CHPRC-02252
Revision 2

Capsule Extended Storage Project (W-135) Functions and Requirements Document

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

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J. L. Pennock
CH2M HILL Plateau Remediation Company

D. W. Bland
Lucas Engineering Management Services

K. K. Lucas
Lucas Engineering Management Services

D. M. Gerboth
Lucas Engineering Management Services

K. D. Auclair
Lucas Engineering Management Services

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P.O. Box 1600
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A-6004-786 (REV 2)

Executive Summary

In the 200 East Area of the Hanford Site, 1,335 cesium capsules and 601 strontium capsules are stored underwater in pool cells at the Waste Encapsulation and Storage Facility (WESF). The cesium contents are in the form of cesium chloride, and the strontium contents are in the form of strontium fluoride. As of February 2014, the capsules contained 98 MCi of radioactivity, including daughter products (approximately 49 MCi of cesium and strontium). The capsules are currently managed as mixed high-level waste and are regulated under the *Resource Conservation and Recovery Act of 1976*[1].

The *Mission Need Statement for the Management of the Cesium and Strontium Capsules (DOE/RL-2012-47, Rev 6)*[2] has established that the current management of the capsules does not align with the Hanford Site cleanup goals described in DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*, specifically goals 6 and 8. These are:

- Goal 6: Safely Manage and Transfer Legacy Materials
- Goal 8: Develop and Implement Institutional Controls and Long-Term Stewardship

Relocation of the capsules out of WESF and placement into extended storage are likely to be necessary for remediation of B Plant in accordance with upcoming regulatory decisions supporting commitments in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)[3], also known as the Tri-Party Agreement, and consistent with DOE/RL-2009-81, *Central Plateau Cleanup Completion Strategy*.[4]
The Capsule Extended Storage Project (CESP) (W-135) has been identified for removal of cesium and strontium capsules from WESF and placement of the capsules into a compliant extended storage configuration, pending final disposition. The CESP scope

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[1] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

[2] *Mission Need Statement for the Management of the Cesium and Stronium Capsules* (DOE/RL-2012-47, Rev 6), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[3] Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

[4] DOE/RL-2009-81, 2009, *Central Plateau Cleanup Completion Strategy*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1002180676.

includes the following major activities to achieve extended storage of the 1,936 cesium and strontium capsules currently stored at WESF:

- Acquisition of storage and transfer systems and associated equipment necessary to support retrieval, packaging, and transfer of the capsules to extended storage
- Construction of the Capsule Storage Area (CSA), including storage pad, fencing, lighting, and road access
- Completion of WESF modifications necessary to support retrieval, packaging, and transfer of capsules from WESF
- Completion of capsule transfer operations, including retrieval from existing storage, packaging, transfer to the extended storage location, and placement into the extended storage configuration.

This document identifies the primary functions and requirements that establish the technical bases for initiating the CESP scoping activities (e.g., preliminary cost estimate, design and construction schedule, and other related activities).

Contents

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Terms

ALARA	as low as reasonably achievable
AMU	aqueous makeup
CESP	Capsule Extended Storage Project
CHPRC	CH2M HILL Plateau Remediation Company
CoC	Certificate of Compliance
CRD	Contractor Requirements Document
CSA	Capsule Storage Area
CSB	Canister Storage Building
CSS	cask storage system
DOE	U.S. Department of Energy
DOE-RL	DOE - Richland Operations Office
DOT	U.S. Department of Transportation
DSA	documented safety analysis
F&R	functions and requirements
FHA	fire hazards analysis
FRD	functions and requirements document
HLW	high-level waste
HMS	Hanford Meteorological Station
HVAC	heating, ventilating, and air conditioning
M&TE	measuring and test equipment
NDE	nondestructive examination
NRC	U.S. Nuclear Regulatory Commission
PRC	Plateau Remediation Contract
QA	quality assurance
RCRA	*Resource Conservation and Recovery Act of 1976*
SSC	structures, systems, and components
WESF	Waste Encapsulation and Storage Facility

1 Introduction

1.1 Purpose

This functions and requirements document (FRD) provides the primary functions and requirements (F&R) for the Capsule Extended Storage Project (CESP) (W-135), which is part of the Environmental Management Cleanup Subproject RL-0013, *Solid and Liquid Waste Treatment and Disposal*. This project will be managed by CH2M HILL Plateau Remediation Company (CHPRC) in compliance with requirements established by the U.S. Department of Energy (DOE), Richland Operations Office (RL) in DE-AC06-08RL14788, *CH2M HILL Plateau Remediation Company Plateau Remediation Contract*, hereinafter called the Plateau Remediation Contract (PRC).

The purpose of this document is to provide the upper level technical basis for CESP design, fabrication, construction, and operations activities. The CESP acquisition strategy calls for the utilization of multiple subcontractors. Figure 1-1 below depicts the planned contract execution structure.

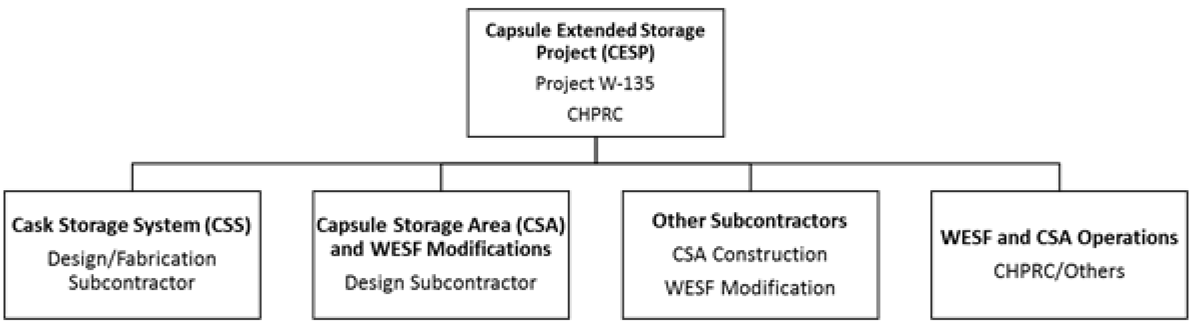


Figure 1-1. CESP Acquisition Structure

This document serves as the basis for the development of the two Functional Design Criteria documents associated with planned CESP major design/fabrication and design subcontracts. These are:

- CHPRC-02622, *Cask Storage System (CSS) Functional Design Criteria (Project W-135)*
- CHPRC-02623, *Capsule Storage Area (CSA) and WESF Modifications Functional Design Criteria (Project W-135)*

CESP involves the removal of cesium and strontium capsules from the Waste Encapsulation and Storage Facility (WESF) and placement of the capsules into a compliant extended storage configuration pending final disposition. The F&R presented in this document establish the basis for initiating CESP scoping activities (e.g., preliminary cost estimate, design and construction schedule, and other related activities). CESP responsibilities for this scope will be consistent with PRC requirements. This FRD was developed in accordance with the requirements of PRC-STD-EN-40254, *Functional Requirements Document*.

Throughout this document, reference is made to the CESP, WESF, the CSS contractor (or vendor), and the CSA/WESF Modifications contractor (or vendor). Requirements and criteria that reference the CESP apply to the project as a whole, including WESF, the CSS contractor, and the CSA/WESF Modifications contractor. Requirements and criteria that specifically reference WESF, the CSS contractor, or the CSA/WESF Modifications contractor apply only to that party.

1.2 Background

From 1974 to 1985, cesium and strontium were recovered from high-level waste (HLW) at the Hanford Site and then encapsulated and stored at WESF. Removal of the cesium and strontium significantly reduced the amount of heat generated in underground tanks where HLW was stored, reducing heat transfer needs for the tanks and enhancing isolation of hazardous materials from the environment. Production of the capsules also provided an opportunity for beneficial use of the cesium and strontium.

In total, 1,577 cesium capsules and 640 strontium capsules were produced, with the capsule contents in the form of cesium chloride and strontium fluoride, respectively. A number of capsules were transported to other facilities and used in test and demonstration programs, ranging from waste form development to potential commercial applications (e.g., sewage sludge sterilization, fruit disinfestations, sterilization of medical equipment, and others). These capsules will not be returned to WESF, and their disposition is not within the scope of this project. Presently, 1,936 capsules are stored at WESF (Figure 1-2), including 1,335 cesium capsules (1,312 standard production capsules, and 23 cesium capsules in Type W overpacks), 600 strontium capsules, and one zero-power tracer capsule produced with natural strontium. As of August 2015, the capsules contained 94 MCi of radioactivity, including daughter products (approximately 47 MCi of cesium and strontium). The capsules are currently managed as mixed HLW and are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA).

The *Mission Need Statement for the Management of the Cesium and Strontium Capsules (DOE/RL-2012-47, Rev 6)* has established that the current management of the capsules does not align with the Hanford Site cleanup goals described in DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*, specifically goals 6 and 8. These are:

- Goal 6: Safely Manage and Transfer Legacy Materials
- Goal 8: Develop and Implement Institutional Controls and Long-Term Stewardship

1.3 Scope

CESP will acquire necessary capabilities and complete the activities needed to remove the cesium and strontium capsules from WESF and place the capsules into extended storage. Accordingly, the scope of the CESP will include the following actions:

- Acquire a Cask Storage System (CSS) which includes storage and transfer systems and associated equipment necessary to support retrieval, packaging, and transfer of the capsules to extended storage.
- Construct a new Capsule Storage Area (CSA), including storage pad, fencing, lighting, and road access.
- Complete WESF modifications needed to support capsule retrieval, packaging, and transfer to the CSA for extended storage.
- Perform capsule transfer operations, including retrieval from existing storage, packaging, and transfer to the CSA, and placement into the extended storage configuration.

Figure 1-2. Capsule Storage in a WESF Pool Cell

- Perform regulatory activities and operational preparations necessary for capsule removal from WESF and implementation of extended storage.
- Disposition the capsule transfer system.

This document establishes F&R for the CESP, which does not include the following scope to be provided by others:

- WESF base operations, including capsule storage in the WESF pool cells
- WESF upgrades other than those specifically identified in this document
- Decontamination and decommissioning of WESF or the CSA
- CSA base operations
- Final disposition of capsules

CESP will be completed when all capsules are placed into the extended storage configuration at the CSA and project closeout is completed. Although the CESP scope does not include final disposition of the capsules, the storage systems acquired by the project shall not preclude actions that can reasonably be expected to be required for future final disposition.

