insulation: Cellular glass block or mineral fiber preformed insulation in accordance with ASTM C547 or ASTM C552. Foamglas® by Pittsburgh Corning Corporation.

H. Threaded Pipe Joint Sealant: Permabond® MH052 or approved substitute.

PART 3 EXECUTION

3.1 PREPARATION

A. Keep piping systems clean during work. Cap open ends when installation is not in progress. Support pipe for full length of barrel.

B. Refer to Drawings and Section 31 20 00, “Earth Moving,” for earth cover, warning tape, documenting new or exposed existing utility location, etc., requirements.

C. All underground utility locations shall be identified by means of marking tape. Place tape in backfill directly above the utility line at approximately 12-in. below grade.

3.2 INSTALLATION

A. Raw/Fire Water Pipe and Fittings

1. Install pipe and pipe accessories in accordance with AWWA C600 (Ductile Iron), ASTM A234 (Steel), manufacturer’s instructions, NFPA 24, UPC, the drawings, and this Section.

2. Install thrust restraint at all bends, tees, plugs, and caps in accordance with NFPA 24, Article 8-6. If concrete thrust blocks are used, size in accordance with details shown on the contract drawings.

---

34 Foamglas is a registered trademark of Pittsburgh-Corning Corporation, Pittsburgh, Pennsylvania.
35 Permabond is a registered trademark of Loxeal Srl, Maderno, Italy.
3. Make joints in threaded piping system with specified joint sealant. Apply sealant sparingly to male threads only.

4. Coat buried carbon steel accessories, such as tie-rods and clamps, with 16.0 mils of Bitumastic in one or two coats (10-24 hours between coats). Allow 8 hours for Bitumastic to dry before backfilling.

5. Use steel pipe where heat tracing is required. Wrap heat tracing with insulation designed for the intended use (exterior, above or below grade as applicable).


3.3 FIELD QUALITY CONTROL

A. Flushing/Testing Preparation

1. Furnish equipment and instruments required to perform mechanical cleaning.

2. Obtain direction for disposal of flushing water from Project/System Engineer. See the Contract Statement of Work.

B. Raw/Fire Water Line Flushing

1. Flush raw water in accordance with NFPA 24 for below ground piping.
   a. The underground pipe trench shall be partially backfilled between joints before testing to prevent movement of pipe.
   b. Notify Project/System Engineer at least five working days before flushing of piping system for witnessing flush. Flushing to verify that new lines are clean and acceptable.
   c. Flush piping with water for five minutes minimum, and until effluent is clean and contains no visible particulate matter. Flushing pressure shall not exceed maximum operating pressure specified for the system. Flushing water supply shall have sufficient capacity to produce a full pipe (largest pipe size) flush.
   d. Document flushing of each piping system on NFPA Form “Contractor’s Material and Test Certificate for Aboveground and Underground Piping,” in accordance with NFPA 24 and submit in accordance with Paragraph 1.3.
3.4 FIELD INSPECTIONS AND TESTS

A. Raw/Fire Water Line Testing

1. Furnish instruments, facilities, and labor required to conduct tests.

2. Test gauges shall be calibrated and capable of measuring at least 1.5 times test pressure, but no more than four times test pressure.

3. Document leak/pressure testing of each piping system on NFPA Form “Contractor’s Material and Test Certificate for Aboveground or Underground Piping,” in accordance with NFPA 24 and submit in accordance with Paragraph 1.3.

4. Perform tests after lines have been flushed and before joints have been backfilled for underground piping.

5. Remove all air from piping and adequately restrain pipe prior to hydrostatic test for underground piping. The last thrust block poured shall have cured a minimum of seven days prior to test.

6. Test mainline at 200 psi for two hours or at 50 psi in excess of the maximum static pressure and measure leakage of raw water lines in accordance with NFPA 24, Article 8.9, for underground piping. Repair any unsatisfactory joints and retest.

7. Install a temporary relief valve during pressure test. Relief valve shall have a discharge capacity of at least 125 percent of the pressurizing device and be set to not more than 110 percent of the test pressure. Demonstrate proper operation of relief valve before relief valve is attached to system for leak test and whenever there is cause to question operating accuracy of valve.

END OF SECTION 33 10 00

END OF SPECIFICATION
APPENDIX D

CALCULATIONS

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<td>Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area</td>
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<tr>
<td>CHPRC-02539</td>
<td>Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135</td>
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<td>Design and Analysis of Road Improvements for Project W-135</td>
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<td>W-135 Capsule Storage Area Lighting Calculation</td>
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<tr>
<td>CHPRC-02536</td>
<td>W-135 Capsule Storage Area Lightning Risk Assessment</td>
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CALCULATION COVER SHEET

Project No. 046414.17.01  Project Title: W-135 Capsule Storage Area  Client: CH2M Hill Plateau Remediation Company

Title:
Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area

Purpose and Objective:
The purpose of this calculation is to provide a stormwater evaluation for the CSA operation pad, storage pad, and haul path and for the haul path at the WESF truck port area. The concrete pads, haul paths, and surrounding surfaces are sloped to direct the storm water to collection points away from the structures for infiltration into the surrounding soil.

Rev. No.  Total Pages  Prepared By  Checked By  PM/TL
D  11  Print Name/Sign:  Print Name/Sign:  DP Devine

Date: 5/22/18  5/22/18

Revision Description (Revision Description/Affected Pages):
Draft issue. Updated Section 7.2 to remove reference to H-2-837593.
## CALCULATION REVIEW CHECKLIST

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### Calculation Checking Method

- ✔ Direct Step-by-Step Check
- ✔ Reference Chart(s) or Book(s) Comparison (Append Documentation)
- ✔ Alternate Calculation (Append Documentation)

### Applicable Pages

- ✔ All Pages

### Comments:

Preparer (Print Name and Sign): Date:

- 5/22/18

Checker (Print Name and Sign): Date:

- 5/22/18

Signatures obtained only after discrepancies are corrected and comments are resolved.
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APPENDICES

Appendix A

CSA Storm Water Area Illustration
WESF Truck Port Storm Water Area Illustration
### 1.0 METHODOLOGY

The intensity and duration for rainfall are provided in PRC-PRO-EN-097. Rational Method is used to determine a flow rate on various surfaces (i.e. sand/gravel, asphalt and concrete). The time of infiltration is also determined and is considered acceptable provided the ponding duration is less than 1 day (24 hours).

### 2.0 DESIGN INPUTS

1. The CSA project has a design basis classification of PC-2. (CHPRC-02623, Section 6.6.5)
2. The amount of rainfall to design for is 2.5 inches within 6 hours. (PRC-PRO-EN-097, Section 2.5.7.1)
3. The improved surface (i.e. asphalt and concrete) runoff coefficient is 0.85. (Lindeburg, Appendix 20.A)
4. The unimproved surface runoff coefficient is 0.15. (Lindeburg, Appendix 20.A)
5. The acceptable amount of time for the water to drain is under one day (24 hours).
6. The infiltration rate for the dune sand is 0.75 in/hr. (Hansen and Trimmer).

### 3.0 ASSUMPTIONS

None

### 4.0 COMPUTER SOFTWARE

No unverified computer software was used in this analysis. Mathcad® 14.0 was used for the hand calculations. Calculations are checked using a handheld calculator.

### 5.0 RESULTS AND CONCLUSIONS

The configuration of the WESF truck port haul path is such that the storm water from the new haul path will flow to the unimproved area located north of the haul path, will create minimal ponding and will infiltrate into the soil in less than 24 hours. The haul path is also designed to prevent significant storm water from flowing onto the future truck port pad from the haul path.

The configuration of the CSA operating pad, storage pad, haul path, and surrounding CSA yard grading is such that the storm water from the structures will flow away from the structures and will create minimal ponding in the area which will infiltrate into the soil in less than 24 hours.

---

1 Mathcad is a registered trademark of Parametric Technology Corporation., Needham, Massachusetts.
6.0 REFERENCES


Hansen and Trimmer, *Irrigation Runoff Control Strategy*, Reprinted October 1997,


7.0 CALCULATIONS

7.1 Determine the Adequacy of the Drainage Area at the CSA

The CSA (as shown on drawings H-2-837592 and H-2-837593) consists of a concrete storage pad, a concrete operating pad, and an asphalt CSA access haul path. The grading plan is designed such that storm water will runoff from the pads and haul path, onto the surrounding grade, and will then travel away from the pads and infiltrate into the ground away from the structures. This evaluation will perform estimates on the storm water runoff and infiltration times to show that the designed conditions will prevent long term ponding (over 24 hours). The storm water on the haul path will flow away from the haul path into a large, relatively flat area south east of the haul path. By inspection, the storm water evaluation of the haul path area is bounded by the evaluation of the storm water at the operating and storage pads. See Appendix A for illustration.

\[
\begin{align*}
A_{SP} &= 90\text{ft} \cdot 90\text{ft} = 8100\cdot\text{ft}^2 \\
A_{OP} &= (168\text{ft} + 9\text{in}) \cdot (93\text{ft} + 9\text{in}) = 15820\cdot\text{ft}^2 \\
A_7 &= 300\text{ft} \cdot 20\text{ft} = 6000\cdot\text{ft}^2 \\
A_{ditch} &= 300\text{ft} \cdot 40\text{ft} = 12000\cdot\text{ft}^2 \\
A_{north} &= 300\text{ft} \cdot 100\text{ft} = 30000\cdot\text{ft}^2 \\
A_{south} &= 300\text{ft} \cdot 150\text{ft} = 45000\cdot\text{ft}^2 \\
A_{inf} &= 300\text{ft} \cdot 50\text{ft} = 15000\cdot\text{ft}^2 \\
A_{add} &= 300\text{ft} \cdot 50\text{ft} = 15000\cdot\text{ft}^2 \\
C_{unimp} &= 0.15 \\
C_{imp} &= 0.85 \\
I &= \frac{2.5\text{in}}{6\text{hr}} = 0.42\frac{\text{in}}{\text{hr}} \\
t &= 6\text{hr}
\end{align*}
\]

Area of the storage pad. (H-2-837593)

Area of the storage pad. (H-2-837593)

Estimated area of 7th street which contributes to the common drainage ditch for the CSA.

Estimated area of the drainage ditch south of 7th street.

Estimated area of the CSA which flows north to the 7th street drainage ditch.

Estimated area of the CSA which flows south to the yard.

Area of the yard at the south end of the CSA where the south flowing CSA storm water will accumulate and infiltrate.

Area located south of the CSA which flows north toward the CSA.

Unimproved surface runoff coefficient. (Lindeburg, Appendix 20.A)

Improved surface (i.e. concrete and asphalt) runoff coefficient. (Lindeburg, Appendix 20.A)

Design storm intensity and duration. (PRC-PRO-EN-097, Section 2.5.7.1)

Flowrate to the drainage ditch along 7th due to the rainfall intensity using Rational Equation. (Lindeburg, Eq. 20.36)

\[
Q_{north} = C_{unimp}I \left[ A_{north} - \frac{1}{2} \left( A_{SP} + A_{OP} \right) \right] + C_{imp}I \left[ \frac{1}{2} \left( A_{SP} + A_{OP} \right) \right] + 100\%I \cdot A_{ditch} = 107.7\text{gpm}
\]

Flowrate to the south portion of the CSA yard.

\[
Q_{south} = C_{unimp}I \left[ A_{north} - \frac{1}{2} \left( A_{SP} + A_{OP} \right) \right] + C_{imp}I \left[ \frac{1}{2} \left( A_{SP} + A_{OP} \right) \right] + 100\%I \cdot A_{inf} + C_{unimp}I \cdot A_{add} = 130.4\text{gpm}
\]
Infiltration Rates of Common Soil Types (Hansen and Trimmer)

\[ R_i := 0.75 \, \text{in/hr} \]

\[ V_{north} := Q_{north} \cdot t = 38762 \cdot \text{gal} \]

\[ V_{south} := Q_{south} \cdot t = 46944 \cdot \text{gal} \]

\[ d_{ditch} := 6\text{in} \]

\[ V_{c_ditch} := \frac{1}{2} \cdot A_{ditch} \cdot d_{ditch} = 22442 \cdot \text{gal} \]

\[ d_{inf} := 0.1\text{in} \]

\[ V_{c_inf} := A_{inf} \cdot d_{inf} = 935 \cdot \text{gal} \]

\[ V_{infiltration(t_{drain})} := t_{drain} \cdot R_i \cdot A_{ditch} \]

\[ t_{drain} := \frac{V_{north} - V_{c_ditch}}{R_i \cdot A_{ditch}} = 2.9 \text{hr} \]

The ponding in the drainage ditch will be minimal. The drainage ditch is sufficient to store and infiltrate the storm water in a timely manner.

\[ V_{infiltration(t_{drain})} := t_{drain} \cdot R_i \cdot A_{inf} \]

\[ t_{drain} := \frac{V_{south} - V_{c_inf}}{R_i \cdot A_{inf}} = 6.6 \text{hr} \]

It is recognized that ponding may occur in area \( A_{inf} \), however, the large footprint of this infiltration area will allow that storm water to infiltrate relatively quickly (~7 hrs).
7.2 Determine the Adequacy of the Drainage Area at the WESF Truck Port

In general, the truck port haul path (as shown on drawing H-2-837595) does not significantly alter the existing condition of the general area from a storm water runoff perspective since the haul path (asphalt) is replacing existed improved surface (asphalt). This evaluation will estimate the amount of storm water which flows into the existing unimproved surface (located west of WESF) and will determine if the existing unimproved surface is adequate to handle the demand. See Appendix A for illustration.

\[
A_{\text{unimp}} := 50\text{ft} \times 50\text{ft} = 2500.0\text{ ft}^2
\]

Approximate area of unimproved surface to which the WESF truck port haul path improved surfaces flow. (See Appendix A)

\[
A_{\text{imp}} := 3.5 \times A_{\text{unimp}} \times 120\% = 10500.0\text{ ft}^2
\]

Area of improved surface which flow to the WESF truck port haul path unimproved surface. (See Appendix A) The additional 20% is to account for additional surrounding area which may be flowing toward area \(A_{\text{unimp}}\).

\[
C_{\text{imp}} := 0.85
\]

Improved surface runoff coefficient. (Lindeburg, Appendix 20.A)

\[
Q_{\text{imp}} := C_{\text{imp}} \times I \times A_{\text{imp}} = 38.6\text{ gpm}
\]

Flowrate from storage pad due to the rainfall intensity using Rational Equation. (Lindeburg, Eq. 20.36)

\[
Q_{\text{unimp}} := 100\% \times I \times A_{\text{unimp}} = 10.8\text{ gpm}
\]

Flowrate directly on area \(A_{\text{unimp}}\) (100% accumulation).

\[
Q_{\text{tot}} := Q_{\text{imp}} + Q_{\text{unimp}} = 49.5\text{ gpm}
\]

Total flowrate contributing to the drainage area.

\[
d_{\text{unimp}} := 0.1\text{in}
\]

Estimated depth of storm water on the surface of area \(A_{\text{unimp}}\). Set at a small depth to model minimal ponding.

\[
V_{\text{runoff}} := Q_{\text{tot}} \times t = 17805\text{ gal}
\]

Volume of runoff.

\[
V_{\text{capacity}} := A_{\text{unimp}} \times d_{\text{unimp}} = 156\text{ gal}
\]

Capacity (volume) of area \(A_{\text{unimp}}\).

\[
V_{\text{infiltration}}(t_{\text{drain}}) := t_{\text{drain}} \times R_i \times A_{\text{unimp}}
\]

Volume for infiltration.

\[
t_{\text{drain}} := \frac{V_{\text{runoff}} - V_{\text{capacity}}}{R_i \times A_{\text{unimp}}} = 15.1\text{ hr}
\]

Time for the water to infiltrate on North side Haul Path at WESF.

It is recognized that ponding may occur in area \(A_{\text{unimp}}\) however, the large footprint of this infiltration area will allow that storm water to infiltrate relatively quickly (~15 hrs).
APPENDIX A

CSA STORM WATER AREA ILLUSTRATION

WESF TRUCK PORT STORM WATER AREA ILLUSTRATION
Title: Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area

Prepared By:  Date: 5/22/18  Checked By:  Date: 5/22/18
Title: Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area
Prepared By: Date: 5/22/18 Checked By: Date: 5/22/18

This is WESF truck port haul path improved surface which flows to $A_{\text{imp}}$.

This is the area to which the WESF truck port haul path improved surfaces drain.
Title:
Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135

Purpose and Objective:
The purpose of this calculation is to perform a detailed design of the Capsule Storage Pad (CSP) and the operational pad for the Capsule Storage Area (CSA) project as shown on drawings H-2-837593 and H-2-837597.

The objective is to verify that the concrete pads are adequate for the expected loading conditions per PRC-PRO-EN-097, operational loads and long term storage of the capsules.
# CALCULATION REVIEW CHECKLIST

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<td>7. Assumptions and input data selected, described, reasonable, and attached or referenced to task documents.</td>
<td>✚</td>
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<tr>
<td>8. Calculation method identified and appropriate for the design activity.</td>
<td>✚</td>
<td></td>
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<td>9. Calculation results reasonable and correctly described in results and conclusions.</td>
<td>✚</td>
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<tr>
<td>10. Physical property calculations generated by CAD software verified via hand calculations.</td>
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<tr>
<td>11. Computer program identified with version and revision.</td>
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<tr>
<td>12. Computer input/output provided or referenced and reasonable.</td>
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<td></td>
</tr>
<tr>
<td>13. Computer run traceable to calculation (file #, etc.).</td>
<td>✚</td>
<td></td>
</tr>
<tr>
<td>14. Computer input/output data and problem type within validation/verification range of use.</td>
<td>✚</td>
<td></td>
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<tr>
<td>15. Computer program validation/verification addressed.</td>
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<tr>
<td>16. Computer operating system in use for calculation preparation is the same as when the software was verified on machine.</td>
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<td></td>
</tr>
</tbody>
</table>

## Calculation Checking Method

<table>
<thead>
<tr>
<th>Calculation Checking Method</th>
<th>Applicable Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Direct Step-by-Step Check</td>
<td>✚ All</td>
</tr>
<tr>
<td>2. Reference Chart(s) or Book(s) Comparison (Append Documentation)</td>
<td></td>
</tr>
<tr>
<td>3. Alternate Calculation (Append Documentation)</td>
<td></td>
</tr>
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</table>

### Comments:

Date: 05-21-2018

Date: 05-21-2018

Signatures obtained only after discrepancies are corrected and comments are resolved.
# TITLE

**Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135**

**Prepared By:**

- Date: 05-21-2018

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Attachments

Attachment 1
Table 4.1-1 From NAC International Document No. 30059-P-01, *MPC-Capsule Storage System (MPC-CSS) Operations And Maintenance Manual*

Attachment 2
General Arrangement Drawing of the Rubber-Tired Towed Cask Transporter

Attachment 3
Vertical Cask Transporter

Attachment 4
Crane Information

Attachment 5
Forklift Information

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AISC</td>
<td>American Institute for Steel Construction</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>CSA</td>
<td>Capsule Storage Area</td>
</tr>
<tr>
<td>CSP</td>
<td>Capsule Storage Pad</td>
</tr>
<tr>
<td>DCR</td>
<td>Demand to Capacity Ratio</td>
</tr>
<tr>
<td>IBC</td>
<td>International Building Code</td>
</tr>
<tr>
<td>LS</td>
<td>Limit State</td>
</tr>
<tr>
<td>SDC</td>
<td>Seismic Design Criteria</td>
</tr>
<tr>
<td>TSC</td>
<td>Transportable Storage Canister</td>
</tr>
<tr>
<td>VCC</td>
<td>Vertical Concrete Cask</td>
</tr>
</tbody>
</table>
1.0 PURPOSE

The purpose of this calculation is to perform a detailed design of the Capsule Storage Pad (CSP) and the operational pad for the Capsule Storage Area (CSA) project as shown on drawings H-2-837593 and H-2-837597.

The objective is to verify that the concrete pads are adequate for the expected loading conditions per PRC-PRO-EN-097, operational loads and long term storage of the capsules.

2.0 METHODOLOGY

Per CHPRC-02623, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135), the design of the Capsule Storage Pad (CSP) will be performed using Seismic Design Category (SDC)-2, Limit State (LS) C loading conditions. The loads on the structure are determined in accordance with Administrative Procedure PRC-PRO-EN-097 Engineering Design and Evaluation (Natural Phenomena Hazard) for SDC-2 LS-C components. Per Section 2.5.12 of PRC-PRO-EN-097, load factors, load combinations, allowable stresses and strength requirements for SDC-2 structures, systems, and components shall comply with the IBC and ASCE 7. Load combinations shall include live load, dead load, snow load and normal operating loads.

The load combinations are defined in Section 5.3 of ACI-318-14 (and ASCE 7-10) as follows:

**Table 2-1: Load Combinations**

1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r$ or $S$ or $R)$
3. $1.2D + 1.6(L_r$ or $S$ or $R) + (L$ or $0.5W)$
4. $1.2D + 1.0W + L + 0.5(L_r$ or $S$ or $R)$
5. $1.2D + 1.0E + L + 0.2S$
6. $0.9D + 1.0W$
7. $0.9D + 1.0E$

The seismic design criteria to be used are detailed in Table 2-2.
Table 2-2 Seismic Design Category and Performance Category Correlation and Corresponding Seismic Design Criteria

(Table 1 from PRC-PRO-EN-097)

<table>
<thead>
<tr>
<th>SDC</th>
<th>Limit State</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
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<tr>
<td>1</td>
<td>ASCE/SEI 7-10 RC II (I = 1.0)</td>
<td>ASCE/SEI 7-10 RC II (I = 1.0)</td>
<td>ASCE/SEI 7-10 RC II (I = 1.0)</td>
<td>ASCE/SEI 7-10 RC II (I = 1.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R_s = R or R_0 (DOE PC 1)</td>
<td>R_s = R or R_0 /1.25</td>
<td>R_s = (R or R_0)/1.5</td>
<td>R_s ≥ 1.2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>N/A</td>
<td>ASCE/SEI 7-10 RC IV (I =1.5)</td>
<td>ASCE/SEI 7-10 RC IV (I =1.5)</td>
<td>ASCE/SEI 7-10 RC IV (I =1.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R_s = R or R_0 (DOE PC 2)</td>
<td>R_s = R or R_0 /1.2</td>
<td>R_s ≥ 1.2</td>
<td>R_0 ≥ 1.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(DOE PC 3)</td>
<td>(DOE PC 3)</td>
<td>(DOE PC 3)</td>
<td>(DOE PC 3)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
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<tr>
<td>5</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td>ASCE 43-05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DOE PC 4</td>
<td>Near NRC NPP</td>
<td>Similar to modern NRC NPP</td>
<td>Similar to modern NRC NPP</td>
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</table>

The seismic design parameters to determine the earthquake loading are defined in Table 6 of PRC-PRO-EN-097 as shown in Table 2-3.

Table 2-3: Seismic Design Parameters

(Table 6 from PRC-PRO-EN-097)

<table>
<thead>
<tr>
<th>PC/SDC</th>
<th>PC1/SDC</th>
<th>PC2/SDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Class*</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>S_s</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>S_t</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Importance Factor (I_p)</td>
<td>1.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

3.0 DESIGN INPUTS

1. The pads are designed for SDC-2, LS C seismic loading conditions per PRC-PRO-EN-097.
2. Material and section properties for structural concrete are per ACI 318-14.
3. Soil properties are per the Preliminary Geotechnical Design Recommendations Report for the W-135 Project Capsule Storage Area, Report No. 22-1-40034-002. Based upon this report, and the absence of saturated clay soil, liquefaction is not a concern.
4. The weight of the loaded Vertical Concrete Cask with VCC Lid and Lifting Lugs is 152,740 lbs. (Attachment 1). Use 155 kips.
5. As the casks will be placed by a VCT on the CSP (note that the crane will not used on the CSP) with a maximum height above the pad of 9-inches, use a dynamic (impact) loading factor of 2.0 per NAC International Document No. 30059-P-01, *MPC-Capsule Storage System (MPC-CSS) Operations And Maintenance Manual*, Section 3.2.1.1.

6. The dimensions of the VCC are 120" in diameter X 132.5" tall per Section 4.1.2 of CHPRC-02623.

7. Concrete strength (28-day compressive) = 5000 psi per Section 03 30 00 of CHPRC-02534.

8. Reinforcing steel is ASTM A615 Gr. 60 per Section 03 30 00 of CHPRC-02534.

9. The CSP shall be 90 ft. x 90 ft. which will allow sufficient spacing for 25 VCCs arranged in a 5 x 5 grid with 15 ft. center to center distance and outside clear perimeter of 10 ft. per Section 4.1.2 of CHPRC-02623. See Figure 3-1.

10. The crane load is estimated by using loads associated with a Terex Demag 200-1 200 ton crane.

![Figure 3-1: Proposed VCC layout](image)

All other Design Inputs can be found in Section 8.0, CALCULATIONS.

### 4.0 ASSUMPTIONS

All to be resolved during final design phase.

- The rubber tire tow vehicle wheel load is assumed evenly distributed to the 4 corners of the vehicle.
- The flat area of the wheels in contact with the ground when compressed is assumed to be a minimum of 12-inches.
5.0 COMPUTER SOFTWARE

No unverified computer software was used in this analysis. Mathcad® release 15.0 was used for the hand calculations and was checked using a handheld calculator.

6.0 RESULTS

The CSA CSP as detailed on drawings H-2-837593 and H-2-837597 is adequate for the given loading conditions. See Section 8.0 for complete results.

The design of the storage pad bounds the design of the operational pad.

7.0 REFERENCES

ACI 318-14, Building Code Requirements for Structural Concrete and Commentary, American Concrete Institute, Farmington Hills, MI.

ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures, ACI, Farmington Hills, MI.

ASCE 7-2010, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, Reston, VA.

CHPRC-02623, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135), Rev. 2, CH2M HILL Plateau Remediation Company, Richland, WA.


Drawing H-2-837597, 2018, W-135 CSA Concrete Slab Sections & Details, Rev. C, U.S. Department of Energy, Richland, WA


PCA Engineering Bulletin, 2008, Concrete Floors on Ground, Portland Cement Association

PRC-PRO-EN-097, Rev. 2, Change 0, Engineering Design and Evaluation (National Phenomena Hazard), CH2M HILL Plateau Remediation Company, Richland, WA

8.0 CALCULATIONS

8.1 Material Properties

8.1.1 Concrete Properties

\[ \rho_{\text{conc}} := 150 \text{pcf} \]

Density of concrete. (AISC 14th Ed., Table 17-12)

\[ \text{padthk} := 18 \text{-in} \]

Thickness of CSP and operating pad (H-2-837597)

\[ f_y := 60 \text{-ksi} \]

Yield strength of rebar.

\[ f_c := 5000 \text{-psi} \cdot (80\%) = 4000 \text{psi} \]

Per Section 03 30 00 of CHPRC-02534, the concrete strength is be 5,000 psi. Per project meetings, the casks will have an external temperature of approximately 300 °F. As ACI318 does not directly address contact temperatures, a review of NUREG-1536 and ACI-349 determined a 20% strength reduction will adequately address the surface contact temperature.

8.1.2 VCC Properties

\[ \text{VCC\_height} := 132.5 \text{-in} \]

CHPRC-02623 Section 4.1.2.

\[ \text{VCC\_dia} := 120 \text{-in} \]

CHPRC-02623 Section 4.1.2.

\[ \text{VCC\_spacing} := 15 \text{-ft} \]

Center to center spacing of casks, CHPRC-02623 Section 4.1.2.

\[ \text{VCC\_weight} := 155 \text{-kip} \]

Attachment 1, consider as a live load for load combinations.
8.1.3 Cask Transporter Wheel Loads

The cask transporter description is contained in Attachment 2. The following notes are from Attachment 1.

**TRANSPORTER DATA:**
- Rated capacity: 170,000 lbs.
- Empty weight: 95,000 lbs.
- Operating weight: 265,000 lbs with the 85 Ton cask.
- Lifting towers: Single stage, double acting, equipped with counterbalance valves for load holding and controlled lowering of the cask.
- Lifting towers are equipped with manual pads for redundant drop protection. Optional self contained automatic wedges are available.
- Full load sideload, ± 4°, for cask placement on storage pad, trailer and position accuracy.
- Lifting towers are in accordance with SAE J1078: a recommended method of analytically determining the competence of hydraulic telescopic cantilevered booms.
- All welding is in accordance with AWS D1.1.
- LPI and MPI in accordance with ASNT, Level I including NDE qualified personnel.
- Environmental conditions: rain and snow, 0°F to 120°F at 0% to 100% humidity.
- Maximum tow speed: 5 mph.
- Maximum grade capability: 5% Longitudinal or 2% transverse with 85 Ton cask.
- Diesel engine: 25 hp.
- Diesel fuel tank capacity: 13 gallons.
- Tires: 16.00R25, foam filled. High capacity, (8) total tires.
- Average ground bearing pressure: 155 psi with 85 Ton cask.
- Push bar for backing up transporter into position while using hydraulic steering.
- Operator control panel: Controls for all cask transporter operations, gauges and instruments to monitor the engine and the hydraulic systems, key-type switches for individual and simultaneous movement requirements, speed control, dead man's throttle, steering controls, emergency brakes, lift tower controls, lift limit trim cylinder(s) controls, hydraulic pressure gauges to measure the load at each lift tower.

\[ \text{wt}_{\text{cask\_trans}} = 265 \text{-kip} \]

Fully loaded cask transporter weight from Attachment 1.

