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# SPECIFICATION FOR
# 241-C-104 Mobile Retrieval System

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**Project:** W-523, SST Waste Retrieval

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**Prepared By:**


M. J. Holm, Systems Engineering

CH2M HILL Hanford Group, Inc.


**Approved By:** **Date**

WE Bryan (see EDT 631717) _____

KE Carpenter (see EDT 631717) _____

AH Friberg (see EDT 631717) _____

PF Kison (see EDT 631717) _____

DB Parkman (see EDT 631717) _____

RW Reed (see EDT 631717) _____

# SPECIFICATION FOR 241-C-104 MOBILE RETRIEVAL SYSTEM

June 2001

M. J. Holm
CH2M HILL Hanford Group, Inc.
Richland, Washington

Prepared for:
U.S. Department of Energy
Richland, Washington

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# 1.0 SCOPE

## 1.1 INTRODUCTION

This specification describes the functional, performance, design, and interface requirements for the tank 241-C-104 Mobile Retrieval System (MRS) and associated monitor and control (M&C). The MRS is a portion of the overall 241-C-104 Waste Retrieval System (WRS); the WRS retrieves tank 241-C-104 waste, transfers the waste to 241-AY-101, and monitors and controls the process. The requirements for the 241-C-104 WRS are documented in RPP-8144, Rev. 0, *Level 2 Specification for the Tank 241-C-104 Waste Retrieval System (Project W-523).* The 241-C-104 MRS portion of the WRS will retrieve the tank 241-C-104 waste and inject it into the 241-C-104 WRS waste transfer pipeline. The MRS M&C performs a subset of the WRS M&C functions that pertain to the MRS operation.

The requirements contained in this specification are derived from and must be maintained consistent with those in RPP-8144. A summary of tank 241-C-104 history is contained in Appendix A.

## 1.2 BACKGROUND

The functions and requirements found in RPP-8144 form the basis for the 241-C-104 MRS and MRS M&C functions and requirements. Using the WRS-level functions and requirements as the starting point helps ensure traceability to the requirements of the 241-C-104 WRS. The applicable 241-C-104 WRS functions include:

- Remove Waste from Tank 241-C-104 (see RPP-8144, Section 3.2.1.5)
- Control & Monitor the Tank 241-C-104 Removal Process (see RPP-8144, Section 3.2.1.6).

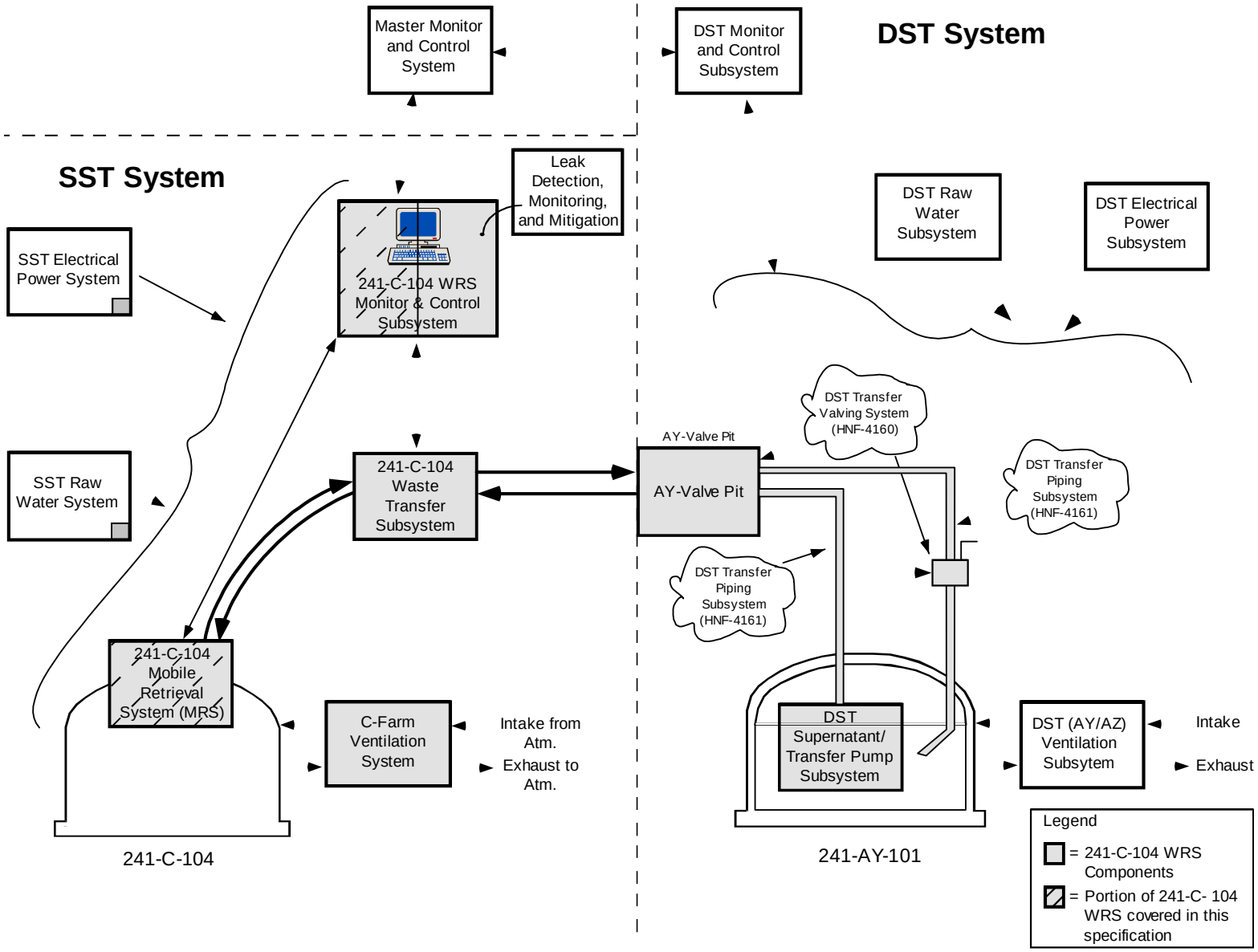
The portions of these functions that apply to the MRS and MRS M&C are defined in Section 3.1.

RPP-8144 also established a 241-C-104 WRS diagram that is shown in Figure 1-1. The diagram demonstrates how the 241-C-104 MRS and the MRS M&C integrate with the 241-C-104 WRS. The requirements contained in this specification pertain to the cross hatched subsystems of Figure 1-1.

## 1.3 GENERAL OBJECTIVES

The information contained in this section reflects expectations for general hardware concepts, reliability, constructability, operability and life cycle objectives of the MRS. The following are the objectives for the concepts proposed.

Figure 1-1. 241-C-104 Waste Retrieval System.



The MRS is envisioned to consist of two major systems that work together to inject waste from tank 241-C-104 into the WRS transfer system (see Figure 1-1).