2 Waste Encapsulation and Storage Facility Description

CESP shall use existing systems at WESF (225-B Building) to the extent that they are cost effective to support capsule retrieval and packaging for onsite transfer and extended storage. Figure 2-1 shows the general configuration of the WESF pool cells, hot cells, and canyon.

Section 2.1 provides a description of the WESF configuration in FY2015. Modifications to WESF, performed by Project W-130, the WESF Stabilization and Ventilation Project, will be prior to execution of CESP. Section 2.2 discusses the anticipated starting configuration for CESP.

2.1 Existing Facility Configuration (FY2015)

The 225-B Building canyon is approximately 22 ft wide by 101 ft long by 20 ft tall (Figure 2-2) and is located on the second floor. The canyon is accessible from the second floor aqueous makeup (AMU) area through a shielded personnel entry door and from a stairwell accessed from the first floor access hallway. Each access door is part of an airlock. An outside access door is also provided at the west end of the canyon as an emergency exit. Canyon operations can be viewed

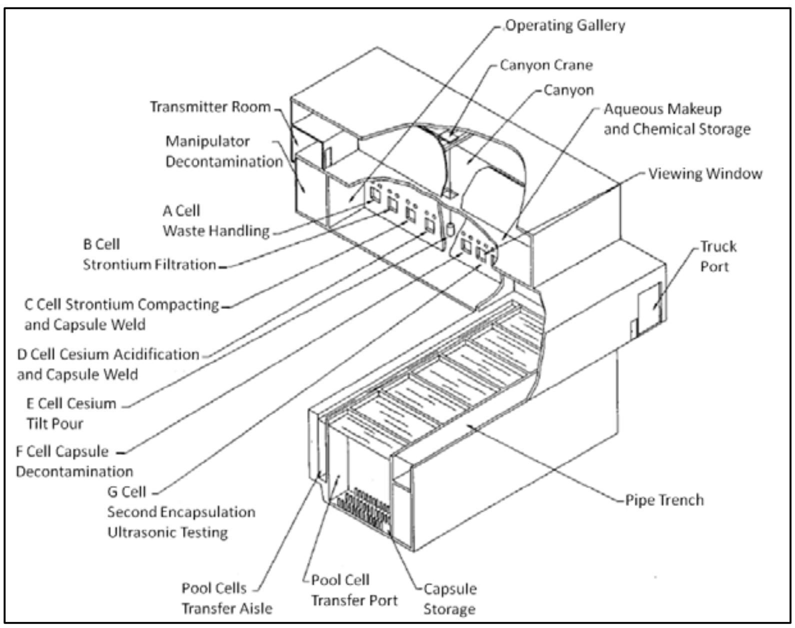


Figure 2-1. WESF Configuration

from the AMU area and manipulator repair shop through four windows in the interior walls of the canyon. The windows are dry-type (no oil), lead-glass.

The canyon provides access to the hot cells, truck port, and pool cell area by means of removable high-density, stepped cover blocks. A 15 ton design capacity remotely operated crane, capable of traveling the full length of the canyon, removes the cover blocks and handles equipment. A decontamination and maintenance area for the crane is located at the east end of the canyon. Canyon crane operations can be observed through four lead-glass viewing windows in the canyon wall at the AMU level. A remote control television system mounted to the crane allows the crane operator to observe the movement of the crane hooks and the load using a television monitor located in the AMU area.

The service gallery, located on the first floor, is used to service the hot cells from the south side and contains some of the auxiliary cold (nonradioactive) process piping. Access to the hot cells from the service gallery is provided by pass-through drawers (in A, F, and G Cells) and by personnel entry doors (in A and G Cells). Each personnel entry door is located in an airlock. The service gallery may be accessed from the truck port and access hallway.

The operating gallery is located on the north side of the hot cells on the first floor. The operating gallery is accessible from the support area, elevator, cold manipulator shop, pool cell area, and heating, ventilating, and air conditioning (HVAC) room. Remote work in the hot cells is accomplished with master-slave manipulators operated from the operating gallery. The hot cell instrumentation control panels are located adjacent to the manipulator operating areas. In the event of manipulator failure, the manipulator is removed from the hot cell by an overhead trolley and moved to the hot manipulator shop, which is located adjacent to and east of the operating gallery. Replacement manipulators are inserted into the hot cell using the overhead trolley. Lead-glass windows are provided for direct viewing of the interior of each hot cell at the operating gallery level. A non-shielding window for viewing the pool cell area is located on the west wall.

The truck port is an enclosed area (approximately 18 ft by 37 ft by 15 ft), located at the west end of WESF, which provides confinement for cask and low-level solid waste loading and unloading. A motor-operated 12 ft wide rollup door (15 ft high) provides access to the outside. Other interior access doors are located in the service gallery and pool cell area. A diesel-powered forklift is used to load and unload casks and solid waste burial boxes in the truck port.

Figure 2-2. WESF Canyon

G Cell was originally the final encapsulation cell and is approximately 16 ft wide by 8 ft deep. Cover blocks provide access to the canyon in the cell ceiling, approximately 13 ft above the floor. This cell is equipped with a 3 ft thick, concrete-shielded, hydraulic-operated personnel entry door (approximately 3 ft wide) and a pass-through drawer, both of which are accessible from the service gallery through the G Cell airlock.

Normally, G Cell has very little contamination and a significant radiation source only when capsules are present. The floor is capable of supporting the existing 25,000 lb Beneficial Uses Shipping System cask. During past operations, G Cell has also accommodated the GE 700 and GE 1500 casks. A penetration through the G Cell floor into Pool Cell 12 is provided for transferring the capsules between G Cell and the pool cells. A manually operated transfer cart is used to move capsules into or out of Pool Cell 12. G Cell is still an active hot cell with installed manipulators and active water sources. G Cell contains a 2-ton capacity hoist that is controlled from the operating gallery. G Cell also contains a shielded storage container (G-7 tank) which would be used to store failed capsules if necessary.

Two 12,000 lb lead-glass windows provide shielding and a direct view into G Cell from the operating gallery (Figure 2-3). Windows contain a small quantity of white oil to enhance visibility through the several panes of shielding glass.

The mechanical Central Research Laboratories Model F master-slave manipulators are used in the hot cells. A manipulator boot or flexible sleeve protects the slave end from contamination and provides an air barrier between the hot cell and the operating gallery.

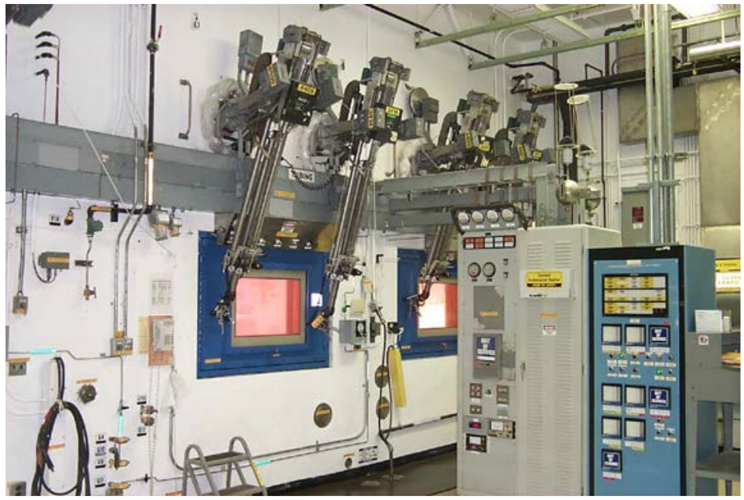


Figure 2-3. WESF G Cell Window and Manipulators

The pool cell area has 12 pool cells that provide underwater storage and transfer capability for the cesium and strontium capsules. This area is located on the west side of the first floor of the 225-B Building. Pool Cells 1 through 11 are positioned south to north, adjacent to each other, and have a water depth of about 13 ft. Pool Cell 12 runs along the east side and partially along the south side of these storage pools and contains about 10.5 ft of water. A general orientation of the pool cells is shown in Figure 2-4.

All pool cells have liners constructed of 16-gauge, type 304 stainless steel, on the sides, and 14-gauge, type 304 stainless steel flooring. Transfer ports consisting of a pipe and 4 in. ball valve connect Pool Cells 1 through 11 to Pool Cell 12. The transfer port can be opened and closed to transfer capsules or water between each of the pool cells and Pool Cell 12. A cask pit for wet loading of capsules is located in Pool Cell 12, to the south of Pool Cell 1. Wet loading operations were not performed during the facility's operating life. Each pool cell can be further shielded and protected by covering it with a series of stepped concrete cover blocks. Currently, the cover blocks are not in place to facilitate the dispersion of radiolytic hydrogen generated by the interaction between radiation from the capsules and the water in the pool cells. Deionized water is added to the pool cells, as required, to make up volumes lost through radiolysis and evaporation. The pool cell water is not contaminated with radionuclides.

A motorized catwalk is located over the pool cells and can travel the full length of the pool cell area. This catwalk provides access to each of the pool cells for capsule inspection, movement, and maintenance activities. A bridge crane with a 10 ton design capacity is used in the pool cell area to move equipment, as necessary.

Capsules are transferred individually between the hot cells and the pool cell area through a capsule transfer chute between G Cell and Pool Cell 12. The capsule transfer chute is equipped with a trolley device for lowering the capsules into Pool Cell 12 or bringing the capsules into G Cell. Once in the pool cells, the capsule is moved down Pool Cell 12 with tongs, through the transfer port, to the assigned pool cell.

Exterior to the WESF facility and to the west of the truck port, there is a 25-ton overhead crane and pad that were originally used to support shipping cask operations. This crane is no longer operational and could be removed by the CSA/WESF Modifications contractor, if required, for space considerations.

2.2 Anticipated Facility Configuration at the Start of CESP

Various maintenance and upgrade activities are planned in the near future for WESF that will modify the facility configuration described in Section 2.1. The anticipated facility configuration at the start of CESP is described in further detail in the following sections.