**Determine Wheel Dimensions Under Load**

The rubber tire tow vehicle wheel load is assumed evenly distributed to the 4 corners.
wheel_load_{cask\_trans} \leq \frac{\text{wt}_{cask\_trans}}{4\text{-corners}} = 66.25\text{-kip} \quad \text{corner} \\
\text{Point load on each corner from the loaded VCT.}

### 8.1.4 Crane Wheel Loads

During the placing of the casks, the crane may be located on the pad. The unloaded crane individual axle loads are all less than 21 kips as seen in Attachment 4. The total weight of the crane is shown to be 141 kips.

\[
\text{wt}_{\text{crane}} := 141\text{-kip} \quad \text{Attachment 4.}
\]

\[
\text{pad}_{\text{crane}} := \frac{\left(\text{wt}_{\text{crane}}\right) + (1.05)\left(\text{VCC\_weight}\right)}{4\text{-pads}} = 75.94\text{-kip} \quad \text{pad}
\]

\text{Point load on pad from the loaded crane.}

\text{VCC weight increased by 5% for conservatism.}

### 8.1.5 Forklift Wheel Loads

From Attachment 5 find the maximum loaded front wheel axle load to be as follows:

\[
\text{wheel\_load}_{\text{front\_axle}} := 290\text{-kip}
\]

\[
\text{wheel\_load}_{\text{forklift}} := \frac{\text{wheel\_load}_{\text{front\_axle}}}{2\text{-sides}} = 145\text{-kip}
\]
8.1.6 Pad Evaluation Load

The pad should be designed for a point load as follows:

\[
\text{max_point_load} := \max(\text{VCC_weight}, \text{wheel_load}_{\text{cask_trans}}, \text{pad_crane}, \text{wheel_load}_{\text{forklift}}) = 155\text{-kip}
\]

\[
\text{VCC_weight} = 155\text{-kip}
\]

8.2 Determine Loads on the Concrete Pad

This section determines the loads on the CSP. As the CSP is at grade level, there is no wind loading.

8.2.1 Dead Load

The CSP self-weight is the only dead load.

8.2.2 Live Load

The weight of the VCC is defined as a live load.

\[
\text{VCC_weight} = 155\text{-kip}
\]

Attachment 1, Consider as a live load for load combinations.

8.2.3 Snow Load

SNOW LOAD

\[
p_g := 15\text{-psf}
\]

\[
I_s := 1.0
\]

\[
C_e := 1.0
\]

Ground snow load, Section 2.5.3, PRC-PRO-EN-097.

Snow importance factor from Table 1.5-2 using Risk Category II from Table 1.5-1 of ASCE 7-10.

Exposure factor from Table 7-2, ASCE 7-10 using surface roughness C.
**Calculation Title:** Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135

\[
C_t := 1.2 \quad \text{Thermal factor from Table 7-3, ASCE 7-10 for unheated and open air structures.}
\]

\[
p_f := (0.7) \cdot (C_e) \cdot (C_t) \cdot (I_s) \cdot (p_g) = 12.6 \text{ psf} \quad \text{Flat roof snow load, Eqn. 7.3-1, ASCE 7-10.}
\]

\[
p_{f\_min} := (I_s) \cdot (p_g) = 15 \text{ psf} \quad \text{Minimum snow load for low-slope roofs, Section 7.3.4, ASCE 7-10.}
\]

\[
\text{Snowpad} := 15 \text{ psf} \quad \text{Consider as a live load for load combinations.}
\]

### 8.2.4 Seismic Load on the Structure

#### 8.2.4.1 Determine Seismic Response Coefficient, \( C_s \), for Structure

Seismic forces acting on the CSP are determined in accordance with Chapter 12.8 from ASCE 7-10, Equivalent Lateral Force Analysis, which is permitted by Table 12.6-1.

\[
S_S := 0.46 \quad \text{g} \quad \text{Short period acceleration, Table 2-3.}
\]

\[
S_1 := 0.15 \quad \text{g} \quad \text{1 second period acceleration, Table 2-3.}
\]

\[
SDS_h := \frac{2}{3} (S_S) = 0.31 \quad \text{g} \quad \text{Design spectral horizontal acceleration parameter at short periods. (Eqn. 11.4-3, ASCE 7-10)}
\]

\[
SD1_h := 0.15 \quad \text{Design spectral horizontal acceleration parameter at short periods. (Eqn. 11.4-4, ASCE 7-10)}
\]

\[
R := 1.0 \quad \text{Response modification factor for concrete pads is not contained in Table 12.2-1 of ASCE 7-10. Conservatively use a value of 1.0}
\]

\[
I_e := 1.5 \quad \text{Importance factor for PC-2 seismic. (Table 2-2)}
\]

\[
C_{s\_nom} := \frac{SDS_h}{R \cdot I_e} = 0.46 \quad \text{g} \quad \text{Nominal seismic response coefficient. (ASCE 7-10, Eqn. 12.8-2)}
\]

\[
C_e := 0.02 \quad \text{Approximate period parameter. (ASCE 7-10, Table 12.8-2)}
\]

\[
x := 0.75 \quad \text{Approximate period parameter. (ASCE 7-10, Table 12.8-2)}
\]

\[
h_n := \text{VCCheight} = 11.04 \text{ ft} \quad \text{Structural Height as defined in ASCE 7-10, Section 11.2.}
Approximated fundamental period. (ASCE 7-10, Eqn. 12.8-7)

\[ T_a := C_t \left( \frac{h_n}{ft} \right) \times s = 0.12 \text{s} \]

Fundamental period of the structure may be taken as the approximated period. (ASCE 7-10, Section 12.8.2)

\[ T_w := T_a = 0.12 \text{s} \]

Long-period transition period. (ASCE 7-10, Section 11.4.5 and Fig. 22-12)

\[ C_{s_{\text{max}}} := \frac{S_{D1_{\text{h}}}}{T_s \cdot \frac{R}{s} \cdot \frac{s}{I_c}} = 1.857 \]

Maximum \( C_s \). (ASCE 7-10, Eq. 12.8-3)

\[ \rho := 1.0 \]

Redundancy factor. (ASCE 7-10, Section 12.3.4.2)

\[ C_{s_{\text{h}}} := \rho \left( \begin{array}{ll}
C_{s_{\text{nom}}} & \text{if } C_{s_{\text{nom}}} < C_{s_{\text{max}}} \\
C_{s_{\text{max}}} & \text{otherwise}
\end{array} \right) = 0.46 \text{ g} \]

Seismic response coefficient for horizontal seismic forces.

\[ C_{s_{\text{v}}} := \rho \left( 0.2 \cdot S_{DS_{\text{h}} \cdot I_c} \right) = 0.09 \text{ g} \]

Coefficient for vertical seismic forces. (ASCE 7-10, Section 12.4.2.2)

ASH LOAD

Ashfall loading shall be 11.8 psf for PC-2 classification per PRC-PRO-EN-097.

\[ \text{Ash}_{\text{pad}} := 11.8 \text{-psf} \]

Consider as a live load for load combinations.

8.2.5 Load Combinations

The load combinations defined in Table 2-1 will be used to evaluate the pad. For the CSA evaluation, the Live Load is defined as the VCC loading. There is no Lr (roof live loading) or rain loading. The snow loading is greatly exceeded by the Live Load. Due to the low overall height and the weight of the VCC, wind loading is negligible compared to seismic loading.

Based on the above load magnitude comparisons, load combinations 1, 2, 5 and 7 are the controlling combinations.

8.2.6 Load Impact Factor

Conservatively assume an impact factor as shown below. As the cask will be only 9-inches above the pad, this is considered to be conservative.

Drop analysis inputs are not available at this time. The drop analysis will be completed during the final design phase.

\[ \text{dynamic\_factor} := 2.0 \]
8.3 Soil Loading

The casks are located on 15-foot centers in both directions.

\[
\begin{align*}
\text{VCC}_{\text{spacing}} &= 15\text{ ft} \\
\text{VCC}_{\text{weight}} &= 155\text{-kip}
\end{align*}
\]

\[10'\text{ typ. diameter}\]

\[5'\text{ typ. clear between VCCs}\]

\[10'\text{ typ. tangent to VCC to slab edge.}\]

\[
\begin{align*}
\text{length}_{\text{pad}} &= 90\text{-ft} \\
\text{wt}_{\text{pad}} &= (\rho_{\text{conc}}) \left( \text{pad}_{\text{thk}} \right) \left( \text{VCC}_{\text{spacing}} \right) \left( \text{length}_{\text{pad}} \right) = 303.75\text{-kip} \\
\text{Area}_{\text{pad}} &= \left( \text{VCC}_{\text{spacing}} \right) \left( \text{length}_{\text{pad}} \right) = 1350\text{ ft}^2 \\
\text{Sp}_{\text{pad}} &= \frac{\left( \text{length}_{\text{pad}} \right) \left( \text{VCC}_{\text{spacing}} \right)^2}{6} = 3375\text{-ft}^3 \\
\text{Area}_{\text{VCC}} &= \frac{\pi \left( \text{VCC}_{\text{dia}} \right)^2}{4} = 78.54\text{ ft}^2 \\
\text{Ash}_{\text{pad}} &= 11.8\text{-psf} \\
\text{Snow}_{\text{pad}} &= 15\text{-psf}
\end{align*}
\]

Load Combination 1:

\[
\begin{align*}
\text{1.4D} \\
q_{u1} &= \frac{(1.4) \cdot (\text{wt}_{\text{pad}})}{\text{Area}_{\text{pad}}} = 315\text{-psf} \quad \text{factored soil pressure for load case 1.}
\end{align*}
\]

Load Combination 2:

\[
\begin{align*}
\text{1.2D+1.6L+0.5Snow} \\
q_{u2} &= \frac{(1.2) \cdot (\text{wt}_{\text{pad}}) + (1.6) \cdot (\text{VCC}_{\text{weight}}) \cdot (5\text{-casks}) + 0.5 \cdot (\text{Snow}_{\text{pad}})}{\text{Area}_{\text{pad}}} = 1196\text{-psf} \quad \text{factored soil pressure for load case 2.}
\end{align*}
\]
Load Combination 5:

\[
\begin{aligned}
1.2D + 1.0E + 1.0L + 0.2S
\end{aligned}
\]

\[
M_{\text{caskSeis}} := (C_{S_h}) \cdot (VCC_{\text{weight}}) \cdot (5 \cdot \text{casks}) \cdot \left(\frac{VCC_{\text{height}}}{2}\right) = 1968 \cdot \text{kip} \cdot \text{ft}
\]

\[
\text{soil}_{\text{LC5seis}} := \frac{M_{\text{caskSeis}}}{S_{\text{pad}}} = 583 \cdot \text{psf}
\]

\[
q_{u5\text{Max}} := \frac{(1.2) \cdot (w_{\text{tpad}}) + (1.0) \cdot (VCC_{\text{weight}}) \cdot (5 \cdot \text{casks})}{\text{Area}_{\text{pad}}} + \text{soil}_{\text{LC5seis}} + 0.2 \cdot (\text{Snow}_{\text{pad}}) = 1430 \cdot \text{psf}
\]

\[
q_{u5\text{Min}} := \frac{(1.2) \cdot (w_{\text{tpad}}) + (1.0) \cdot (VCC_{\text{weight}}) \cdot (5 \cdot \text{casks})}{\text{Area}_{\text{pad}}} - \text{soil}_{\text{LC5seis}} + 0.2 \cdot (\text{Snow}_{\text{pad}}) = 264 \cdot \text{psf}
\]

Load Combination 7:

\[
0.9D + 1.0E
\]

\[
q_{u7\text{Max}} := \frac{0.9 \cdot w_{\text{tpad}}}{\text{Area}_{\text{pad}}} + \text{soil}_{\text{LC5seis}} = 786 \cdot \text{psf}
\]

\[
q_{u7\text{Min}} := \frac{0.9 \cdot w_{\text{tpad}}}{\text{Area}_{\text{pad}}} - \text{soil}_{\text{LC5seis}} = -381 \cdot \text{psf}
\]
8.4 Pad Evaluation

8.4.1 Rebar and Concrete Bending

The worst case soil loading is load combination 5. Conservatively determine the bending moment in the cantilever section between the edge of the slab and the edge of the VCC.

\[ q_{\text{cant}} := q_{\text{u5Max}} - \frac{q_{\text{u5Max}} - q_{\text{u5Min}}}{90 \cdot \text{ft}} (10 \cdot \text{ft}) = 1.30 \cdot \text{ksf} \]

\[ \phi_t := 0.9 \]

Reinforcing steel capacity reduction factor, ACI 318-14, Table 21.2.2.

\[ M_{\text{cant}} := \frac{(q_{\text{cant}} \cdot 1 \cdot \text{ft}) \cdot (10 \cdot \text{ft})^2}{2} + \frac{(q_{\text{u5Max}} - q_{\text{cant}}) \cdot (1 \cdot \text{ft}) \cdot (10 \cdot \text{ft}) \cdot 2 \cdot (10 \cdot \text{ft})}{3} = 832.2 \cdot \text{kip-in} \]

\[ M_u := \frac{M_{\text{cant}}}{\phi_t} = 925 \cdot \text{kip-in} \]

\[ b_{\text{cant}} := 12 \cdot \text{in} \]

Width of typical evaluation section

\[ d_{\text{bar}} := \frac{3}{4} \cdot \text{in} \]

Diameter of rebar

\[ d_{\text{cant}} := p_{\text{padthk}} - (3 \cdot \text{in}) - \frac{d_{\text{bar}}}{2} = 14.63 \cdot \text{in} \]

Distance from top of slab to centerline of rebar.
Concrete compressive strength = steel tensile strength

\[ 0.85 \cdot f'_c \cdot b \cdot a = A_s \cdot f_y \]

See figure to left for visual.

\[ M_u = \phi M_n = \phi_t \cdot A_s \cdot f_y \left( d - \frac{a}{2} \right) \]

where \( a = \frac{A_s \cdot f_y}{0.85 \cdot f'_c \cdot b} \)  
Equations from ACI 318-14, 22.2.2.4.

\[ M_u = \phi_t \cdot A_s \cdot f_y \left( d - \frac{A_s \cdot f_y}{0.85 \cdot f'_c \cdot b} \cdot \frac{1}{2} \right) \]

Substitution for 'a' made into previous equation.

\[ \frac{d_{\text{cant}} \cdot 0.85 \cdot (f_c) \cdot b_{\text{cant}}^2}{f_y} - \sqrt{\frac{d_{\text{cant}} \cdot 0.85 \cdot (f_c) \cdot b_{\text{cant}}^2}{f_y}} - 4 \cdot (1) \left[ \frac{M_u \cdot 0.85 \cdot (f_c) \cdot b_{\text{cant}}^2}{\phi_t (f_y)^2} \right] = 1.25 \cdot \text{in}^2 \]

\[ A_{\text{req'd}} := \frac{\frac{d_{\text{cant}} \cdot 0.85 \cdot (f_c) \cdot b_{\text{cant}}^2}{f_y} - \sqrt{\frac{d_{\text{cant}} \cdot 0.85 \cdot (f_c) \cdot b_{\text{cant}}^2}{f_y}}}{2 \cdot (1)} \]
Minimum amount of reinforcement steel, ACI 318-14. Eqn, 9.6.1.2(a)

\[ A_{s\_min1} = \frac{3 \cdot \sqrt{f_c'(\text{psi})}}{f_y} \cdot (b_{\text{cant}}) \cdot (d_{\text{cant}}) = 0.55 \cdot \text{in}^2 \]

Minimum amount of reinforcement steel, ACI 318-14. Eqn, 9.6.1.2(b)

\[ A_{s\_min2} = \frac{200}{f_y} \cdot (b_{\text{cant}}) \cdot (d_{\text{cant}}) = 0.59 \cdot \text{in}^2 \]

Per ACI 318-14 Section 9.6.1.3, if the amount of steel provided in the section is at least 1/3 greater than that required by Eqns. 9.6.1.2(a) or (b), then the requirements of Eqns. 9.6.1.2(a) or (b) do not apply. As the amount of steel required to meet the bending requirement exceeds the minimum values of Eqns. 9.6.1.2(a) or (b), the minimum amount of steel required is met.

\[ A_{s\_min} = \max\left[ \right] \cdot A_{s\_min1}, A_{s\_min2} = 1.25 \cdot \text{in}^2 \]

(1) #9 on 9-inch centers = 1.25 in^2
(1) #8 on 6-inch centers = 1.58 in^2

Reinforcing steel required in each direction in the bottom of the 18-inch thick slab.

The same steel will be used in the top of the slab to minimize cracking and use of joints (see Section 8.4.5 of calc).

**8.4.2 Concrete Shear**

Conservatively determine the applied shear load for a single cask over a 1-foot wide strip with the length of the diameter of a cask.

\[ L_{\text{shear}} := VCC_{\text{dia}} = 10\text{ft} \]
\[ d_{\text{cant}} = 1.22\text{ft} \]
\[ A_{\text{shear}} := (2\text{sides}) \cdot (L_{\text{shear}}) \cdot (d_{\text{cant}}) = 24.38\text{ft}^2 \]
\[ V_{\text{applied}} := (VCC_{\text{weight}}) = 155\text{-kip} \]
\[ \lambda := 1.0 \]
\[ \text{Shear} := \frac{V_{\text{applied}}}{A_{\text{shear}}} = 44.16\text{psi} \]

Applied shear load at the centerline of the cask.

Modification factor for normal weight concrete, ACI 318, Table 19.2.4.2.
\[ V_c := (2 \cdot \lambda) \left( \frac{f_c}{\psi \text{ psi}} \right) \text{ psi} = 126.5 \cdot \text{psi} \]  
\[ \phi_{\text{shear}} := 0.75 \]  
\[ \text{Strength reduction factor per Table 21.2.1 of ACI 318-14.} \]

\[ \text{DCR}_{\text{shear}} := \frac{\text{Shear}}{\phi_{\text{shear}} \cdot V_c} = 0.47 < 1.0, \text{ OK for shear} \]

**8.4.3 Concrete Punching Shear VCC** - Per Section 9.4.3.2 of ACI 318-14, shear to be evaluated at a distance of \( d_{\text{cant}} \) from the outer diameter of the VCC.

\[ \text{dynamic_factor} = 2 \]  
\[ \text{VCC}_{\text{dia}} = 10 \text{ ft} \]  
\[ \text{d}_{\text{cant}} = 14.63 \cdot \text{in} \]  
\[ b_{\text{punch\_VCC}} := \pi \left( \text{VCC}_{\text{dia}} + 2 \cdot d_{\text{cant}} \right) = 39.07 \text{ ft} \]  
\[ V_{c\_\text{punch\_VCC}} := 2 \cdot (\lambda) \cdot \left( \frac{f_c}{\psi \text{ in}} \right) \cdot \left( \frac{b_{\text{punch\_VCC}}}{\text{in}} \right) \cdot \left( \frac{d_{\text{cant}}}{\text{in}} \right) \cdot \text{(lbf)} = 867 \cdot \text{kip} \]

\[ \phi V_{c\_\text{punch\_VCC}} := \phi_{\text{shear}} \cdot V_{c\_\text{punch\_VCC}} = 651 \cdot \text{kip} \]  
\[ \text{Factored allowable shear load.} \]

\[ V_{\text{applied\_punch\_VCC}} := \left[ (1.6) \cdot (\text{VCC}_{\text{weight}}) \cdot (1\cdot\text{cask}) \right] \cdot \text{(dynamic_factor)} = 496 \cdot \text{kip} \]

\[ \text{DCR}_{\text{shear\_punch\_VCC}} := \frac{V_{\text{applied\_punch\_VCC}}}{\phi V_{c\_\text{punch\_VCC}}} = 0.76 < 1.0, \text{ OK for VCC punching shear} \]
8.4.4 Concrete Punching Shear VCT Wheel or Crane Pad - Per Section 9.4.3.2 of ACI 318-14, shear to be evaluated at a distance of $d_{\text{cant}}$ from the outer diameter of the VCC.

$$\text{wheel}_\text{load} = \frac{\text{kip}}{\text{corner}}$$

Wheel load per corner of VCT, previously defined

$$\text{pad}_{\text{crane}} = 75.94 \text{kip}$$

Pad load per corner of crane, previously defined

$$\text{wheelpad} := 12 \text{ in}$$

Minimum assumed dimension of crane pad or wheel loading imprint.

$$d_{\text{cant}} = 14.63 \text{ in}$$

Depth of compression block, previously defined.

$$V_{\text{applied}}_{\text{wheelpad}} := \max(\text{wheel}_\text{load}, \text{pad}_{\text{crane}}) = 1 \text{ kip}$$

Applied shear load increased by a dynamic factor.

$$b_{\text{punch}}_{\text{wheelpad}} := \pi \left(\text{wheelpad} + 2 \cdot d_{\text{cant}}\right) = 10.8 \text{ ft}$$

Length of concrete shear resistance

$$V_c_{\text{punch}}_{\text{wheelpad}} := 2 \cdot (\lambda) \cdot \sqrt{\frac{f_c}{\text{psi}}} \left(\frac{b_{\text{punch}}_{\text{wheelpad}}}{\text{in}}\right) \left(\frac{d_{\text{cant}}}{\text{in}}\right) \cdot (\text{lbf}) = 240 \text{ kip}$$

ACI 318-14, Eqn. 22.5.5.1

$$\phi V_c_{\text{punch}}_{\text{wheelpad}} := (\phi_{\text{shear}}) \cdot (V_c_{\text{punch}}_{\text{wheelpad}}) = 180 \text{ kip}$$

$$\text{DCR}_{\text{shear}}_{\text{punch}}_{\text{wheelpad}} := \frac{V_{\text{applied}}_{\text{punch}}_{\text{wheelpad}}}{\phi V_c_{\text{punch}}_{\text{wheelpad}}} = 1$$

$< 1.0$, OK for punching shear

8.4.5 Control Joints

Per PCA Engineering Bulletin, 2008, pg 107, of Concrete Floors on Ground, large areas can be cast without control joints if the amount of distributed steel in the top 1/3 of the slab is 0.5% - 0.7% of the cross sectional area.

$$A_{\text{s-min}}_{\text{crtl-int}} := (0.5\%) \cdot (d_{\text{cant}}) \cdot (1 \cdot \text{ft}) = 0.88 \cdot \text{in}^2$$

Minimum amount of reinforcing steel required in order to NOT HAVE control joints.

$$A_{\text{s}}_{\text{slab}} := (A_{\text{s-min}}) = 1.25 \cdot \text{in}^2$$

Amount of top reinforcing steel provided per foot.

As the provided steel exceeds the required steel, control joints are not required.
8.5 **Check Soil Bearing** - Per preliminary Geotechnical Design Recommendations Report for the W-135 Project Capsule Storage Area, Report No. 22-1-40034-002, a conservative allowable soil bearing capacity is found to be 1000 psf. The maximum soil load, using LRFD factors, was determined in Load Case 5 above. Redetermine the soil pressure without seismic loading or load factors.

\[
q_{u\text{Max}} = \frac{(1.2) \cdot (w_{\text{pad}}) + (1.0) \cdot (VCC_{\text{weight}}) \cdot (5 \cdot \text{casks})}{A_{\text{pad}}} + \text{soil}_{\text{LC5seis}} = 1427 \text{ psf}
\]

\[
\text{soil}_{\text{pressure}} := \frac{(1.0) \cdot (w_{\text{pad}}) + (1.0) \cdot (VCC_{\text{weight}}) \cdot (5 \cdot \text{casks})}{A_{\text{pad}}} = 799 \text{ psf}
\]

\[
\text{DCR}_{\text{soil\_bearing}} := \frac{\text{soil}_{\text{pressure}}}{1000 \text{ psf}} = 0.80 < 1.0, \text{OK for soil bearing.}
\]
ATTACHMENT 1

TABLE 4.1-1 FROM NAC INTERNATIONAL DOCUMENT NO. 30059-P-01, *MPC-CAPSULE STORAGE SYSTEM (MPC-CSS) OPERATIONS AND MAINTENANCE MANUAL*
### Table 4.1-1  MPC-CSS Storage System Component Weights (Estimated)

<table>
<thead>
<tr>
<th>MPC-CSS Component/Configuration</th>
<th>Weight (lbs. - est.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Capsule Sleeves (loaded) – 22 @ 350 lbs. each</td>
<td>7,700</td>
</tr>
<tr>
<td>UCS Shell</td>
<td>180</td>
</tr>
<tr>
<td>W Type UCS Shell</td>
<td>220</td>
</tr>
<tr>
<td>UCS Plug Assembly</td>
<td>40</td>
</tr>
<tr>
<td>TSC Basket Assembly</td>
<td>14,500</td>
</tr>
<tr>
<td>TSC Outer Closure Lid</td>
<td>2,000</td>
</tr>
<tr>
<td>TSC Inner Closure Lid</td>
<td>800</td>
</tr>
<tr>
<td>TSC (w/basket, w/UCS and closure lids)</td>
<td>22,100</td>
</tr>
<tr>
<td>TSC (w/basket, w/W Type UCS and closure lids)</td>
<td>22,920</td>
</tr>
<tr>
<td>VCC Lifting Lug (est.)</td>
<td>270</td>
</tr>
<tr>
<td>VCC (empty w/o lid)</td>
<td>120,000</td>
</tr>
<tr>
<td>VCC Lid</td>
<td>7,200</td>
</tr>
<tr>
<td>VCC In Storage Awaiting Loading (w/empty TSC, closure lids, and VCC lid)</td>
<td>144,500 (72.3 tons)</td>
</tr>
<tr>
<td><strong>Loaded MPC-CSS Storage System – Ready for Transport to Capsule Storage Area</strong></td>
<td><strong>155,000 (77.5 tons)</strong></td>
</tr>
<tr>
<td>AWS with Frame and cabling (est.)</td>
<td>3,450</td>
</tr>
</tbody>
</table>
## ATTACHMENT 2

**GENERAL ARRANGEMENT DRAWING OF THE RUBBER-TIRED TOWED CASK TRANSPORTER**
TRANSPORTER DATA:
- Rated capacity 170,000 lbs.
- Empty weight: 95,000 lbs.
- Operating weight: 265,000 lbs with the 85 Ton cask.
- Lifting towers: Single stage, double acting, equipped with counterbalance valves for load holding and controlled lowering of the cask.
- Lifting towers are equipped with manual pins for redundant drop protection. Optional self contained automatic weldlocks are available.
- Full load sideshift, ± 4.0”, for cask placement on storage pad, trailer and position accuracy.
- Lifting towers are in accordance with SAE J1078: a recommended method of analytically determining the competence of hydraulic telescopic cantilevered booms.
- All welding is in accordance with AWS D1.1.
- LPI and MPI in accordance with ASNT, Level I including NDE qualified personnel.
- Environmental conditions: rain and snow, 0°F to 120°F at 0% to 100% humidity.
- Maximum tow speed: 5 mph.
- Maximum grade capability: 5% Longitudinal or 2% transverse with 85 Ton cask.
- Diesel engine: 25 hp.
- Diesel fuel tank capacity: 13 gallons.
- Tires: 16.00R25, Foam Filled, High capacity, (8) total tires.
- Average ground bearing pressure: 155 psi with 85 Ton cask.
- Push bar for backing up transporter into position while using hydraulic steering.
- Operator control panel: Controls for all cask transporter operations, gauges and instruments to monitor the engine and the hydraulic systems, key-type switches for individual and simultaneous movement requirements, speed control, dead man’s throttle, steering controls, emergency brakes, lift tower controls, lift link trim cylinder(s) controls, hydraulic pressure gauges to measure the load at each lift tower.
<table>
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<tr>
<th>TOLERANCES (EXCEPT AS NOTED)</th>
<th>LIFT SYSTEMS, INC.</th>
</tr>
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<tbody>
<tr>
<td>DECIMAL</td>
<td>DRAWN BY: CRP</td>
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<tr>
<td>± 0.02&quot;</td>
<td>APPR BY:</td>
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<tr>
<td>± 0.05&quot;</td>
<td>TITLE:</td>
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<td>± 0.15&quot;</td>
<td>General Arrangement Drawing of the Rubber-Tired Towed Cask Transporter for NAC International at the West Valley Project.</td>
</tr>
<tr>
<td>FRACTIONAL</td>
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<td>± 1/16&quot;</td>
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<td>SHEET 1 OF 1</td>
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</tbody>
</table>
ATTACHMENT 3

VERTICAL CASK TRANSPORTER
**Vertical Cask Transporter**

**VCT Dimensions**
- Maximum width: 17.75 feet
- Overall height: Fully Extended 21.75 feet
- Wheel diameter: ~5 feet

**Weight/Lifting Capacity**
- Unburdened transporter weight: ~47.5 tons
- Rated lifting capacity: 90 tons
- VCT weight with loaded cask: 135 tons

**Cask Engagement Features**
- 4 inch thick lifting lugs attach to Vertical Storage Cask
- Lifting lug yoke on swivel attaches to mobile gantry crane

**Engineered for Safe Cask Transport**
- NAC International, an international supplier of nuclear fuel storage systems, and Lift Systems, Inc., which specializes in equipment to lift and transport heavy and oversized loads, designed and constructed the Vertical Cask Transporter to interface with the WVDP’s Vertical Storage Casks.
- The equipment is designed and tested to meet stringent industry standards.
- Safety features include advanced systems for stopping, parking, load securement and lift limiting devices.