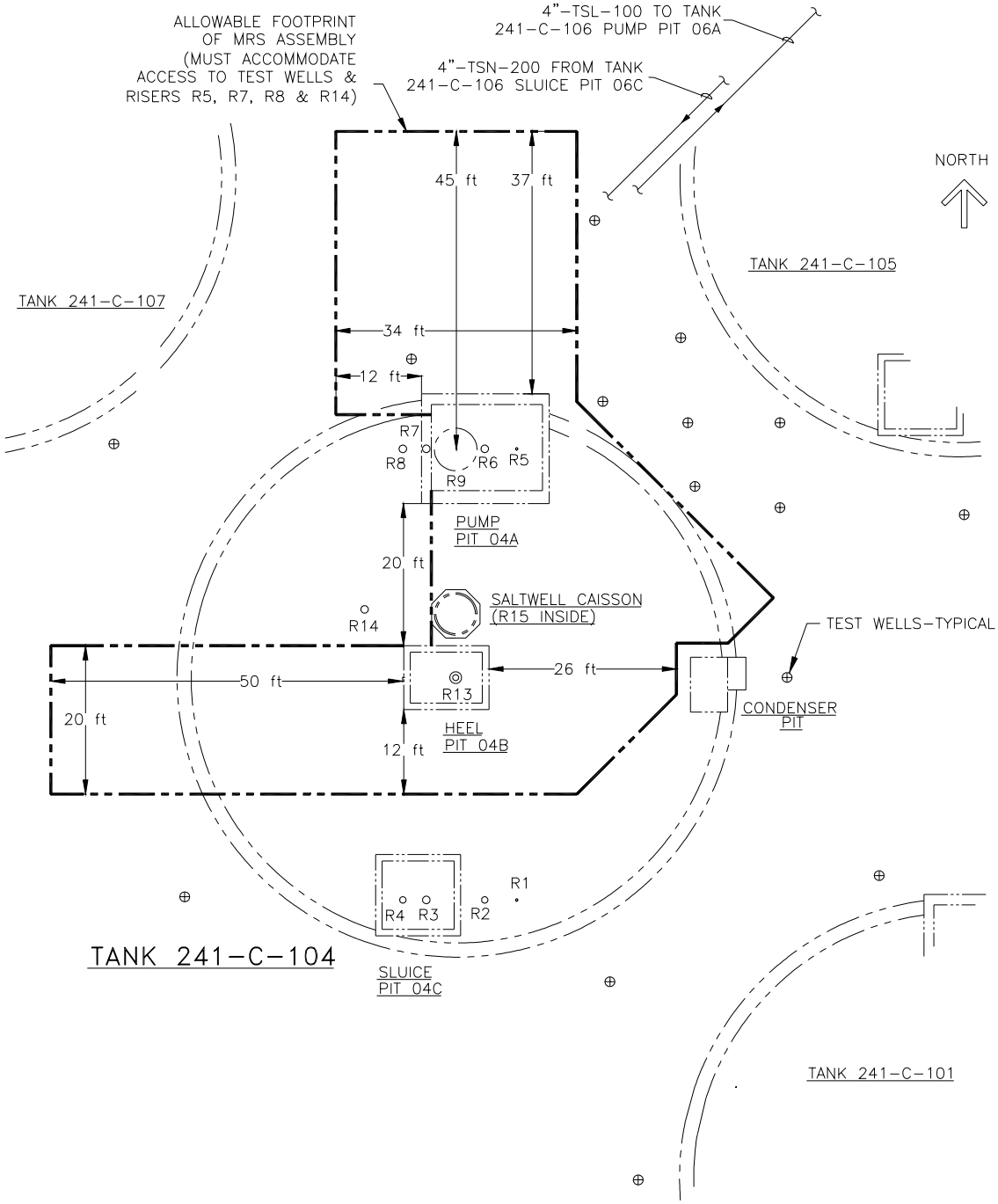
The deployment and installation location for the MRS is proposed in Figure 1-2. Also provided in RPP-7155, Rev. 0, and in Figure 1-2, is information detailing the allowable topside footprint and field constraints for the major system installation.

The long-term plan for the MRS equipment is to relocate it for use on another tank. This can be accomplished through refurbishment and/or robustness in construction. Ease of decontamination is critical to the success of this approach. A simple design is necessary to accomplish these objectives. The MRS design life and continued usability can be impacted during the course of the C-104 retrieval, so ease of disposal and storage container provisions are also incorporated into the design. Portions of the overall system may be left in place after the retrieval operation is completed, however addressing post waste retrieval disposal of equipment is expected.

## 1.4 DESCRIPTION OF SERVICES

A complete description of the services to be provided with the MRS is included in the Statement of Work. The services include qualification and functional testing of the MRS at both the MRS equipment manufacturer's plant and at the Hanford Site.

Figure 1-2. Allowable MRS Equipment Placement Diagram.



# 2.0 APPLICABLE DOCUMENTS

Design requirements applicable to the 241-C-104 MRS come from government and non-government source documents and various codes and standards consistent with the Tank Farm Contractor (TFC), contract (No. DE-AC27-99RL14047) in their application. Each document of the exact revision identified and discussed in this section is invoked by one or more requirements of this specification and represents a part of this specification to the extent specified.

## 2.1 GOVERNMENT DOCUMENTS

U. S. Department of Energy (DOE) orders, regulatory documents, including those promulgated by the Federal Government and Washington State, and the Hanford Site documents, constitute a part of this specification to the extent specified herein. In addition, some requirements are based on the existing authorization basis documents (e.g., *Tank Farm Final Safety Analysis Report*, HNF-SD-WM-SAR-067; and *Tank Farm Technical Safety Requirements*, HNF-SD-WM-TSR-006). If necessary, the authorization basis requirements may be changed after the analysis and justification of the resulting risks being incurred have been outlined in a final safety analysis report amendment and approval is obtained from the DOE Office of River Protection. The regulatory and Hanford Site documents that form a part of this specification are listed in Table 2-1.

Table 2-1. Government Documents.

| Document Number | Title |
|---|---|
| 29 CFR 1910, 1997 | "Occupational Safety and Health Standards," *Code of Federal Regulations.* |
| 40 CFR Subchapter R, et seq., 2000 | "Toxic Substances Control Act," *Code of Federal Regulations*. |
| HNF-SD-WM-ER-679, Rev. 0b, 2000 | *Tank Characterization Report for Single-Shell Tank 241-C-104*, CH2M HILL Hanford Group, Inc., Richland, Washington |
| RPP-5798, Rev. 0, 2000 | *Results of Retrieval Studies with Waste from Tank 241-C-104*, Fluor Hanford, Inc., Richland, Washington. |
| RPP-7155, Rev. 0, 2000 | *C Tank Farm and 241-C-104 Systems and Components Functionality Assessment Report*, CH2M HILL Hanford Group, Inc., Richland, Washington. |
| WAC 173-400, 1998 | "General Regulations For Air Pollution Sources," *Washington Administrative Code*, as amended |

Table 2-1. Government Documents.

| Document Number | Title |
|---|---|
| WAC 173-460, 1998 | "Controls For New Sources of Toxic Air Pollutants," *Washington Administrative Code*, as amended |
| WAC 246-247, 1998 | "Radiation Protection-Air Emissions," *Washington Administrative Code*, as amended |

## 2.2 NON-GOVERNMENT DOCUMENTS

National codes/standards listed in Table 2-2 constitute a part of this specification to the extent specified herein.

Table 2-2. Non-Government Documents.

| Document Number | Title |
|---|---|
| ANSI/ASME B30.20, 1993 | *Below-the-Hook Lifting Devices*, American Society of Mechanical Engineers, New York, New York. |
| ANSI/ASME N509, 1989 | *Nuclear Power Plant Air-Cleaning Units and Components*, American Society of Mechanical Engineers, New York, New York. |
| ANSI/ASME N510, 1989 | *Testing of Nuclear Air Treatment Systems*, American Society of Mechanical Engineers, New York, New York. |
| ANSI/AWS D1.1, 1996 | *Structural Welding Code/Steel*, American Welding Society, Miami, Florida. |
| ANSI/AWS D1.2, 1996 | *Structural Welding Code/Aluminum*, American Welding Society, Miami, Florida. |
| ANSI/IEEE C37.90.1, 1989 | *IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*, Institute of Electrical & Electronics Engineers, Inc., Piscataway, New Jersey. |
| ASCE 7-95, 1995 | *Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers, Reston, Virginia. |
| ASME AG-1, Article FC, 1997 | *Code on Nuclear Air and Gas Treatment*, American Society of Mechanical Engineers, New York, New York. |
| ASME B&PV, 1998 | *Boiler and Pressure Vessel Code*, American Society of Mechanical Engineers, New York, New York. |
| ASME B31.3, 1996 | *Chemical Plant and Petroleum Refinery Piping*, American Society of Mechanical Engineers, New York, New York. |