2.2.1 WESF Stabilization and Ventilation Project

The WESF Stabilization and Ventilation Project (Project W-130) will stabilize legacy contamination in WESF, and replace the existing K3 exhaust system. This project is scheduled to be completed in December 2016. The final design for Project W-130 includes the following modifications:

- Filling WESF hot cells A through F with grout with the current equipment in place
- Filling two tunnels beneath the hot cell floors with grout (these tunnels are a hot pipe trench, which contains process piping to and from the hot cells, and the existing K3 ventilation system exhaust duct from the hot cells)
- Replacing the existing K3 exhaust system with a new system (K3N) having modified requirements based on reduced hazards in the areas ventilated by the existing K3 system.

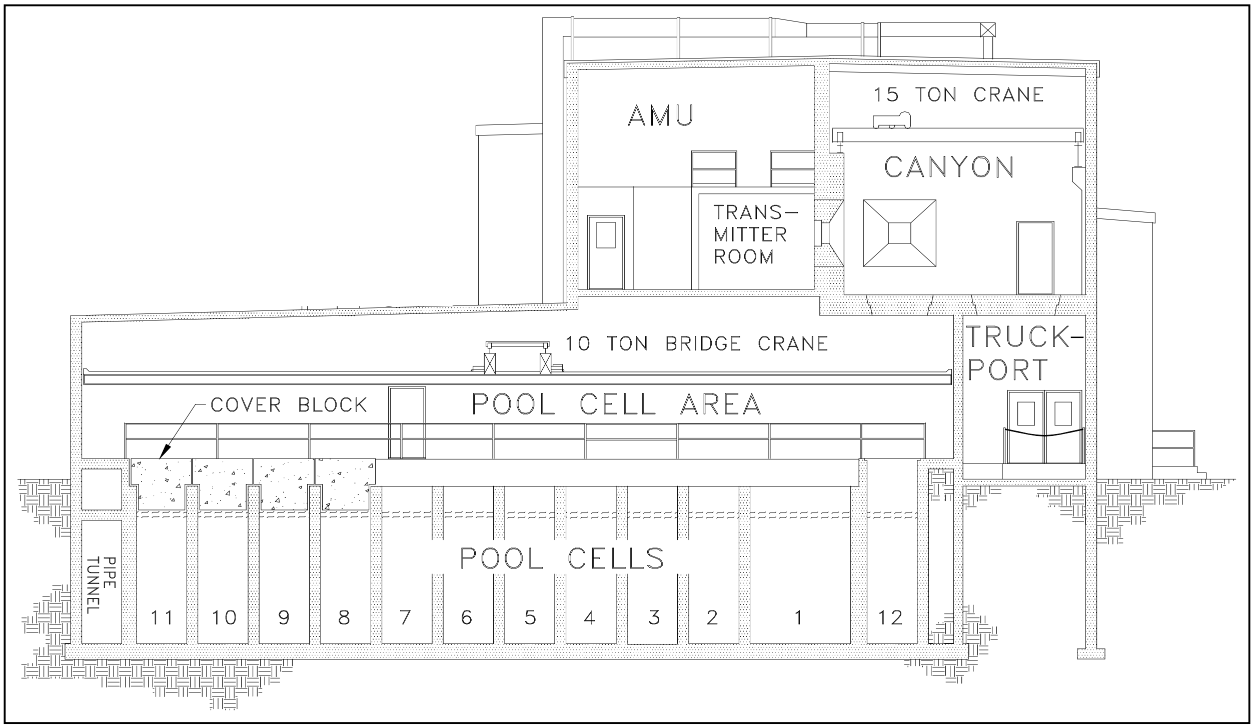


Figure 2-4. WESF Section View

The new ventilation system has been designed to allow for expansion by adding an additional skid-mounted ventilation filter.

2.2.2 WESF Canyon

Residual contamination remains within the WESF canyon. For this reason, the canyon is maintained at a negative pressure with respect to the pool cell area and truck port. The K3N ventilation system is capable of maintaining this differential pressure when the cover block between the truck port and canyon is removed, although manipulation of the system configuration is required. The K3N ventilation system may have difficulty maintaining this differential pressure if the cover block separating the pool cell area from the canyon is removed. Removing the cover block between the pool cell area and the canyon will likely require either additional ventilation upgrades or further decontamination of the canyon to allow the facility pressure zones to be "collapsed." This decontamination is not currently planned prior to CESP. Use of a pass through for transfer of loaded canisters between the pool cell area and the canyon might be feasible if this option maintains differential pressures between the pressure zones.

The canyon crane has a design capacity of 15 tons. It is functional but not in frequent use. It is available for use by CESP, and all required periodic maintenance will be performed by WESF. Acceptability of the crane to lift desired loads should be verified early in the project. The current control system for the crane is aged and may require replacement to ensure reliable operations. This upgrade is not planned prior to CESP.

2.2.3 WESF Pool Cells

The pool cell crane has a design capacity of 10 tons. It is available for use by CESP, and all required periodic maintenance will be performed by WESF. Acceptability of the crane to lift desired loads should be verified early in the project.

Capsules may be stored in Pool Cells 1, 3 through 7, and 12. A documented safety analysis (DSA) (HNF-8758, *Waste Encapsulation and Storage Facility Documented Safety Analysis*) and HNF-8759, *Waste Encapsulation and Storage Facility Technical Safety Requirements*, currently prohibit movement of cover blocks and other heavy loads that have potential to damage the capsules or pool structure over pool cells containing capsules unless for emergency response. Lifting of heavy objects over the pool cells containing capsules will require a DOE-RL approved change to the DSA.

Cover blocks may not be placed on pool cells containing capsules unless measures are implemented to address the potential accumulation of hydrogen in the vapor space beneath the cover blocks. These measures will also require a DOE-RL approved change to the DSA.

2.2.4 WESF G Cell

The capsule transfer system to move capsules between G Cell and Pool Cell 12 will be available for use by CESP. The 2-ton hoist inside G Cell is also available but may require upgrade or replacement prior to use. WESF will perform required periodic maintenance activities on the 2-ton hoist. The G-7 tank can be removed from G Cell upon successful development of an approved, alternate methodology for managing failed capsules. Manipulators are installed in the G Cell manipulator ports and are available for use. There are some spare Central Research Laboratory Model F manipulators available, as well as some replacement parts for the manipulators; however, capability for manipulator repair and refurbishment is limited. The CESP will be responsible for any required manipulator upgrade/replacement or maintenance activities.

3 Process Requirements

The process of loading capsules into canisters and transferring them to the CSA will be conducted in accordance with detailed procedures that implement requirements from the WESF and CSA safety basis documents, transportation safety documents, and environmental permits. These procedures will cover all aspects of the loading and transfer process including, but not limited to, the following activities:

- Capsule movement and loading into canisters
- Capsule identification and verification
- Field closure operations
- Transfer to the CSA
- Transfer to the storage configuration
- Radiological protection
- Nondestructive examination (NDE) inspections
- Rigging and heavy load handling

Prior to the start of actual loading operations, a readiness review will be performed according to the requirements of PRC-PRO-OP-055, *Startup Readiness*, to demonstrate readiness for capsule loading, transfer, and storage activities. This readiness review will assess the completion of construction activities at WESF and CSA, availability and implementation of safety basis documents and environmental permits, availability and adequacy of operations and maintenance procedures, and personnel training. As part of this readiness review, dry runs will be performed to demonstrate the capabilities and readiness of the personnel performing the operations and verify functionality of the facilities and ancillary equipment. Lessons learned from the dry runs will be incorporated into the final procedures used to conduct the loading and transfer operations.

Canister design, fabrication, and final closure shall be based on a design previously approved by the U.S. Nuclear Regulatory Agency (NRC). The canister design, fabrication, and final closure shall be in accordance with *ASME Boiler and Pressure Vessel Code*, Section III requirements, with any code exceptions listed in the applicable Certificate of Compliance (CoC) documentation previously approved by the NRC for the particular CSS selected as the basis for WESF design.

Design, fabrication, and operation of the capsule transfer and storage systems shall comply with the requirements of ASME NQA-1-2008, Parts I and II, as applicable. The requirements contained in ASME NQA-1a-2009 (Addenda to ASME NQA-1-2008) shall also be followed. The CSS components will also be required to comply with the applicable portions of 10 CFR 72, while the capsule transfer system components shall also meet the applicable quality requirements of 10 CFR 71. Detailed qualifty assurance requirements are provided in Section 11 of this FRD.

Design verification of safety-class structures, systems, and components (SSCs) will be conducted through design review to ensure that design characteristics can be controlled, inspected and tested, and that inspection and test criteria are identified. Quality assurance (QA) oversight will be required for equipment receipt and verification, measuring and test equipment (M&TE) verification, documentation of closure activities, and NDEs. Documentation of the capsule loading and transfer operations will include completed procedures, closure documentation (e.g., welding and NDE records), and records of capsule loading and capsule verification.

Calibrated M&TE will be used, as required, for closure operations. Calibration certificates will be provided as part of the documentation record. Personnel qualifications will be documented and maintained during the loading and transfer operation and included in the final record.

3.1 Design Basis Feed Characteristics

Inventory of capsules within the CESP scope is limited to the 1,936 cesium and strontium capsules currently in storage at WESF. The design basis feed characteristics that shall be used for CESP are identified in this section.

The capsules consist of a sealed inner capsule, filled with either cesium chloride or strontium fluoride, and sealed within an outer capsule. Original functions of the capsules included the following characteristics:

- Containment of the long-lived (approximately 30-year half-life) heat-generating fission products (cesium-137 and strontium-90) for 50 years from the time of encapsulation
- Stability when stored and handled in air
- Capability of underwater storage and the handling requirements involved
- Retrievability of encapsulated material

Due to integrity concerns, a small number of cesium chloride capsules have been sealed within an additional containment boundary, called a Type W overpack. Capsule materials and dimensions are identified in Table 3-1. A typical capsule is shown in Figure 3-1. Capsules in wet storage are shown in Figure 3-2.