The Vertical Cask Transporter (top photo) that will be used for outdoor transport of HLW storage casks at the West Valley Demonstration Project and the tow tractor that will pull it are pictured above.

The West Valley Demonstration Project (WVDP) is preparing to package and relocate 278 canisters (275 production canisters and 3 end-of-process canisters) of vitrified high-level waste (HLW) from inside the Main Plant Process Building (MPPB) to a new on-site storage location. The 47-ton Vertical Cask Transporter (VCT) is a mobile hydraulic gantry crane that will be used for the heavy hauling operation at the WVDP.

The specially-designed VCT is one of three task-specific pieces of heavy lifting/hauling equipment that will be used to maneuver the storage casks through loading and storage procedures. The VCT will operate entirely outdoors, where it will transport empty concrete storage casks to the MPPB and the 87-ton loaded casks from the MPPB to the Storage Pad. It is equipped with a diesel engine for lifting the casks, but will be towed by a separate GT50 aircraft tow tractor, which is commonly used to move airplanes.

The VCT is designed to operate under the wide temperature and humidity ranges that exist at the WVDP. Operating at its maximum loaded speed of approximately 2 miles per hour, on-site transport of a loaded storage cask from the MPPB to the Storage Pad will take approximately 3 hours.
**Vertical Cask Transporter**

**Cask Loading and Transport**

The series of steps involved with loading and transporting the High-Level Waste (HLW) Vertical Storage Casks (VSC) from the Main Plant Process Building (MPPB) to the HLW Storage Pad require several movements of the bulky steel-line concrete storage casks. The WVDP's Vertical Cask Transporter (VCT) will play an important role in transporting casks for loading and placement in storage. To facilitate loading and storage, the VCT will:

- Pick up empty VSCs at the fabrication area in the WVDP’s North Parking Lot
- Deliver the empty VSCs to the entrance of the Load-In Facility (LIF)
- Pick up VSCs loaded with 5 canisters at the LIF
- Transport loaded VSCs approximately one-half mile from the MPPB to the HLW Storage Pad
- Position the loaded VSCs on the Storage Pad

Lifting and transporting the VSCs requires precision and the utmost attention to safety. Design of the Vertical Cask Transporter, which is specifically made for outdoor movement and positioning of the WVDP’s casks, is based on similar transport equipment used for moving spent nuclear fuel in concrete storage casks at nuclear power plants.

**Proven, Safe, Long-Term Storage Technology**

The WVDP HLW Storage System

- Maximizes the use of off-the-shelf technology
- Safely and securely packages HLW in multi-pack configuration to reduce handling and shipping costs
- Offers maintenance-free, passive storage
- Meets high nuclear quality assurance standards
- Interfaces with NRC Type-B licensed transportation casks

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The West Valley Demonstration Project (WVDP) is a U.S. Department of Energy-led environmental remediation project located approximately 35 miles south of Buffalo, NY. CH2M HILL Babcock & Wilcox, LLC, (CHBWV) was formed to meet the specific requirements of Phase 1 decommissioning of the WVDP. The limited-liability partnership combines the experience and capabilities of CH2M HILL Constructors Inc. (CH2M HILL), Babcock & Wilcox Technical Services Group, Inc. (B&W), and Environmental Chemical Corporation (ECC).
## Attachment 4

### Crane Information

(Terex Demag AC 200-1)
## Title
Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135

### Prepared By:
Date: 05-21-2018

### Checked By:
Date: 05-21-2018

---

### Quality Assurance Procedure 3.1 Calculation Sheet (05-10)

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### Bigge Equipment Co.

### Terex DEMAG

### AC 200-1 | All Terrain Crane 240 t Lifting Capacity

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This information is for reference use only. Operators manual should be consulted and adhered to. Please contact Bigge Crane and Rigging Co. at 888-337-BIGGE or email info@bigge.com for further information.
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<tr>
<td>Axle weight with dolly</td>
<td>7</td>
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<td>Lifting capacities</td>
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This information is for reference use only. Operators manual should be consulted and adhered to. Please contact Bigge Crane and Rigging Co. at (888) 331-4BGE or email info@bigge.com for further information.
### AXLE WEIGHT WITH DOLLY AC 200-1

#### CRANE CONFIgURATION

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<tr>
<td>Tires</td>
<td>20.0 x 2.25</td>
</tr>
<tr>
<td>Outrigger front</td>
<td></td>
</tr>
<tr>
<td>Outrigger rear</td>
<td></td>
</tr>
<tr>
<td>Boom extended</td>
<td>3.3'</td>
</tr>
<tr>
<td>Hook block 2 dozers</td>
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<tr>
<td>2 axle boom dolly</td>
<td>5,700 lb</td>
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#### AXLES

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<td>27,936 lb</td>
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<tr>
<td>2</td>
<td>27,182 lb</td>
</tr>
<tr>
<td>3</td>
<td>18,723 lb</td>
</tr>
<tr>
<td>4</td>
<td>18,968 lb</td>
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<tr>
<td>5</td>
<td>18,287 lb</td>
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<tr>
<td>6</td>
<td>20,640 lb</td>
</tr>
<tr>
<td>7</td>
<td>20,488 lb</td>
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</table>

---

**Diagram:**

[Diagram of crane setup]

---

Quality Assurance Procedure 3.1
### SPECIFICATIONS

#### AXLE LOADS
- Basic machine with hook block in position
- Axles:
  - Front: 5 x 20,400 lb
  - Rear: 132,000 lb

#### WORKING SPEEDS (INFINITELY VARIABLE)

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Normal speed</th>
<th>High speed</th>
<th>Max. permissible line pull</th>
<th>Rope diameter / Rope length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoist 1</td>
<td>147.6 ft/min</td>
<td>410 ft/min</td>
<td>22,000 lb</td>
<td>0.03&quot; / 1132 ft</td>
</tr>
<tr>
<td>Hoist 2</td>
<td>147.6 ft/min</td>
<td>410 ft/min</td>
<td>22,000 lb</td>
<td>0.03&quot; / 1132 ft</td>
</tr>
<tr>
<td>Slowing</td>
<td></td>
<td></td>
<td></td>
<td>max. 1.3&quot; / min</td>
</tr>
<tr>
<td>Boom elevation</td>
<td></td>
<td></td>
<td></td>
<td>-1.5° - +3°</td>
</tr>
</tbody>
</table>

#### CARRIER PERFORMANCE
- Travel speed: 0.53 mph
- Gradeability: max. 71.1%

#### HOOK BLOCK / SINGLE LINE HOOK

<table>
<thead>
<tr>
<th>Type</th>
<th>Possible load</th>
<th>Number of sheaves</th>
<th>Weight</th>
<th>&quot;D&quot;</th>
<th>Number of lines</th>
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<tbody>
<tr>
<td>206</td>
<td>324,800 lb</td>
<td>9</td>
<td>3,864 lb</td>
<td>9.8&quot;</td>
<td>16</td>
</tr>
<tr>
<td>140</td>
<td>365,800 lb</td>
<td>7</td>
<td>3,316 lb</td>
<td>9.4&quot;</td>
<td>15</td>
</tr>
<tr>
<td>126</td>
<td>326,920 lb</td>
<td>6</td>
<td>2,498 lb</td>
<td>9.4&quot;</td>
<td>11</td>
</tr>
<tr>
<td>80</td>
<td>146,400 lb</td>
<td>3</td>
<td>1,870 lb</td>
<td>9.0&quot;</td>
<td>7</td>
</tr>
<tr>
<td>52</td>
<td>64,000 lb</td>
<td>1</td>
<td>1,520 lb</td>
<td>9.6&quot;</td>
<td>3</td>
</tr>
<tr>
<td>12.5</td>
<td>21,850 lb</td>
<td>Single line hook</td>
<td>770 lb</td>
<td>9.6&quot;</td>
<td>1</td>
</tr>
</tbody>
</table>

*Remarks:

1. values depending on national regulations
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<tr>
<th>Prepared By:</th>
<th>Date: 05-21-2018</th>
<th>Checked By:</th>
<th>Date: 05-21-2018</th>
</tr>
</thead>
</table>

**ATTACHMENT 5**

**FORKLIFT INFORMATION**
Figure 2.1 – CHU Terminology Diagram
Steering: Four hydraulic motors.

High Pressure Relief Valves: Located at the top of each rear cylinder, these valves maintain the rear cylinder hold down pressure.

Proportional Valves: Located inside the grill on the right side of the CHU, these valves control the flow of hydraulic oil to the cylinders.

Drive Circuit: Closed loop hydrostatic drive pump, 40 GPM with electronic control. Operates at 5000 psi (344.76 bar).

Electrical Characteristics

The 12-Volt starting system is capable of starting the Engine at 32 degrees Fahrenheit (0 degrees Celsius).

Alternator: 12 Volt 55 amp
Battery: Group 31, 12 Volt, 150-amp capacity, 950 cold cranking

Electronic Characteristics

The IQAN MDL2 load management system computer is located in the Relay Box under the operator's seat.

Controls: The computer operated hydraulic controls provide variable control of ascent and descent speeds to allow precise setting of the load.

Automatic Overload Shut-off: If the weight being lifted causes the rear wheels to "nearly" lift off the surface, the shut off system will not allow the use of Lift, Boom Out, or Counterweight In functions. However, corrections can be made using Boom In, Counterweight Out, or Lower functions.

Speed Specifications

\[
\begin{align*}
\text{Drive mode = low (with/without load):} & \quad 0-32 \text{ ft. / min (0-9.75 m/min)} \\
\text{Drive mode = high (only without load):} & \quad 0-64 \text{ ft. / min (0-19.5 m/min)} \\
\text{Lift mode = low (With/without load):} & \quad 0-12.8 \text{ ft. / min}
\end{align*}
\]

Weight Specifications

\[
\begin{align*}
\text{Without Counterweight:} & \quad 64,180 \text{ lbs. (29,111 kg)} \\
\text{With All Counterweights:} & \quad 123,118 \text{ lbs. (55,845 kg)} \\
\text{Rear Axle load without Load} & \quad 88,800 \text{ lbs. (40,279 kg)} \\
\text{W/Counterweight:} & \quad 289,000 \text{ lbs. (131,088 kg)} \\
\text{Front Wheels with 90 Tons Load:} & \quad \text{Not specified}
\end{align*}
\]
Floor Loading Weights

With 90 Tons Load:  
  Front Wheels: 439 psi (30.27 bar)
  Back Wheels: 323 psi (36.2 bar)

W/Counterweight:  
  No load
  Front Wheels: 103 psi (7.1 bar)
  Back Wheels: 241 psi (16.6 bar)

Basic Dimensions

Lift Height:  
  Min: 127.13 in (322.9 cm)
  Max: 194.75 in (494.7 cm)

Upright Height:
  Lowered: 132.38 in (336.2 cm)
  Extended: 200.75 in (509.9 cm)

Length with counterweight installed:
  W/Counterweight and Boom Retracted: 344 in (873.8 cm)
  Counterweight Retracted and Boom Extended: 368 in (934.7 cm)
  W/Counterweight and Boom Extended: 428 in (1087.1 cm)

Width: 102.63 in (260.7 cm)

Load Center Distance:
  Boom In: 43.25 in (109.9 cm)
  Boom Out: 67.25 in (170.8 cm)

Turning Radius:
  Counterweight Retracted:
    Inside: 0 in (0 cm)
    Outside: 300 in (762 cm)
  Counterweight Extended:
    Inside: 0 in (0 cm)
    Outside: 360 in (914.4 cm)

Stability

Gradeability:  
  Loaded: 8%
  Without Load: 20%

Tipping:  
  Loaded: 2% Lateral grade
  Without Load: 20%

Riggers Manufacturing Company
CHU Manual
Transporting the CHU

1. Chain the front of the CHU to the trailer by the load tie down ears located at the front corners of the CHU above the front wheels.

2. Chain the rear of the CHU to the trailer by the load tie down ears located on the back of the frame tube.
Figure 7.6 – Bottom of CHU showing locations drive motor bolts.

1 1/8 HHCS – 10 INSIDE WHEEL TORQUE TO 909 ft. lbs.

1 1/8 HHCS – 10 EACH MOTOR – 2 MOTORS TORQUE TO 909 ft. lbs.
**CALCULATION COVER SHEET**

**Project No.** 046414.17.01  
**Project Title:** W-135 Capsule Storage Area  
**Client:** CH2M Hill Plateau Remediation Company

**Title:** Design and Analysis of Road Improvements for Project W-135

**Purpose and Objective:**

The purpose of this calculation is to determine the adequacy of the asphalt haul paths located at the WESF truck port and Capsule Storage Area (CSA) as shown on drawings H-2-837593 and H-2-837595. An evaluation of the adequacy of Atlanta Avenue and 7th Street (between WESF and the CSA) is also performed. An evaluation is also performed of the adequacy of Atlanta Avenue and 7th Street (between WESF and the CSA).

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<th>Total Pages</th>
<th>Prepared By</th>
<th>Checked By</th>
<th>PM/TL</th>
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<tr>
<td>C</td>
<td>19</td>
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**Revision Description (Revision Description/Affected Pages):**

## CALCULATION REVIEW CHECKLIST

**Project No.** 046414.17.01  
**Calculation No.** 046414.17.01-C-002  
**Rev.** C  
**Page No.** 2 of 19

<table>
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<tr>
<th>Items Checked</th>
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<th>Description of Resolution for Unacceptable Items</th>
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<tr>
<td>1. Cover sheets properly completed.</td>
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<tr>
<td>2. Calculation sheet headers complete with calculation number, revision number, etc.</td>
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</tr>
<tr>
<td>3. Calculation sheet contents are legible, accurate and complete per format.</td>
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<tr>
<td>4. Listed attachments included.</td>
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<tr>
<td>5. Calculation objective clearly described.</td>
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<tr>
<td>6. Criteria are suitable and properly referenced to task specific documents.</td>
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</tr>
<tr>
<td>7. Assumptions and input data selected, described, reasonable and attached or referenced to task documents.</td>
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</tr>
<tr>
<td>8. Calculation method identified and appropriate for the design activity.</td>
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</tr>
<tr>
<td>9. Calculation results reasonable and correctly described in results and conclusions.</td>
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<tr>
<td>10. Physical property calculations generated by CAD software verified via hand calculations.</td>
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<tr>
<td>11. Computer program identified with version and revision.</td>
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<tr>
<td>12. Computer input/output provided or referenced and reasonable.</td>
<td>✓</td>
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</tr>
<tr>
<td>13. Computer run traceable to calculation (file #, etc.).</td>
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<td>14. Computer input/output data and problem type with validation/verification range of use.</td>
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<td>15. Computer program validation/verification addressed.</td>
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<td>16. Computer operating system in use for calculation preparation is the same as when the software was verified on machine.</td>
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**Calculation Checking Method**  
- **✓** Direct Step-by-Step Check  
- **✓** All Pages  
- **✓** Reference Chart(s) or Book(s) Comparison (Append Documentation)  
- **✓** Alternate Calculation (Append Documentation)

**Comments:**

---

**Date:**  
5/10/18

**Signatures obtained only after discrepancies are corrected and comments are resolved.**

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Quality Assurance Procedure 3.1  
Calculation Review Checklist (10-17)
Table of Contents

1.0 METHODOLOGY ......................................................................................................................................4
2.0 DESIGN INPUTS ........................................................................................................................................4
3.0 ASSUMPTIONS ..........................................................................................................................................4
4.0 COMPUTER SOFTWARE .........................................................................................................................4
5.0 RESULTS AND CONCLUSIONS .............................................................................................................4
6.0 REFERENCES ............................................................................................................................................5
7.0 CALCULATIONS .......................................................................................................................................6

Attachments
- Lift Systems, Inc. Drawing
- Lift Systems, Inc. Drawing (Transporter Data)
- Manitowoc Grove RT9150E Crane
- Terrex Demag AC 200-1 Crane
1.0 METHODOLOGY

The pavement is evaluated in accordance with AASHTO 1993 Empirical Equation for Flexible Pavements and WSDOT Pavement Design Guide with the demand (Equivalent Single Axle Load (ESAL)) computed per AASHTO 1993 in order to account for the various axle weights which are greater than the standard for calculating ESALs (18 kips).

2.0 DESIGN INPUTS

1. The haul path is evaluated for Vertical Cask Transporter (VCT), crane (Grove RT9150E 150 ton and Terex Demag AC-200-1 200 ton), HS20 heavy trucks, and cars. See Assumptions.

3.0 ASSUMPTIONS

1. In order to determine the asphalt thickness, a few assumptions are made based on the number of cars, design life, etc. The estimated number of cars per day is 50. The estimated number of trucks (HS-20 loading) per day is 4. The estimated number of cranes per day is 1 and 1 VCT. The design life of the pavement is 5 years. This basis for the design life is that the VCCs will be delivered, filled, and stored during the first few years of the project. The design and construction of the new haul paths will be significantly newer and more robust than the surrounding roads in the WESF area which are adequate for the typical general traffic. The growth factor for traffic is estimated at 1% per year.

There are no other unverified assumptions in this calculation.

4.0 COMPUTER SOFTWARE

No unverified computer software was used in this analysis. Mathcad®1 14.0 was used for the hand calculations. Calculations are checked using a handheld calculator.

5.0 RESULTS AND CONCLUSIONS

For the new entrance to the CSA, use 6" thick asphalt with 10" of base, and 4" of top course (minimum) as defined in CHPRC-02537, Appendix C, “Construction Specification,” Section 32 12 00, “Hot Mix Asphalt Paving,” and Section 32 11 23, “Aggregate for Gravel Base.”

It is also recommended that since the section of 7th Street between the CSA and intersection with Atlanta Avenue is in poor condition and is not wide enough for the VCT, this section of roadway be replaced with the same pavement design as the CSA entrance. Atlanta Avenue is adequate as-is for transport of the VCT between WESF and the CSA.

1 Mathcad is a registered trademark of Parametric Technology Corporation., Needham, Massachusetts.
6.0 REFERENCES


Terex Demag, *All Terrain Crane AC 200-1*, Order Nr. AC 200-1, Bigge Crane and Rigging Co. 2006 (Attached)

7.0 CALCULATIONS

7.1 Determine the Total number of ESALs

The total number of ESALs are determined using the method described in AASHTO 1993 Appendix D.

\[
T_{\text{VCT}} := \frac{1}{\text{VCTs}} \quad \text{day} \quad \quad \quad \text{Estimated number of VCT trips per day. (See Assumptions)}
\]

\[
T_{\text{crane}} := \frac{1}{\text{cranes}} \quad \text{day} \quad \quad \quad \text{Estimated number of cranes per day. (See Assumptions)}
\]

\[
T_{\text{HS20}} := \frac{4}{\text{trucks}} \quad \text{day} \quad \quad \quad \text{Estimated number of heavy trucks (HS20) per day. (See Assumptions)}
\]

\[
T_{\text{car}} := \frac{50}{\text{cars}} \quad \text{day} \quad \quad \quad \text{Estimated number of cars per day. (See Assumptions)}
\]

The following axle load equivalency factors are per AASHTO 1993, Table D.4 with a structural number of 3. The terminal serviceability level is estimated to be 2.5 based upon the criteria of AASHTO 1993, Part II, Section 2.2.1. The axle load for Table D.4 does not exceed 50 kips. The amplification factor for a 50 kip axle load is used to amplify the 150 ton crane and VCT axle loads. This is done by solving for the power to get the number listed in AASHTO 1993, Table D.4. Note that an HS20 consists of an 8 kip steering (front) axle and a 32 kip drive (rear) axle. Cars are estimated to weigh 12 kips with half of the weight on each axle.

\[
\left( \frac{50}{18} \right)^x = 79 \quad a := \log \left( \frac{79}{\frac{50}{18}} \right) = 4.3 \quad \left( \frac{50}{18} \right)^a = 79.0
\]

Equations to solve for the axle load equivalency factor from AASHTO 1993, Table D.4.

\[
\text{Axle}_{\text{VCT}} := \frac{265000 \text{lb}}{2} = 132500 \text{lbf}
\]

Estimated axle load of the VCT. (Lift Systems, Inc., See Attachments) Model the VCT as a two axled vehicle.

\[
\text{Axle}_{150 \_ r} := 124669 \text{lbf}
\]

Rear axle load of the 150 ton crane. (Grove RT9150E Product Guide, See Attachments)

\[
\text{Axle}_{150 \_ f} := 68870 \text{lbf}
\]

Front axle load of the 150 ton crane. (Grove RT9150E Product Guide, See Attachments)

\[
\text{Axle}_{200} := 26400 \text{lb} + \frac{152000 \text{lb}}{5} = 56800.0 \text{lbf}
\]

Axle load of the 200 ton crane (including 152,000 lb counterweight distributed over 5 axles). (Terex Demag AC 200-1 Catalog, See Attachments)

\[
\text{Axle}_{\text{LEF\_VCT}} := \left( \frac{\text{Axle}_{\text{VCT}}}{18000 \text{lbf}} \right)^{\log \left( \frac{79}{\frac{50}{18}} \right)} = 5102.5
\]

VCT load equivalency factor.
Grove 9150E crane load equivalency factors.

AxleLEF_crane_f := \left( \frac{Axle_{150}}{18000lbf} \right)_{\log \left( \frac{50}{18} \right)} = 310.7

AxleLEF_crane_r := \left( \frac{Axle_{150}}{18000lbf} \right)_{\log \left( \frac{50}{18} \right)} = 3932.2

AxleLEF_crane_200 := \left( \frac{Axle_{200}}{18000lbf} \right)_{\log \left( \frac{50}{18} \right)} = 136.3

Terex Demag AC 200-1 crane load equivalency factor.

AxleLEF_HS20_f := 0.051

AxleLEF_car_f := 0.017

ESALfactor_VCT := 2 \cdot AxleLEF_VCT = 10205

VCT ESAL factor. (AASHTO 1993, Section D.3)

Crane ESAL factor. (AASHTO 1993, Section D.3)

ESALfactor_crane := \max\left(\text{AxleLEF}_f + \text{AxleLEF}_r, 5 \cdot \text{AxleLEF}_200\right) = 4243

ESALfactor_HS20 := \text{AxleLEF}_{f} + \text{AxleLEF}_{r} = 10.6

HS20 ESAL factor. (AASHTO 1993, Section D.3)

ESALfactor_car := \text{AxleLEF}_f + \text{AxleLEF}_r = 0.034

Car ESAL factor. (AASHTO 1993, Section D.3)

Y := 5yr

G := \frac{(1 + 0.01)^yr - 1}{0.01} = 5.10

Traffic\_d\_VCT := T_{VCT} \cdot 1yr \cdot G = 1863

Design crane traffic (including growth factor). (AASHTO 1993, Section D.3)

Traffic\_d\_crane := T_{crane} \cdot 1yr \cdot G = 1863

Design crane traffic (including growth factor). (AASHTO 1993, Section D.3)

Traffic\_d\_HS20 := T_{HS20} \cdot 1yr \cdot G = 7452

Design HS20 traffic (including growth factor). (AASHTO 1993, Section D.3)

Traffic\_d\_car := T_{car} \cdot 1yr \cdot G = 93155

Design car traffic (including growth factor). (AASHTO 1993, Section D.3)

ESALt\_VCT := Traffic\_d\_VCT \cdot \text{ESALfactor}_VCT = 19013075

Total VCT ESALs for the haul path design life. (AASHTO 1993, Section D.3)

ESALt\_crane := Traffic\_d\_crane \cdot \text{ESALfactor}_crane = 7904918

Total crane ESALs for the haul path design life. (AASHTO 1993, Section D.3)

ESALt\_HS20 := Traffic\_d\_HS20 \cdot \text{ESALfactor}_HS20 = 78630

Total HS20 ESALs for the haul path design life. (AASHTO 1993, Section D.3)
7.2 Determine the Thicknesses of the Surface, Top, and Base Courses

\[ a_{HMA} = 0.50 \]

Layer Coefficient for Hot Mix Asphalt. (WSDOT Pavement Policy, Table 5.2)

\[ a_{CSBC} = 0.13 \]

Layer Coefficient for the crushed surfacing base course. (WSDOT Pavement Policy, Table 5.2 and AASHTO 1993, Part II, Table 2.4)

\[ m_{CSBC} = 1.0 \]

Drainage coefficient for the crushed surfacing base course. (WSDOT Pavement Policy, Table 5.2)

\[ M_R = 10000 \text{psi} \]

Modulus of resilience of the roadbed. (WSDOT Pavement Policy, Table 5.2)

\[ E_{base} = 30000 \text{psi} \]

Base modulus of elasticity. (WSDOT Pavement Policy, Table 5.2)

\[ \Delta \text{PSI} = 1.5 \]

Difference between the initial design serviceability index, \( p_0 \), and the design terminal serviceability index, \( p_t \). (WSDOT Pavement Policy, Table 5.2)

\[ S_0 = 0.5 \]

Combined standard error of the traffic prediction and performance prediction. (WSDOT Pavement Policy, Table 5.2 and AASHTO 1993, Part I, Table 4.1 and Part II, Table 2.2)

\[ Z_R = -0 \]

Standard Normal Deviate with a reliability value of 50%. (AASHTO 1993, Part I, Table 4.1 and Part II, Table 2.2)
Determine the Minimum Pavement Thicknesses

This section will determine the minimum thickness for HMA. This is found using the equation and guidelines from 1993 AASHTO Flexible Pavement Guide.

Given

\[ SN_1 := 3 \]

Structural Number (an index that is indicative of the total pavement thickness required). This is an initial guess and is required for a Mathcad solve block.

\[ \log(ESAL) = Z_S S_0 + 9.36 \log(SN_1 + 1) - 0.20 + \log\left( \frac{\Delta PSI}{4.2 - 1.5} \right) + 2.32 \log\left( \frac{E_{base}}{psi} \right) - 8.07 \]

AASHTO 1993, Equation 1 2 1.

SN_1 := \text{Find}(SN_1) = 2.869

Structural Number of the HMA.

\[ D_1 := \text{Round}\left( \frac{SN_1}{a_{HMA}} \cdot \text{in}, 0.5\text{in} \right) = 5.50\text{in} \]

Depth of the HMA based on the structural number rounded to the nearest 1/2 inch per AASHTO 1993, Part II, Section 3.1.4. (AASHTO 1993, Appendix H, Section H.3)

Determine the Minimum Thickness of the Top Course

Given

\[ SN_2 := 1.5 \]

Structural Number (an index that is indicative of the total pavement thickness required). This is an initial guess and is required for a Mathcad solve block.

\[ \log(ESAL) = Z_S S_0 + 9.36 \log(SN_2 + 1) - 0.20 + \log\left( \frac{\Delta PSI}{4.2 - 1.5} \right) + 2.32 \log\left( \frac{M_R}{psi} \right) - 8.07 \]

AASHTO 1993, Equation 1 2 1.

SN_2 := \text{Find}(SN_2) = 4.419

Structural Number for the crushed surfacing top course.

\[ D_2 := \text{Round}\left( \frac{SN_2 - a_{HMA}}{a_{CSBC} m_{CSBC}} \cdot \text{in}, 0.5\text{in} \right) = 13.00\text{in} \]

Depth of the crushed surfacing top course based on the structural number rounded to the nearest 1/2 inch per AASHTO 1993, Part II, Section 3.1.4. (AASHTO 1993, Appendix H, Section H.3)
Determine the Minimum Thickness of the Base Course

\[ SN_3 := SN_2 = 4.419 \]

Structural Number for the crushed surfacing base course.

\[ D_3 := \text{Round} \left( \frac{SN_3 - \left( a_{HMA} \frac{D_1}{\text{in}} + a_{CSBC} \frac{D_2}{\text{in}} - m_{CSBC} \right)}{a_{CSBC} \cdot m_{CSBC}} \right) \text{in}, 0.5 \text{in} = 0.00 \text{in} \]

Depth of the crushed surfacing base course based on the structural number rounded to the nearest 1/2 inch per AASHTO 1993, Part II, Section 3.1.4. (AASHTO 1993, Appendix H, Section H.3)

Summary

Based upon the results above use 6" thick asphalt with 13" of top/base (minimum total).

7.3 Evaluate the Existing Road Conditions

Based upon the width, current good condition, and resilience to typical traffic usage (including cranes, trucks, etc.) of Atlanta Avenue, it is judged to be adequate to support the transport between the WESF truck port and the CSA in its as-is condition. This evaluation also includes consideration of the Atlanta Avenue and 7th Street intersection.