Table 2-2. Non-Government Documents.

| Document Number | Title |
|---|---|
| ASME NUM-1-2000, 2000 | *Rules for Construction of Cranes, Monorails, and Hoists (with Bridge, Trolley or Hoist of the Underhung Type),* American Society of Mechanical Engineers, New York, New York. |
| IEEE C62.41, 1991 | *IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits,* Institute of Electrical & Electronics Engineers, Inc., Piscataway, New Jersey. |
| IEEE STD-518-1982 | *IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources,* Institute of Electrical & Electronics Engineers, Inc., Piscataway, New Jersey. |
| IESNA, 2000 | *The IESNA Lighting Handbook,* Illumination Engineering Society of North America, New York, New York. |
| UBC, Volume 2, Chapter 16, Division III, 1994 | "Earthquake Design," *Uniform Building Code,* International Conference of Building Officials, Whittier, California. |
| UL508A Standard, 2000 | *Outline of Investigation for Industrial Control Panels,* Underwriter's Laboratories, Inc., Northbrook, Illinois. |

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# 3.0 REQUIREMENTS

## 3.1 MRS AND MRS MONITOR AND CONTROL SUBSYSTEM DEFINITION

The following functional description outlines *what* the MRS and MRS M&C must do to support the 241-C-104 waste retrieval mission. These functions are based on the applicable 241-C-104 WRS functions listed in Section 1.2, and functional analyses done for other projects (e.g., Hanford Tanks Initiative). The 241-C-104 WRS functions listed below are shown in bold; the functions that apply to the MRS and MRS M&C are shown in italic. The functions in italic and their performance requirements are discussed further in Section 3.2.1.

**Remove Waste from Tank 241-C-104**

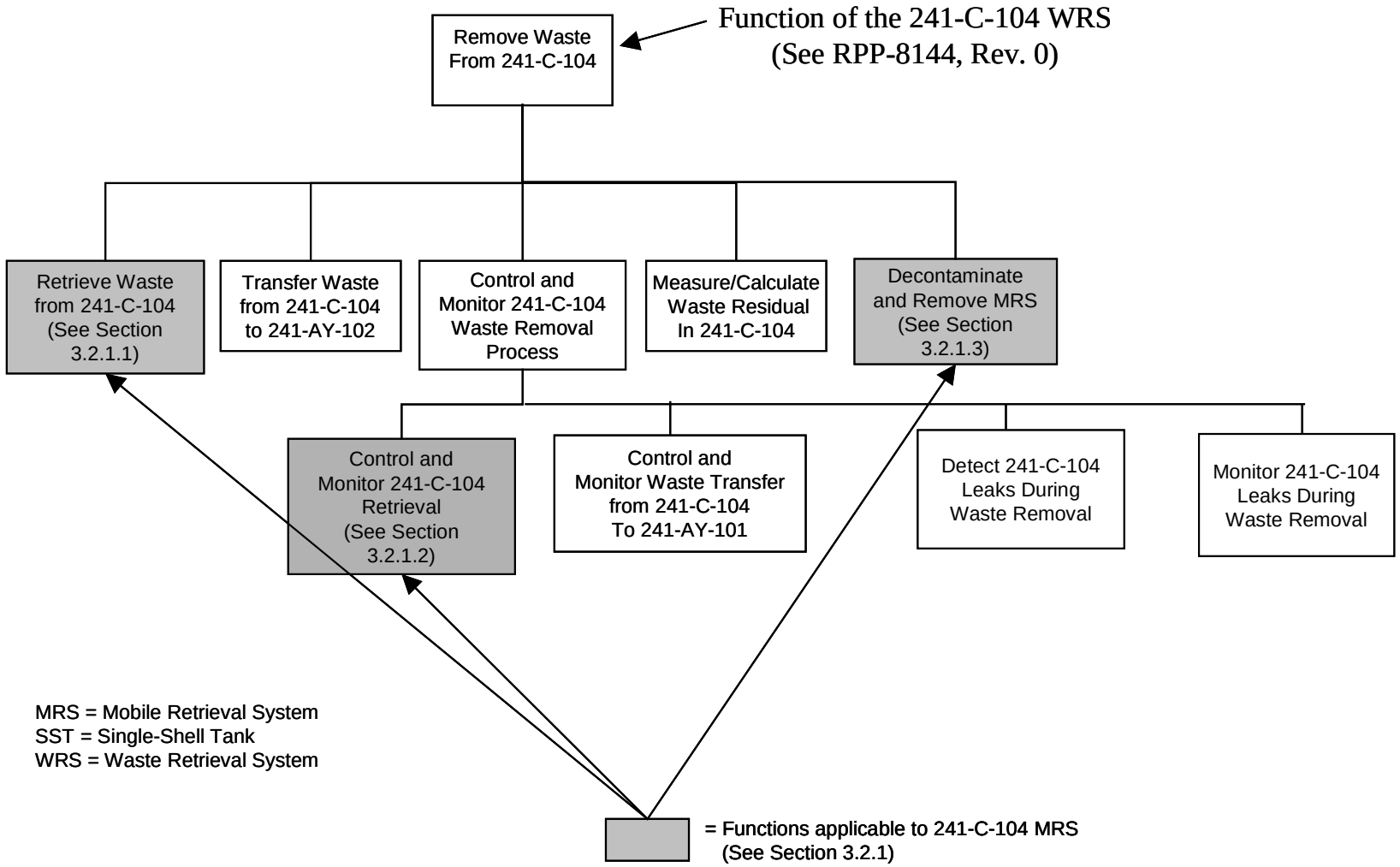
- *Retrieve Waste from tank 241-C-104*
- Transfer Waste from tank 241-C-104 to tank 241-AY-101 (Note: Not a function of the MRS)
- **Control and Monitor the Waste Removal Process**
  - *Control and Monitor Waste Retrieval*
  - Control and Monitor Waste Transfer (Note: Not a function of the MRS)
  - Detect 241-C-104 Leaks During Waste Removal (Note: Not a function of the MRS)
  - Monitor 241-C-104 Leaks During Waste Removal (Note: Not a function of the MRS)
- Measure/Calculate Residual Waste in 241-C-104 (Note: Not a function of the MRS)
- *Decontaminate and Remove the MRS*

Figure 3-1 shows these functions graphically in a functional hierarchy and provides a roadmap to the requirements associated with these functions contained in this specification. (Notice that these requirements and the MRS operational strategy [e.g., mining strategy] will be impacted by the activities currently taking place to define the Leak Detection, Monitoring and Mitigation [LDMM] scheme for tank 241-C-104. Requirements that will likely be impacted by these LDMM activities are marked with a “TBR” [to be refined] throughout this specification. A revision to this specification will be required to update the requirements marked with a “TBR” due to LDMM uncertainties as well as other “TBR” requirements.)

### 3.1.1 Subsystem/Component Diagrams

The MRS consists of the in/on-tank retrieval equipment, associated M&C equipment and utility distribution required to remove waste from 241-C-104. The in/on-tank retrieval system includes the mobile platform and the supporting equipment. The supporting equipment consists of waste dislodging, mobilization and in-tank conveyance, and umbilical enclosure and process equipment. Supporting equipment also includes the piping necessary to convey the waste stream through the 241-C-104 WRS waste transfer system. The utilities consist of electrical, water and

Figure 3-1. Functional Decomposition for the 241-C-104 MRS as Derived from 241-C-104 WRS Functions.



air distribution equipment needed to support the MRS when retrieving waste from tank 241-C-104 and removing the MRS from the tank.

Definition of the major sub-elements of the MRS will be accomplished during the system definition activities called out in *Tank 241-C-104 Waste Retrieval Services Statement of Work*, RPP-7734, Rev. 0. Figure 3-2 shows the MRS (refer to Figure 1-1 for context) and its relationship to the existing C farm equipment and to the other 241-C-104 WRS sub-elements.