Cesium chloride in the cesium capsules was produced at WESF by reaction of a cesium carbonate solution with hydrochloric acid. The cesium chloride aqueous solution was evaporated to form a solid cesium chloride that was then heated to approximately 740°C to produce a molten material. Each batch of molten cesium chloride salt filled up seven inner capsules.

Sodium fluoride in the strontium capsules was produced by adding solid sodium fluoride to an aqueous feed solution containing strontium that had been neutralized to a pH of 8 to 9 with a sodium hydroxide solution. The resulting slurry was heated, with mixing, for one hour and then filtered. The filter cake was washed with water and fired at approximately 800°C in argon for several hours. After cooling, the sodium fluoride was pulverized and loaded into an inner capsule by impact consolidation, which was essentially a cold-step-pressing operation.

Nearly 190 of the strontium capsules contain both sodium fluoride and impurities collected from the hot cell floor during operations. The type and quantity of the impurities are not specifically known but can be bounded. Based on comparative power-to-weight ratios with other strontium capsules processed at the same time, some of these capsules contain up to approximately 50 percent impurities.

Table 3-1. Capsule Properties

Item	Initial Activity	Containment Boundary	Material	Wall Thickness[a] (cm [in.])	Outside Diameter (cm [in.])	Total Length (cm [in.])	Cap Thickness (cm [in.])
CsCl Capsule	70 kCi Cs-137	Inner	316L	0.241, 0.262, or 0.345 (0.095, 0.103, or 0.136)	5.715 (2.25)	50.165 (19.75)	1.016 (0.4)
		Outer	316L	0.277, 0.302, or 0.345 (0.109, 0.119, or 0.136)	6.668 (2.625)	52.769 (20.775)	1.016 (0.4)
SrF_2 Capsule	90 kCi Sr-90	Inner	Hastelloy[b]	0.305 or 0.345 (0.12 or 0.136)	5.715 (2.25)	48.387 (19.05)	1.016 (0.4)
		Outer	316L[c]	0.277, 0.302, or 0.345 (0.109, 0.119, or 0.136)	6.668 (2.625)	51.054 (20.1)	1.016 (0.4)
Type W Overpack	70 kCi Cs-137	Single	316L	0.318 (0.125)	8.255 (3.25)	55.436 (21.825)	1.016 (0.4)

Note: Capsule data are taken from HNF-22687, *WESF Capsule Data Book.*

a. The specified wall thickness of the capsules was changed during production.

b. Hastelloy is a registered trademark of Haynes International, Inc.

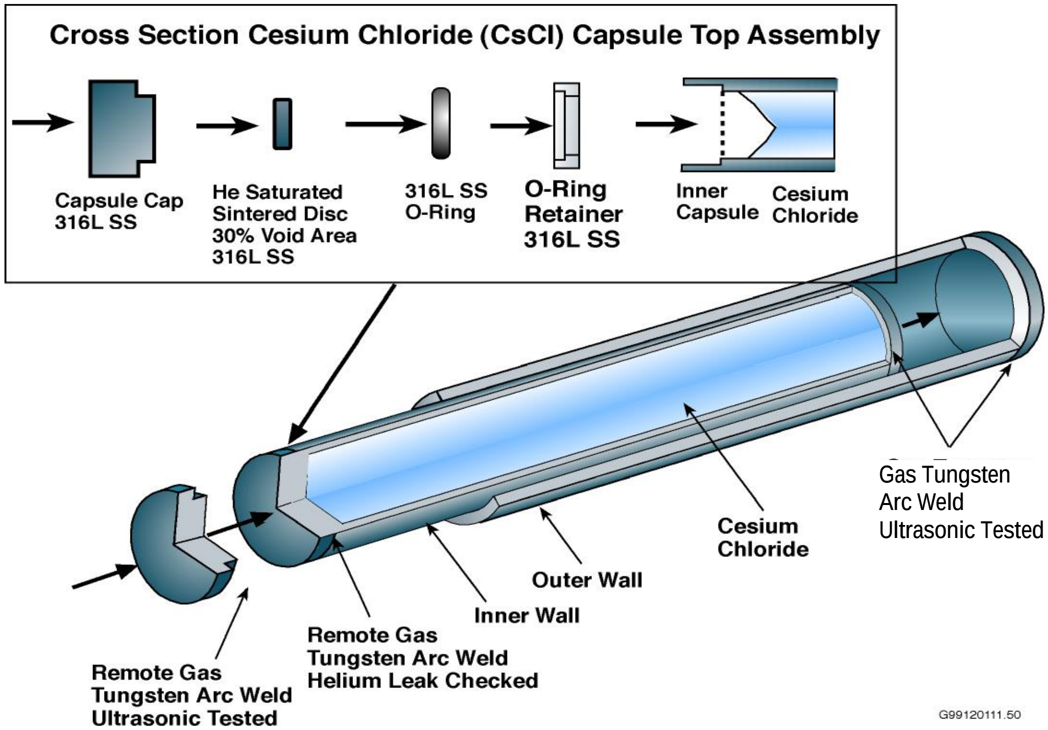
c. Some of the initial SrF_2 capsules were made with Hastelloy C-276 outer capsules.

Cs-137 = cesium-137

CsCl = cesium chloride

Sr-90 = strontium-90

SrF_2 = strontium fluoride



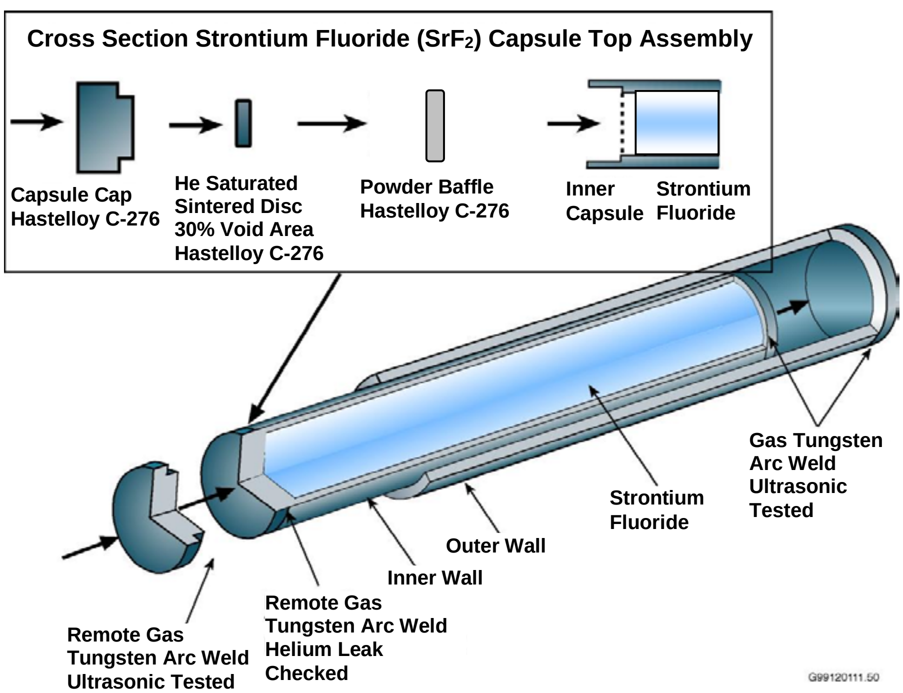


Figure 3-1. Schematic of Cesium and Strontium Capsules

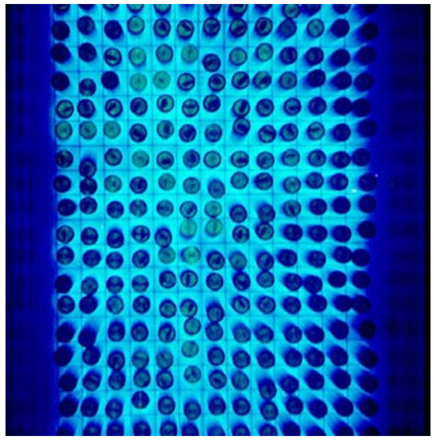


Figure 3-2. Capsules in Wet Storage

The cesium capsules contain two radioactive isotopes of cesium: cesium-135 and cesium-137 and their decay daughter products, nonradioactive cesium-133, and small quantities of impurities such as sodium, aluminum, and iron. The strontium capsules contain strontium-90 and its decay daughter products, nonradioactive isotopes strontium-84, strontium-86, strontium-87, strontium-88, and small quantities of impurities such as aluminum and calcium. The primary isotopes of concern are cesium-137 and strontium-90, which have radioactive half-lives of 30 years and 29 years, respectively. The isotope cesium-135, which is present in small quantities, has a significantly longer half-life than cesium-137 and is a weak beta emitter with no gamma radiation. Because cesium-135 does not contribute significantly to the activity of a cesium capsule, it is not considered to be an isotope of concern. The total activity within a capsule is approximately double that of the cesium-137 and strontium-90 due to barium-137m and yttrium-90 daughter products from the decay of the cesium-137 and strontium-90, respectively.

Approximately half of the cesium capsules were leased to private irradiators in the 1980s. Many of these capsules experienced significant thermal cycles and two of them failed. One leaked radioactive material outside of the capsule and the other experienced a failed outer capsule weld. All of the leased capsules were returned to WESF. Sixteen of these capsules, including the two failed capsules, did not pass acceptance criteria for continued storage in the pool cells and were placed inside a third container (Type W overpack). An additional seven Type W overpacks contain repackaged cesium chloride that was originally contained within WESF capsules.

As of August 2015, the capsules contained 94 MCi of radioactivity, including daughter products. CESP shall assume capsule removal from WESF starting no earlier than January 1, 2018. The individual capsule decay heats are found in CHPRC-02248, *Estimate of WESF Capsule Decay Heat Values on January 1, 2018.*

Detailed information, including descriptions of capsule anomalies that may have an effect on the storage system design such as cesium capsules that were created from multiple pours about the capsules, is located in the following documents:

- HNF-7100, *Capsule System Design Description Document*
- HNF-21462, *WESF Capsule Families*
- HNF-22687, *WESF Capsule Data Book*
- HNF-22693, *WESF Strontium Capsule Weight Data*

- HNF-22694, *WESF Cesium Capsule Weight Data*
- WMP-16937, *Corrosion Report for Capsule Dry Storage Project*
- WMP-16938, *Capsule Characterization Report for Capsule Dry Storage Project*
- WMP-16939, *Capsule Integrity Report for Capsule Dry Storage Project*
- WMP-16940, *Thermal Analysis of a Dry Storage Concept for Capsule Dry Storage Project*
- WMP-17265, *Summary Report for Capsule Dry Storage Project*

3.2 Process Functions

CESP will load the capsules into a modified commercially-available CSS. The selected CSS will be modified to accommodate the unique needs of the capsules stored at WESF. CSS shall passively store the capsules in a dry configuration.