7th Street is not as wide as Atlanta Avenue and the width of the VCT is such that the wheels of the VCT will be traveling near the edge of the roadway. In order to prevent failure of the roadway near the edges, 7th Street should be widened. Based upon the current condition of 7th Street and since the roadway already requires widening, it is recommended that the entire 7th Street roadway between the CSA and the intersection with Atlanta Avenue be replaced with a design equivalent to the haul paths evaluated in this calculation.
## ATTACHMENTS

**LIFT SYSTEMS, INC. DRAWING**

**LIFT SYSTEMS, INC. DRAWING (TRANSPORTER DATA)**

**MANITOWOC GROVE RT9150E CRANE**

**TERREX DEMAG AC 200-1 CRANE**

---

Lift Systems, Inc.
Lift Systems, Inc. (Enlarged)
TRANSPORTER DATA:

- Rated capacity: 170,000 lbs.
- Empty weight: 95,000 lbs.
- Operating weight: 265,000 lbs. with the 85 Ton cask.
- Lifting towers: Single stage, double acting, equipped with counterbalance valves for load holding and controlled lowering of the cask.
- Lifting towers are equipped with manual pins for redundant drop protection. Optional self-contained automatic wedgelocks are available.
- Full load sideshift, ± 4.0”, for cask placement on storage pad, trailer and position accuracy.
- Lifting towers are in accordance with SAE J1078: a recommended method of analytically determining the competence of hydraulic telescopic cantilevered booms.
- All welding is in accordance with AWS D1.1.
- LP1 and MP1 in accordance with ASNT, Level 1 including NDE qualified personnel.
- Environmental conditions: rain and snow, 0° F to 120° F at 0% to 100% humidity.
- Maximum tow speed: 5 mph.
- Maximum grade capability: 5% Longitudinal or 2% transverse with 85 Ton cask.
- Diesel engine: 25 hp.
- Diesel fuel tank capacity: 13 gallons.
- Tired: 16.00R25, Foam Filled, High capacity, (8) total tires.
- Average ground bearing pressure: 155 psi with 85 Ton cask.
- Push bar for backing up transporter into position while using hydraulic steering.
- Operator control panel: Controls for all cask transporter operations, gauges and instruments to monitor the engine and the hydraulic systems, key-type switches for individual and simultaneous movement requirements, speed control, dead man’s throttle, steering controls, emergency brakes, lift tower controls, lift link trim cylinder(s) controls, hydraulic pressure gauges to measure the load at each lift tower.
Lift Systems, Inc. (Enlarged)
Lift Systems, Inc. (Enlarged)
Lift Systems, Inc. (Enlarged)
Grove RT9150E Data Sheet (weights include counterweights)

| Basic Machine: Including 60.0 m (197 ft) main boom, main hoist with 256 m (837 ft) of rope, auxiliary hoist with 225 m (738 ft) of wire rope, 28.57 kg (63,000 lb) counterweight, 36 ft - 59 ft manual extension, 9 t (10 US) headache ball, and 90 t (100 US) hook block: |
|-----------------|-----------------|-----------------|
| Remove: 28.57 kg (63,000 lb) counterweight: |
| Crane weight: 59.21 (130.590) |
| Remove: 36 ft - 59 ft manual extension: |
| Crane weight: 57.63 (127.062) |
| Remove: 100 US t hook block: |
| Crane weight: 56.48 (124.327) |
| Remove: 9.0 t (10 US t) headache ball: |
| Crane weight: 56.24 (123.800) |
| Remove: Front and rear outrigger boxes and beams: |
| Crane weight: 47.02 (104.546) |
| Remove: (4) tire/wheel assemblies: |
| Crane weight: 43.25 (95.290) |
| Remove: Main boom assembly, auxiliary boom nose, and extension brackets: |
| Crane weight: 27.04 (60.604) |
**SPECIFICATIONS**

**AXLE LOADS**

<table>
<thead>
<tr>
<th>Basic machine with hook block</th>
<th>5 x 26,400 lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axles Total weight</td>
<td>132,000 lb</td>
</tr>
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</table>

**WORKING SPEEDS (INFINITELY VARIABLE)**

<table>
<thead>
<tr>
<th>Mechanisms</th>
<th>Normal speed</th>
<th>High speed</th>
<th>Max. permissible line pull</th>
<th>Rope diameter / Rope length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoist I</td>
<td>147.6 ft/min</td>
<td>410 ft/min</td>
<td>22,000 lb</td>
<td>0.83&quot; / 1132 ft</td>
</tr>
<tr>
<td>Hoist II</td>
<td>147.6 ft/min</td>
<td>410 ft/min</td>
<td>22,000 lb</td>
<td>0.83&quot; / 1132 ft</td>
</tr>
<tr>
<td>Slew</td>
<td></td>
<td></td>
<td></td>
<td>max. 1.3 1/1/min</td>
</tr>
<tr>
<td>Boom</td>
<td></td>
<td></td>
<td></td>
<td>-1,5° - +82°</td>
</tr>
</tbody>
</table>

**CARRIER PERFORMANCE**

<table>
<thead>
<tr>
<th>Travel speed</th>
<th>Gradeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 . . 53 mph</td>
<td>max. 71 %</td>
</tr>
</tbody>
</table>

**HOOK BLOCK / SINGLE LINE HOOK**

<table>
<thead>
<tr>
<th>Type</th>
<th>Possible load</th>
<th>Number of sheaves</th>
<th>Weight</th>
<th>&quot;D&quot;</th>
<th>Number of lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>324,500 lb</td>
<td>9</td>
<td>3,860 lb</td>
<td>9.8 ft</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>305,800 lb</td>
<td>7</td>
<td>3,310 lb</td>
<td>9.8 ft</td>
<td>15</td>
</tr>
<tr>
<td>125</td>
<td>228,600 lb</td>
<td>5</td>
<td>2,480 lb</td>
<td>9.8 ft</td>
<td>11</td>
</tr>
<tr>
<td>80</td>
<td>148,400 lb</td>
<td>3</td>
<td>1,870 lb</td>
<td>9.8 ft</td>
<td>7</td>
</tr>
<tr>
<td>32</td>
<td>64,800 lb</td>
<td>1</td>
<td>1,320 lb</td>
<td>8.9 ft</td>
<td>3</td>
</tr>
<tr>
<td>12,5</td>
<td>21,800 lb</td>
<td>Single line hook</td>
<td>770 lb</td>
<td>6.6 ft</td>
<td>1</td>
</tr>
</tbody>
</table>

Remarks: 1) varies depending on national regulations
W-135 Capsule Storage Area Lighting Calculation

Purpose and Objective:
The purpose of this document is to perform a lighting calculation for area lighting at the Capsule Storage Area.

<table>
<thead>
<tr>
<th>Rev. No.</th>
<th>Total Pages</th>
<th>Prepared By</th>
<th>Checked By</th>
<th>PM/TL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>16</td>
<td></td>
<td></td>
<td>Denis P. Devine</td>
</tr>
</tbody>
</table>

Date: 5/10/2018

Revision Description (Revision Description/Affected Pages):
Draft issue. Revision B comments have been incorporated.
### CALCULATION REVIEW CHECKLIST

<table>
<thead>
<tr>
<th>Items Checked</th>
<th>Accept</th>
<th>Description of Resolution for Unacceptable Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cover sheets properly completed.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>2. Calculation sheet headers complete with calculation number, revision number, etc.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>3. Calculation sheet contents are legible, accurate, and complete per format.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>4. Listed attachments included.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>5. Calculation objective clearly described.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>6. Criteria are suitable and properly referenced to task specific documents.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>7. Assumptions and input data selected, described, reasonable, and attached or referenced to task documents.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>8. Calculation method identified and appropriate for the design activity.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>9. Calculation results reasonable and correctly described in results and conclusions.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>10. Physical property calculations generated by CAD software verified via hand calculations.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>11. Computer program identified with version and revision.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>12. Computer input/output provided or referenced and reasonable.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>13. Computer run traceable to calculation (file #, etc.).</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>14. Computer input/output data and problem type within validation/verification range of use.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>15. Computer program validation/verification addressed.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>16. Computer operating system in use for calculation preparation is the same as when the software was verified on machine.</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

**Calculation Checking Method**

- 1. Direct Step-by-Step Check  
- 2. Reference Chart(s) or Book(s) Comparison  
- 3. Alternate Calculation (Append Documentation)

**Comments:**

---

**Preparer (Print Name and Sign):**  
Date: **5/10/18**

**Checker (Print Name and Sign):**  
Date: **5/10/18**

Signatures obtained only after discrepancies are corrected and comments are resolved.
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2.0 METHODOLOGY ......................................................................................................................................4
3.0 DESIGN INPUTS ........................................................................................................................................4
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5.0 ASSUMPTIONS AND CLARIFICATIONS ..............................................................................................4
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Appendices
Appendix A – Luminaire Vendor Data
Appendix B – Luminaire Locations and Calculation Points
Appendix C – Luminaire Schedule

Acronyms
CSA Capsule Storage Area
CSP Cask Storage Pad
CSS Cask Storage System
VCC Vertical Concrete Cask
1.0 PURPOSE

The purpose of this document is to perform a lighting calculation for area lighting at the Capsule Storage Area (CSA).

2.0 METHODOLOGY

CAD files were imported as a background to the lighting design software, and a 3-dimensional model was created for the CSA. Luminaires and calculation areas were then inserted into the model.

The direction calculation method was used with no reflectances as is appropriate for the calculation of outdoor illumination since there are no ceilings or walls for reflectance of light.

Calculation results are as shown in the appendices.

3.0 DESIGN INPUTS

- CHPRC-02623, Revision 2, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)
- H-2-837606, Sheet 1, Revision C, Capsule Storage Area Electrical Enlarged Plan
- H-2-837609, Sheet 2, Revision C, Capsule Storage Area Electrical Lighting Pole Assembly

4.0 ILLUMINATION CRITERIA

CHPRC-02623, Revision 2, Section 4.1.4 states that lighting around the perimeter of the storage location shall be provided with an illumination level of not less than that recommended by IES 2013 (sic), The Lighting Handbook. Lighting shall be replaceable without the need to enter the inner fenced area.

CHPRC-02623, Revision 2, Section 6.7 states that sufficient lighting and accessibility shall be provided for the CSSs on the CSP to enable their visual inspection on all sides for security purposes from a distance of 250 ft, and no less than 0.2 foot candles.

5.0 ASSUMPTIONS AND CLARIFICATIONS

5.1 Luminaire

The luminaire is Lithonia D-Series LED wide flood model DSXF3 LED 6 P2 WFL. Each luminaire is pole-mounted on a bullhorn pole-top attachment. Configuration is shown on drawing H-2-837609, and luminaire locations are shown on drawing H-2-837606.

Luminaire vendor data is shown in Appendix A. Luminaire locations are shown in Appendix B.
5.2 Reflectance

The direct calculation method was used, so surface reflectances are not used in the calculation although reflectance values are required to be entered into the model.

5.3 Light Loss Factor

Worst case lumen ambient temperature correction factor and worst case lumen maintenance factor provided by the fixture manufacturer were used to determine light loss factor. Maximum temperature correction factor provided is 0.96 for 95 degree F. Maximum lumen maintenance factor provided is 0.96 at 100,000 operating hours.

The two correction factors were multiplied to obtain the light loss factor: 0.96 x 0.96 = 0.92.

5.4 Luminaire Locations and Mounting Heights

Luminaires were placed in locations shown on drawing H-2-837606, Sheet 1, Revision B. Lighting poles are located outside the outer CSA fence. Lighting poles along the north, west, and south fence lines are located in line with the midpoint of the Cask Storage Pad. The lighting pole on the east fence line is at the south end of the vehicle gate opening.

Luminaire mounting heights are 30ft above grade as shown on drawing H-2-837609, Sheet 2, Revision B.

5.5 Calculation Points

Illumination levels were calculated at grade. Calculation points are shown in Appendix B.

6.0 COMPUTER SOFTWARE

Calculations were performed using the lighting analysis software Visual 2017 version 2.00.0029.

Visual is a 3-dimensional computational program that performs numerical point-by-point calculations of incident direct and reflected light on any real surface or imaginary plane. Within this scope, it is used to predict or quantify the distribution of artificial or natural light in any environment.

Visual allows AutoCAD files to be imported into the model as a background, then the user creates rooms and objects, defines luminaires based on a library of manufacturer-provided photometry files, inserts and arranges luminaires, and selects calculation points, all of which Visual uses to perform its point-by-point calculations.

Visual then provides output reports for object, room and luminaire definitions, luminaire locations, and calculation results. A plan view of the model is also printed showing location and orientation of each luminaire and calculated illumination intensity (in units of foot-candles) of calculation points.

This lighting system is general service. However, a verification and validation report has been performed to demonstrate that Visual produces accurate and repeatable results. Results of verification and validation for the computer that ran these calculations (RL_C0291) are documented in ARES Report NSR-17-01-009, Rev. 0.
7.0 RESULTS

Calculated illumination at grade, in units of foot-candles, are shown in the Appendices. Minimum illumination from the VCCs to the outside edge of the CSP is 0.3 foot-candles.

8.0 CONCLUSIONS

Requirements discussed in the Illumination Criteria have been met with the luminaire arrangement shown in the Appendices.

9.0 REFERENCES

- CHPRC-02623, Revision 2, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)
- H-2-837606, Sheet 1, Revision C, Capsule Storage Area Electrical Enlarged Plan
- H-2-837609, Sheet 2, Revision C, Capsule Storage Area Electrical Lighting Pole Assembly
APPENDIX A

LUMINAIRE VENDOR DATA
Title: W-135 Capsule Storage Area Lighting Calculation

Prepared By:  Date:  5/10/2018  Checked By:  Date:  5/10/2018

D-Series Size 3
LED Flood Luminaire

Specifications

EPA:  1.4 ft²

Depth:  5'

Width:  13'

Height:  13-5/8'

Overall Height:  17-1/2'

Weight:  21 lbs

DSXF3 LED 6 P2 40K PFL IS

Ordering Information

EXAMPLE: DSXF3 LED 6 P2 40K FL MVOLT THK DDBXD

PER UBV

Options

Shipped installed

PER

PES

DNG

SF

DF

UBV

DDBXD

Shipped separately

UBV

PMS2003

PHV2003

RHV2003

DF: Double Face 120°, 240°, 400°

Quality Assurance Procedure 3.1

Calculation Sheet (05-10)
### Ordering Information

**Accessories**
- **Horizontal and Vertical Adjustable:**
  - 90° (up to 240° of horizontal, and up to 90° of vertical in 15° increments)
- **Base Only:**
  - 90° (up to 240° of horizontal, and up to 90° of vertical in 15° increments)
- **Vertical Only:**
  - 90° (up to 240° of horizontal, and up to 90° of vertical in 15° increments)
- **Adjustable Combination:**
  - 90° (up to 240° of horizontal, and up to 90° of vertical in 15° increments)
- **Rotary Arm:**
  - 90° (up to 240° of horizontal, and up to 90° of vertical in 15° increments)

**Stock configurations are offered for shorter lead times:**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**

**Stock Part Number:**
- **D8-001 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-001 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-001 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-001 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-001 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**

**CI Code:**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**
- **D8-S1 LED 6-PK 4000K (50,000, 5000, 3000, 2000, 9000, 6000, 5000, 4000K)**

**Notes:**
1. **M4050:** Driver operates on any line voltage from 120-277V.
2. **Single-circuit (D20):** Requires 120, 277, or 347V input Voltage option.
3. **Double circuit (D21):** Requires 208, 240, or 480V input Voltage option.
4. **Must be ordered as an accessory:** See Accessories Information at left.
5. **For use with a photocell control system:** The mounting height must be set to 9-40 ft. from horizontal area per ANSI C72.60-97.
6. **Specified:** A ROAD36® enabled luminaire with 2-5% dimming capability, M4050 option required. Additional hardware and services required for ROADM60 deployment, must be purchased separately. Call 1-800-463-4700 ext. 173772 for lead times.
7. **M4050 only. Not available with 24V, 48V, or LED options.**
8. **A ROAD36® luminaire to be specified with PER option. Reference PSR table on Page 2 for functionality.

### Performance Data

#### Lumen Output

Lumen values are from photometric tests performed in accordance with EESNA LM-79-06. Data is considered to be representative of the configurations shown, with the tolerances allowed by Lighting Facts. Contact factory for performance data on any configuration not shown here.

<table>
<thead>
<tr>
<th>Type</th>
<th>Lumen</th>
<th>Watt</th>
<th>CRI</th>
<th>Color</th>
<th>Quat</th>
<th>Temp</th>
<th>Lumen Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>129</td>
<td>1.76</td>
<td>85</td>
<td>3000K</td>
<td>160</td>
<td>500</td>
<td>129</td>
</tr>
<tr>
<td>P1</td>
<td>129</td>
<td>1.76</td>
<td>85</td>
<td>3000K</td>
<td>160</td>
<td>500</td>
<td>129</td>
</tr>
<tr>
<td>P1</td>
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<td>1.76</td>
<td>85</td>
<td>3000K</td>
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<tr>
<td>P1</td>
<td>129</td>
<td>1.76</td>
<td>85</td>
<td>3000K</td>
<td>160</td>
<td>500</td>
<td>129</td>
</tr>
</tbody>
</table>

#### Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for ambient temperatures from 0-25°C (32-77°F).

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>LAT Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.90</td>
</tr>
<tr>
<td>10</td>
<td>0.95</td>
</tr>
<tr>
<td>20</td>
<td>0.98</td>
</tr>
<tr>
<td>30</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Projected LED Lumen Maintenance

Data reference the extrapolated performance projections for the OSYF3 LED 6-FZ platform based on 50,000 hours of LED testing performed per EESNA LM-66-06 as expected per EESNA TM-27-11.

To calculate LED lumen maintenance factors, refer to the chart below. For other lumen maintenance factors, contact factory.

<table>
<thead>
<tr>
<th>LED Type</th>
<th>10,000 Hours</th>
<th>25,000 Hours</th>
<th>50,000 Hours</th>
<th>100,000 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>P1</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>P1</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>P1</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>80</td>
</tr>
</tbody>
</table>

### Electronic Load

<table>
<thead>
<tr>
<th>Electronic Load</th>
<th>10,000 Hours</th>
<th>25,000 Hours</th>
<th>50,000 Hours</th>
<th>100,000 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1.08</td>
<td>0.95</td>
<td>0.84</td>
<td>0.76</td>
</tr>
<tr>
<td>P1</td>
<td>1.08</td>
<td>0.95</td>
<td>0.84</td>
<td>0.76</td>
</tr>
<tr>
<td>P1</td>
<td>1.08</td>
<td>0.95</td>
<td>0.84</td>
<td>0.76</td>
</tr>
<tr>
<td>P1</td>
<td>1.08</td>
<td>0.95</td>
<td>0.84</td>
<td>0.76</td>
</tr>
</tbody>
</table>

**Notes:**
- **PER Table:**
  - **PER (current):**
    - **PER (0.0):**
      - **PER (0.0):**
        - **PER (0.0):**
          - **PER (0.0):**

**Recessed Ceiling:**
- **Recessed Ceiling:...**
Title: W-135 Capsule Storage Area Lighting Calculation

Prepared By: [Prepared By] Date: 5/10/2018

Checked By: [Checked By] Date: 5/10/2018

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series D-11 and D-10 reflect the embedded high-performance LED technology in a visually appealing, efficient and functional lighting solution for commercial and institutional facilities.

CONSTRUCTION
The cast aluminum housing has integral heat sinks to optimize thermal management through conduction and convective cooling. The LED driver is installed in direct contact with the casing to promote efficient operating temperatures. LED life is enhanced by this closely packaged arrangement, and the unit is designed to meet or exceed IEC61347 and UL1598 standards. When installed within a listed enclosure, the fixture can be remotely operated.

FINISH
Durable parts are protected by a tough, high-impact, UV-stabilized, weather-resistant coating that provides a scratch-resistant surface that resists scratches and abrasions. A high-gloss finish is an optional finish for a sleek, elegant finish that complements modern design.

OPTICS
A variety of precision-machined collimator/reflectors paired with integrated optics are engineered for exceptional field-of-view ratios, uniformity and aiming. Light engines are available in 300W (3000 K lm), 400W (4000 K lm) or 500W (5000 K lm) power outputs. Optional shown are additional accessories.

ELECTRICAL
Light engines consist of 16-40 Watt ECO18 LEDs directly coupled to the heat sink to maintain optimal operating temperature and promote longevity (200,000 hrs; 35°C Class I electrical design). The LED driver has a power factor >0.96, THD <2%, and has an expected life of 50,000 hours with 2% failure rate. Single protection/wiring is minimum Category B Low voltage per ANSI/NFPA 70 (2017 Edition).

INSTALLATION
Height calculations should be done with 1/4"-1/2" threaded pipe, or 3/8"-1/2" non-threaded pipe, or 3/8"-1/2" square tubing, or 3/8"-1/2" round tubing. The fixture can be mounted using a variety of mounting options or with the D-3550 Universal Mounting Kit. The fixture can be mounted directly to the wall or suspended from the ceiling. The fixture is designed for mounting on a concrete floor or a steel beam. The fixture is designed for use in industrial, commercial, and institutional applications.

WARRANTY
A ten-year limited warranty is included with the fixture. The warranty covers the fixture against defects in materials and workmanship for a period of ten years from the date of shipment. The warranty period is calculated from the date of shipment to the original owner.

LITHONIA LIGHTING
One Lithonia Way • Conyers, Georgia 30013 • Phone: 800-279-0361 • mail@lithonia.com

LITHONIA LIGHTING
One Lithonia Way • Conyers, Georgia 30013 • Phone: 800-279-0361 • mail@lithonia.com

Quality Assurance Procedure 3.1
Calculation Sheet (05-10)
APPENDIX B

LUMINAIRE LOCATIONS AND CALCULATION POINTS
Title: W-135 Capsule Storage Area Lighting Calculation

Prepared By: Date: 5/10/2018

Checked By: Date: 5/10/2018
APPENDIX C

LUMINAIRE SCHEDULE
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Label</th>
<th>Quantity</th>
<th>Manufacturer</th>
<th>Catalog Number</th>
<th>Description</th>
<th>Lamp</th>
<th>Filename</th>
<th>Number Lamps</th>
<th>Lumens Per Lamps</th>
<th>Light Loss Factor</th>
<th>Wattage</th>
</tr>
</thead>
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<td>A</td>
<td>Lithonia Lighting</td>
<td>9</td>
<td>DSXFL LED 6P2 40K WFL MVLMT</td>
<td>2015 D-Series Flood 3 with 6 COOIs, performance package P2, 4000K CCT, with WFL distribution</td>
<td>LED</td>
<td>6_P2_40K_WFL</td>
<td>1</td>
<td>Absolute</td>
<td>0.92</td>
<td>183.0</td>
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Quality Assurance Procedure 3.1
Title:
W-135 Capsule Storage Area Lightning Risk Assessment

Purpose and Objective:
The purpose of this document is to perform a lightning risk assessment of the Capsule Storage Area.

The lightning risk assessment methodology determines the risk of property damage or personnel injury due to lightning, and provides a determination on whether a lightning protection system is recommended.

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<td></td>
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<td></td>
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<td>Date: 5/10/2018 5/10/2018</td>
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Revision Description (Revision Description/Affected Pages):
Draft issue. Revision B comments have been incorporated.
# Calculation Review Checklist

**Project No.** 046414.17.01  
**Calculation No.** 046414.17.01-E-002  
**Rev. No.** C  
**Page No.** 2 of 10

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<th>Description of Resolution for Unacceptable Items</th>
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<td>1. Cover sheets properly completed.</td>
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<td>2. Calculation sheet headers complete with calculation number, revision number, etc.</td>
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</tr>
<tr>
<td>3. Calculation sheet contents are legible, accurate, and complete per format.</td>
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<td>4. Listed attachments included.</td>
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<tr>
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</tr>
<tr>
<td>6. Criteria are suitable and properly referenced to task specific documents.</td>
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<tr>
<td>7. Assumptions and input data selected, described, and reasonable, and attached or referenced to task documents.</td>
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<td></td>
</tr>
<tr>
<td>8. Calculation method identified and appropriate for the design activity.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>9. Calculation results reasonable and correctly described in results and conclusions.</td>
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<td></td>
</tr>
<tr>
<td>10. Physical property calculations generated by CAD software verified via hand calculations.</td>
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<tr>
<td>11. Computer program identified with version and revision.</td>
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<td>12. Computer input/output provided or referenced and reasonable.</td>
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<td>13. Computer run traceable to calculation (file #, etc.).</td>
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<td></td>
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<tr>
<td>15. Computer program validation/verification addressed.</td>
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<tr>
<td>16. Computer operating system in use for calculation preparation is the same as when the software was verified on machine.</td>
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<td></td>
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</table>

**Calculation Checking Method**  
1. Direct Step-by-Step Check  
2. Reference Chart(s) or Book(s) Comparison  (Append Documentation)  
3. Alternate Calculation (Append Documentation)

**Comments:**

**Preparer (Print Name and Sign):**  
**Date:** 5/10/18

**Checker (Print Name and Sign):**  
**Date:** 5/10/18

Signatures obtained only after discrepancies are corrected and comments are resolved.
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Acronyms
CSA Capsule Storage Area
CSS Cask Storage System
NFPA National Fire Protection Association
VCC Vertical Concrete Cask

Units
ft foot
in inch
m meter
sq ft square feet
1.0 PURPOSE

The purpose of this document is to perform a lightning risk assessment of the Capsule Storage Area (CSA).

2.0 METHODOLOGY


The simplified risk assessment methodology determines the risk of property damage or personnel injury due to lightning, and provides a determination on whether a lightning protection system is recommended.

A simplified risk assessment calculates the tolerable lightning frequency (N_c) and compares it to the annual threat of occurrence (N_d). The tolerable lightning frequency (N_c) is a measure of the risk of damage to the structure, including factors affecting risks to the structure, to the contents, and of environmental loss. It is calculated by dividing the acceptable frequency of property losses by various coefficients relating to the structure, the contents, and the consequence of damage.

If N_d is less than or equal to N_c, a lighting protection system can be optional. If N_d is greater than N_c, a lighting protection system is recommended.

This assessment analyzes the following two scenarios.

- Scenario 1: One VCC on cask storage pad, worst case for relative structure location coefficient C1
- Scenario 2: 24 VCCs on cask storage pad, worst case for equivalent collective area A_e

3.0 DESIGN INPUTS

- CHPRC-02623, Revision 2, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)
- CHPRC-03326, Revision 0, NAC Hanford MCSC Conceptual Design Report (30059-R-02 Rev A)
- H-2-837593, Sheet 1, Revision C, Capsule Storage Area Enlarged Plan
- H-2-837606, Sheet 1, Revision C, Capsule Storage Area Electrical Enlarged Plan
- NFPA 780-2014, Standard for the Installation of Lighting Protection Systems
- WHC-SD-WM-ES-387, Revision 1, Probability, Consequences, and Mitigation for Lightning Strikes to Hanford High-Level Waste Tanks.

4.0 ASSUMPTIONS AND CLARIFICATIONS

A lighting risk assessment is required by CHPRC-02623, Revision 2.
Dimensions of the CSA were obtained from in-process ARES design drawings.

An average of 0.06 lightning strikes per year per square kilometer is used based on Hanford Site document WHC-SD-WM-ES-387.

Dimensions of the Vertical Concrete Cask (VCC) were obtained from CHPRC-03326, Revision 0, Appendix C, *NAC’s Interface Requirements*. Each VCC is 120” in diameter x 132.5” tall.

VCCs are assumed to be constructed with a concrete exterior and nonflammable contents.

### 5.0 CALCULATION

#### Yearly Annual Threat of Occurrence ($N_d$)

The yearly annual threat of occurrence ($N_d$) to a structure is determined by the following equation from NFPA 780 (Reference 5, Section 8.0):

$$ N_d = (N_g)(A_e)(C_1)(10^{-6}) = \text{potential events per year} $$

Where:

- $N_d$ = the yearly lightning strike frequency to the structure
- $N_g$ = the yearly average flash density in the region where the structure is located
- $A_e$ = the equivalent collective area of the structure in m$^2$
- $C_1$ = the environmental coefficient from NFPA 780 Table L.4.2

#### Yearly Average Flash Density ($N_g$)

The yearly average flash density ($N_g$) can be taken from NFPA 780 Figure L.2. This figure shows that the yearly average flash density for the area in the United States, which includes southeastern Washington, falls within the range of 0.1 to 0.5 flashes to ground per km$^2$. Hanford Site document WHC-SD-WM-ES-387, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford High-Level Waste Tanks*, calculated an average of 0.06 lightning strikes per year per square kilometer for the Hanford Site. A flash density of 0.06 lightning strikes per year per square kilometer was used in Equation 1.

#### Equivalent Collection Area ($A_e$)

The equivalent collection area ($A_e$) refers to the ground area having the same yearly direct lightning flash probability as the structure, and is an increased area for the structure that includes the effect of the height and location of the structure.
Equivalent Collection Area (A_e) – Scenario 1 (One VCC)

NFPA 780 Figure L.4.1.2(a) indicates that for structures where a prominent part encompasses all portions of the lower part of the structure, the method of calculating equivalent collection area is performed using the following equation. See Figure 1-1.