### 3.1.2 Interface Definition

This section identifies the interfaces of the MRS. The following interface descriptions are intended to help define the subsystem boundaries and identify specific physical interfaces. These interface relationships are illustrated in Figure 3-2. This section discusses the inputs from these interfacing systems and facilities. Outputs from the MRS to other systems are discussed in Section 3.2.1

The MRS shall be designed to interface with the WRS. An interface boundary diagram is shown in Figure 3-3, with locations and interface requirements for each infrastructure support system, as well as all possible MRS to WRS waste injection points.

**3.1.2.1 Functional Interfaces.** The MRS shall interface with the following C Farm utilities, waste transfer infrastructure and control instrumentation. The interfaces currently have the following existing conditions.

- Electrical Input. The available power is 484 kVA of 3-phase power at 480 volts at 60 Hertz.
- Compressed Air Input. The available compressed air is 708 L/m (25 cfm) of dry compressed air at 690 kPa (100 psig).
- Water Input. The available raw water is supplied by a 5.1 cm (2 in.) line at 551 kPa (80 psig).

**3.1.2.1.1 Raw Water Limits.** The MRS shall be designed to minimize the usage of raw water during tank 241-C-104 retrieval and shall not exceed 120,000 gal (TBR) of raw water usage during the entire campaign. This includes raw water used for MRS back-flushing and decontamination (i.e., the limit applies to all in-tank raw water additions for the MRS). This does not include possible raw water usage outside the tank as long as it does not drain back into the tank. This limit also does not include the waste receiver tank raw water additions (currently designated as tank 241-AY-101) or transfer line flushes.

**3.1.2.1.2 241-C-104 Waste.** The MRS shall retrieve the tank 241-C-104 waste. A description of tank 241-C-104 waste is documented in the *Tank Characterization Report for Single-Shell Tank 241-C-104*, HNF-SD-WM-ER-679, Rev. 0b, and *Results of Retrieval Studies with Waste from Tank 241-C-104*, Rev. 0, RPP-5798.

Figure 3-2. 241-C-104 MRS Interfaces.

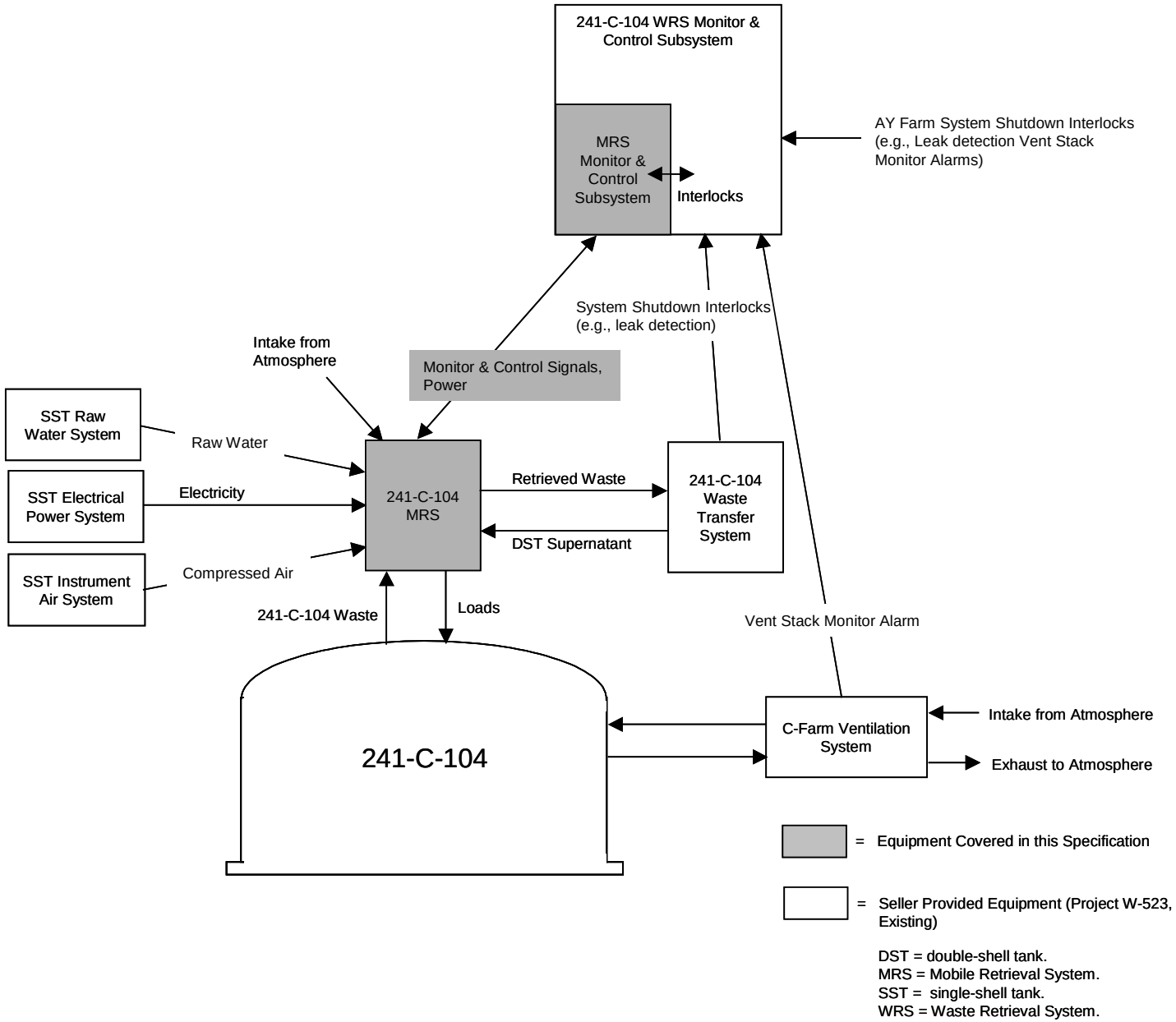
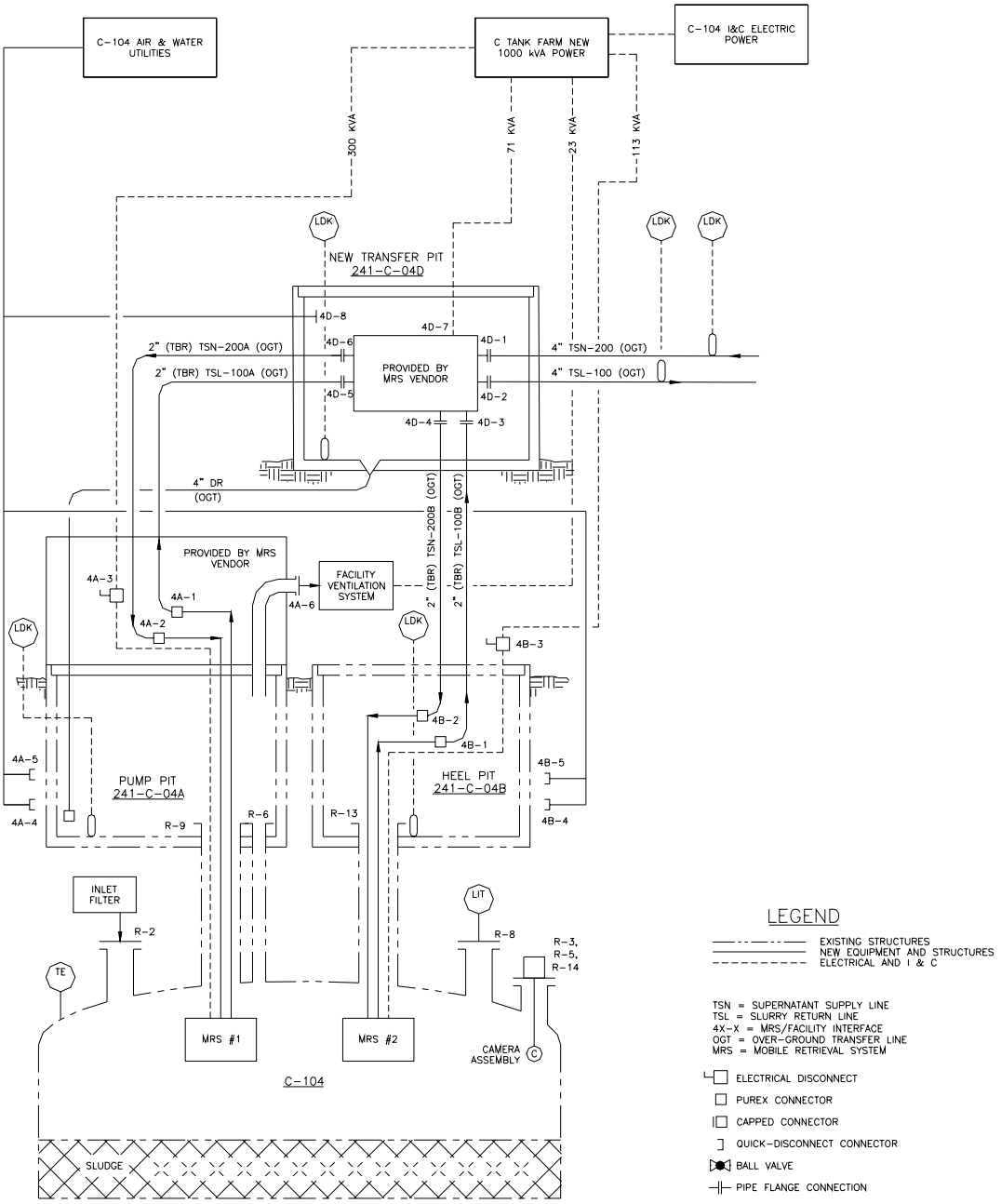