Typically, a CSS consists of a canister, a transfer cask and a storage overpack. The canister is a metal cylinder with an internal support structure used to confine the capsules. In the storage configuration, the canister is protected from normal, off-normal and accident conditions by the storage overpack.
The transfer cask is a metal cylinder that provides physical protection, shielding, and heat removal during onsite movement of a loaded canister and during transfer of the canister to the storage overpack.
The storage overpack is a device into which a canister is placed for storage. It is typically a concrete or steel cask or horizontal concrete module. Storage overpacks provide long term radiological shielding and physical protection for the canister containing the capsules.

CESP shall provide the capability to perform the top-level process functions identified in Figure 3-3.

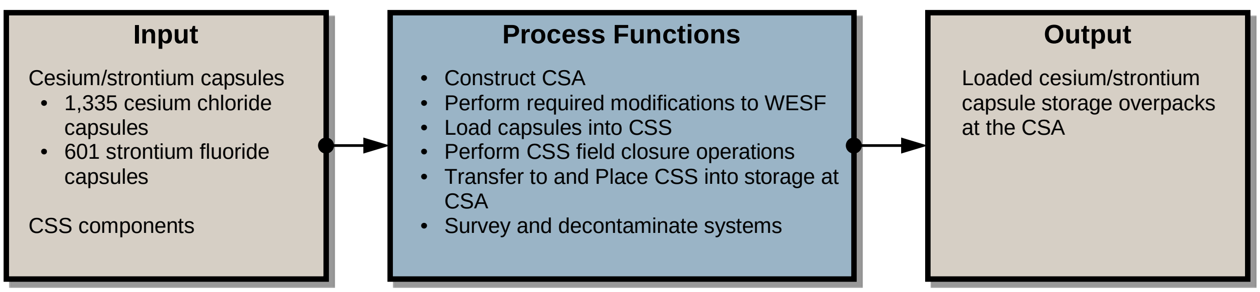


Figure 3-3. Top Level Process Functions

The first step in the process entails construction of the CSA and modification of WESF in accordance with CHPRC requirements and the selected CSS, as well as evaluation of, and any subsequent required modifications to, the existing roadway from the WESF to the CSA site. The remaining steps in the process entail retrieving and loading capsules into canisters, performing canister field closure operations, transferring canisters to the CSA, and placing canisters into storage at the CSA. The required functional capabilities are described in Sections 3.2.1 through 3.2.5. The throughput requirements are identified in Section 3.3.

General requirements that apply to all process steps, such as contamination control and shielding, are identified in other sections of this document. Additionally, the CESP process shall ensure that capsule packaging operations can be conducted such that the total G Cell capsule inventory does not exceed a maximum of 150 kCi ^{137}Cs and 150 kCi ^{90}Sr . Any increase above the safety basis inventory limit for G Cell will require a DOE-RL approved change to the DSA.

3.2.1 Load Capsules into Canisters

The following functional capabilities are required to load the capsules into canisters:

- An empty canister will be transferred into WESF and moved to the selected loading location.
- Capsules will be retrieved from the pool cells, inspected, and loaded into the canister.

Capsule identification numbers shall be recorded, as capsules are loaded into the canister, and verified before closure operations begin.

An individual canister shall not be loaded with a mix of strontium and cesium capsules or Type W and standard capsules. This separation of capsule types is intended to reduce any design complexity that may result from the differing capsule dimensions and materials and will allow for a different long-term disposition path for cesium and strontium capsules without repackaging.

3.2.2 Canister Closure

Once a canister is loaded with capsules, the CSS closure system will be put in place. The closure operations will be performed in accordance with CSS specifications and related procedures. Typically, the closure operation consists of installation of one or more top cover plates, vacuum drying the contents of the canister, and backfilling the canister with helium. The closure requirements for the capsule CSS will be determined during design. The canisters will be *ASME Boiler and Pressure Vessel Code*, Section III compliant with allowable exceptions limited to those previously approved and documented in the CoC issued by the NRC for CSS that was used as the basis for WESF design.

A proof-of-dryness test demonstrates that each canister loaded with capsules is dry to the point that unacceptable pressure or buildup of a flammable gas mixture, at any point in the movement or storage of capsules, is not credible. Proof-of-dryness shall be conducted in accordance with CSS specifications.

The ability to maintain capsules and canister shells within required temperatures during the closure welding and inspection period shall be provided to maintain capsules within temperature limits. Required inspections of the canister closure welds will be performed in accordance with CSS specifications and consistent with the packaging requirements identified in Chapter 4.

3.2.3 Load Canisters into Transfer System

CESP shall provide the functional capabilities to transfer the canister to the CSS transfer system once field closure operations are complete. These capabilities are expected to include hoisting, rigging, and decontamination.

Some form of transfer system will be used to move the loaded canister to CSA. This transfer system is expected to be a prime mover with a heavy haul trailer configuration or self-propelled heavy haul transporter. In either case, the transfer cask with the canister inside will be moved to the transfer system for transfer operations.

3.2.4 Place Canisters into Storage

Final transfer of the canister into the storage overpack will occur either at WESF or CSA. If the transfer occurs at WESF, the transfer system will move the storage overpack with the loaded canister inside to CSA. If the transfer occurs at CSA, the transfer system will move the transfer cask with the loaded canister to CSA for placement into a storage overpack and then return the transfer cask to WESF.

CESP will provide the functional capabilities required to maintain safe, compliant storage of the capsules at CSA after placement in the storage overpack commensurate with the requirements identified in Chapter 4.

3.2.5 Survey and Decontamination

The process to move canisters out of WESF shall be designed as a clean operation with no contamination external to the package the canisters are in when they leave WESF:

- The exterior surface of the equipment used to transfer the canister will be surveyed and decontaminated prior to leaving WESF.
- Radiation control will be maintained during transfer to CSA, transfer to the storage overpack, and return to WESF.
- If a transfer cask is used, the empty interior of the transfer cask will be surveyed and decontaminated prior to re-entry to WESF.

Decontamination capabilities shall comply with CHPRC-00073, *CH2M HILL Plateau Remediation Company Radiological Control Manual*.

3.3 Throughput Requirements

CESP shall have the capability to transfer all 1,936 capsules from WESF to CSA, within a 52 week period, following successful completion of system startup and readiness review. This includes all activities necessary to retrieve and inspect the capsules, load the capsules into the canisters, close the canisters, transfer the canisters to CSA, and place the canisters in the storage overpacks at CSA. This 52 week operational period includes anticipated system downtime for routine maintenance.

Changes to the normal WESF work schedule may be requested to support meeting throughput requirements (see Section 7.2).

4 Packaging/Storage System Requirements

Common equipment within CSS may be used for transfer and storage of canisters, if the equipment satisfies requirements for both functions.

The CSA design shall provide the necessary structural foundation to support storage overpacks adequately. This typically consists of a reinforced concrete pad, with ample space to maneuver the transfer system and transfer the canisters to storage, as well as perform maintenance operations.

The CSA design shall consider security requirements in accordance with MSC-PRO-396, *Planning Construction Projects in Security Areas*; and MSC-RD-11440, *Physical Protection of Property and Facilities*, including any required lighting, surveillance, and access control.

The overall CSS shall be based upon an NRC CoC issued canistered dry storage system listed in 10 CFR 72.214, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste,” “List of Approved Spent Fuel Storage Casks,” as modified for use at WESF. The basis for structural design will be in accordance with previously NRC approved code, analysis methods, and processes. The remainder of the design will be performed in accordance with DOE approved methods. The analyses, calculations, design, fabrication, and QA of CSS shall be equivalent to that which would support a licensed system and consistent with DOE requirements.

Transfer systems and activities shall comply with 10 CFR 71, “Packaging and Transportation of Radioactive Material,” and DOE/RL-2001-36, *Hanford Sitewide Transportation Safety Document*, unless approval is obtained from DOE-RL allowing transfers under an approved DSA (see Section 9.7).

CSA will be permitted as a RCRA storage facility. CSA and CSS design must comply with applicable requirements. The following additional requirements apply to CSS and/or CSA:

- CSS components shall be designed to allow the use of common handling equipment.
- Internal variations to the canister system to accommodate dimensional differences in the capsules or to provide loading geometries specific to strontium and cesium are acceptable.
- CSS shall be designed to ensure that the following maximum temperatures at the salt/capsule interface are not exceeded during movement and storage of the capsules (WMP-16939):

	Strontium Capsules	**Cesium Capsules**
Accident Conditions	800°C	600°C
Processing, Including Process Upset	540°C	450°C
Extended storage configuration, summer storage conditions as described in the current and archival data housed within the HMS web-accessed database (http://www.hanford.gov/page.cfm/hms)	540°C	317°C

Source: HMS, 2011, "Hanford Meteorological Station" website.

HMS = Hanford Meteorological Station

- Blending of high and low heat capsules within a canister to meet temperature requirements is acceptable. However, if blending is required, a 10 percent margin must be added to the estimated decay heat in any specific canister, and a complete loading sequence of all capsules must be addressed within the thermal analysis. Alternately, a design may be developed that will accept a bounding array of capsules within a canister.
- CSS shall provide containment compliant with leak tight requirements (listed in ANSI N14.5-1997, *Radioactive Materials – Leakage Tests on Packages for Shipment*) and appropriate *ASME Boiler and Pressure Vessel Code* requirements applicable to the system. The capsules shall be assumed to maintain the gross configuration of the salts, but there may be some leakage of radioactive material outside the capsule during storage. The canister provides containment, must be constructed of 316L stainless steel, and must include an allowance of 0.125 in. for internal corrosion from contact of cesium or strontium salts with the canister interior. The canister shall use a welded closure.
- The capsules were previously tested for special form qualification (ARH-CD-440, *Cesium Chloride Capsule Testing for Special Form Qualification*). The entire capsule loading and transfer process shall be designed such that loads to the capsules do not exceed these values under both normal and accident conditions. The canister shall be designed to maintain its containment and the integrity of the outer capsule wall when subject to these same loads, without taking credit for the corrosion allowance.
- CSS material selection and storage configuration shall be selected to minimize degradation over the design life due to gamma exposure and/or cesium salt exposure.
- The dose rate shall be controlled to less than 0.5 mrem/hr at the fenced perimeter of CSA when all capsules are in their storage configuration, and as far below this value as is reasonably achievable. The dose rate must not exceed 100 mrem/hr at any accessible point in the storage array. Dose rates during transfers must not exceed 100 mrem/hr on contact, and are further subject to an as low as reasonably achievable (ALARA) decision making process.