Equation 2: \[ A_e = \pi H^2 \]

where \( H \) = height of the prominent structure (m)

The VCC is a cylindrical structure with height of 132.5” or 3.37 m.

\[ H = 132.5” \times 0.0254 \text{ m} / 1” = 3.37 \text{ m} \]

The equivalent collection area for the CSA is calculated using Equation 2. The result is shown in Table 1-1.

\[ A_e = \pi \times 9 \times (3.37)^2 = 321 \text{ m}^2 \]

Equivalent Collection Area (A_e) – Scenario 2 (24 VCCs)

To be conservative since locations of VCCs are not determined at this time, for determining the equivalent collection area, the entire 90 ft x 90 ft capsule storage pad area will be used plus three times the VCC height of 11 ft on each side. This results in a square of 156 ft x 156 ft, or 24,336 sq ft.

Converting to square meters is 24,336 sq ft \( \times 0.0929 \text{ m}^2 / 1 \text{ sq ft} = 2261 \text{ m}^2 \)

The result is shown in Table 1-1.

Environmental Coefficient (C_1)

The environmental coefficient (C_1) is assigned from NFPA 780 Table L.4.2. See Figure 1-2. For Scenario 1, the nearest structure is a power pole line that is greater than a distance of 3H from the VCC. For Scenario 2, VCCs are located within 3H of one another.
Environmental Coefficient ($C_1$) – Scenario 1 (1 VCC)

$C_1 = 1$ for an isolated structures with no other structures location within a distance of 3H

Environmental Coefficient ($C_1$) – Scenario 1 (24 VCCs)

$C_1 = 0.5$ for structure surrounded by structures of equal or lesser height within a distance of 3H

Yearly Annual Threat of Occurrence ($N_d$) Result – Scenario 1 (One VCC)

The yearly annual threat of occurrence ($N_d$) to a structure is determined by Equation 1 with results from above incorporated into the equation:

\[
N_d = (N_g)(A_e)(C_1)(10^{-6}) \text{ potential events per year}
\]

\[
N_d = (0.06)(321)(1)(10^{-6}) \text{ potential events per year}
\]

\[
N_d = 0.0001926 \text{ potential events per year}
\]

\[
N_d = 1.926 \times 10^{-5} \text{ potential events per year}
\]

Yearly Annual Threat of Occurrence ($N_d$) Result – Scenario 1 (24 VCCs)

The yearly annual threat of occurrence ($N_d$) to a structure is determined by Equation 1 with results from above incorporated into the equation:

\[
N_d = (N_g)(A_e)(C_1)(10^{-6}) \text{ potential events per year}
\]

\[
N_d = (0.06)(2261)(0.5)(10^{-6}) \text{ potential events per year}
\]

\[
N_d = 0.00006783 \text{ potential events per year}
\]

\[
N_d = 6.783 \times 10^{-5} \text{ potential events per year}
\]

Tolerable Lightning Frequency ($N_c$)

The Tolerable Lightning Frequency ($N_c$) is a measure of the damage risk to the structure including factors affecting risks to the structure, environment, and monetary loss and is expressed by the following NFPA 780 formula:

\[
\text{Equation 3 } \quad N_c = \left(1.5 \times 10^3\right) / C
\]

Where $N_c$ is the tolerable lightning frequency, and $C$ is obtained by the following formula:

\[
\text{Equation 4 } \quad C = (C_2)(C_3)(C_4)(C_5)
\]
Quality Assurance Procedure 3.1

CALCULATION SHEET

Project No. 046414.17.01  Calculation No. 046414.17.01-E-002  Rev. C  Page No. 8 of 10

Title: W-135 Capsule Storage Area Lightning Risk Assessment

Prepared By:  Date: 5/10/2018  Checked By:  Date: 5/10/2018

Where:

\[ C_2 = \text{Structural Coefficient} \]
\[ C_3 = \text{Structure Contents Coefficient} \]
\[ C_4 = \text{Structure Occupancy Coefficient} \]
\[ C_5 = \text{Lightning Consequence Coefficient} \]

Coefficients \( C_2, C_3, C_4, C_5 \) are taken from Tables L.5.1.2(a) through L.5.1.2(d) of NFPA 780, and are the same for both scenarios as they are not dependent upon the number of structures. See Figure 1-2 for descriptions of coefficient values.

- \( C_2 \) was assigned a value of 1.0 based on the VCC’s non-metallic, nonflammable concrete construction.
- \( C_3 \) was assigned a value of 0.5 based on VCC contents being low value and nonflammable.
- \( C_4 \) was assigned a value of 0.5 due to VCCs being unoccupied.
- \( C_5 \) was assigned a value of 10 based on potential environmental consequences resulting from a lightning strike.

Tolerable Lightning Frequency \( (N_c) \) – Scenarios 1 and 2

Tolerable lightning frequency \( (N_c) \) is calculated using Equations 3 and 4.

\[ C = (C_2)(C_3)(C_4)(C_5) \]
\[ C = (1.0)(0.5)(0.5)(10) \]
\[ C = 2.5 \]

\[ N_c = (1.5 \times 10^{-3}) / C \]
\[ N_c = (1.5 \times 10^{-3}) / 2.5 \]
\[ N_c = 0.0006 \]
\[ N_c = 6.0 \times 10^{-4} \]

Results are summarized in Table 1-1.
Table L.4.2 Determination of Environmental Coefficient C₁

<table>
<thead>
<tr>
<th>Relative Structure Location</th>
<th>C₁</th>
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<tr>
<td>Structure located within a space containing structures or trees of the same height or taller within a distance of 3H</td>
<td>0.25</td>
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<tr>
<td>Structure surrounded by smaller structures within a distance of 3H</td>
<td>0.5</td>
</tr>
<tr>
<td>Isolated structure, no other structures located within a distance of 3H</td>
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<tr>
<td>Isolated structure on a hilltop</td>
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Table L.5.1.2(a) Determination of Structural Coefficient C₂

<table>
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<tr>
<th>Structural Coefficients C₂</th>
<th>Metal Roof</th>
<th>Nonmetallic Roof</th>
<th>Flammable Roof*</th>
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<tr>
<td>Metal</td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Nonmetallic</td>
<td>1.0</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Flammable</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
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Table L.5.1.2(b) Determination of Structure Contents Coefficient C₃

<table>
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<th>Structure Contents</th>
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<tr>
<td>Low value and nonflammable</td>
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</tr>
<tr>
<td>Standard value and nonflammable</td>
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</tr>
<tr>
<td>High value, moderate flammability</td>
<td>2.0</td>
</tr>
<tr>
<td>Exceptional value, flammable, computer or electronics</td>
<td>3.0</td>
</tr>
<tr>
<td>Exceptional value, irreplaceable cultural items</td>
<td>4.0</td>
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Table L.5.1.2(c) Determination of Structure Occupancy Coefficient C₄

<table>
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<th>Structure Occupancy</th>
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<tr>
<td>Unoccupied</td>
<td>0.5</td>
</tr>
<tr>
<td>*** Normally occupied</td>
<td>1.0</td>
</tr>
<tr>
<td>Difficult to evacuate or risk of panic</td>
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Table L.5.1.2(d) Determination of Lightning Consequence Coefficient C₅

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<td>Continuity of facility services not required, no environmental impact</td>
<td>1.0</td>
</tr>
<tr>
<td>Continuity of facility services required, no environmental impact</td>
<td>5.0</td>
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<tr>
<td>Consequences to the environment</td>
<td>10.0</td>
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Figure 1-2. Coefficient Tables from NFPA 780.
6.0 RESULTS

Calculated results are shown in Table 1-1. VCC height is provided in both English and metric units.

Table 1-1. CSA Lightning Risk Assessment Data

<table>
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<th>Scenario 1 One VCC</th>
<th>Scenario 2 24 VCCs</th>
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<tr>
<td>(H = \text{(in)})</td>
<td>132.5</td>
<td>132.5</td>
</tr>
<tr>
<td>(H = \text{(m)})</td>
<td>3.37</td>
<td>3.37</td>
</tr>
<tr>
<td>(A_e = \text{(m}^2)</td>
<td>321</td>
<td>2261</td>
</tr>
<tr>
<td>(N_g = )</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>(C_1 = )</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>(N_d = )</td>
<td>(1.926 \times 10^{-5})</td>
<td>(6.783 \times 10^{-5})</td>
</tr>
<tr>
<td>(C_2 = )</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>(C_3 = )</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>(C_4 = )</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>(C_5 = )</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>(C = )</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>(N_c = )</td>
<td>(6.0 \times 10^{-4})</td>
<td>(6.0 \times 10^{-4})</td>
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The risk assessment calculates the tolerable lightning frequency \((N_c)\) and compares it to the annual threat of occurrence \((N_d)\). For both scenarios, \(N_d\) is less than \(N_c\) by an order of magnitude.

7.0 CONCLUSIONS

Since the tolerable lightning frequency \((N_c)\) is less than the annual threat of occurrence \((N_d)\), a lighting protection system can be optional in accordance with the methodology of the NFPA 780 simplified lightning risk assessment.

8.0 REFERENCES

- CHPRC-02623, Revision 2, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)
- CHPRC-03326, Revision 0, NAC Hanford MCSC Conceptual Design Report (30059-R-02 Rev A)
- H-2-837593, Sheet 1, Revision C, Capsule Storage Area Enlarged Site Plan
- H-2-837606, Sheet 1, Revision C, Capsule Storage Area Electrical Enlarged Plan
- NFPA 780-2014, Standard for the Installation of Lighting Protection Systems
- WHC-SD-WM-ES-387, Revision 1, Probability, Consequences, and Mitigation for Lightning Strikes to Hanford High-Level Waste Tanks
APPENDIX E

CSA OPERATIONS ANALYSIS REPORT
PROJECT W-135
CAPSULE STORAGE AREA
OPERATIONS ANALYSIS REPORT

prepared for

CH2M HILL PLATEAU REMEDIATION COMPANY
Contract No. 64824
Report No. 046414.17.01-003
Revision 0

April 2018

Prepared by: ________________________ 4/30/18

Reviewed by: ________________________ 4/30/18

Approved by: ________________________ 4/30/18
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EXECUTIVE SUMMARY

The overall objective of the Management of Cesium and Strontium Capsules (MCSC) Project is to transition the capsules from underwater storage in the Waste Encapsulation and Storage Facility (WESF) pool cells to a new dry-storage facility for long-term storage pending availability of a permanent disposal option. Major project operational activities include: retrieval of the capsules from the pool cells, packaging of the capsules into a Cask Storage System (CSS), and transfer of the casks to a new Capsule Storage Area (CSA). Major supporting activities to prepare for operations include: procurement of the CSS, design and construction of WESF modifications to accommodate CSS packaging equipment, and design and construction of the new CSA including cask haul path improvements.

The Vertical Concrete Casks (VCCs), Transportable Storage Canisters (TSCs), and VCC lids will be constructed off-site and will be delivered and received at the CSA. Once assembled, these components will comprise an empty CSS. The capability to assemble these components needs to be provided at the CSA. Empty CSSs will be transported to WESF using the Vertical Cask Transporter (VCT) where the loaded Universal Capsules Sleeves (USCs) will be placed into the empty CSSs. The loaded CSSs will then be transported back to the CSA using the VCT. The loaded CSSs will be placed on the Capsule Storage Pad (CSP) for long-term storage.

The CSA layout as shown in Appendix B is adequate to support the delivery and receipt of the VCCs, TSCs, and VCC lids, including storage of this equipment on the CSP. There is sufficient remaining space available on the operating pad for manipulation and assembly of the VCCs, TSCs, and VCC lids. As the empty CSSs are assembled, they will be relocated to the north end of the operating pad in order to provide access to the CSP for placement of the loaded CSSs. Atlanta Avenue and the intersection of Atlanta Avenue and 7th Street are sufficiently wide for transport of the CSSs using the VCT and tug. However, the shoulders of 7th Street should be widened (approximately two feet on each side) in order to accommodate the width of the VCT (17.75 ft) and still have some available space for misalignment and to avoid overloading the edges of the paved surface.
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Acronyms

CHPRC   CH2M Hill Plateau Remediation Company
CSA     Capsule Storage Area
CSS     Cask Storage System
DOE     U.S. Department of Energy
MCSC    Management of Cesium and Strontium Capsules
TSC     Transportable Storage Canister
tug     GT50 TUG Aircraft Gate Tractor
UCS     Universal Capsule Sleeve
VCC     Vertical Concrete Cask
VCT     Vertical Cask Transporter
WESF    Waste Encapsulation and Storage Facility

Units

',    foot
ft.    feet
lb     pound
1.0 PURPOSE AND SCOPE

As a Prime Contractor to the U.S. Department of Energy (DOE), the CH2M HILL Plateau Remediation Company (CHPRC) is focused on safe environmental cleanup of the Central Plateau of the DOE Hanford Site. The CHPRC scope of work includes: environmental remediation activities, treatment and disposal of radioactive waste streams, management of spent nuclear fuel, and disposition of nuclear materials and non-reactor nuclear facilities.

The Management of Cesium and Strontium Capsules (MCSC) Project will fill the capability gap for interim storage of cesium and strontium capsules currently stored underwater at the Waste Encapsulation and Storage Facility (WESF). The MCSC Project is centered on the WESF which is a Hazard Category 2 non-reactor nuclear facility located adjacent to B Plant in the 200 East Area of the Hanford Site. The mission of WESF is the safe and compliant storage of 1,936 cesium and strontium capsules.

The overall objective of the MCSC Project is to transition the capsules from underwater storage in the WESF pool cells to a new dry-storage facility for long-term storage pending availability of a permanent disposal option. Major project operational activities include retrieval of the capsules from the pool cells, loading of the capsules into a Cask Storage System (CSS), and transfer of the casks to a new Capsule Storage Area (CSA). Major supporting activities to prepare for operations include: procurement of the CSS, design and construction of WESF modifications to accommodate CSS packaging equipment, and design and construction of the new CSA including cask haul path improvements.

This document is the operations analysis for the receipt, assembly, and interim storage of CSS components (the Vertical Concrete Casks [VCCs], Transportable Storage Canisters [TSCs], and VCC lids). It also evaluates movement of empty and loaded CSSs at the CSA, transfer of empty and loaded CSSs between the CSA and WESF, and placement of loaded CSSs in their storage locations.

2.0 DESIGN INPUTS

The input data for the operations analysis are as follows:

- Descriptions of the various MCSC Project terminologies (i.e. CSA, VCC, UCS, etc.) are provided in CHRPC-03328, Capsule Storage Area Conceptual Design Report (Project W-135) and CHRPC-02623, Capsule Storage Area (CSA) Functional Design Criteria (Project W-135).
- Up to 24 CSSs may be required to store all of the capsules from the WESF Storage Pool. (CHRPC-02623, Section 4.1.2)
- An empty VCC will weigh approximately 127,740 lb. (Doc. No. 30059-P-01, Table 3.2-1)
- A loaded CSS (loaded with TSC liner, basket, and capsules) will weigh approximately 155,000 lb. (Doc. No. 30059-P-01, Table 3.5-1)
- The VCC has a diameter of 120-in. (CHRPC-02623, Section 4.1.2)
- VCT Track Width: 16’ 7.5” (CHRPC-03326)
- VCT Track Length: 26’ 8-5/16” (CHRPC-03326)
- VCT Overall Width: 17’ 9” (CHRPC-03326)
- VCT Overall Height (maximum extension): 22’ 7/8” (CHPRC-03326)
- VCT Length: 35’ 7-5/8” (CHPRC-03326)
- VCT Turning Radius: 33’ 5/8” (inside) 56’ 4-3/8” (outside) (CHPRC-03326)
- Overall Length (includes length of GT-50): 54’ 3-5/8” (CHPRC-03326)
- The CSSs will be arranged on the CSP in a 5 x 5 grid with 15 ft. center-to-center distance and an outside clear perimeter of 10 ft. (CHPRC-02623, Section 4.1.2)
- The TSCs and VCC lids will be delivered on 24 pallets each (48 total). Each pallet will be no larger than 8’ x 8’ and may be stored approximately 1’ apart from one another. These dimensions are based upon the TSC diameter (52.5”) and lid diameter (49.37”). (Doc. No. 30059-P-01, Section 3.4)

3.0 EVALUATION

The VCCs, TSCs, and VCC lids will be constructed off-site and will be delivered and received at the CSA via various methods as described in Section 3.1. The TSCs, VCC lids, and VCCs will also be assembled at the CSA. Once assembled, these components will be collectively referred to in this report as empty CSSs. Assembly of the empty CSS is described in Section 3.2. The empty CSSs will be transferred to WESF where the loaded USCs will be placed into the CSSs. Transfer, loading, and storage of the VCC is described in Section 3.3.

3.1 Delivery/Receipt

The VCCs will be delivered to the CSA on a Goldhofer-type trailer which is approximately 72-ft. long. The VCCs may be transported in either the vertical position or the horizontal position using an assembly similar to that shown in Appendix A (Figure A1). The flatbed trailer will be backed onto the operating pad, along with a crane. The crane will most likely be at least a 200 ton crane (i.e. Terex Demag AC 200-1 All Terrain Crane). The crane will be used to unload the VCCs from the trailer (including repositioning the VCC from horizontal to vertical as necessary). The VCCs will be placed on the operating pad behind the crane. The crane and semi-truck/trailer may then be removed from the operating pad and the VCC may be placed onto either the CSP or operating pad using the VCT and a GT50 TUG aircraft gate tractor (tug). An illustration of the delivery configuration of the crane, semi-truck/trailer, and VCCs is provided in Appendix B (Figure B1).

The TSCs and VCC lids will be delivered to the CSA on pallets which are no larger than 8’ x 8’ square. The method of transport for the TSCs and VCC lids may be performed via a variety of various truck and/or trailer configurations. A forklift will then be utilized to unload the pallets and place them on the storage pad as shown in Figure B1. The specifics of the truck and/or trailer and forklift need not be specified at this time since the specifications and operational requirements of this equipment will be governed by that for delivery and receipt of the VCCs.

3.2 CSS Assembly

In preparation for placing the loaded USCs into the VCCs, the TSCs and TSC lids must be placed into the VCCs (assembled). Assembly of the CSSs may take place on the operating or CSP wherever space is available at the time. The VCCs located on the operating pad should be used for assembly first in
order to provide room for the empty CSSs as they are assembled. As each empty CSS is completed, it will be placed on the north-east side of the operating pad working to the south-west. The empty CSSs will be relocated using the VCT and tug and the exterior gate of the CSA will be opened as necessary such that the CSA driveway may be utilized for additional space. The interim (approximately half complete) and assembled illustrations are shown in Appendix B (Figures B2 and B3).

3.3 Loading, Transport and Placing of the Loaded CSS

The empty CSSs may be stored on the operating pad for an extended period of time before the capsules at WESF are ready to be loaded into the UCSs and placed in the CSSs. The empty CSSs will be transferred to WESF (using the VCT and tug). The empty VCC will be placed on the new concrete pad outside of the WESF truck port and the empty VCC will be transported into WESF using an air pallet. The CSS will then be loaded with USCs. When the loaded CSSs are returned to the CSA, they will be placed on the CSP for long-term storage in a configuration as shown in Appendix B (Figure B4) with 5–ft. spacing between each CSS and a minimum of 10–ft. spacing between the edge of the CSS and the edge of the concrete. By meeting these spacing requirements (as stipulated in CHPRC-03326), the VCT is capable of placing and maneuvering the VCCs/CSSs as necessary on and off of the storage and operating pads.

3.4 Existing Roads

The VCT and tug will travel between the CSA and WESF along 7th Street and Atlanta Avenue. The width of Atlanta Avenue is sufficient to accommodate the width of the VCT (17.75 ft). Additionally, the intersection of 7th Street and Atlanta Avenue is sufficient to provide the required turning radius for the VCT and tug. However, 7th Street is barely wide enough for the VCT to fit within it (shoulder-to-shoulder). Therefore, 7th Street should be widened by at least two feet on each side, (or four feet on one side) in order to accommodate the VCT and tug and still have some available space for misalignment and to avoid overloading the edges of the paved surface. The axle loads of the VCT are not significantly higher than those of cranes typically used at the Hanford site (132,500 lb vs 124,669 lb). The typical cranes are used on asphalt roads at the Hanford site on a regular basis and the typical asphalt road construction is sufficient to resist the crane loads. The new section of 7th Street and the WESF truck port and CSA haul paths will be designed with asphalt and base course thickness which exceed typical roadway thicknesses. Therefore, typical Hanford practices provide justification that the overall haul path, including the existing roadways and new section of 7th Street and haul paths at the WESF and CSA, are sufficient to resist the loading of the VCT.

3.5 Grading

The existing grade of 7th Street near the CSA is approximately 710–ft. The existing surface of the ground at the CSA site varies, but in general is at an elevation of approximately 709.5–ft. The elevation of the CSP and operating pad will be set at an elevation of approximately 710–ft. This will allow the CSA haul path to be constructed approximately level. The adjacent grade will be leveled to an elevation of approximately 709.5–ft. This grade elevation will allow for minimal grading, cutting, and smoothing of the area surrounding the CSA yard.
3.6 Traffic Control

The VCT will be required to travel between the CSA and the WESF truck port for the loading and placement of each CSS (up to 24 round trips). The estimated travel distance for each way is approximately 1000–ft. At a speed of approximately 5 mph (maximum tow speed), the transport will likely be performed in less than 10 minutes each way. The VCT width (~18–ft) is not much narrower than the width of the updated 7th Street (24–ft) and Atlanta Avenue (~30–ft). Therefore, while there is potentially sufficient room for emergency vehicles to pass by the VCT on Atlanta Avenue, there is likely not sufficient space for emergency vehicles to pass by the VCT along 7th Street. However, there are sufficient alternative routes in the WESF and CSA areas, that this condition need not be mitigated in support of such a short duration effort of minimal repetition. Therefore, extra widening of 7th Street and/or Atlanta Avenue need not be performed for the specific support of emergency vehicles. The proper emergency authorities should be contacted prior to activities which block 7th Street or Atlanta Avenue.

3.7 Haul Path Geometry

The turning radius of the VCT is approximately 56–ft as illustrated in Appendix B (Phase III). The haul path, WESF truck port pad, operation pad, and CSP (including configuration thereof) are sufficiently sized to provide space for relatively easy maneuverability of the CSSs and related components. Additionally, as illustrated in Appendix B, Phase I, there is sufficient space for the trailers, cranes, forklifts, etc. to navigate and perform the required work without significant challenges associated with vehicle maneuverability. The size (width, length, height, etc.) of the VCCs and associated delivery trailer will require special consideration for traveling between the VCC fabrication site and the CSA. The travel route should be evaluated once the route is known in order to verify that the travel path is equipped with sufficient turn radii, widths, overhead clearances, etc. There is sufficient space on the CSA haul path to support the required turning radius of a delivery trailer with sufficient capacity to haul the VCCs.

The VCT is capable of traversing up to 4% grades (CHPRC-03326). Both the truck port and CSA haul paths have grades below 4% (thus preventing overstress of the VCT and tug components).

4.0 CONCLUSIONS

The CSA layout, including the operating pad, CSP, and haul path as shown in Appendix B is adequate to support the planned operations necessary to receive, assemble, transport, and store up to 24 CSSs.

Atlanta Avenue and the intersection of Atlanta Avenue and 7th Street are sufficiently wide and structurally adequate for transport of the CSSs using the VCT and tug. However, the shoulders of 7th Street should be widened (at least 4–ft) in order to accommodate the width of the VCT (17.75–ft.) and still have some available space for misalignment and to avoid overloading the edges of the paved surface.

The improved haul path at the WESF is adequate for transport of the CSSs. The WESF truck port pad
will be improved by the WESF portion of Project W-135.

5.0 REFERENCES


APPENDIX A

EQUIPMENT ILLUSTRATIONS

Note that equipment illustrations may not match the final design exactly. However, the illustrations are sufficiently accurate to the current design for facilitation of the operations analysis.
The Vertical Cask Transporter (top photo) that will be used for outdoor transport of HLW storage casks at the West Valley Demonstration Project and the tow tractor that will pull it are pictured above.

The West Valley Demonstration Project (WVDP) is preparing to package and relocate 278 canisters (275 production canisters and 3 end-of-process canisters) of vitrified high-level waste (HLW) from inside the Main Plant Process Building (MPPB) to a new on-site storage location. The 47-ton Vertical Cask Transporter (VCT) is a mobile hydraulic gantry crane that will be used for the heavy hauling operation at the WVDP.

The specially-designed VCT is one of three task-specific pieces of heavy lifting/hauling equipment that will be used to maneuver the storage casks through loading and storage procedures. The VCT will operate entirely outdoors, where it will transport empty concrete storage casks to the MPPB and the 87-ton loaded casks from the MPPB to the Storage Pad. It is equipped with a diesel engine for lifting the casks, but will be towed by a separate GT50 aircraft tow tractor, which is commonly used to move airplanes.

The VCT is designed to operate under the wide temperature and humidity ranges that exist at the WVDP. Operating at its maximum loaded speed of approximately 2 miles per hour, on-site transport of a loaded storage cask from the MPPB to the Storage Pad will take approximately 3 hours.
Vertical Cask Transporter

Cask Loading and Transport

The series of steps involved with loading and transporting the High-Level Waste (HLW) Vertical Storage Casks (VSC) from the Main Plant Process Building (MPPB) to the HLW Storage Pad require several movements of the bulky steel-concrete storage casks. The WVDP’s Vertical Cask Transporter (VCT) will play an important role in transporting casks for loading and placement in storage. To facilitate loading and storage, the VCT will:

- Pick up empty VSCs at the fabrication area in the WVDP’s North Parking Lot
- Deliver the empty VSCs to the entrance of the Load-In Facility (LIF)
- Pick up VSCs loaded with 5 canisters at the LIF
- Transport loaded VSCs approximately one-half mile from the MPPB to the HLW Storage Pad
- Position the loaded VSCs on the Storage Pad

Lifting and transporting the VSCs requires precision and the utmost attention to safety. Design of the Vertical Cask Transporter, which is specifically made for outdoor movement and positioning of the WVDP’s casks, is based on similar transport equipment used for moving spent nuclear fuel in concrete storage casks at nuclear power plants.