Figure 3-3. Boundary Interface Diagram.



**3.1.2.1.3 Double-Shell Tank Supernatant.** The MRS shall use double-shell tank supernatant having the following properties:

- Minimum flow rate of 17.7 L/s (280 gpm)
- Minimum pressure of 103 kPa (15 lbs/square in. gauge) (TBR)
- Specific gravity of up to 1.12 (10 percent solids by volume)
- Fluid temperatures between 27 C (80 F) and 49 C (120 F)
- Viscosity from 3 to 12 cP (TBR).

**3.1.2.1.4 MRS Allowable Air In-Leakage.** The MRS shall limit air in-leakage into tank 241-C-104 to a maximum of 100 scfm (TBR) during normal operation.

3.1.2.1.4.1 Air Flow Direction. The MRS shall be designed such that airflow is from the MRS into tank 241-C-104. See Section 3.2.5.2 for expected tank 241-C-104 pressures and 3.3.6.3.1 for additional MRS airflow design features.

**3.1.2.1.5 MRS Control System Interfaces.**

a. **System Interlocks**. The MRS shall be designed to respond to interlock signals from the 241-C-104 WRS M&C system.

b. **In-Tank Video**. The MRS shall be designed to operate with a maximum of three TFC video cameras. The TFC will provide up to three overview in-tank video systems, if needed, to assist with MRS control. The cameras will be deployed in risers 3, 5 and 14. See Figure 3-4.

**3.1.2.2 Physical Interfaces.** The MRS shall physically connect to the following waste tank infrastructure. The deployment and installation location for the MRS is proposed in Figure 1-2. Also provided in RPP-7155, Rev. 0 and Figure 1-2, is information detailing the allowable topside footprint and field constraints for the subsystem installation.

**3.1.2.2.1 Tank Interfaces.** The MRS shall interface with tank 241-C-104 at one or more of the pits located above the tank (H-2-73344, Rev. 4) and separate risers located above the tank. The three rectangular, reinforced concrete pits contain risers (pipes) that may be used for the installation and operation of the MRS equipment. In addition to these pits, other risers are also available above grade. The inside clearance dimensions are planned to be confirmed by TFC prior to the start of design. The interface point with the risers is either a flange located inside the pit or as otherwise defined in the applicable drawings. The MRS may need to interface with existing tank risers that are off vertical and out of round and still achieve an airtight seal to the riser.

- Pump Pit Interfaces. The pump pit (241-C-04A) is located on the north side of the tank. The pump pit contains a 30-in. (TBR) riser (R9), a 12-in. riser (R6) and a 4-in. riser (R5). See drawing H-2-41343.

- Sluice Pit Interfaces. The sluice pit (241-C-04C) is located on the south side of the tank. The pit contains a 4-in. riser (R4) and a 12-in. riser (R3). Riser (R3) can also be contacted above the pit cover block due to a through block penetration. See drawing H-2-41344.

- Heel Pit Interfaces. The heel pit is located in the approximate center of the tank. The pit contains an 18-in. riser (R13) that reduces to a 12-in. at the tank dome interface. See drawing H-2-41345.

- HVAC Pit Interface. The HVAC hatchway is located on the east side of the tank. Inside the hatchway allows indirect access to the tank though two right angles. See drawing HW-72743.

- Salt Well Pump Pit Interface. The salt well pump pit is listed to contain a 12-in. riser (R15).

- Riser interface available above grade includes a 4-in. riser (R14), a 4-in. riser (R8), 12-in. riser (R7), and a 12-in. riser (R2).

- Below grade riser interface includes a 4-in. riser (R1).

Table 3-1 and Figure 3-4 identify the estimated size, general location, use description, and obstruction details**.**

Table 3-1. Estimated Riser Configuration Summary.