- Additional requirements from 10 CFR 835, "Occupational Radiation Protection," Subpart K, "Design and Control," that must be addressed include use of optimization methods to ensure that occupational exposure is maintained ALARA, control of airborne radioactive material, and selection of materials that facilitate operations, maintenance, decontamination, and decommissioning (see also Section 9.1).
- CSS design shall enable future removal of canisters from CSS and the shipment of canisters to another facility for final disposition or as a recovery action.
- Sufficient monitoring capability shall be included to ensure continued performance of CSS, including storage overpack integrity, over the design life of the system (see Section 8.1).
- Heat removal from the capsules during storage at CSA shall be by passive means.

5 Waste Encapsulation and Storage Facility Modification Requirements

The following sections describe modifications that may be required to WESF to support CESP. This listing is not comprehensive. The selected project approach will ultimately dictate the required equipment layouts and modifications to WESF. All required modifications will be the responsibility of the CESP.

5.1 G Cell

Radiation monitoring equipment and controls for the personnel access door into G Cell may require upgrade and/or replacement. Existing manipulators within G Cell may need to be replaced, and additional manipulators may be purchased as spares to ensure the availability of functional manipulators. Tools and equipment for the decontamination and repair of manipulators may be required. G Cell contains a one -ton hoist that may require upgrade and/or replacement if it is needed to handle equipment.

5.2 Canyon Crane

Significant upgrades to the canyon crane may be required, depending on the needs of the project. Crane control systems, cameras, and display monitors may require replacement regardless. Any upgrades or modifications shall be the responsibility of the CESP. Major upgrades or modifications shall be performed according to the requirements of ASME NQA-1-2008 (with the 2009 addenda), *Quality Assurance Requirements for Nuclear Facility Applications*, Part II, "Quality Assurance Requirement for Hoisting, Rigging, and Transporting of Items for Nuclear Power Plants."

5.3 Pool Cell Crane

Significant upgrades to the pool cell crane are not expected but may be required depending on the selected approach. Any upgrades or modifications shall be the responsibility of the CESP. Major upgrades or modifications shall be performed according to the requirements of ASME NQA-1-2008 (with the 2009 addenda), Part II.

5.4 WESF Canyon, Truck Port, and Pool Cell Area

Further decontamination and source-term removal may be required in the WESF canyon to allow access to the truck port and pool cell area via the canyon cover blocks. Additional ventilation upgrades may be required to ensure that required ventilation pressure zones are maintained, depending upon demonstrated and anticipated contamination levels. The truck port may require modification to support the weight of transfer equipment.

5.5 WESF Capsules

Certain capsules contain a residual coating of foreign organic material due to storage at offsite locations (CHPRC-02306, *WESF Capsule Residue Inspection Report*). Depending upon the safety evaluation, this material may require removal to reduce a potential source of hydrogen generation or to enhance thermal transfer properties prior to placing the capsules in their storage configuration.
Mechanisms that will positively identify the capsules and compare them to the existing inventory, including identifying and recording the capsule identification number, will be required. Equipment to ensure that capsules will fit into the required storage configuration will be required (e.g., roundness and straightness gauging).

5.6 Canister Closure

Equipment needed to weld, helium leak-check, and/or perform proof-of-dryness tests will need to be installed inside WESF, as needed, to support canister closure activities.

5.7 Storage Site Location

Based on Site Evaluation 2E-11-09, *Cesium and Strontium Capsules Dry Storage Project*, CSA will be located as shown in Figure 5-1. The CESP shall ensure a biological survey and a cultural resource review will be completed to confirm the acceptability of this site.

Existing Canister Storage Building (CSB) support facilities (e.g., change room, administrative offices, and shift office) shall be used to satisfy CSA long-term operational requirements. CSB facilities may not be available for use during construction and transfer activities. Access to CSA shall be configured for ease of entry from the CSB for routine operations, surveillance, and maintenance. 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 and movement of overhead interferences) may be required.

CSS shall consist of passive storage systems requiring minimal staff for maintenance and operation during extended storage. Any required support personnel will be housed at existing CSB facilities. CESP will not provide new facilities or capabilities to house support personnel for CSA operations.

The CSA location depicted in Figure 5-1 is in the vicinity of a catch tank (241-ER-311), diversion box, (241-ER-351) and underground pipeline (V-224) used to transfer radioactive wastes within the Hanford tank waste system. Historic releases from these underground utilities have led to an area of contaminated soil (UPR-600-20) in the vicinity of the anticipated CSA. Site surveys will be required to delineate this area and ensure that it is not impacted by the new construction. Depending on the extent of UPR-600-20 and the needs of CSA, excavation work for CSA and related roadways may require some soil remediation work. CESP shall be responsible for the identification of any other potential utility interference, based on the selected design solution, and determination of how best to resolve any interference.

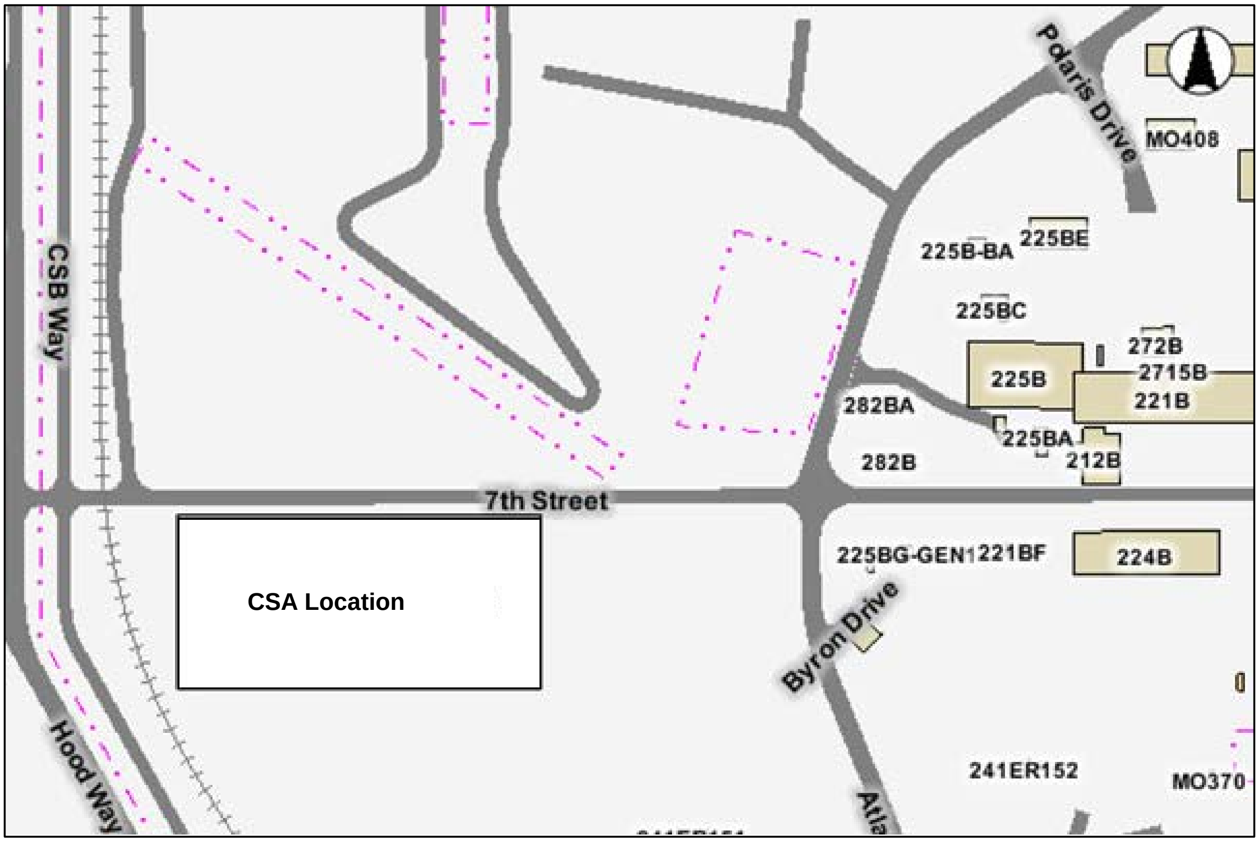


Figure 5-1. Location of Capsule Storage Area

6 Utility Requirements

6.1 Hanford Site Utilities/Infrastructure

CESP shall interface with existing Hanford Site utilities and infrastructure, as needed, to support construction, capsule transfer operations, and long-term storage operations. Existing systems at WESF and CSB shall be used to the maximum extent possible to distribute required utilities (e.g., water, electricity, and sanitation). 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. Interface requirements for utilities and infrastructure are undefined, pending maturation of design. Initial assessment of utilities and infrastructure interfaces shall occur following completion of conceptual design.

Access roads, aprons, and walkways for CSA will be integrated into the existing CSB infrastructure.

6.2 Service Roads

To the greatest extent possible, CESP shall take advantage of existing asphalt roads at the selected site. CESP shall extend the existing roadways to the CSA boundary. The construction workforce, facility operations workers, and casks/canisters will arrive at CSA by existing and extended roadways.
The extension of existing roadways and construction of new roadways shall be compatible with the existing roadways. A design analysis shall be performed by the CSA/WESF Modifications contractor to confirm that the existing roadways can accommodate the vehicles transfer casks to and from CSA.