Proven, Safe, Long-Term Storage Technology

The WVDP HLW Storage System

- Maximizes the use of off-the-shelf technology
- Safely and securely packages HLW in multi-pack configuration to reduce handling and shipping costs
- Offers maintenance-free, passive storage
- Meets high nuclear quality assurance standards
- Interfaces with NRC Type-B licensed transportation casks

The West Valley Demonstration Project (WVDP) is a U.S. Department of Energy-led environmental remediation project located approximately 35 miles south of Buffalo, NY. CH2M HILL Babcock & Wilcox, LLC (CHBWV) was formed to meet the specific requirements of Phase 1 decommissioning of the WVDP. The limited-liability partnership combines the experience and capabilities of CH2M HILL Constructors Inc. (CH2M HILL), Babcock & Wilcox Technical Services Group, Inc. (B&W), and Environmental Chemical Corporation (ECC).
Figure A1. VCT Configuration
APPENDIX B

CSA ILLUSTRATIONS
Figure B1. CSA Operations Plan Phase 1 (Before)
Figure B3. CSA Operations Plan Phase 3 (After)
Figure B4. CSA Operations Plan Phase 4 (Storage)
Figure B5. WESF Truck Port Operations Plan Phase 4 (Storage)
<table>
<thead>
<tr>
<th>Req. No.</th>
<th>FDC Section No.</th>
<th>Requirement Text</th>
<th>Applicable to Current Design Phase?</th>
<th>Compliance Verification</th>
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<td>Major Systems, Functions, and Requirements</td>
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<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
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<tr>
<td>4.1</td>
<td>Capsule Storage Area</td>
<td></td>
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<tr>
<td>1</td>
<td>4.1</td>
<td>The CSA will include a concrete operating area near the CSP sufficient for CSS placement activities, surveillance, and maintenance operations. The remainder of the CSA will be graded, compacted gravel.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>2</td>
<td>4.1</td>
<td>The fencing will be used to limit radiological exposure to non-radiological workers from the loaded CSSs and will provide required physical security.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>3</td>
<td>4.1</td>
<td>The CSA shall include features to address stormwater, in a manner that does not interfere with the operation of the CSS (e.g., passive cooling).</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
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<tr>
<td>4.1.1</td>
<td>Siting</td>
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<tr>
<td>4</td>
<td>4.1.1</td>
<td>The CSA will be located in the 200E Area approximately 0.12 miles (200 m) from WESF.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within drawing H-2-837591.</td>
</tr>
<tr>
<td>5</td>
<td>4.1.1</td>
<td>The contractor shall be responsible for identifying any potential utility interferences based on the selected design solution. This includes but is not limited to the potential interferences described above, and proposing the best means for resolving them to CHPRC.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within drawings H-2-837593 and H-2-837608.</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Capsule Storage Pad</td>
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<tr>
<td>6</td>
<td>4.1.2</td>
<td>The CSP shall be within the CSA fenced area.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>7</td>
<td>4.1.2</td>
<td>The CSP shall be designed to accommodate the full set of CSSs containing all MCSC-associated cesium and strontium capsules, and shall be designed to allow for routine surveillance and monitoring as required by the CSS design requirements, the Resource Conservation and Recovery Act of 1976 (RCRA) permit, and operations procedures.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, <em>Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</em></td>
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<tr>
<td>8</td>
<td>4.1.2</td>
<td>The CSS design and operational approach for placing the CSSs on the CSP will include a concrete operating area near the CSP sufficient for CSS operations, and surveillance and maintenance operations.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>9</td>
<td>4.1.2</td>
<td>Reinforced concrete pads that support confinement casks in storage do not constitute &quot;pavements.&quot; As such, the CSP shall be designed and constructed as foundations under an applicable code.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>10</td>
<td>4.1.2</td>
<td>The CSP design shall be based on the CSS contractor’s anticipated maximum number of CSSs and associated storage layout, and shall consider loading from the CSS drop and tip-over analysis.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>11</td>
<td>4.1.2</td>
<td>Based on these assumptions, the CSP shall be a square design, 90 ft. on each side.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>12</td>
<td>4.1.2</td>
<td>The elevation of this pad shall be anywhere from 1 ft. to 2 ft. above finish grade of the CSA.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawings H-2-837592 &amp; H-2-837593.</td>
</tr>
<tr>
<td>13</td>
<td>4.1.2</td>
<td>The CSP shall be centered within a larger CSA fenced area, which should also be square and shall have minimum overall dimensions of 80 meters x 80 meters. This will provide for a minimum 85-ft. wide operations/working area around the CSP.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>14</td>
<td>4.1.2</td>
<td>The CSP and the CSS have been determined to be safety significant SSCs (refer to Section 7.0, Nuclear Safety Requirements). The design basis classification for seismic design shall be seismic design criteria SDC-2 and limit state (LS C) in accordance with CHPRC procedure PRC-PRO-EN-097, Engineering Design and Evaluation (Natural Phenomena Hazard).</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
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<tr>
<td>15</td>
<td>4.1.2</td>
<td>Grading around the CSP shall be such that all stormwater shall flow away from the structure to a properly designed drainage system, such that no standing water occurs.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
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<td>FDC Section No.</td>
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<td>Y (Yes)</td>
<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
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<tr>
<td>16</td>
<td>4.1.2</td>
<td>Drainage structures shall be incorporated throughout the CSA that will capture and convey water away from the structure and approach roadways.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
</tr>
<tr>
<td>17</td>
<td>4.1.2</td>
<td>The design of the drainage system shall be such that it minimizes maintenance needs (surface drainage to swales and ditches are preferred over drainage structures and pipes) while still complying with relevant site surface water discharge permit requirements.</td>
<td>N</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
</tr>
<tr>
<td>18</td>
<td>4.1.2</td>
<td>The contractor shall determine if any soil improvements are required to support the loads on the CSP. If significant soil modifications or other preparations are required, the contractor shall review options and make recommendations to CHPRC for review and approval.</td>
<td>Y</td>
<td>None required per CHPRC-02539.</td>
</tr>
<tr>
<td>19</td>
<td>4.1.2</td>
<td>Environmental design conditions and existing site soil conditions shall be considered in the design and analysis of the CSP foundations. The CSA contractor shall consider the potential for liquefaction or other soil instabilities attributable to vibrating ground motion, and the pad shall be designed with this in mind.</td>
<td>Y</td>
<td>None required per CHPRC-02539.</td>
</tr>
<tr>
<td>20</td>
<td>4.1.2</td>
<td>The CSP shall meet the requirements of WAC-173-303-630 (7)(c) and (7)(d) for impervious surface precipitation control. Therefore, the CSA contractor shall design and construct the CSP such that: - it is sloped or is otherwise designed and operated to drain and remove liquid resulting from precipitation; or - The storage casks are elevated or are otherwise protected from contact with accumulated liquids.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
</tr>
<tr>
<td>21</td>
<td>4.1.2</td>
<td>The grading and drainage calculation shall include requirements for concrete slabs, roadway and structures in the area of the CSP, and any excavation and backfill requirements for installation of the CSP.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592 and CHPRC-02532, Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area.</td>
</tr>
<tr>
<td>22</td>
<td>4.1.2</td>
<td>Steel embedments in reinforced concrete structures must satisfy the requirements of the design code applicable to the reinforced concrete structure. Similarly, structural steel must satisfy the requirements of the applicable steel design code.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
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<td>Y (Yes) N (No) P (Partially)</td>
<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
</tr>
<tr>
<td>23</td>
<td>4.1.2</td>
<td>The CSP layout shall consider transportation equipment and heavy equipment access required to place the CSS for each successive loading. The CSP shall incorporate a design approach apron between the road and the CSP to bridge the elevation difference. This allows casks to be placed directly on the CSP with the VCT, in order to provide operational efficiency eliminating the need for crane lifts of the loaded casks.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. An operational analysis was also performed for the CSA (Project W-135 Capsule Storage Area Operations Analysis Report). This document performed an operations analysis for the receipt, transportation, interim storage, and permanent storage of the Vertical Concrete Casks (VCCs), Transportable Storage Canisters (TSCs), and Transportable Storage Canister (TSC) lids.</td>
</tr>
<tr>
<td>24</td>
<td>4.1.2</td>
<td>The CSP shall be protected with metal edging at each pad access point.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>25</td>
<td>4.1.2</td>
<td>The heat transfer from CSS shall be totally passive, by natural convection, radiation and conduction, without any moving parts. The maximum temperature of adjacent concrete surfaces of the storage pad shall be in accordance with the guidelines and requirements of the ACI 318, Building Code Requirements for Structural Concrete.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>26</td>
<td>4.1.2</td>
<td>The CSA contractor will be provided with thermal data for the CSS by the CSS contractor, and shall provide in the basis for the design of the CSA an analysis of maximum concrete temperatures and demonstrate how this complies with the system design life requirements.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
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<td>4.1.3 Operating Area</td>
</tr>
<tr>
<td>27</td>
<td>4.1.3</td>
<td>The CSA design shall include a concrete area near the CSP sufficient for receipt, assembly and staging of empty CSS casks; CSS loading activities and placement of loaded CSSs on the CSP for interim storage; and CSA surveillance and maintenance operations. The remainder of the CSA will be graded, compacted gravel.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>28</td>
<td>4.1.3</td>
<td>The operating area shall be concrete and shall be designed to support expected loads. The design basis load requirements shall be provided by the CSS contractor. If the existing soil will not support this bearing capacity, then the area shall be rebuilt to obtain the required bearing capacity.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593 and CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
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<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>29</td>
<td>4.1.3</td>
<td>The operating area shall include the apron between the CSP and the access road.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>30</td>
<td>4.1.3</td>
<td>The operating area shall be sized to allow storage of up to 24 empty VCCs and 24 empty TSC/TSCBs. Storage of empty components shall not interfere with moving and placing loaded CSSs. The operating area shall also support the placement of empty TSC/TSCBs into empty VCCs. All CSS assembly activities shall be completed before any capsule loading activity occurs at WESF.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>31</td>
<td>4.1.4</td>
<td>CSA Security Fencing, Lighting, and Access Control Requirements</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606.</td>
</tr>
<tr>
<td>32</td>
<td>4.1.4</td>
<td>CSA perimeter shall be enclosed by a chain link fence with outriggers.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>33</td>
<td>4.1.4</td>
<td>Vehicle gates shall be sufficiently sized and placed for entry and movement of transporters and cranes for receipt operations and maintenance activities. Personnel entry gates with crash bars shall be provided for routine entry by personnel from the CSB; high security locks shall be provided on each fence gate.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>34</td>
<td>4.1.4</td>
<td>Lighting around the perimeter of the storage location shall be provided with an illumination level of not less than that recommended by IES 2013, <em>The Lighting Handbook</em>. Lighting shall be replaceable without need to enter the fenced area.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606 and the CSA Lighting Calculation CHPRC-02535.</td>
</tr>
</tbody>
</table>

**Note:**

- **Y** (Yes) indicates the requirement has been met.
- **N** (No) indicates the requirement has not been met.
- **P** (Partially) indicates the requirement is partially met.

Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.
<table>
<thead>
<tr>
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<tr>
<td>35</td>
<td>4.1.4</td>
<td>The need for a security alarm system, communications, and other measures to prevent unauthorized access to CSA and the stored materials shall be determined by a security requirement analysis performed by others and provided to the CSA contractor. Safeguards and security features shall prevent theft, vandalism, and other malicious acts that could release radioactive material or disrupt facility operations.</td>
<td>Y</td>
<td>CHPRC directed that no security system is required other than manual locks.</td>
</tr>
</tbody>
</table>
| 36      | 4.1.5          | **Temperature Monitoring System**  

The CSA contractor shall design support equipment for the TMS to include but not be limited to:  
- a protective structure located adjacent to the CSA to house the CSS contractor supplied monitoring/recording panel, accessible as required to allow evaluation of CSS temperature conditions;  
- all conduits/cabling required to provide power to the TMS components at the CSA;  
- CE&I cabling to connect the signals from the CSS and the ambient air temperature monitors to the centralized monitoring/recording panel at the CSA;  
- all conduits/cabling and interfaces to provide signals to a remote annunciation panel/interface at the CSB;  
- all conduits/cabling required to provide power to the TMS components at the CSB; and  
- a remote annunciation panel/interface at the CSB.                                                                                                                                                             | Y                             | This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawings H-2-837606, H-2-837607, H-2-837610 and H-2-837611.                          |
| 37      | 4.1.6          | **CSA Utility and Support System Requirements**  

The MCSC Project shall interface with the existing Hanford Site electrical distribution system. The CSA contractor shall provide designs to modify or extend the existing 13.8kV system as required to provide for construction power and for long-term CSA operations. Designs for interfaces to the electrical distribution system shall be coordinated with Hanford Site Electrical Utilities group (EU). | Y                             | This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605 and H-2-837606.                                             |
| 38      | 4.1.6          | **Existing systems at WESF and the CSB shall be used to the maximum extent possible to distribute required utilities (e.g., water, power).**  

Assessment of utilities and infrastructure interfaces shall occur following preliminary facility definition and interface definition.                                                                                                                                                   | Y                             | Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.  

The power interface requirement is addressed in drawing H-2-837605 and H-2-837606.                                                                                                                                     |
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<td>Y (Yes)</td>
<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
</tr>
<tr>
<td>39</td>
<td>4.1.6</td>
<td>If existing systems modified to support long-term storage operations are not adequate to support construction and capsule transfer operations, then temporary means shall be used to supply the required utilities. Assessment of the adequacy of the 13.8 kV electrical distribution system is to be done in conjunction with EU.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA. CHPRC has directed that temporary power for construction is not required to be in the design.</td>
</tr>
<tr>
<td>40</td>
<td>4.1.6</td>
<td>General personnel access to the CSA shall be configured for ease of entry from the CSB for routine operations, surveillance, and maintenance.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
<td>41</td>
<td>4.1.6</td>
<td>The use of existing roadways, electrical distribution systems, and communications network shall be maximized to satisfy CSA requirements; however, modifications (e.g., roadway enhancements to support anticipated vehicle loads; movement of overhead interferences) may be required.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawings H-2-837592, H-2-837606, H-2-837608.</td>
</tr>
<tr>
<td>42</td>
<td>4.1.6</td>
<td>CSS delivery to the CSP shall be by the vehicular entrance established further to the east, off of 7th Street, to take advantage of previously disturbed areas.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837592.</td>
</tr>
<tr>
<td>43</td>
<td>4.1.6</td>
<td>Any required support personnel will be housed at existing CSB facilities. MCSC Project will not provide new facilities or capabilities to house support personnel for CSA operations.</td>
<td>Y</td>
<td>No design required.</td>
</tr>
<tr>
<td>44</td>
<td>4.1.6</td>
<td>Access roads, aprons, and walkways for CSA will be integrated with the existing infrastructure at CSB.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>45</td>
<td>4.1.6</td>
<td>A raw water system is required for the CSA in order to supply fire water to fire hydrants. There are no structures associated with the CSA; therefore, automatic fire sprinkler systems are not required. The CSA will interface with the on-site water distribution for raw water.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
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<td></td>
<td>Y (Yes)</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>46</td>
<td>4.1.6</td>
<td>Raw and potable water systems shall meet the requirements specified in Washington State Department of Health (DOH) 331-123, Water System Design Manual. Cross-connection control features shall prevent cross-connection of raw and potable water systems. The Hanford Site water purveyor controls the water system.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>47</td>
<td>4.1.6</td>
<td>The applicable requirements of Contractor Requirements Document (CRD) O 420.1C (Supplemented Rev. 0), Facility Safety, Section 3 and DOE-STD-1066-2012, Fire Protection shall be followed for fire suppression (sprinklers and/or hydrants) water supplies. Per the RL Authority Having Jurisdiction (AHJ), Section 3.b.3 of CRD O 421.1C (Supplemented Rev. 0) is not applicable to the CSA since it is not a building.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>48</td>
<td>4.1.6</td>
<td>The CSA is expected to be a Category 2 nuclear facility. Therefore, CRD O 420.1C, (Supplemented Rev. 0), Section 3.b.4.a requires a minimum of two operational fire hydrants be provided such that parts of the exterior of the facility can be reached by hose lays of not over 300 feet.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>49</td>
<td>4.1.6</td>
<td>DOE-STD-1066-2012 requires that hydrants should be provided such that: - Hydrants are no closer than 40 feet to the facility. - Hose runs from the hydrants are no more than 300 feet to all exterior portions of the facility (i.e., coverage over the entire pad, plus 35 ft. of clearspace to wildland areas on all open sides). - A minimum of two hydrants per facility are provided. The location, access, and arrangement of fire hydrants is subject to the review and approval of the CHPRC cognizant Deputy Fire Marshal and the Hanford Fire Chief. - Branch piping between the water main and hydrants should not be greater than 300 feet.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
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<td>50</td>
<td>4.1.6</td>
<td>The installation of the raw water system shall be in accordance with Hanford Water Utility Standards. NFPA 24, <em>Standard for the Installation of Private Fire Service Mains and Their Appurtenances</em> should be used as reference for the installation of the raw water system. Thrust blocking should be provided as required in accordance with NFPA 24. - The fire water supply shall be capable of providing the minimum fire flow per NFPA 1, <em>Fire Code</em>, as adjusted by the Hanford Fire Chief. The minimum fire flow is 3500 gpm at 20 psi for a minimum duration of four hours in accordance with the Hanford Fire Marshal’s Office Interpretation/Clarification Request (ICR) 2017-02, Rev 1. - Detailed plans, specifications, and calculations shall be submitted to the CHPRC cognizant fire protection engineer (FPE) for review and approved prior to installation.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>51</td>
<td>4.1.6</td>
<td>Inspection, testing, and maintenance for fire water supplies shall be performed in accordance with NFPA 25, <em>Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection System</em>.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>52</td>
<td>4.1.6</td>
<td>A lightning risk assessment shall be performed per NFPA 780, <em>Standard for the Installation of Lightning Protection Systems</em>. If the assessment determines lightning protection is required, then it shall be provided.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02536.</td>
</tr>
<tr>
<td>53</td>
<td>4.1.6</td>
<td>Cathodic protection systems shall be provided if required by the MCSC Project design and shall be designed in accordance with the guidelines provided in NACE SP0285, <em>External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection</em>, and NACE SP0169, <em>Control of External Corrosion on Underground or Submerged Metallic Piping Systems</em>.</td>
<td>Y</td>
<td>This requirement has been determined to not be applicable.</td>
</tr>
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<tr>
<td>54</td>
<td>4.1.6</td>
<td>Communications systems shall be designed in accordance with DOE O 200.1A, Information Technology Management. MCSC Project shall use existing telephone capabilities at WESF and CSB for internal and external communication. CSA will not be a normally occupied area and will not require installation of a telephone system. Portable communication devices will be used at CSA. It is not anticipated that any new telephone conduits will need to be installed for communication lines.</td>
<td>Y</td>
<td>This requirement has been determined to not be applicable.</td>
</tr>
<tr>
<td>55</td>
<td>4.1.6</td>
<td>MCSC Project shall use the existing public address system at WESF and CSB and ensure that the public address system broadcasts to all CSA areas.</td>
<td>Y</td>
<td>There is no design associated with this requirement.</td>
</tr>
<tr>
<td>56</td>
<td>4.1.6</td>
<td>MCSC Project shall use the existing computer intranet system available at WESF and CSB for interfaces with the Hanford Local Area Network, unless new system capacity is identified as needed for the TMS. It is not anticipated that any new computer intranet system interfaces will be required at CSA.</td>
<td>Y</td>
<td>There is no design associated with this requirement.</td>
</tr>
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<td><strong>4.2 Transfer Roadway</strong></td>
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<tr>
<td>57</td>
<td>4.2</td>
<td>To the greatest extent possible, the MCSC Project shall take advantage of existing asphalt road (7th - Street) at the site.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
<td>58</td>
<td>4.2</td>
<td>The MCSC Project shall extend the existing roadways to the CSA boundary.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
<td>59</td>
<td>4.2</td>
<td>The construction workforce, facility operations workers, and CSSs will arrive at CSA by existing and extended roadways.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
<td>60</td>
<td>4.2</td>
<td>The extension of existing roadways and construction of new roadways shall be compatible with existing roadways.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
<td>61</td>
<td>4.2</td>
<td>The Transfer Roadway shall be modified/improved as necessary to provide for the safe transfer of the CSSs from WESF to the CSA with minimal maintenance being required during the transfer operations period.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
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<tr>
<td>62</td>
<td>4.2</td>
<td>The Transfer Roadway will require modifications as needed to accommodate the VCT width, loaded weight, and turning radius. These modifications may include widening, grade adjustments, subgrade improvements, new paving, and protections as may be required to under road utilities, drainage culverts, etc.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>63</td>
<td>4.2</td>
<td>Above grade structures such as fences, bullocks (sic), overhead lines, etc. may also require relocation to accommodate the CSS transport equipment.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837608.</td>
</tr>
<tr>
<td>64</td>
<td>4.2</td>
<td>Roadways, subsurface conditions, and existing infrastructure (i.e., drainage culverts, underground utility lines, overhead lines) shall be investigated and confirmed to be adequate to support and sustain the loading that will be imposed by the transport of the CSSs to the CSA.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>65</td>
<td>4.2</td>
<td>Should the roadways and existing infrastructure not be adequate for the design loads and life-cycle use, then replacement structure design or modifications shall be provided. Proof testing with a simulated design load is an acceptable means for determining the adequacy of the existing infrastructure, except that before proof testing can be performed, calculations shall show that the structures and underground utilities to be traversed are capable of supporting the proposed loading. If not, then the locations above the areas of concern shall be adequately reinforced to assure that no damage to the utility or structure will occur.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>66</td>
<td>4.2</td>
<td>Unless otherwise directed, access roadways within the CSA shall typically be concrete or crushed stone and shall be designed to support expected loads. If the existing soil will not support this bearing capacity, then the area shall be rebuilt to obtain the required bearing capacity.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>67</td>
<td>4.2</td>
<td>DOE-0359, Hanford Site Electrical Safety Program (HSESP), identifies limited approach boundaries for overhead lines that could be impacted by equipment and cranes in transit or performing work. The CSA contractor shall evaluate overhead electrical and communication lines that are in or near the path that will be used by the VCT to transfer loaded or unloaded CSSs and move or raise any lines that do not meet DOE-0359 requirements.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837608.</td>
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<td></td>
<td>Interfaces</td>
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<td>5.2</td>
<td></td>
<td>Utility Interfaces</td>
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<tr>
<td>5.2.1</td>
<td></td>
<td>Hanford Site Utilities/Infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>5.2.1</td>
<td>MCSC Project shall interface with existing Hanford Site utilities and infrastructure as needed to support construction, capsule transfer operations, and long-term storage operations.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>5.2.1</td>
<td>MCSC Project shall use existing systems at WESF and the CSB (or as elsewhere may be identified) to distribute required utilities (e.g., water, electricity, and sanitation).</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>5.2.1</td>
<td>If existing systems modified to support long-term storage operations are not adequate to support construction and capsule transfer operations, then temporary means shall be used to supply the required utilities.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>5.2.1</td>
<td>Interface requirements for utilities and infrastructure are undefined, pending maturation of design.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>5.2.1</td>
<td>Initial assessment of utilities and infrastructure interfaces shall occur following completion of conceptual design.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>5.2.1</td>
<td>Access roads, aprons, and walkways for the CSA will be integrated into the existing CSB infrastructure.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.2.2</td>
<td>Service Roads</td>
<td></td>
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</tr>
<tr>
<td>74</td>
<td>5.2.2</td>
<td>To the greatest extent possible, MCSC Project shall take advantage of existing asphalt roads at the selected site.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>5.2.2</td>
<td>The CSA contractor design shall extend the existing roadways to the CSA boundary.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>76</td>
<td>5.2.2</td>
<td>The extension of existing roadways and construction of new roadways shall be compatible with the existing roadways.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>77</td>
<td>5.2.2</td>
<td>A design analysis shall be performed to confirm that the existing roadways can accommodate the vehicles transporting casks to and from CSA. If existing roadways cannot accommodate cask transport, modifications to the roadways shall be designed by the contractor.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>78</td>
<td>5.2.2</td>
<td>Any new roads or road modifications for the MCSC Project shall meet the requirements of M 41-10, Standard Specification for Road, Bridge, and Municipal Construction.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591 and CHPRC-03632, Design and Analysis of Road Improvements for Project W-135.</td>
</tr>
<tr>
<td>79</td>
<td>5.2.3</td>
<td>MCSC Project electrical power needs – as may be required - shall interface with the existing Hanford Site electrical distribution system. MCSC Project shall provide extension of the existing electrical power grid as required for construction power and long-term CSA operations. Depending on facility location and power requirements, the existing electrical distribution system may require upgrades.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606.</td>
</tr>
<tr>
<td>80</td>
<td>5.2.3</td>
<td>The assessment and definition of interface requirements for a MCSC Project substation shall occur following final CSA siting within the designated siting area and definition of electrical loads. Designs for interfaces to the electrical distribution system shall coordinated with EU.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606.</td>
</tr>
<tr>
<td>81</td>
<td>5.2.3</td>
<td>Electrical power delivered to the system and electrical installation and any modifications to the site electrical utilities distribution system, including the 13.8 kVac-480 Vac transformers, shall conform to NFPA 70-2008, National Electric Code, and IEEE C2, National Electrical Safety Code.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605. Design Code of Record is NFPA 70-2017.</td>
</tr>
<tr>
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<tr>
<td>82</td>
<td>5.2.4</td>
<td>Interface with Site Water Distribution</td>
<td>Y Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
</tr>
<tr>
<td>83</td>
<td>5.2.4</td>
<td>Raw and potable water systems shall meet the requirements specified in DOH 331-123. Cross-connection control features shall prevent cross-connection of raw and potable water systems. The Hanford Site water purveyor controls the water system.</td>
<td>Y Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>5.2.4</td>
<td>The applicable requirements of CRD O 420.1C (Supplemented Rev. 0), Section 3 and DOE-STD-1066-2012 shall be followed for fire suppression (sprinklers and/or hydrants) water supplies. Per the RL AHI, Section 3.b.3 of CRD O 421.1C (Supplemented Rev. 0) is not applicable to the CSA, since it is not a building.</td>
<td>Y Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>5.2.4</td>
<td>The CSA is expected to be a Hazard Category 2 nuclear facility. CRD O 420.1C, (Supplemented Rev. 0), Section 3.b.4.a requires a minimum of two operational fire hydrants be provided, such that parts of the exterior of the facility can be reached by hose lays of not over 300 feet.</td>
<td>Y Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>5.2.4</td>
<td>DOE-STD-1066-2012 requires that hydrants should be provided such that: - Hydrants are no closer than 40 feet to the facility. - Hose runs from the hydrants are no more than 300 feet to all exterior portions of the facility (i.e. coverage over the entire pad, plus 35 ft. of clear space to wildland areas on all open sides). - A minimum of two hydrants per facility are provided. The location, access, and arrangement of fire hydrants is subject to the review and approval of the CHPRC cognizant Deputy Fire Marshal and the Hanford Fire Chief. - Branch piping between the water main and hydrants should not be greater than 300 feet.</td>
<td>Y Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
<td></td>
</tr>
<tr>
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<tr>
<td>87</td>
<td>5.2.4</td>
<td>The installation of the raw water system shall be in accordance with Hanford Water Utility Standards. NFPA 24 should be used as reference for the installation of the raw water system. Thrust blocking should be provided as required in accordance with NFPA 24. The fire water supply shall be capable of providing the minimum fire flow per NFPA 1, as adjusted by the Hanford Fire Chief. The minimum fire flow is 3500 gpm at 20 psi for a minimum duration of four hours in accordance with the Hanford Fire Marshal’s Office ICR 2017-02, Rev 1. Detailed plans, specifications, and calculations shall be submitted to the CHPRC cognizant FPE for review and approved prior to installation.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
</tr>
<tr>
<td>88</td>
<td>5.2.4</td>
<td>Inspection, testing, and maintenance for fire water supplies shall be performed in accordance with NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection System.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
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<td>6</td>
<td>General Requirements</td>
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<td>6.1</td>
<td>Discipline Specific Design Requirements</td>
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<tr>
<td>6.1.1</td>
<td>Mechanical/HVAC</td>
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<tr>
<td>89</td>
<td>6.1.1</td>
<td>Per DOE O 420.1C, safety significant mechanical handling equipment shall meet the requirements of the codes listed in Table 6-1.</td>
<td>Y</td>
<td>There is no mechanical handling equipment as part of the design.</td>
</tr>
<tr>
<td>90</td>
<td>6.1.1</td>
<td>All cranes, hoists, and lifting devices designed or used for activities associated with the MESC Project shall meet the requirements of DOE-STD-1090-2011, Hoisting and Rigging, and DOE/RL-92-36, Hanford Site Hoisting and Rigging Manual.</td>
<td>Y</td>
<td>Not required for design.</td>
</tr>
<tr>
<td>6.1.2</td>
<td>Civil / Structural</td>
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<tr>
<td>91</td>
<td>6.1.2</td>
<td>The CSP shall have a design basis classification of seismic design criteria (SDC-2) and limit state (LS C) in accordance with CHPRC procedure PRC-PRO-EN-097, Engineering Design and Evaluation (Natural Phenomena Hazard).</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC 02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>Req. No.</td>
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<tr>
<td>92</td>
<td>6.1.2</td>
<td>Per DOE O 420.1C, safety significant structures shall, at a minimum and unless more restrictive requirements are otherwise specified elsewhere in this FDC, meet the requirements of the codes listed in Table 6-2.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>93</td>
<td>6.1.2</td>
<td>All activities associated with the installation, inspection, and testing of structural concrete, structural steel, soils and foundations shall be performed under the quality assurance requirements outlined in Section 10 of this FDC. The determination of, and basis for the application of, specific safety basis codes and standards shall be documented in a project specific nuclear safety document which shall be prepared by CHPRC and supported by the CSA contractor and other project contractors.</td>
<td>Y</td>
<td>This requirement will be met during Final Design and is addressed in CHPRC-02534, W-135 Capsule Storage Area Construction Specification.</td>
</tr>
<tr>
<td>94</td>
<td>6.1.2</td>
<td>All activities associated with the installation, inspection, and testing of structural concrete, structural steel, soils and foundations shall also meet and support the requirements and design basis of the CSS. Therefore, the CSA contractor shall obtain the necessary design inputs from the CSS contractor, including thermal analysis, as they relate to the CSP design.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>6.1.3</td>
<td>Instrumentation and Control Systems</td>
<td></td>
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<tr>
<td>95</td>
<td>6.1.3</td>
<td>The design of control devices shall conform to the General Industry safety requirements as specified in 29 CFR 1910, “Occupational Safety and Health Standards,” and DOE-0359, Hanford Site Electrical Safety Program (HSESP)</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>96</td>
<td>6.1.3</td>
<td>Control equipment and devices shall comply with NEMA ICS 1, Industrial Control and Systems: General Requirements, and UL 508, Standard for Industrial Control Equipment. Control devices shall be designed in accordance with NUREG-0700, Human System Interface Design Review Guidelines, as appropriate based on a safety evaluation. Control equipment and devices shall comply with 29 CFR 1910. Control equipment and devices shall conform to NFPA 70-2008 and the FM Global, Approval Guide. Control panels shall comply with UL508A, Standard for Industrial Control Panels.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>97</td>
<td>6.1.3</td>
<td>In addition, the instrumentation and control system shall meet the requirements for the following industry standards as applicable to the project:</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
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<td></td>
<td>- Instruments and controls selected for the expected environment;</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>98</td>
<td>6.1.3</td>
<td>- Enclosure type ratings in accordance with NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum);</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>99</td>
<td>6.1.3</td>
<td>- Instrumentation and control system equipment certification by an Occupational Safety &amp; Health Administration-registered nationally recognized testing laboratory as required by DOE-0359;</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>100</td>
<td>6.1.3</td>
<td>- Instrumentation and control design and installation to facilitate operations and maintenance; and</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>101</td>
<td>6.1.3</td>
<td>- Instrument calibration with National Institute of Standards and Technology traceable documentation.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>102</td>
<td>6.1.3</td>
<td>The design of safety-related instrumentation and control systems shall provide for the periodic in-place testing and calibration of instrument channels and interlocks. The design shall allow periodic testing of protective functions to determine if failure or loss of redundancy may have occurred.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>103</td>
<td>6.1.3</td>
<td>Per DOE O 420.1C, safety significant instrumentation, control, and alarm components shall meet the requirements of the codes listed in Table 6-3 as applicable to the specific MCSC Project design.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>104</td>
<td>6.1.3</td>
<td>All TMS support equipment, inclusive of the TMS protective structure, CE&amp;I cabling, conduit and other CSA contractor provided TMS support equipment shall meet the following criteria as applicable:</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>104</td>
<td>6.1.3</td>
<td>- Enclosure environmental ratings shall meet or exceed NEMA 250 rating;</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>105</td>
<td>6.1.3</td>
<td>- Maximum expected radiation dose in areas containing temperature monitoring system components shall be considered in the design and component selection;</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612 and H-2-837611.</td>
</tr>
<tr>
<td>106</td>
<td>6.1.3</td>
<td>- Expected service life shall be adequate to meet both short term operational needs and long term monitoring needs as applicable;</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
<tr>
<td>107</td>
<td>6.1.3</td>
<td>- Quality level and safety class requirements shall be met as identified in the DSA.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837612.</td>
</tr>
</tbody>
</table>