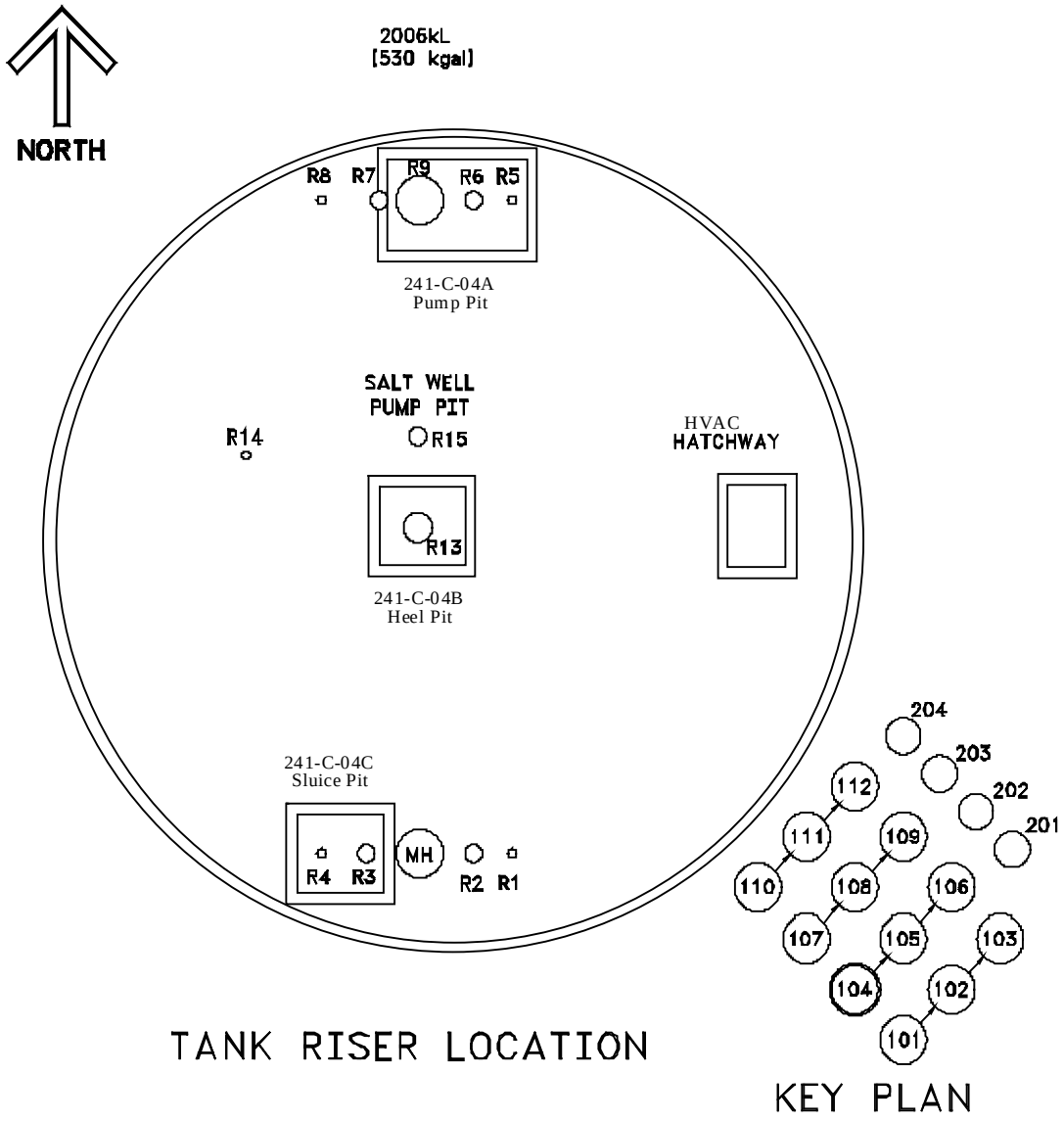
| Riser # | Minimum Diameter (inches) | Description | Access | Objects in Riser |
|---|---|---|---|---|
| R1 | 4 | Spare | Below grade | -- |
| R2 | 10 | Breather Filter | Above grade | Process drain line blocking access to tank |
| R3 | 12 | Observation Port | Above grade | -- |
| R4 | 4 | Recirculating Dip Leg | Inside pit 04C | 3 in. pipe, traveling from riser to waste |
| R5 | 4 | Spare | Inside pit 04A | -- |
| R6 | 12 | Pump | Inside pit 04A | 4 in. pipe, traveling from riser to waste |
| R7 | 12 | Temperature Probe | Above grade | 3 in. pipe, traveling from riser to waste |
| R8 | 4 | Level Gauge, Enraf | Above grade | 3 in. pipe, traveling from riser to 5 ft into dome space, Level gauge cable extends down to contact waste |
| R9 | 30 | Sludge Pump | Inside pit 04A | 4 in. pipe, traveling from riser to waste |
| R13 | 12 | Salt well Screen and Pump | Inside pit 04B | 10 in. pipe, traveling from riser to waste |
| R14 | 4 | Spare / Blind Flange | Above grade | -- |
| R15 | 12 | Salt Well Pit | Inside pit | -- |
| HVAC | 36 | Condenser Pit | Inside HVAC pit | -- |

Notes:

Table data derived from in-tank photos, videos, and drawings.

CHG is also responsible for all site preparation, including obstruction removal, cover block removal, pit preparation, and currently existing in-tank hardware removal, as required by the MRS design. This also includes design and preparation of the WRS structures, systems, and components.

Figure 3-4. Tank 241-C-104 Plan View and Riser Location.



**3.1.2.2.2 Waste Slurry Interface.** The MRS shall connect to the waste transfer pipeline in a new transfer pit provided by the TFC or other agreed upon connection points. The mating female connector will be supplied by the TFC for installation on the MRS. See boundary interface drawing (Figure 3-3).

**3.1.2.2.3 Supernatant Interface.** The MRS shall connect to the supernatant pipeline in a new transfer pit provided by the TFC or at other agreed upon connection points. See boundary interface drawing (Figure 3-3). The mating female connector(s) will be provided by the TFC for the MRS integration into the WRS.

**3.1.2.2.4 Ventilation Access**. The MRS shall provide a 12 inch (TBR) pipe flange for active tank 241-C-104 ventilation.

### 3.1.3 Major Component List

See Section 3.1.1.

## 3.2 CHARACTERISTICS

### 3.2.1 Performance Characteristics

**3.2.1.1 Retrieve Waste from Tank 241-C-104.** A goal of removing 99% of the tank contents by volume shall be targeted for the initial waste retrieval. The waste volume includes all liquids remaining in the tank at the completion of the retrieval operations. Metal tapes, rocks, debris, abandoned equipment, waste transfer line flush water, and final decontamination water are excluded from the waste volume.

**3.2.1.1.1 Retrieval Duration**. The MRS shall be capable of completing retrieval of tank 241-C-104 waste within 145 days.

**3.2.1.1.2 Slurried Waste Output.** The MRS shall retrieve slurried tank waste having the following properties:

- Liquid density – 1.1 to 1.4 kg/L (TBR)
- Liquid viscosity* – 10 to 100 cP (TBR)
- Slurry temperature – 80 to 120 degrees F
- Solids density – 2.5 to 3.0 kg/L (TBR)

* Note that the mobilized slurry may have a viscosity as high as 460 cP at pump startup.

3.2.1.1.2.1 Design Pressure. The MRS shall inject slurried waste into the waste transfer pipeline at a minimum of 130 psig, such that the piping system design pressure is not exceeded.

3.2.1.1.2.2 Flow Rate. The MRS shall inject slurried tank 241-C-104 waste into the slurry return line at the 241-C-04D transfer pit at a minimum flow rate of 280 gpm at 10% solids by volume and a maximum of 325 gpm at 30% solids by volume.

3.2.1.1.2.3 Maximum Output Particle Size. The maximum particle size of material injected into the pipeline by the MRS shall not exceed that which is capable of being transported without settling in the WRS transfer system.

3.2.1.1.2.4 Entrained Gas. The MRS shall not inject more than 2.83 $m^3$ per minute (100 cfm) of air at standard conditions into the slurry waste transfer line.

**3.2.1.1.3 Free Standing Liquid**. The MRS shall limit the free standing liquid in tank 241-C-104 to less than 7.6 cm (3 in.), or 34,100 L (8,200 gal) over the entire surface of the waste at any given time. This limit does not apply to 'pockets' or waste valleys.

**3.2.1.1.4 Existing In-Tank Hardware.** The MRS shall be capable of unencumbered operation in and around existing tank 241-C-104 "in-tank hardware, " e.g., installed equipment, abandoned thermocouple trees, 50-100 ft. steel tapes, plummets, plastics, gloves, etc. The removal of such debris is not required.

**3.2.1.2 Control and Monitor of 241-C-104 MRS.** The 241-C-104 MRS M&C shall monitor and control the MRS waste removal based on operation input and signals received from 241-C-104 WRS M&C system.

**3.2.1.2.1 Remote Operation.** The MRS shall be operated from a control station outside the C-farm fence, at a distance of less than 108 m (350 ft), or from a control station inside the C-farm fence.

**3.2.1.2.2 Waste Retrieval System Emergency Stop Feature.** The MRS shall have a field located and a remotely located emergency stop feature that will shut down prescribed MRS functions, to be determined in design review.

**3.2.1.2.3 Waste Retrieval (Transfer) Pump Administrative Lock Controls.** The MRS shall have an administrative lock control feature that removes and secures the motive power from the waste retrieval pump. The administrative lock and the administrative lock program will be the responsibility of the TFC Operations. The location of the lock will be determined by the MRS equipment design.

**3.2.1.2.4 Equipment Observation.** The MRS shall include visual observation systems in all enclosures (TBR).

**3.2.1.3 Decontaminate and Remove the MRS.** The MRS in-tank equipment shall be decontaminated, measured for radiation, and removed from tank.