Any new roads provided by the CESP shall meet the requirements of M 41-10, *Standard Specifications for Road, Bridge, and Municipal Construction.*

6.3 Interface with Existing Electrical Power Grid

CESP shall interface with the existing Hanford Site electrical distribution system. CESP shall provide extension of the existing electrical power grid as required for long-term CSA operations. Depending on facility location and power requirements, the existing electrical distribution system may require upgrades.

The assessment and definition of interface requirements for a CESP substation shall occur following final CSA siting within the designated siting area and definition of electrical loads. The primary interface for the electrical distribution system shall occur through the Hanford Site utilities group that has responsibility for onsite power distribution.

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, *National Electrical Code*, and IEEE C2, *National Electrical Safety Code*.

6.4 Interface with Site Water Distribution

CESP shall interface with the onsite water distribution system for potable and raw water. Requirements for potable and raw water remain undefined pending appropriate analyses (e.g., fire hazards analysis [FHA]). Raw and potable water systems shall meet the requirements specified in 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.

The need for a water suppression system for CESP fire protection will be addressed in the CESP DSA and FHA.

7 Operating Requirements

7.1 Operations Scope

CESP includes all operational activities required for retrieval and inspection of the capsules; placement of the capsules into the canisters; closure of the canisters; transfer of the canisters to the CSA; and placement of the canisters into the storage overpacks. This includes development of all required operations, maintenance, and response procedures.

7.2 Operational Shifts

WESF operates on a 4-10’s schedule. The standard workday consists of 10 hours of work between the core hours of 6:00 AM to 4:30 PM. There is also a surveillance shift that mans the facility around the clock. No work occurs on Fridays or Facility Closure Days. This schedule may be changed if required to meet the throughput requirements provided in Section 3.3.

7.3 Conduct of Operations

CESP operations must comply with the requirements of CHPRC-00192, *Decommissioning Waste, Fuels and Remediation Services Project (DWF&RS) Conduct of Operations Applicability Matrix*.
This document lists the implementing documents used by CHPRC to meet the Contractor Requirements Document (CRD) of DOE O 422.1, *Conduct of Operations*.

7.4 Response Procedures

CESP shall develop response procedures for off-normal events. Events that shall be considered include capsule damage during the loading process and identification of an off-specification capsule during pre-loading inspections.

7.5 Providing a Safe Work Site

CESP shall incorporate SSCs and features required to maintain worker, public, and environmental safety (e.g., radiological and industrial). The facility design shall incorporate features that provide for employee safety in accordance with 29 CFR 1910, "Occupational Safety and Health Standards;" 29 CFR 1926, "Safety and Health Regulations During Construction;" the CRD for DOE O 420.1C, *Facility Safety*; DOE-STD-1098-99, *Radiological Control*; and DOE O 440.1B, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*.

7.6 General Configuration

The CESP design shall conform to the requirements of NFPA 70; NFPA 101, *Life Safety Code®*; and the *International Building Code* (ICC, 2012). Control devices for access to high radiation areas shall conform to the requirements of 10 CFR 835.

The CESP design shall protect facility workers from excessive radiation exposure during capsule handling and packaging, canister closure and transfer, canister placement into storage overpacks, and storage operations using appropriate methods (e.g., remote handling, shielding, and contamination control ventilation). The CESP design shall not select administrative controls over engineered features to minimize employee exposure to radiation.

Existing capabilities for decontamination of personnel (e.g., safety showers, personnel decontamination facilities, and change rooms) are available at CSB and may be used during CSA activities if needed.

Work performed in support of CESP shall be planned and implemented to ensure that facility equipment is not damaged.

7.7 Testing and Inspection Requirements

An integrated test plan shall be prepared to support design verification and validation in accordance with PRC-PRO-EN-286, *Testing of Equipment and Systems*. The test plan will identify testing to be performed to demonstrate maturity and functionality of design features and systems.

CESP shall use mock-ups, as necessary, to verify any remote handling design configuration and validate the final equipment configuration with respect to design requirements.

7.8 Hoisting and Rigging

Cranes, hoists, and lifting devices designed to handle CSS components shall meet the requirements of ASME NQA-1-2008, Part II; DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*; and ASME NOG-1-2010, *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)*, as determined by the safety evaluation.

The CESP design shall preclude drops of CSS components that would result in loss of confinement or containment at any time during the process. A drop analysis will be performed by the CSS contractor for the CSS components.

Canister lifting devices shall meet the requirements of ASME B30.20, *Below-the-Hook Lifting Devices*, and ANSI N14.6, *Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds or More*, as applicable.

8 Design Requirements

8.1 Design Life

The canister and storage overpack 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. They 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.

Transfer system components designed for CESP shall have a minimum 20-year design life.

WESF modifications and equipment used within WESF shall have a minimum design life of five years or be designed for ease of replacement. All systems and equipment provided shall be designed, to the maximum extent practicable, to provide a minimum five-year, maintenance-free service life. Tools provided shall be designed, to the maximum extent practicable, to provide a minimum one-year, maintenance-free service life. Consumables shall have a one-year minimum service life and be located for ease of inspection, maintenance, and replacement.

CSS shall be designed with the intent to enable future extension of the storage period to a total of 300 years without loss of containment.

8.2 Reliability

The CESP design shall incorporate the following concepts in evaluating the mean time to failure of systems and components:

- Maximize equipment interchangeability.
- Locate complex components, including electronic devices or those having a high probability of failure, in non-radiation areas.
- Specify fabrication materials for equipment that provide appropriate performance (e.g., corrosion resistance and durability) in the intended operating environment.
- Base system and component designs on a thorough reliability, availability, and maintainability analysis to ensure that throughput can be accomplished.
- Conform to requirements in IEEE 493, *IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems*, for 480/277 Vac electrical distribution subsystems to ensure a continuous power supply to systems and equipment designated as critical.

8.3 Maintainability

The CESP 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 CESP 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
- Day-to-day operation

The storage overpacks shall be designed to be passive. Thermal cooling is provided by natural circulation that allows for heat removal.

Maintenance requirements for the storage overpacks will be determined by the design but typically consist of periodic inspections, to ensure vents are not blocked by debris or wildlife, and annual inspections to ensure general operability.

Safety is the most important design factor and shall not be compromised by cost or schedule considerations.

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.

The design shall consider maintainability factors particular to the specific equipment used. The CESP design shall provide for routine maintenance, repair, or replacement of equipment subject to failure.

SSC design shall allow inspection, maintenance, and testing to ensure their continued function, readiness for operation, and accuracy. The CESP design should locate ancillary equipment (e.g., pumps, blowers, motors, compressors, gear trains, and controls) in areas least likely to become contaminated. The design of equipment that must be located within contamination areas shall allow for in-place maintenance or replacement.

The design of all process equipment shall include features to minimize self-contamination of the equipment, piping, and confinement areas. The design of process equipment shall also include features to minimize the spread of contamination out of local areas.

8.4 Natural Forces Criteria

The natural forces criteria for CESP SSCs shall be established and implemented as specified in PRC-PRO-EN-097, *Engineering Design and Evaluation (Natural Phenomena Hazard)*. Additionally, natural forces design criteria from DOE-STD-1020-2012 shall be applied to CSA components.

8.5 Environmental Safety

CESP shall comply with applicable federal, state, and local laws and regulations to protect the public, worker health and safety, and the environment.

CSA will be permitted as a RCRA storage facility, and WESF is currently permitted as a RCRA storage facility. Design of the CSA and CSS must comply with applicable requirements.

CESP design and construction shall be performed in compliance with the CRD for DOE O 436.1, *Departmental Sustainability*, and sustainable environmental stewardship goals. 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 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*) shall be implemented to the extent practical.

8.6 Heating, Ventilation, and Air Conditioning

CSA is not expected to require an HVAC system. CESP activities shall not compromise the capability of the existing WESF ventilation system to comply with the existing air permit. The WESF ventilation system shall be evaluated during the hazard analysis process to determine if it requires upgrades to support capsule packaging activities.

8.7 Decontamination Requirements

CESP 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 industry and NRC required best practices and requirements for materials exposed to radioactive materials. CESP will not upgrade existing surfaces at WESF.

8.8 Human Factor Requirements

Systems, subsystems, and equipment shall consider the human engineering guidelines of DOE-HDBK-1140-2001, *Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance*, and IEEE 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*.

8.9 Systems Control Requirements

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. Control panels shall comply with UL 508A, *Standard for Industrial Control Panels*.

8.10 Electrical System Requirements

CESP shall receive and distribute electrical power to meet all system requirements. The electrical system shall conform to the requirements in IEEE C2; NFPA 70; and DOE-0359, *Hanford Site Electrical Safety Program (HESP)*.

Onsite acceptance testing shall be required for each major electrical system. Tests shall be specified to demonstrate that each function and important parameter is implemented. Specific criteria shall be included to determine pass/fail acceptance.

Emergency power systems are not expected to be required for CSA or CESP equipment at WESF. A final determination will be made during development of safety basis documentation. 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, onsite 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. 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.

Lightning protection/grounding shall be provided as required for the CSA in accordance with the requirements in NFPA 70 and NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

Cathodic protection systems, if required, shall be designed in accordance with the guidelines provided in NACE SP0285, *External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*, and NACE SP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*.

9 Health, Safety, and Environment

9.1 Radiation Safety

CESP shall be designed to limit occupational radiation exposures in accordance with the requirements of 10 CFR 835 and CHPRC-00073.

CESP shall perform capsule loading and packaging in an area serviced by high-efficiency particulate air filters to minimize potential releases from the building during these activities. The existing WESF ventilation system is available for use but may require modification (see Section 5.4).

Limiting radiation exposure to facility personnel is a key driver for operations at WESF, during transfer, and at CSA. Due to the high dose rates associated with the capsules, all capsule handling and packaging activities will be conducted with remote operated equipment or sufficient shielding to protect facility workers.

To ensure that exposure limits are satisfied, dose estimates shall be developed for capsule loading, canister closure welding, cask transfer, overpack placement into storage, and storage configurations. Preliminary estimates shall be provided as part of the conceptual design. Final dose estimates shall be provided as a part of the final design.