**6.1.4 Electrical**
<table>
<thead>
<tr>
<th>Req. No.</th>
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</thead>
<tbody>
<tr>
<td>108</td>
<td>6.1.4</td>
<td>The MCSC Project shall interface with the existing Hanford Site electrical distribution system. Depending on facility location and power requirements, the existing electrical distribution system may require upgrades. The CSA contractor shall provide designs to modify or extend the existing 13.8kV system as required to provide for construction power and for long-term CSA operations. Designs for interfaces to the electrical distribution system shall be coordinated with EU. Electrical power delivered to the CSS system, any new electrical installations as may be required, and any modifications to the site electrical utilities distribution system, including the 13.8 kV to 480 Vac transformers, shall conform to NFPA 70-2008 and IEEE C2. All electrical work is subject to the lockout/tagout requirements of DOE-0336, Hanford Site Lockout/Tagout Procedure.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605.</td>
</tr>
<tr>
<td>109</td>
<td>6.1.4</td>
<td>Where applicable, modifications or extensions of the 13.8kV electrical system will be in accordance with IEEE C2.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605.</td>
</tr>
<tr>
<td>110</td>
<td>6.1.4</td>
<td>The electrical distribution system designed by the CSA Contractor shall conform to NFPA 70-2008 and NFPA 70E-2009, Standard for Electrical Safety in the Workplace.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605.</td>
</tr>
<tr>
<td>111</td>
<td>6.1.4</td>
<td>An electrical meter shall be installed to allow monitoring of power usage at the CSA.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605.</td>
</tr>
<tr>
<td>112</td>
<td>6.1.4</td>
<td>On-site acceptance testing shall be required for each major electrical system to which there has been any modification or new installation. Tests shall be specified to demonstrate that each function and important parameter is implemented. Specific criteria shall be included to determine pass/fail acceptance.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in Construction Specification CHPRC-02534.</td>
</tr>
<tr>
<td>113</td>
<td>6.1.4</td>
<td>Acceptance and testing procedures for the electrical 480/208/120V distribution equipment shall conform to ANSI/NETA ATS-2013, Standard for the Acceptance Testing Specifications for Electrical Power Equipment and Systems, and any other stipulated site specific inspection or safety requirements.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in Construction Specification CHPRC-02534.</td>
</tr>
<tr>
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<tr>
<td>114</td>
<td>6.1.4</td>
<td>All electrical equipment installed or used on the Hanford Site shall be labeled or listed for use by a nationally recognized testing laboratory as required by DOE-0359.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837605.</td>
</tr>
<tr>
<td>115</td>
<td>6.1.4</td>
<td>MCSC Project lighting levels shall be guided by <em>The IES Lighting Handbook</em>. Energy efficient lighting shall be used where practical.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606 and in CHPRC-02535 CSA Lighting Calculation.</td>
</tr>
<tr>
<td>116</td>
<td>6.1.4</td>
<td>Emergency power systems or legally required standby systems as defined by NFPA 70-2008 Articles 700 and 701 are not expected to be required for MCSC Project equipment at CSA. If emergency power is determined to be necessary, it shall be provided as required to support safety functions. Emergency power shall provide uninterruptible power where continuity of monitoring is essential. If required, on-site Class 1E electrical distribution systems, including batteries, shall be designed with independence, testability, and redundancy. These distribution systems shall be sufficient to perform safety-related functions under single-failure conditions. At a minimum, emergency backup power will be provided to meet the sign and egress requirements of the ICC, <em>International Building Code</em>.</td>
<td>Y</td>
<td>This requirement has been determined to not be required.</td>
</tr>
<tr>
<td>117</td>
<td>6.1.4</td>
<td>As may be required for any upgrades or modifications to existing electrical systems, a lightning risk assessment shall be performed per NFPA 780, Annex L. If the assessment determines lightning protection is required, then it shall be provided.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02536 CSA Lightning Risk Assessment.</td>
</tr>
<tr>
<td>118</td>
<td>6.1.4</td>
<td>Cathodic protection systems shall be designed, if required, in accordance with the guidelines provided in NACE SP0285 and NACE SP0169.</td>
<td>Y</td>
<td>This requirement has been determined to not be required.</td>
</tr>
<tr>
<td>119</td>
<td>6.1.4</td>
<td>Per DOE O 420.1C, safety significant and safety class electric systems shall meet the requirements of the codes listed in Table 6-4 and Table 6-4 as applicable to the specific MCSC Project design.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606.</td>
</tr>
</tbody>
</table>

**6.2 Design Life**

**6.2.1 General Requirements**

<table>
<thead>
<tr>
<th>Req. No.</th>
<th>FDC Section No.</th>
<th>Requirement Text</th>
<th>Applicable to Current Design Phase?</th>
<th>Compliance Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>6.2.1</td>
<td>Components shall be designed such that continued integrity of the component can be verified over the design life to ensure continued functionality of the component within original requirements.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>Req. No.</td>
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<td></td>
<td>Y (Yes)</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>121</td>
<td>6.2.1</td>
<td>Unless otherwise stated, all systems and equipment provided shall be designed, to the maximum extent practical, to provide a minimum five year, maintenance-free service life unless stipulated otherwise.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>122</td>
<td>6.2.1</td>
<td>Tools provided shall be designed, to the maximum extent practical, to provide a minimum one year, maintenance-free service life.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>123</td>
<td>6.2.1</td>
<td>Consumables shall have a one-year minimum service life and be located for ease of inspection, maintenance, and replacement.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td></td>
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<td></td>
<td>N (No)</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>6.2.2</td>
<td>Capsule Storage Area</td>
<td>Components within CSA shall have a minimum design life of 100 years, or be designed to be easily replaced without relocation of the capsules from the storage configuration.</td>
<td>Y</td>
</tr>
<tr>
<td>125</td>
<td>6.2.3</td>
<td>Design Life Analysis</td>
<td>The contractor is responsible to document that components meet design life requirements as described in this document.</td>
<td>Y</td>
</tr>
<tr>
<td>126</td>
<td>6.3</td>
<td>Human Factors</td>
<td>The design or the selection of equipment to be operated and maintained by personnel shall include the application of human factors engineering criteria together with other appropriate design criteria.</td>
<td>Y</td>
</tr>
<tr>
<td>127</td>
<td>6.3</td>
<td></td>
<td>Decisions concerning which system functions to allocate to the human versus the machine shall be determined by analyses of system functions required, impact of error or no action on safety, and a comparison of human capabilities and equipment capabilities for the separate system functions.</td>
<td>Y</td>
</tr>
<tr>
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<tr>
<td>128</td>
<td>6.3</td>
<td>Systems, subsystems, and equipment shall consider the human engineering guidelines of DCE + HDBK-1140, Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance, NUREG-0700, and IEEE Standard 1023, IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>129</td>
<td>6.3</td>
<td>A human factors evaluation shall be performed and documented on the completed design.</td>
<td>Y</td>
<td>This will be performed during the final design phase.</td>
</tr>
<tr>
<td>130</td>
<td>6.4</td>
<td>The MCSC Project design shall consider requirements associated with reliability, availability, maintainability, and inspectability.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>131</td>
<td>6.4.1</td>
<td>Key performance indices associated with Availability areas follows: losses due to unexpected breakdown, lengthy and unplanned-for repeat set-up and adjustments, frequent stoppage and quality defect losses, and poor durability and productive life-span. The CSA contractor shall provide input to a CHPRC analysis demonstrating that the throughput requirements can be met.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
</tbody>
</table>
| 132     | 6.4.2           | The MCSC Project design shall consider maintainability factors specific to equipment used in high radiation areas. The design shall provide for routine preventive maintenance/calibration where required, and maintenance, repair, or replacement of equipment subject to failure. Planning and design of the MCSC Project systems and equipment, and evaluation of the mean time to repair systems and equipment, shall take into account all aspects of operation and maintenance, including the following:  
  - Personnel safety;  
  - Equipment accessibility;  
  - Dismantling;  
  - Replacement;  
  - Repair;  
  - Frequency of preventive maintenance;  
  - Inspection requirements; and | Y                                   | This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.                                      |
<table>
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<td>Y (Yes) N (No) P (Partially)</td>
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<tr>
<td>133</td>
<td>6.4.2</td>
<td>Day-to-day operation.</td>
<td></td>
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<tr>
<td>134</td>
<td>6.4.2</td>
<td>Design decisions shall consider life-cycle costs and all other programmatic requirements affecting WESF and CSS. The initial construction cost shall be balanced against operating and maintenance costs over the design life. Selection of materials and equipment shall include the cost and availability of materials, parts, and labor required for operation, maintenance, repair, and replacement. Safety is the most important design factor and shall not be compromised by cost or schedule considerations.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<tr>
<td>135</td>
<td>6.5</td>
<td>The design shall consider maintainability factors particular to the specific equipment used. The CSA design shall provide for routine maintenance, repair, or replacement of equipment subject to failure.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td></td>
<td>6.5</td>
<td>ALARA Requirements</td>
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<tr>
<td>136</td>
<td>6.5.1</td>
<td>As low as reasonably achievable (ALARA) principals shall be applied for any worker activity with the potential of dose and contamination exposure. In the course of application of these ALARA principles, the project will ensure radiation exposures to workers and the public, and releases of radioactivity to the environment, are maintained below regulatory limits. Deliberate efforts are taken to further reduce exposures and releases as low as reasonably achievable. Design considerations shall include contamination control, shielding, remote activities, failure recovery, and maintenance.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td></td>
<td>6.5.1</td>
<td>Key ALARA Requirements</td>
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<td>MCSC Project shall be designed to limit occupational radiation exposures in accordance with the requirements of 10 CFR 835, “Occupational Radiation Protection” and CHPRC-00073, CH2M HILL Plateau Remediation Company Radiological Control Manual. Beginning at the earliest design stage, requirements for radiological design shall be incorporated into the designs for new components and equipment and modifications of existing components and equipment. ALARA requirements are defined in 10 CFR 835, Subpart K, “Design and Control.”</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td></td>
<td>137 6.5.1</td>
<td>The dose rate from the capsules shall be controlled to less than 0.5 mrem/hr. at the fenced perimeter of the CSA when all capsules are in their storage configuration and as far below this value as is reasonably achievable. The dose rate in storage shall not exceed 100 mrem/hr. at any accessible point in the storage array.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td></td>
<td>138 6.6.1</td>
<td>MCSC Project shall be designed for safe installation, operation, and maintenance in accordance with the applicable requirements of 10 CFR 851, “Worker Safety and Health Program,” 29 CFR 1910, and 29 CFR 1926, “Safety and Health Regulations for Construction.”</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td></td>
<td>139 6.6.2</td>
<td>MCSC Project will protect facility workers, collocated workers, and the public by providing multiple layers of protection (i.e., defense-in depth) to prevent and mitigate uncontrolled releases of hazardous materials.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td></td>
<td>140 6.6.3</td>
<td>MCSC Project shall protect personnel from fires in accordance with the DOE O 420.1C Contractor Requirements Document (CRD), NFPA 101, Life Safety Code, International Building Code, 29 CFR 1910, and 29 CFR 1926. MCSC Project shall minimize requirements for fire protection by eliminating unprotected combustible materials from the facility design to the extent practical. The design shall consider fire retardant materials based on ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, and NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td>Y (Yes) N (No) P (Partially)</td>
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<tr>
<td>6.6.5</td>
<td>6.6.5</td>
<td><strong>Safety Analysis</strong></td>
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<td>141</td>
<td>6.6.5</td>
<td>The MCSC Project shall be managed under the requirements of DOE-STD-1189-2008, <em>Integration of Safety into the Design Process</em>. The MCSC Project-specific strategy is described in CHPRC-02236, <em>Waste Encapsulation and Storage Facility Management of Cesium and Strontium Capsules (Project W-135)</em> Safety Design Strategy. The CSP shall have a design basis classification of PC-2, safety significant.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>6.7</td>
<td>6.7</td>
<td><strong>Safeguards and Security</strong></td>
<td></td>
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<tr>
<td>142</td>
<td>6.7</td>
<td>MCSC Project shall comply with applicable requirements in DOE O 470.48, <em>Safeguards and Security Program</em>. The need for a security alarm system, communications, and other measures to prevent unauthorized access to CSA and nuclear materials shall be determined by completion of a security requirements analysis. Safeguards and security measures shall prevent theft, vandalism, and other malicious acts that could release radioactive material or disrupt facility operations.</td>
<td>P</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>143</td>
<td>6.7</td>
<td>- Canisters and debris will be handled, over packed and placed into shielded storage within the CSA fenced area. Logistics required for Security in processing of materials, tools, equipment and personnel (including removal and restoration of security barriers, if required) into and out of the controlled area shall be considered in the design.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>144</td>
<td>6.7</td>
<td>- Sufficient lighting and accessibility shall be provided for the storage casks on the storage pad to enable their visual inspection on all sides for security purposes from a distance of 250 feet, and no less than 0.2 foot candles.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837606 and the CSA Lighting Calculation CHPRC-02535.</td>
</tr>
<tr>
<td>145</td>
<td>6.7</td>
<td>- In addition to the existing 200E Area perimeter fence, additional local fencing, alarms and security features will be provided as necessary at CSA.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837593.</td>
</tr>
<tr>
<td>146</td>
<td>6.7</td>
<td>- Movement and/or relocation of existing ecology blocks in the vicinity of the CSA location shall be</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in drawing H-2-837591.</td>
</tr>
<tr>
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<td>Y (Yes) N (No) P (Partially)</td>
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<tr>
<td>6.8.1</td>
<td>6.8.1</td>
<td>Seismic</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
</tr>
<tr>
<td>147</td>
<td>6.8.1</td>
<td>Seismic design criteria for CSA SSCs shall be established and implemented as specified in PRC-PRO-EN-097, Engineering Design and Evaluation (Natural Phenomena Hazard), using SDC-2/LS C seismic design criteria.</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>6.8.1</td>
<td>DOE-STD-1189 and ANSI/ANS 2.26-2004, Categorization of Nuclear Facility Structures, Systems and Components for Seismic Design, (ANS 2.26) were used to determine the general seismic criteria for the new CSA.</td>
<td>Y</td>
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<td>DOE-STD-1189, Appendix A states the following:</td>
<td>Y</td>
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<td>&quot;The seismic design classifications of ANS 2.26 are to be used in association with DOE radiological criteria provided in this appendix. It is intended that the requirements of Section 5 of ANS 2.26 and the guidance in Appendix A of ANS-2.26 be used for selection of the appropriate LS for SSCs performing the safety functions specified. The resulting combination of SDC and LS selection provides the seismic design basis for SSCs to be implemented in design through ASCE/SEI 43-05.&quot;</td>
<td>Y</td>
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<td>This text has been interpreted to state that the SDC is to be assigned based on DOE-STD-1189, Appendix A, specifically Table A-1, radiological criteria. The LS designations will be derived using Section 5 and Appendix A of ANS 2.26.</td>
<td>Y</td>
<td></td>
</tr>
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<td>SDC Determination: Using the guidance provided by DOE-STD-1189, Appendix A for seismic design of SSCs and the unmitigated consequences from a seismic event in the existing WESF DSA, a Seismic Hazard Category of SDC-2 will be used for CSA, which includes the CSS and CSP.</td>
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<tr>
<td>149</td>
<td>6.8.1</td>
<td>Limit State Determination: Section 5 and Appendix B of ANS 2.26 were reviewed to support the determination of an LS. LS C for building structural components was chosen for the CSA pad. The Section 5 definition of LS C for buildings and structural components is that the SSC retains nearly full stiffness and retains full strength, and the passive component it is supporting will perform its normal and safety functions during and following an earthquake. LS C for structures or vessels containing hazardous material was chosen for the CSS. The Section 5 definition of LS C for structures or vessels containing hazardous material is applicable to low-pressure vessels and tanks with hazardous contents where a release may potentially injure workers. Damage will be sufficiently minor and usually will not require repair.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02539, Design Analysis of the Concrete Pads for the 200 East Capsule Storage Area (CSA), Project W-135.</td>
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6.8.2 Natural Phenomena Other Than Seismic

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<tr>
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</thead>
<tbody>
<tr>
<td>150</td>
<td>6.8.2</td>
<td>Natural phenomena impacts other than seismic, including storm drainage runoff and collection, will be in accordance with DOE-STD-1020-12, Natural Phenomenon Hazards Analysis and Design Criteria for Department of Energy Facilities, HNF-SD-GN-ER-501, Natural Phenomena Hazards, Hanford Site, Washington, and PRC-PRO-EN-097.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02532, Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area.</td>
</tr>
<tr>
<td>151</td>
<td>6.8.2</td>
<td>When applicable, the environmental data found in the current and archival data housed within the HMS web-accessed database shall be used when performing analysis and design in accordance with PRC-PRO-EN-097.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed in CHPRC-02532, Storm Water Evaluation for W-135 CSA and WESF Truck Loading Area.</td>
</tr>
<tr>
<td>152</td>
<td>6.8.2</td>
<td>Data from HMS that is different than that specified in PRC-PRO-EN-097 shall not be used in final calculations without supporting justification and review and approval from CHPRC.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td></td>
<td></td>
<td>Decontamination and Decommissioning</td>
<td>Y (Yes)</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>153</td>
<td>6.9</td>
<td>The MCSC Project shall comply with the design criteria in DOE O 430.1B, <em>Real Property Asset Management</em>, and 10 CFR 835. The design shall enable future closure of CSA in accordance with 40 CFR 264, &quot;Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,&quot; and WAC 173 303-610, &quot;Closure and Post-Closure.&quot; Designs consistent with the program requirements of DOE O 430.1B shall be developed during the planning and design phases based on a proposed decommissioning method, or a conversion method leading to other uses. SSCs shall include features that will facilitate decontamination for future decommissioning, increase the potential for other uses, or both. Design or modification of the facility and selection of materials shall also include features that facilitate decontamination and decommissioning.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
</tbody>
</table>
| 154     | 6.9             | MCSC Project should incorporate the following design principles:  
- Provide equipment that precludes, to the extent practical, accumulation of radioactive or other hazardous materials in relatively inaccessible areas;  
- Use materials that reduce the amount of radioactive and other hazardous materials requiring disposal, and materials easily decontaminated;  
- Incorporate designs that facilitate cut-up, dismantlement, removal, and packaging of contaminated equipment and components at the end of useful life;  
- Use modular radiation shielding, in lieu of or in addition to monolithic shielding walls; and  
- MCSC Project equipment that is likely to become contaminated shall have special coatings that facilitate decontamination. The design should consider use of rounded corners and epoxy-coated walls in areas that handle or store radioactive material. Finishes shall meet the requirements set forth in ANSI N512, *Protective Coatings (Paints) for the Nuclear Industry*. | Y | This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications. |
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<td>7</td>
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<td>Nuclear Safety Requirements</td>
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<tr>
<td>7.1</td>
<td></td>
<td>The MCSC Project shall comply with the requirements of 10 CFR 830 and DOE-STD-1189, as implemented by PRC-PRO-NS-700, Safety Basis Development. The specific strategy that will be used to ensure compliance is described in CHPRC-02236. CHPRC-03293, Conceptual Safety Design Report for the Capsule Storage Area, includes an initial list of safety equipment. The CSP and the TMS have been identified as safety significant. Required safety documentation that will be developed by CHPRC for the CSA includes a preliminary hazard analysis, a concept safety design report, a preliminary DSA, and a final DSA document. The CSA contractor will provide input to the CHPRC analysis as described in the CSA contractor SOW.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
</tr>
<tr>
<td>7.2</td>
<td></td>
<td>Safety Basis</td>
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<tr>
<td>7.3</td>
<td></td>
<td>Fire Hazards Analysis</td>
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<td>7.3</td>
<td></td>
<td>Required documentation that will be developed by CHPRC with support from the CSA contractor includes a preliminary FHA and a final FHA for WESF and CSA. The FHAs will be developed according to the requirements of PRC-PRO-FF-40420, Fire Protection Analysis.</td>
<td>Y</td>
<td>CHPRC will provide the final FHA during the final design phase.</td>
</tr>
</tbody>
</table>

CHPRC-02537, Rev. 0
<table>
<thead>
<tr>
<th>Req. No.</th>
<th>FDC Section No.</th>
<th>Requirement Text</th>
<th>Applicable to Current Design Phase?</th>
<th>Compliance Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>158</td>
<td>7.3</td>
<td>Preliminary analysis has determined that the CSA design shall include a minimum of two fire hydrants. A water suppression system for fire protection is not required.</td>
<td>Y</td>
<td>Information for fire water usage is not currently available during the preliminary design phase. CHPRC is working with MSA to determine the requirements for fire protection of the CSA.</td>
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<td>9</td>
<td>9.1</td>
<td>Environmental / Permitting Requirements</td>
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<td>158</td>
<td>9.1</td>
<td>Dangerous Waste Permitting</td>
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<td>MCSC Project shall comply with the following sections of WAC 173-303:</td>
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<td>- WAC 173-303-280 – “General requirements for dangerous waste management facilities”</td>
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<td>- WAC 173-303-281 – “Notice of intent”</td>
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<td>- WAC 173-303-282 – “Siting criteria”</td>
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<td>- WAC 173-303-283 – “Performance standards”</td>
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<td>- WAC 173-303-290 – “Required notices”</td>
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<td>- WAC 173-303-300 – “General waste analysis”</td>
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<td>- WAC 173-303-320 – “General inspection”</td>
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<td>- WAC 173-303-330 – “Personnel training”</td>
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<td>- WAC 173-303-335 – “Construction quality assurance program”</td>
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<td>- WAC 173-303-340 – “Preparedness and prevention”</td>
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<td>- WAC 173-303-350 – “Contingency plan and emergency procedures”</td>
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<td>- WAC 173-303-360 – “Emergencies”</td>
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<td>- WAC 173-303-370 – “Manifest system”</td>
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<td>- WAC 173-303-380 – “Facility recordkeeping”</td>
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<td>- WAC 173-303-390 – “Facility reporting”</td>
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<td>- WAC 173-303-395 – “Other general requirements”</td>
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<td>- WAC 173-303-600 – “Final facility standards”</td>
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<td>- WAC 173-303-610 – “Closure and post-closure”</td>
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<td>- WAC 173-303-630 – “Use and management of containers”</td>
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<td>- WAC 173-303-680 – “Miscellaneous units”</td>
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<td>- WAC 173-303-803 – “Permit application requirements”</td>
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<td>Y (Yes) N (No) P (Partially)</td>
<td>State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.</td>
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<td>WAC 173-303-806 – “Final facility permits”</td>
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<td>WAC 173-303-830 – “Permit changes.”</td>
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<td>The CSA contractor shall be responsible for designing the CSA and any assigned WESF interface modifications in accordance with the requirements of the above sections of WAC 173-303. The CSA contractor will be responsible for preparing the work-scope specific documentation required for CHPRC to apply for a Washington State Dangerous Waste permit as described in WAC 173-303-803(3) and WAC 173-303-806. This will include, but is not limited to, design documents, and the documentation required by WAC 173-303-806(4)(a) through (m), as appropriate to the CSA design. This includes certification of design drawings, specifications, and engineering studies by a registered professional engineer as required by WAC 173-303-806(4)(a).</td>
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<td>159</td>
<td>9.2</td>
<td>CSA will be permitted as a RCRA miscellaneous unit that is fully compliant with WAC 173-303-280, “General Requirements for Dangerous Waste Management Facilities,” and WAC-173-303-680, “Miscellaneous Units.”</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<tr>
<td>160</td>
<td>9.3</td>
<td>MCSC Project design and construction activities shall be performed in compliance with the CRD of DOE O 436.1, Departmental Sustainability. Strategies will be aimed at improving performance in energy savings, water efficiency, carbon dioxide emissions reductions, indoor environmental quality, and stewardship of resources. The High Performance Sustainability Building requirements (Executive Order 13693, Planning for Federal Sustainability in the Next Decade) shall be implemented to the extent practical.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<tr>
<td>161</td>
<td>9.5</td>
<td>The MCSC Project shall interface with existing Hanford Site waste treatment and disposal facilities for disposition of hazardous and radioactive solid wastes generated by MCSC Project. CSA contractor provided systems shall be designed with intent to minimize future generations of waste, requiring management and disposal by the MCSC Project.</td>
<td>Y</td>
<td>This requirement has been met with the design/engineering documentation performed during the preliminary design. This requirement is addressed within the project drawings, calculations, and specifications.</td>
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<td></td>
<td>9.6</td>
<td>Airborne Emissions</td>
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### Compliance Verification

State if the requirement has been met with the design/engineering documentation performed during current design phase. How it is met? Reference supporting documentation and provide further explanatory notes as may be needed to support Compliance Verification.

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<th>Req. No.</th>
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<th>Requirement Text</th>
<th>Applicable to Current Design Phase?</th>
<th>Compliance Verification</th>
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<tbody>
<tr>
<td>162</td>
<td>9.6</td>
<td>To be protective of personnel, toxic and hazardous airborne emissions shall comply with the permissible exposure levels identified in DOE O 458.1, <em>Radiation Protection of the Public and the Environment</em>, and 29 CFR 1910, Subpart Z, &quot;Toxic and Hazardous Substances.&quot;</td>
<td>Y</td>
<td>There is no design associated with this requirement.</td>
</tr>
<tr>
<td>163</td>
<td>9.6</td>
<td>To meet ambient air quality standards, toxic and hazardous airborne emissions shall comply with WAC 173-400 &quot;General Regulations for Air Pollution Sources&quot; and WAC 173-460, &quot;Controls for New Sources of Toxic Air Pollutants.&quot;</td>
<td>Y</td>
<td>There is no design associated with this requirement.</td>
</tr>
<tr>
<td>164</td>
<td>9.6</td>
<td>Radionuclide airborne emissions shall comply with the ALARA-based limits for exposure (dose) to the public, as identified in WAC 173-480, &quot;Ambient Air Quality Standards and Emissions Limits for Radionuclides,&quot; and WAC 246-247.</td>
<td>Y</td>
<td>There is no design associated with this requirement.</td>
</tr>
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<td>10</td>
<td></td>
<td>Quality Assurance Requirements</td>
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<td>165</td>
<td>10</td>
<td>MCSC Project will be performed under a quality assurance program meeting the requirements of ASME NQA-1-2008, <em>Quality Assurance Requirements for Nuclear Facility Applications</em>, with the ASME NQA-1a-2009 addenda, Part I and applicable portions of Part II. The applicable portions of Part II are Subparts 2.2, 2.7, 2.14, and 2.15. Contractors performing design, construction, or operation activities shall be subject to the enforcement actions under 10 CFR 820, &quot;Procedural Rules for DOE Nuclear Activities,&quot; Subpart G, &quot;Civil Penalties,&quot; Appendix A, &quot;General Statement of Enforcement Policy.&quot;</td>
<td>Y</td>
<td>The design will be performed in accordance with upper level QA requirements as well as the subcontractors QA Program (which is on the approved Evaluated Supplier List).</td>
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<td>MCSC Project activities shall comply with applicable portions of IAEA-TECDOC-1169, <em>Managing suspect and counterfeit items in the nuclear industry</em>. Cleaning, cleanliness, and foreign material exclusion requirements shall be implemented during design, procurement, construction, and operations activities according to the requirements of PRC-PRO-QA-33415, <em>Structures, Systems, Components Cleaning/Cleanliness and Foreign Material Exclusion</em>.</td>
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</table>
PROJECT W-135 CAPSULE STORAGE AREA
FINAL DESIGN BASIS TECHNICAL MEMO

preparation for

CH2M HILL PLATEAU REMEDIATION COMPANY
Contract No. 64824
Report No. 046414.17.01-005
Revision 0

April 2018

Reviewed by: ________________ 4/12/18

Approved by: ________________ 4/12/18
## Revision Description

<table>
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<tr>
<th>Rev.</th>
<th>Reason for Revision</th>
<th>Change Description</th>
<th>Affected Pages (Page/Sec./Para.)</th>
<th>Date</th>
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<tbody>
<tr>
<td>0</td>
<td>Initial Issue</td>
<td></td>
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<td>April 2018</td>
</tr>
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2.0 SCOPE .............................................................................................................................................1

3.0 REFERENCES ................................................................................................................................2

## Appendices

Appendix A
- CSA Detailed Design Basis Interface Matrix

Appendix B
- Comments On CSA CDR Deferred To Detailed Design
# Acronyms

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>CHPRC</td>
<td>CH2M Hill Plateau Remediation Company</td>
</tr>
<tr>
<td>CSA</td>
<td>Capsule Storage Area</td>
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<tr>
<td>WESF</td>
<td>Waste Encapsulation and Storage Facility</td>
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</tbody>
</table>
1.0 INTRODUCTION

This document provides an assessment of the functional requirements, the design criteria, and project-specific design inputs that form the design basis for Project W-135, Capsule Storage Area (CSA). This assessment is a requirement prior to the initiation of Final Design activities.