**3.2.1.3.1 Decontamination Fluid.** The MRS shall be capable of withstanding the use of water/TFC approved cleaning solutions as the decontamination fluid at a maximum flow rate of 3.2 L/s (50 gpm) at 20,700 kPa (3000 psi) and less than 65 °C (150 °F), without damage, during the decontamination process. The TFC will provide the raw water supply for decontamination.

**3.2.1.3.2 Radiation Measurement.** The MRS shall measure the radiation levels (e.g., beta, gamma, alpha) of the MRS equipment after decontamination (i.e., after it has passed

through a decontamination system) at locations within the MRS enclosure(s), dependent on design.

**3.2.1.3.3 Radiation Levels.** The MRS shall be capable of measuring radiation levels between 0.02 mSv/hr (2 mrem/hr) and 50 mSv/hr (5 rem/hr) above background within the MRS enclosures.

**3.2.1.3.4 MRS Removal.** The MRS shall be capable of removal of in-tank hardware for the purpose of maintenance at any time after the initial deployment and at the completion of the waste retrieval campaign.

### 3.2.2 Physical Characteristics

#### 3.2.2.1 Load Limitations.

**3.2.2.1.1 MRS Load Limitations.** The MRS shall apply no more than $4.45 \times 10^5$ N (50 tons) of concentrated dead plus total live loads (including initial installation cranes) to the soil above the 241-C-104 tank dome or 6.1 m (20 ft) radially outboard of the tank wall (32 m [105 ft] diameter).

**3.2.2.1.2 Allowable Loads on Tank Bottom.** The bottom surface of the tank may be used to support in-tank equipment. The maximum load exerted by the MRS shall not exceed the value given by the formula:

W (N) = ½ x 4380 kg x (load area diameter [cm.] + 10.8)

W (lbf) = ½ x 2,500 lbs x (load area diameter [in.] + 4.25)

(Note: The factor of one half is to account for the uneven distribution of load resulting from tank curvature, waste solids remaining, etc.)

**3.2.2.1.3 Riser Loads.** The MRS shall access, align with, and deploy into tank 241-C-104.

3.2.2.1.3.1 Maximum Loads. The maximum imposed axial loads and moments on risers shall be determined on a case by case basis. The following provides general guidance for the design. The final determination will be provided by the TFC at the initial conceptual design review.

- Four Inch Risers. The MRS should impose axial loads on 4 in. risers of no more than 227 kg (500 lb) or impose a moment of no more than 339 N.m (250 ft-lbs) unless specific, approved calculations indicate higher loads are acceptable.

- Twelve Inch or Larger Risers. The MRS should impose axial loads on 12 in. or larger risers of no more than 1362 kg (3000 lb) or impose a moment of no more than 2034 N.m (1,500 ft-lbs) unless specific, approved calculations indicate higher loads are acceptable.

**3.2.2.2 Waste Transfer Covers.** The MRS cover blocks, covers doors, and hatches shall be designed so that the installed condition can be verified (normally visual verification) prior to the start of waste retrieval and transfer operations and on a periodic basis thereafter. Movement of cover blocks will follow requirements stated in Section 3.3.1.12.

**3.2.2.3 241-C-104 MRS M&C.** The MRS M&C station shall be co-located with the WRS M&C, less than 350 ft from tank 241-C-104 in a non-controlled area. There is approximately 450 $ft^2$ of space available in the existing operations trailer, MO-211, for the MRS M&C. Trailer MO-211 is located less than 350 ft from tank 241-C-104 in a non-radiological control area outside the C Farm fence. A separate monitoring station may be designed for the M&C.

### 3.2.3 Reliability

Component selection shall be made based upon proven performance history, robustness, and integrated system failure analysis.

**3.2.3.1 Reuse.** The MRS shall be designed for reuse.

**3.2.3.2 Equipment Connections.** The MRS connection points shall be capable of withstanding anticipated dynamic loads and stresses. Drop test data and tensile strength test data is addressed in the Statement of Work.

**3.2.3.3 Failure Recovery.** The MRS design shall provide for the possibility of partial or complete replacement should catastrophic system failure occur. Failure recovery and redundant design approaches will be used to augment MRS reliability.

**3.2.3.4 Design Life.** The design life of MRS components shall satisfy the following:

a. In-tank MRS equipment – 1 year.

b. Pit enclosures and contained equipment – 5 years with limited planned preventative maintenance.

### 3.2.4 Maintainability

**3.2.4.1 Modularity.** The MRS design shall be constructed of modular and easily replaceable subsystem components.

**3.2.4.2 Component Accessibility.** MRS components shall be designed for handling and maintenance by personnel wearing contamination protection clothing.

**3.2.4.3 Special Tools.** Special tools for maintenance of MRS components shall be identified, provided, and available on site in accordance with the Statement of Work.

**3.2.4.4 Spare Parts.** A full complement of spare parts shall be provided with the MRS in accordance with spare parts requirements in the Statement of Work. Special consideration will be given to catastrophic failure modes and expedient recovery.

### 3.2.5 Environmental Conditions

**3.2.5.1 MRS Ex-Tank Environment.** MRS Ex-Tank Environment. The MRS shall be designed for outdoor installation and use on the Hanford Site, consistent with the design of a performance category '2' (PC-2) system. The corresponding environmental (ex-tank) conditions for the Hanford Site are as follows:

- Temperatures ranging from -34°C (-30°F) to 47°C (117°F)
- Relative humidity ranging from 5% to 100%
- Rainfall up to 2.5 in. in 6 hours
- Frequent dust storms and blowing sand (at least 5 days/yr)
- Solar radiation up to 900 langleys

The *Uniform Building Code* (UBC 1994) and ASCE 7-95 shall be used as the minimum basic design load requirements for the MRS. This includes design of MRS structures and components, and their anchorage, to withstand loads associated with the operation of the system and the effects of natural phenomena hazards, including dead, live, snow, wind, and earthquake loads. Minimum unit weights of materials and components are those given in ASCE 7-95, or as documented in manufacturers' data. Minimum live loads are as stipulated in ASCE 7-95, with a minimum roof live load of 20 lb/sq.ft. Snow loads, calculated in conformance with ASCE 7-95 based on a ground snow load of 15 lb/sq.ft, are to be substituted for roof live loads where such loading results in higher stresses. Wind load design is based on ASCE 7-95 using the following site-specific parameters:

| | |
|---|---|
| 3-second gust wind velocity: | 85 mi/hr (38 m/s) |
| Importance Factor: | 1.07 |
| Exposure Category: | C |

Seismic design is based on UBC 1994 requirements, as specified in Sec. 3.3.7.2.3, "Damage to Tank 241-C-104".

If the above grade or in-pit portions of the MRS are in communication with the tank dome space, Ignition Source Control Set '2' (ISC-2) design features are also required. The TFC Flammable Gas Equipment Advisory Board (FGEAB) will be available to assist in interpretation of MRS equipment design requirements.

**3.2.5.2 MRS In-Tank Environment.** The MRS shall operate within the following in-tank environmental conditions:

a. In-tank radiation dose rate:

- The penetrating dose at the waste surface is estimated to be 57 rad/hr.
- The penetrating dose at the riser bottoms in the dome space is estimated to be 39 rad/hr.
- The nonpenetrating dose at the waste surface is estimated to be 565 rad/hr.
- Dose rates to equipment submerged in the waste material would be roughly double the surface numbers.