- 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. Optimization methods shall be used to assure that occupational exposure is maintained ALARA in developing and justifying facility design and physical controls.

- The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2,000 hours/year) shall be to maintain exposure levels below an average of 0.5 mrem (5 μSv) per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for a potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed 20 percent of the applicable standards in 10 CFR 835.202, “Occupational Dose Limits for General Employees.”

- The design objective for control of airborne radioactive material shall be to avoid releases to the workplace atmosphere under normal conditions and to control the inhalation of such material by workers to levels that are ALARA in any situation; confinement and ventilation shall normally be used.

- The design or modification of the facility and the selection of materials shall include features that facilitate operation, maintenance, decontamination, and decommissioning.

9.2 Nuclear Safety

CESP shall comply with the requirements of 10 CFR 830, “Nuclear Safety Management,” and DOE-STD-1189-2008, *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, *Capsule Extended Storage Project Safety Design Strategy*.

Required safety documentation that will be developed includes a preliminary hazard analysis, a preliminary FHA, a conceptual safety design report, a preliminary safety design report, a preliminary DSA, and final DSA and FHA documents for WESF and CSA. The impacts of natural phenomena hazards shall be addressed consistent with the requirements of PRC-PRO-EN-097.

CSS design and fabrication will provide analyses per the requirements of 10 CFR 830.

9.3 Environmental and Safety Management

The environmental and safety management system, which integrates environment, safety, and health requirements into the work planning and execution processes for effective protection of workers, the public, and the environment, is described in PRC-MP-MS-003, *Integrated Safety Management System/Environmental Management System Description (ISMSD)*. Personnel safety, equipment safety, and environmental safety are all part of the Integrated Safety Management System.

9.4 Managing Waste Generated

CESP may generate a minimal amount of waste in several forms during decontamination, normal operations, and maintenance. CESP shall provide for disposal of waste, including accumulation and handling areas as applicable, in accordance with DOE O 435.1, *Radioactive Waste Management*; DOE-STD-1098-99; WAC 173-303, “Dangerous Waste Regulations;” and WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*. CESP shall interface with existing Hanford Site waste treatment and disposal facilities for disposition of hazardous and radioactive solid wastes generated by CESP.

9.5 Airborne Emissions

To be protective of personnel, toxic and hazardous airborne emissions shall comply with the permissible exposure levels identified in DOE O 458.1, *Radiation Protection of the Public and the Environment*, 29 CFR 1910, Subpart Z, “Toxic and Hazardous Substances”, and the American Conference of Governmental Industrial Hygienists Threshold Limit Values.

To meet ambient air quality standards, toxic and hazardous airborne emissions shall comply with WAC 173-400 “General Regulations for Air Pollution Sources” and WAC 173-460, “Controls for New Sources of Toxic Air Pollutants.”

Radionuclide airborne emissions shall comply with the ALARA based limits for exposure (dose) to the public, as identified in WAC 173-480, “Ambient Air Quality Standards and Emissions Limits for Radionuclides,” and WAC 246-247, “Radiation Protection—Air Emissions.”

9.6 Occupational Safety and Health

CESP shall be designed for safe installation, operation, and maintenance in accordance with the applicable requirements of 29 CFR 1910, 29 CFR 1926, and 10 CFR 851, “Worker Safety and Health Program.”

9.7 Transportation and Packaging

Transfer of canisters between WESF and CSA shall be performed according to the requirements of PRC-PRO-TP-156, *Onsite Hazardous Material Shipments*, and PRC-MP-TP-40476, *Transportation Program Management Plan*, which provides the following two options:

1. Shipments can be performed in full compliance with U.S. Department of Transportation (DOT) regulations, which will require strict adherence to use of DOT packaging as well as all marking, labeling, placarding, and shipping papers requirements.

2. Shipments can be performed as a risk based shipment that demonstrates by DOE approved analysis a DOT equivalent level of safety. An appropriate transportation safety document will be developed and implemented according to the requirements of DOE/RL-2001-36 and PRC-PRO-TP-15665, *Transportation Safety Documents*.

Alternatively, an approach to analyze and control the hazards associated with transfer of the canister using the WESF and/or CSA DSA can be made but will require approval by DOE-RL.

9.8 Fire Protection

CESP shall protect personnel from fires in accordance with the DOE O 420.1C CRD, NFPA 101, the 2012 *International Building Code*, 29 CFR 1910, and 29 CFR 1926. CESP 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*.

Required documentation that will be developed includes a preliminary FHA and final FHA for WESF and CSA. FHAs will be developed according to the requirements of PRC-PRO-FP-40420, *Fire Protection Analyses*.

HNF-SD-WM-FHA-019, *Fire Hazards Analysis for Building 225-B Waste Encapsulation and Storage Facility (WESF)*, describes fire protection controls applicable to WESF. Current controls include a requirement that G Cell may not exceed a maximum combustible loading equivalent to 100 kg of polystyrene and a limitation that no flammable gases (e.g., propane and acetylene) and no highly volatile fuels, including gasoline, shall be used or stored in WESF.

Introduction of combustible material in the pool cell area, G Cell, and the canyon shall be limited. These areas of the facility lack automatic fire suppression systems. The type and quantity of material introduced into these areas shall be reviewed and approved by CHPRC Fire Protection Engineering.

9.9 Environmental Protection

CESP shall comply with applicable federal, state, and local laws and regulations to protect the public, worker health and safety, and the environment. Ecological and cultural reviews shall be performed as necessary to support siting and construction activities.

CSA will be permitted as a RCRA storage facility that is fully compliant with WAC 173-303-280, "General Requirements for Dangerous Waste Management Facilities." CESP shall comply with the permit requirements.

WESF is currently operating under the RCRA interim status regulations, and facility modifications to support CESP will require final status permitting activities.

National Environmental Policy Act of 1969 review requirements for CESP activities will be established through an amended record of decision for the Tank Closure and Waste Management Environmental Impact Statement.

10 Interrelationships with Other Processes, Facilities, and Support Services

10.1 Waste Encapsulation and Storage Facility Interfaces

CESP shall interface with WESF as described in this document. Detailed interface controls shall be developed and documented to define and manage interfaces between CESP and WESF. Activities at WESF shall be designed to enable use of existing WESF systems and facility capabilities without major modification to the facility.

10.2 Canister Storage Building Interfaces

CESP shall interface with CSB as described in this document. Detailed interface controls shall be developed and documented to define and manage interfaces between CESP and CSB.

10.3 Final Disposition

Based on the uncertainties in the technical path and timing of cesium and strontium capsule disposition, CESP shall ensure that CSS is designed and fabricated to enable extended storage for a 100 year period and with the intent to provide for continued storage without removal from the existing storage overpacks for a period of up to 300 years. The ability to remove the overpacks from storage at any time during the storage period to enable disposition of the capsules by others shall be maintained. Due to the uncertainty in final disposition requirements, the ability to remove the capsules from overpacks in an appropriate facility with remote handling capability provided by others shall be maintained.

11 Quality Assurance

Design, fabrication, and operation of the CSS, CSA, and capsule transfer sysem shall comply with the requirements of ASME NQA-1-2008, Parts I and II. The requirements contained in ASME NQA-1a-2009 (Addenda to ASME NQA-1-2008), will also be followed. The specific long term storage units will also be required to comply with the applicable portions 10 CFR 72, while any capsule transfer systems shall meet the applicable requirements contained in 10 CFR 71. CSS and CSA/WESF Modifications contractors will be required to develop and submit for CESP approval a QA program and associated procedures to meet these requirements. As specified in the terms and conditions associated with this contract, contractors shall be subject to the enforcement actions under 10 CFR 820, “Procedural Rules for DOE Nuclear Activities,” Subpart G, “Civil Penalties,” Appendix A, “General Statement of Enforcement Policy.”

Contractor QA programs shall be submitted to the CESP for review prior to the start of work, and work shall not be authorized until the program is specifically approved by the CESP as meeting the requirements noted above. Such approval may be conditional and limited to certain program elements.

Design verification for safety-class SSCs conducted through design review or alternative calculations shall be performed by competent individuals or groups other than those who performed the original design, but who may be from the same organization or project team. Design verification shall include a review to ensure that design characteristics can be controlled, inspected, and tested, and that inspection and test criteria are identified. Contractors shall be responsible for performing and documenting all design verifications for each system developed.

The CESP reserves the right to witness any design verification conducted through qualification testing. The CESP reserves the right to witness any inspections or testing conducted during fabrication and construction. The CESP will identify any inspection hold-points during review and approval of contractor fabrication/construction documents.

Contractors shall control nonconforming items during fabrication and construction, in accordance with approved procedures. The CESP reserves the right to approve the installation of any items dispositioned "use-as-is" or "repair."

Overall CESP activities shall comply with applicable portions of DOE O 414.D, *Quality Assurance*, DOE O 252.1A, *Technical Standards Program*, and IAEA-TECDOC-1169, *Managing suspect and counterfeit items in the nuclear industry*.

12 Safeguards and Security

CESP shall comply with applicable requirements in DOE O 470.4B, *Safeguards and Security Program*. 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.

13 Communications

Communications systems shall be designed in accordance with DOE O 200.1A, *Information Technology Management*. CESP 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. No new telephone conduits will be installed for communication lines.

CESP shall use the existing public address system at WESF and CSB and ensure that the public address system broadcasts to all CSA areas.

CESP shall use the existing computer intranet system available at WESF and CSB for interfaces with the Hanford Local Area Network. Computer intranet system interfaces will not be required at CSA.

14 Decontamination and Decommissioning

CESP shall comply with the design criteria in DOE O 430.1B, *Real Property Asset Management*. The design shall enable future closure of the CSA in accordance with 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," and WAC 173-303-610, "Closure and Post-Closure."

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. SSC 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. CESP should incorporate the following design principles:

- Provide equipment that precludes, to the extent practicable, 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.

15 Codes and Standards

The project shall be performed in accordance with the PRC, including applicable federal and state regulations and DOE Orders. Additionally, applicable PRC procedures and national consensus codes and standards shall be used for CESP design and construction activities, consistent with contractual and legal requirements. A code of record document will be developed by CESP to document the applicable codes and standards.

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