The overall objective of the Management of Cesium and Strontium Capsules Project is to transition the capsules from underwater storage in the Waste Encapsulation and Storage Facility (WESF) pool cells to a new dry-storage facility for long-term storage, pending availability of a permanent disposal option. Major project operational activities include retrieval of the capsules from the pool cells, packaging of the capsules into a Cask Storage System and transfer of the casks to the new CSA.

This report 1) provides an assessment of the technical baseline documents that have been prepared in support of the CSA Final Design, 2) identifies any open design basis issues that require resolution in order to complete design activities, and 3) identifies interfaces associated with design input needs from other supporting organizations, such as Mission Support Alliance (MSA), NAC International, and the Geotechnical Contractor.

2.0 SCOPE

Five technical baseline documents were reviewed by the design team, as follows:

- CHPRC-02252, Rev. 3, Management of the Cesium and Strontium Capsules Project (W-135) Functions and Requirements Document;
- CHPRC-02623, Rev. 2, Capsule Storage Area Functional Design Criteria (Project W-135);
- CHPRC-03275, Rev. 0, Capsule Storage Area and WESF Modifications Code of Record (Project W-135);
- CHPRC-03328, Rev. 0, Capsule Storage Area Conceptual Design Report (Project W-135); and
- Statement of Work, Rev. 3, Detailed Design for W-135 WESF Modifications and Capsule Storage Area.

Design basis issues resulting from this review are reflected in Appendix A (Design Input Matrix) and Appendix B (Comments on CDR Deferred to Detailed Design). A summary of open issues are as follows:

- Design Input Matrix
  - Item 2 – Final geotechnical information.
  - Item 3 – Determine extent of radiological contamination.
  - Item 5 – Final fire water tie-ins.
  - Item 6 – Temperature monitoring system detailed information.
  - Item 7 – Radiological dose rates at outer fence area.
  - Item 16 – Laydown area.
Item 19 – Delivery of VCCs to 200E Area.
Item 20 – Quantity of VCCs (24 or 17).
Item 21 – Space requirements for TSC internals.
Item 25 – CSS drop and tip-over analysis.

Comments on CDR
Item 3 – Radiological dose rates.
Item 5 – Fire water supply.
Item 9 – Radiological survey of the site.
Item 13 – Radiological underground contamination.

Details with all of these open items are contained in the respective appendices.

3.0 REFERENCES


APPENDIX A

CSA DETAILED DESIGN BASIS INTERFACE MATRIX
<table>
<thead>
<tr>
<th>Item</th>
<th>Last Update</th>
<th>System/Area</th>
<th>Title</th>
<th>Detailed Description</th>
<th>Actionee</th>
<th>Date Required</th>
<th>Status and Notes</th>
</tr>
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</table>
| 1    | 1/30/18     | CSA         | Security System Requirements | Provide final CSA security system requirements. Requirements shall address both technology (e.g., perimeter intrusion detection and assessment systems [PIDAS]) and CMC/MEP elements (e.g., fencing, gates, and lighting). These requirements will need to address the areas both during construction and when operational. | CHPRC    | Prior to start of final design. | Status: Closed  
Note: CSA FDC R2 Sect. 4.1.4 states: "The need for a security alarm system, communications, and other measures to prevent unauthorized access to CSA and the stored materials shall be determined by a security requirement analysis performed by others and provided to the CSA contractor." CHPRC reported on 30-Jan-18 that they met with Security and the conclusion is that no PIDAS is required; security requirements for detailed design remain as in the FDC, as summarized below.  
Final Design Input: PIDAS not required (including no cameras). Normal fencing, truck/men gates, and lighting will be required on the perimeter of the CSA and the CSP (but no lighting is required at the CSP). In all cases, the fence is designed as 8-ft high chain link fence with outriggers and 3-strand barb wire, 10 ft on center anchor poles with top rail. There will be a single vehicular gate in each fence. There will be two personnel gates in each fence and these gates will have emergency crash bars. All gates shall have security lock capability. Ecotone blocks on the north side can "dowelp" around the CSA pad and meet up with the ecotone blocks on the east side. Security require a simple swing barrier to close 7th Street at approximate location of current gate, gate design to be equal to or better than existing design. |
| 2    | 3/13/18     | CSA         | Geotechnical Engineering Design Inputs | ARES requires site specific geotechnical engineering design inputs. This includes:  
- Allowable soil bearing pressure for a slab up to 3-ft thick, based on the following settlement criteria (provided to CHPRC on 06-Mar-18):  
  - Total settlement not greater than 1 inch  
  - Differential settlement between CSP and Operations Pad not to exceed 0.25 inches  
- Recommendations for obtaining a subsoil modulus of elasticity less than or equal to 30,000 psi with an in-place density greater than or equal to 100 bbl/ft³ and less than or equal to 160 bbl/ft³ at least 5 feet beyond the edge of the concrete pad and to a depth at least 10 feet as measured from the bottom surface of the concrete pad.  
- Suggested number of borings:  
  - One for CSP  
  - One for Operating Pad;  
  - One for haul path road access;  
  - One at WESSF truck pad; and  
  - One at haul path next to WESSF truck pad. | CHPRC    | Prior to start of final design.  
3/6/18: It was noted that the Geotech Report will not be issued until Mid-June. | Status: Open.  
Preliminary Input: ARES will proceed per S&Ws  
Preliminary Geotechnical Design Recommendations Report, to be issued as Rev. 0 (4/8/18).  
Note: CHPRC has contracted Ojeda Business Ventures with Shannon & Wilson to develop required geotechnical design inputs for civil/mechanical design. The ARES requirements have been provided to Ojeda. Preliminary input expected early February. Final recommendations will likely require additional geotechnical field investigation to confirm.  
3/13/18: Preliminary Geotechnical Recommendations Report, Revision 0, was provided to ARES.  
3/13/18: Jeff Martin and Chip Consalvi had a telecon this afternoon with Cnt Wilson and Bill Perkins at Shannon and Wilson.  
for the design of concrete structures using AEC 318 utilizes factored... |
<table>
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<tr>
<th>Item</th>
<th>Last Update</th>
<th>System/Area</th>
<th>Title</th>
<th>Detailed Description</th>
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<th>Date Required</th>
<th>Status and Notes</th>
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<tr>
<td>3</td>
<td>1/23/18</td>
<td>CSA and Truck Port Entrance Ramp</td>
<td>Radiological Contamination</td>
<td>Provide ARES with design inputs regarding the presence (or not) of radiological</td>
<td>CHPRC</td>
<td>Prior to start of final design</td>
<td>Status: Open</td>
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<td>contamination within the footprint of CSA and SLF and, if contamination is present,</td>
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<td>Preliminary Design Input:</td>
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<td>also provide an assessment of how that contamination should be accounted for</td>
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<td>CHPRC instructed ARES to proceed based on following:</td>
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<td>during detailed design. For example, if soil remediation is required, would that</td>
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<td>- ARES to base PD on assumption that the CSA site is</td>
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<td>work form part of the CSA construction contract for which ARES will develop bid</td>
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<td>free of contamination.</td>
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<td>- ARES to ensure that CSA construction footprint does not encroach on adjacent</td>
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<td>- ARES to ensure that CSA works do not encroach on existing groundwater wells.</td>
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<td>Note: There are no known issues in the designated CSA site. However, the site</td>
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<td>limited based upon Site Evaluation 2E-11-09. Further review is required of an</td>
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<td>area of contaminated soil (UPR-690-20) in the vicinity of the CSA site. CHPRC</td>
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<td>is planning a radiological survey of the CSA footprint for April / May.</td>
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<td>4</td>
<td>1/23/18</td>
<td>CSA, Transfer Roadway</td>
<td>Utility Interferences</td>
<td>Identify known &amp; suspected existing underground and overhead utilities that need</td>
<td>ARES and</td>
<td>Prior to start of final design</td>
<td>Status: Closed</td>
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<td>protection and/or to be moved [temporary or permanent].</td>
<td>CHPRC</td>
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<td>Note: See input provided below. Per SOW, it is ARES’ responsibility to initiate</td>
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<td>progress the design.</td>
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<td>ARES reports on 30-Jan-18 that no further input is required from CHPRC.</td>
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<td>Design Input: To date, CHPRC has provided ARES with:</td>
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<td>- Report for recent surface geophysics survey.</td>
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<td>- Subsurface utility drawings for the areas immediately</td>
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<td>adjacent to WIDS.</td>
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### Chart Table

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<th>Item</th>
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<th>Detailed Description</th>
<th>Actionee</th>
<th>Date Required</th>
<th>Status and Notes</th>
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<tbody>
<tr>
<td>5</td>
<td>3/13/18</td>
<td>CSA</td>
<td>Utilities Availability</td>
<td>Identify availability of current electrical and water utilities near CSA site for ARES Project needs</td>
<td>ARES and CHPMC</td>
<td>Prior to start of final design.</td>
<td>Status: Open</td>
</tr>
</tbody>
</table>

#### Preliminary Design Input:

1. **Power** – TBD, ARES has identified preferred tie-in location and anticipates adequate supply KSR 369756 submitted to MSA EU 3/3/14/18.
   (For the CSA, permanent power needs are for site lighting, fuel temperature monitoring system, motorized sliding gates (potentially) and convenience receptacles through the CSA.)
2. **Water** – TBD, CHPMC FP Engineer has still to meet with MSA FP to confirm exact requirement - 
   - # of hydrants & locations. Current assumption is tie in at CSIS with 12-inch looped line running down 7th Street on CSA side with 2 hydrants.

*3/14/18: Riley Stenton met with Hanford Fire Marshal (ref. e-mail, Dave to DeVine, 3/14/18). The following was ascertained:

1. **What does the size of the line need to be?**
   - Distribution mains, either sanitary or raw water, that are being used to supply water for domestic and/or process water and will provide water for fire suppression systems (sprinklers and/or hydrants), shall be at least 12 inches in diameter.

2. **How many hydrants do we need for the CSA?**
   - "A minimum of two operational fire hydrants shall be provided such that parts of the exterior of the building or buildings can be reached by hose lays of not over 300 feet for all Category 2 or 3 nuclear facilities, or where the MFL exceeds $15 million."
   - The Fire Marshal concurred that we do not need more than two fire hydrants for the CSA.

3. **Where do we tie in with the existing 2008 raw water system?**
   - "Underground distribution systems for fire protection water supplies shall be of the looped type arranged with two-way flow and sectional valving to provide alternate flow paths from the source to any point in the distribution system for Category 1, 3, and 4 nuclear facilities and buildings or groups of buildings with Maximum Possible Fire Loads (MFL) totaling over $15 million."
   - The position of the Fire Marshal, the IL AHI, and CHPMC Fire Protection Engineering is that a croisette should be installed to connect the CSIS raw water loop and the WESF raw water loop. The two CSA fire hydrants would come off this line. The croisette also solves...
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<th>Item</th>
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<tbody>
<tr>
<td>6</td>
<td>3/13/18</td>
<td>CSA</td>
<td>Temperature Monitoring System Requirements</td>
<td>Power requirements for the VCC Temperature Monitoring System, operating frequency and signal transmission requirements, including identification as to whether the system will be of wired or wireless design; any special housing requirements for the local and/or remote annunciator system; TMS enclosure; interface point for alarm and system monitoring at CSB and/or any other local or remote location.</td>
<td>CHPRC</td>
<td></td>
<td>Status: Open. Preliminary Design Input: TBD. 3/13/18: NAC's draft TMS design provided to ARE5 3/7/18: ARE5 provided comments on 3/9/18. Specific information ARE5 needs are:  - Line of separation between O5 and SS.  - Is backup power required, and if so, for what amount of time?  - Where should CSB annunciator be located?  - What signals will be provided by TMS control panel?</td>
</tr>
<tr>
<td>7</td>
<td>1/30/18</td>
<td>CSA</td>
<td>Radiological dose rates at CSA Outer Fence</td>
<td>ARE5 requires radiological dose rates at the outer CSA fence line from CHPRC to assess compliance with the 0.5 rem/hr dose rate criterion and to assess related potential need for CSA design to include supplementary shielding at fence line.</td>
<td>CHPRC</td>
<td>Prior to start of final design.</td>
<td>Status: Open. Preliminary Design Input: CHPRC instructed ARE5 to proceed with design based on assumption that outer fence line remains at 80m x 80m and that no supplemental shielding barrier will be required. Note: NAC's draft PD dose rate calculation anticipated by March 8th. CHPRC will evaluate and if results impact preliminary design input (below), ARE5 will be informed.</td>
</tr>
<tr>
<td>8</td>
<td>3/13/18</td>
<td>CSA</td>
<td>Fire Water Requirements</td>
<td>ARE5 requires CHPRC input on requirement for fire hydrants. Source: Statement of Work &quot;Detailed Design for W-135 WEHSF Modifications and Capsule Storage Area&quot;, Rev. 2, Table A3.2, Item 6, and CHPRC-02623 &quot;Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)&quot;</td>
<td>CHPRC</td>
<td>Prior to start of final design.</td>
<td>Status: Closed Notes: CHPRC has provided the design input below: ARE5 to initiate further actions as needed to finalize FP system design inputs. Design Input: TBD (see #5. Riley Sutton, CHPRC Fire Protection Engineer, provided input that fire hydrants need to be provided. There will most likely be two required alongside 7th Avenue. ARE5 will contact Riley</td>
</tr>
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</table>

3/20/18: Provide tie-in location near WESF
## Project W-135 CSA
### Design Basis Input Matrix

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<tr>
<th>Item</th>
<th>Last Update</th>
<th>System/Area</th>
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<tbody>
<tr>
<td>9</td>
<td>1/23/18</td>
<td>CSA and SLF</td>
<td>Crash Bar Requirements</td>
<td>Incorporate crash bars into the final design for the CSA. Source: Statement of Work &quot;Detailed Design for W-135 WESF Modifications and Capsule Storage Area&quot;, Rev. 2, Table A3.2, Items 7 and 8.</td>
<td>ARES</td>
<td>Prior to start of final design.</td>
<td>Status: Closed. The need for crash bars will be evaluated during the Preliminary Design Phase. Crash bars are required on the main gates for the CSA parameter fence and on the CSP fence.</td>
</tr>
<tr>
<td>10</td>
<td>1/23/18</td>
<td>CSA</td>
<td>Dangerous Waste Permitting</td>
<td>ARES requires design input from CHPRC regarding if Dangerous Waste Permit will require a building or other protective covering. Source: CHPRC-00252 <em>Capsule Storage Area (CSA) Functional Design Criteria (Project W-135)</em></td>
<td>CHPRC</td>
<td>Prior to start of final design.</td>
<td>Status: Closed. Design Input: There is no Dangerous Waste Permit requirement.</td>
</tr>
<tr>
<td>11</td>
<td>1/23/18</td>
<td>CSA</td>
<td>Criteria for Size of CSP and Spacing of CSSs.</td>
<td>CHPRC to confirm the following design input related to CSP storage cited in the CSS CDR: In order to provide sufficient spacing between the CSSs for placement on the CSP using on-site transportation equipment, a minimum center-to-center distance of fifteen feet is required with an outside boundary of five feet on each side of the CSS. Based on these assumptions, the CSP shall be a square design with a minimum step-five feet on each side. Source: CHPRC-00326, &quot;Cask Storage System Conceptual Design Report (Project W-135)&quot; Appendix C.</td>
<td>CHPRC</td>
<td>Prior to start of final design.</td>
<td>Status: Closed. Note: The new information will be included in CSA FDC Rev. 2, Section 4.1.2. See below for description. Final Design Input: The CSP shall be 95 ft. x 95 ft. which will allow sufficient spacing for 25 CSSs arranged in a 5 x 5 grid with 15 ft. center to center distance and outside clear perimeter of 10 ft.</td>
</tr>
<tr>
<td>12</td>
<td>2/13/18</td>
<td>CSA</td>
<td>CSP Concrete Criteria.</td>
<td>CHPRC to confirm the following design inputs related to concrete cited in the CSS CDR: A loaded FDC is shown in N/C drawing 80059-060 with an estimated loaded weight of 125,670 lbs. Previous CSP design criteria specified by N/C (based on a CSS that is much heavier) are suitable for this conceptual CSP CDR. These CSP criteria are: • Concrete pad compression strength shall be less than or equal to 5,000 psi. • Concrete pad dry density shall be greater than or equal to 125 lb/ft³ and less than or equal to 160 lb/ft³. • The concrete pad shall have a thickness less than or equal to 36 inches. Source: CHPRC-00326, &quot;Cask Storage System Conceptual Design Report (Project W-135)&quot; Appendix C.</td>
<td>CHPRC</td>
<td>ARES</td>
<td>Prior to start of final design.</td>
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<th>Item</th>
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<th>Action</th>
<th>Date Required</th>
<th>Status and Notes</th>
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<tr>
<td>14</td>
<td>1/30/18</td>
<td>CSA</td>
<td>CSA Apron Criteria.</td>
<td>CHPRC to confirm the following design inputs related to CSA Apron cited in the CSS CDR. Typically, a concrete apron is provided as a transition between the haul path and the edge of the CSP. If an apron feature is desired, it shall be sufficient in strength to accommodate the anticipated wheel loads of the on-site transportation equipment carrying a loaded system placed over subsoil with the same characteristics as the CSP. The apron should be constructed in such a manner as to ensure adequate drainage exists and does not present a condition that water flows onto the CSP from the apron. Concrete strength and density shall be the same as that used for the CSP with only the depth of the concrete placement being staked differently than the CSP. If the apron is required to additionally serve as potential extended waste storage area, it will need to be designed to the same requirements as the CSP.</td>
<td>CHPRC</td>
<td>Prior to start of final design.</td>
<td>Preliminary Design Input: ARES to progress preliminary design based on information at least as excerpted from CDR. EXCEPT: - Regarding drainage, ARES to confirm relevant regulatory requirements and design accordingly. - Regarding &quot;net free area,&quot; this is now ~83.5 feet; ARES to make its own evaluation if this is adequate to support CSA operations. This item has been closed with the release of FDC Revision 2.</td>
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</table>

15  | 2/20/18     | Transfer Roadway Criterias. | CHPRC to confirm the following design inputs related to transfer roadway cited in the CSS CDR. The roadway (Haul Path) must be capable of transporting the on-site transportation equipment during movement between the Track Port and the CSP for placement (or staging) of CSSs on the CSP. The on-site transportation equipment proposed in the conceptual design is identified below: - TUG Industries Model GT-30 Tow Tractor (Prime Mover) - Towed Wheeled Vertical Cask Transporter (VCT) | CHPRC | Prior to start of final design. | Status: Closed |

Final Design Input: Design input is confirmed by CHPRC with exception that all Pads within the CSA shall be the same thickness to allow for transfer, assembly, movement, and storage of any combination. The haul path ramp does not have to be 36" in depth, and can be either concrete or asphalt. Note: Input from CHPRC Engineering was to assume for CD that the operating apron could be utilized for future waste storage. Therefore, the CD specifies that the operating apron is constructed to the same 36" thickness, reinforcement and concrete specification as the CSP. If the CSP operating apron will not be used for future extended waste storage, its thickness could likely be reduced to 18", saving excavation and construction costs. | Status: Closed |

Final Design Input: CHPRC has confirmed the information cited in Detailed Description column. CHPRC Engineering will supply ARES with cut sheet information for the equipment in supplemental information. CHPRC to provide ARES wheel/wheel loads for the loaded VCT. CHPRC provided wheel/wheel load, 2/20/18 (email Dene to Dev/re). | Status: Closed |
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<th>Item</th>
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| 16   | 1/23/18     | CSA, Transfer Roadway, and SLF | Construction Contractor Area | A laydown area needs to be defined for the construction contractor. | CHPRC | Prior to start of final design. | Status: Open  
Note: CHPRC is working with PTS team. Not necessarily required for detailed design deliverable; however, required for construction RFP.  
Final Design Input: N/A. |
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<th>Item</th>
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<th>Detailed Description</th>
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<th>Status and Notes</th>
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<tr>
<td>18</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>What is the weight of an empty VCC?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Closed</td>
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<td>Final Design Input: See NAC Document 30059-S-01 Rev. 1, Design Specification for the Cask Storage System, Table 4-1.</td>
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<tr>
<td>19</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>What is the overall timeline for delivery of the VCCs, delivery of internals, placing of internals in VCCs, and filling the VCCs with capsules?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Open</td>
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<td>Design Input: Based off the current NAC schedule, the delivery of the VCCs is July of 2020, and the TSCs around the same time frame. Their preference is to store the TSCs out of the site, rather than in the hall. Plan on assembly of the TSCs inserted into the VCCs on site, all parts would be on site around the July 2020 time frame and assembly time over the next 6 months after July, to fill with VCCs capsules one year later.</td>
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<tr>
<td>20</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>Will all 17 VCCs (empty) be delivered prior to start of placing internals in VCCs?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Open</td>
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<td>Design Input: The current assumption (for preliminary design) is that the project will need to store and assemble up to 24 VCCs on site within the CSA. This issue will be revisited prior to final design.</td>
</tr>
<tr>
<td>21</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>How much space is required for storage of internals?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Open</td>
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<td>Current preliminary design input: The TSCs and internals all shipped together vertically on a standard size pallet weigh around 22,000 lbs., so you would have 24 TSC pallets. The lids would be shipped separately also on a standard size pallet weighing around 2,700 lbs. per lid. Let’s assume 24 pallets. A pallet size of 8’x8’x8” being used as a basis. This issue will be revisited prior to final design.</td>
</tr>
<tr>
<td>22</td>
<td>1/23/18</td>
<td>CSA</td>
<td>VCC’s</td>
<td>Can the VCC internals be stored on gravel?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Closed</td>
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<td>Preliminary design input: Yes, but they must be kept.</td>
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<td>23</td>
<td>1/23/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>Can ARES get a survey that includes the WIDS site located south-east of the proposed CSA area?</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Closed</td>
</tr>
<tr>
<td>24</td>
<td>2/7/1818</td>
<td>CSA</td>
<td>CSA Surface Water Management</td>
<td>Can CHPRC provide the current requirement for storm water deposit near the WIDS site? ARES is assuming that storm water from the pads may be directed to the area around the pads for infiltration, rather than specifically attempting to slope the grade or run storm water piping away from the WIDS site. Please verify assumption.</td>
<td>CHPRC</td>
<td>1/23/18</td>
<td>Status: Closed</td>
</tr>
<tr>
<td>25</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>The CSP design shall consider loading from the CSS drop and tip-over analysis.</td>
<td>CHPRC</td>
<td>2/8/18</td>
<td>Status: Open</td>
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<td>Item</td>
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<tr>
<td>26</td>
<td>3/6/18</td>
<td>CSA</td>
<td>VCC's</td>
<td>Need CSS temperature information from NAC so ARES can perform the required analysis per following excerpt from CSA FDC:</td>
<td>CHPRC</td>
<td>2/8/18</td>
<td>Status: Closed. Final Design Input: See NAC Document 50059-S-01 Rev. 1, Design Specification for the Cask Storage, Section 4.2.2, VCC Concrete Temperature Limits. Notes: The thermal analysis will be part of the slab sizing calculation. It was discussed that ARES will make a bounding assumption (based on what the Code allows) in order to move forward with this activity. CHPRC noted that the calculation needs to take into consideration that the bottom of the cask will be 300°F.</td>
</tr>
<tr>
<td>27</td>
<td>3/6/18</td>
<td>CSA</td>
<td></td>
<td>Provide dimensions of “bounding size” delivery truck.</td>
<td>CHPRC</td>
<td>2/8/18</td>
<td>Status: Closed. Information provided by D. Dose to ARES 3/2/18.</td>
</tr>
</tbody>
</table>
APPENDIX B

COMMENTS ON CSA CDR DEFERRED TO DETAILED DESIGN
### Table A3-2: Comments on CSA CDR deferred to Detailed Design

<table>
<thead>
<tr>
<th>No.</th>
<th>Comment</th>
<th>Comment Response</th>
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<tbody>
<tr>
<td>1.</td>
<td>DRWG W135-CSA-SK-C-007. Minimize area covered by entrance to the operating area.</td>
<td>The configuration has been updated to accommodate concerns about maneuverability during placement operations and includes the number of VCCs to be stored, final dimensions for the CSP and Operations pads, the weight of the VCCs, and a more detailed model of the VCT/Tug combination. All of these subjects are addressed in the operations analysis report.</td>
</tr>
<tr>
<td>2.</td>
<td>Entry/exit to WESF truck port “S” curve turning radius has potential for undue stress on VCT tongue.</td>
<td>See Response to Item 1 above.</td>
</tr>
<tr>
<td>3.</td>
<td>Requirements #132 &amp; #133 compliance verification indicates a design dose rate of ≤5 mrem/h at the fence line. An additional barrier will be necessary for radiological controls to ensure dose rates are less than 0.05 mrem/hr to meet 10 CFR 835 requirements for monitoring workers that may receive 100 mrem.</td>
<td>Open. There was a typo in the value stated in the compliance matrix as the CSS FDC states the limit is &lt;0.5 mrem/hr. The typo was corrected. For Preliminary Design, CHPRC directed ARES to proceed with design based on the assumption that no supplemental shielding barrier will be required. NAC is expected to provide a dose rate calculation prior to the initiation of Final Design; this will be used to confirm that supplemental shielding barrier is not required.</td>
</tr>
<tr>
<td>4.</td>
<td>Req. No. 59. What drives such a large SLF area? Can this area be reduced such that Palms Drive does not need to be relocated?</td>
<td>NAC International now plans to fabricate the VCC’s offsite; therefore the FDC Revision 2 eliminates the SLF from the project’s scope.</td>
</tr>
<tr>
<td>5.</td>
<td>The FPE shall reevaluate the need for fire hydrant water supply to the CSA in preliminary and final design.</td>
<td>The FPE has determined that a fire water supply will be provided to the CSA site, and that two fire hydrants will be installed.</td>
</tr>
<tr>
<td>6.</td>
<td>The FPE shall reevaluate the need for fire hydrant water supply to the SLF in preliminary and final design.</td>
<td>FDC Revision 2 eliminates the SLF from the project’s scope.</td>
</tr>
<tr>
<td>7.</td>
<td>Incorporate crash bars into the final design for the CSA.</td>
<td>Crash bars are provided on the personnel gates for the CSA perimeter fence and on the CSP fence.</td>
</tr>
<tr>
<td>8.</td>
<td>Incorporate crash bars into the final design for the SLF.</td>
<td>FDC Revision 2 eliminates the SLF from the project’s scope.</td>
</tr>
<tr>
<td>No.</td>
<td>Comment</td>
<td>Comment Response</td>
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</table>
| 9   | Perform and document site characterization activities during preliminary design to verify levels of contamination in the surface and subsurface soil, and vegetation at the CSA site are not at a level requiring future remedial actions. | A surface radiological survey of the CSA construction area was performed on March 16, 2018; no contamination was identified. The W-135 Project consulted with CHPRC Environmental on January 31, 2018 and were informed that there is no known reason to anticipate contamination at depth. The CSA site is sufficiently distant from 200-IS-1 OU pipelines & pipeline components (e.g., diversion boxes) that it is very unlikely for there to have been lateral subsurface migration of contamination from these sources into CSA construction footprint. For Preliminary Design, CHPRC instructed ARES to proceed based on the following:  
  - ARES to base PD on assumption that the CSA site is free of contamination;  
  - ARES to ensure that CSA construction footprint does not encroach on adjacent WIDS sites; and  
  - ARES to ensure that CSA works do not encroach on existing groundwater wells. |
| 10  | Where photographs of the site are used as background in the sketches, these photos should be updated to reflect the most recent configuration of WESF (the modifications of the K3 vent system). | All Preliminary Design media reflects current background reference information. |
| 11  | Need to use most recent WESF civil drawings that show location of new K3N skid in all drawings and aerial photo overlays in order to accurately depict obstructions. | All Preliminary Design media reflects current background reference information. |
| 12  | A Section 4.1.1. The proposed VCT haul path should be analysed to include the removal of the inactive crane (WESF-C41A), and provide a direct path through the inactive crane area from the truck port to CSA. | The selected haul path for the preliminary design does not go through the WESF-C41A area. |
| 13  | A number of WIDS sites and underground contamination areas are located near the proposed site of the laydown area. | Refer response to Comment #9. |
| 14  | Design calls for re-grading the road between the new laydown area and the WESF apron, including filling in a dip in the road. Confirm that this is not deliberate to accommodate water run-off. | FDC Revision 2 eliminates the SLF from the project’s scope. |