- Primary nuclide gamma energy is $^{137}Cs$ at 0.667 MeV
- Primary nuclide beta energy is $^{90}Y$ at 2.281 MeV.

b. In-tank humidity range – 10% to 100%

c. Waste pH range – greater than 12.0 (prior to dilution)

d. Temperature range – 20.8 °C (80 °F) to 45.7 °C (100 °F)

e. Vapor space Pressure – -0 Pa to -2250 Pa (-0 in. w.g. to -9 in. w.g.) (TBR)

f. Flammable Gas – Hydrogen, Ammonia, Methane.

g. Debris – 10 cm. (4 in.) diameter x 6.1 m (20 ft) length of pipe, 12.2 m (40 ft) long steel tapes (1.3 cm. [0.5 in.] x 0.16 cm. [0.0625 in.]), rubber/leather gloves, rocks, 0.5 in. diameter rope and cable are possible items that may be encountered during retrieval.

## 3.3 DESIGN AND CONSTRUCTION

### 3.3.1 Materials, Processes, and Parts

**3.3.1.1 MRS Lead Usage.** Lead shall not be used in the MRS unless fully hard encapsulated (i.e., polymer wrapped, embedded within enclosure walls or floor, etc.), identified and approved.

**3.3.1.2 TSCA Listed Substances.** The MRS shall exclude all 40 CFR Subchapter R, Toxic Substances Control Act listed materials, including polychlorinated biphenyls.

**3.3.1.3 MRS In-Tank Equipment Hydraulic Fluid.**

**3.3.1.3.1 Hydraulic Fluid.** The MRS equipment shall use only hydraulic fluid that is approved by the TFC or Shell Tellus 32* for in-tank equipment.

**3.3.1.3.2 Loss of Fluid.** The maximum credible loss of hydraulic fluid in an accident scenario shall be less than 285 L (75 gal). There are no requirements for the MRS to recover the lost fluid should there be leaks.

**3.3.1.4 Materials Restrictions.** The MRS shall not deliberately add material to the waste other than the water that is used in the retrieval and decontamination processes or supernatant from the waste transfer recirculation line.

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* Tellus is a registered trademark of Shell Oil Company Corporation.

**3.3.1.5 Process Piping.** Process piping shall conform to the requirements of ASME B31.3-1996, *Chemical Plant and Petroleum Refinery Piping*, normal service. Jumpers will include features that allow the introduction of water after installation to verify that the PUREX connectors are leak tight.

**3.3.1.6 Process Piping Temperature.** The MRS process piping shall be designed to handle fluids with a maximum temperature of 80 °C (176 °F).

**3.3.1.7 Welding.** Welding of MRS structures and components shall be in accordance with the requirements of ANSI/AWS D1.1, ANSI/AWS D1.2, Section IX of the ASME *Boiler and Pressure Vessel Code*, or other TFC approved national welding standard.

**3.3.1.8 MRS HEPA Filter Assemblies.** HEPA filter assemblies for the MRS confinement shall be designed in accordance with *Code of Nuclear Air and Gas Treatment*, AG-1, and *Nuclear Power Plant Air-Cleaning Units and Components*, ASME N509.

**3.3.1.8.1 MRS HEPA Filter Testing.** HEPA filter assemblies shall meet the testing requirements stated in *Testing of Nuclear Air Treatment Systems*, ASME N510. Acceptance criteria for in-place leak tests for HEPA filters shall be 0.05% maximum penetration.

**3.3.1.9 MRS Confinement Boundary.** The MRS confinement boundary shall be designed for a maximum pressure of +10 in. w.g.

**3.3.1.10 Electrical Codes and Standards.** The MRS shall comply with industry electrical codes and standards.

**3.3.1.10.1 Electrical Design.** Electrical design shall use Underwriter's Laboratory (UL) listed components, or components listed through other Nationally Recognized Testing Laboratories (NRTL), where available.

**3.3.1.10.2 Cabinet Design.** Cabinets containing assembled monitoring and control systems shall be designed and constructed to the UL508A Standard, or be inspected and tagged either by a state licensed inspector, or by an authorized Hanford NEC inspector.

**3.3.1.11 Ultraviolet Resistant Components.** The MRS components (e.g., elastomers) subjected to the ex-tank environment specified in Section 3.2.5.1.1 shall be resistant to and continue to function as designed while exposed to ultraviolet solar radiation for up to 3 years before requiring replacement.

**3.3.1.12 MRS Equipment Portability.** The MRS shall be designed to allow the equipment to be installed, transported in the field, and dismantled; either easily disposable equipment or appropriate storage containers are required. The following standards will be used where applicable to the design.

- All built-in hoisting equipment that is part of the MRS will, as a minimum, conform to ASME NUM-1-2000, *Rules for Construction of Cranes, Monorails, and Hoists (with Bridge, Trolley or Hoist of the Underhung Type)*. Hoisting equipment designs, tests and

reports will be submitted to the TFC for safety evaluation and approval during design review.

- Below-the-Hook Lifting Device Requirements. Structural and mechanical below-the-hook lifting devices, as defined by ANSI/ASME B30.20, *Below-the-Hook Lifting Devices*, will conform to the requirements of B30.20. The lifting attachment(s) on the equipment (lifting eyes, lugs, ears, etc) will be designed to maintain a safety factor of 3 against yield. Documentation will be submitted as evidence that the appropriate welding codes, qualified welders, non-destructive examination procedures, testing requirements, etc., have been used. Calculations stamped by a registered Professional Engineer will be provided for the design of all hoisting and rigging equipment and lifting points (of those regulated by B30.20).

- All critical welds on lifting devices will be full-penetration welds, if possible, and will be verified by magnetic particle testing or other non-destructive examination subject to the TFC approval. Critical welds are those welds where failure will result in loss of load or loss of load control.

- Below-the-Hook Lifting Device Markings. The MRS structural and mechanical below-the-hook lifting devices will be provided with identification. The identification will include total gross weight for lifting purposes, lifting attachments clearly indicated, and special lifting instructions. The identification will be in the form of a name tag, name plate, or other permanent marker displaying the following data:

  - Rated load
  - Lifting device weight, if over 45.4 kg (100 lb)
  - Drawing number (if applicable)
  - Serial number (if applicable).

### 3.3.2 Electromagnetic Radiation

**3.3.2.1 Radio Frequency Interference Susceptibility.** MRS control circuit functions shall not be interrupted when subjected to a 30 V/m electric field in the frequency range of 20 to 500 MHz.

**3.3.2.2 Surge Protection in AC Power Circuits.** Any electrical supply or monitoring and control circuitry utilized by the MRS shall be designed in accordance with the recommended practice on surge protection of AC power circuits found in IEEE C62.41.

**3.3.2.3 Surge Withstand Capability.** The applicable portions of the MRS (e.g., protective relays and relay systems) shall be designed to withstand the surge test waveforms of ANSI/IEEE C37.90.1.

**3.3.2.4 Equipment Installation and Wiring Practices.** The MRS shall be designed in accordance with the equipment installation and wiring practices given in IEEE STD-518, Section 6.

### 3.3.3 Identification and Marking

See Statement of Work.

### 3.3.4 Workmanship

The MRS shall be constructed to the following industry Codes and Standards.

**3.3.4.1 Fabrication Welds.** Fabrication welds on containment boundaries, lifting devices, structural components and at other critical locations shall be performed by certified welders and to ANSI/AWS D1.1, D1.2. The TFC will need to approve of other welding standards the vendor proposes.

**3.3.4.2 Electrical Components.** Electrical components shall meet national standards, or shall be approved by onsite NEC inspectors.

**3.3.4.3 Pressurized Components.** Pressure retaining components shall be selected, designed and constructed to national standards.

### 3.3.5 Interchangeability

The 241-C-104 MRS design shall incorporate standardization of like-function components and selection will consider documented performance history in similar environments.

### 3.3.6 Safety

#### 3.3.6.1 Personnel Safety.

**3.3.6.1.1 Radiation Shielding.** Radiation shielding shall be provided for the MRS equipment to maintain the worker exposure dose rates at less than 0.02 mSv/hr (2 mrem/hr) during operation. Dose rates are at the point of exposure, i.e., where a worker would be positioned during the operation of the retrieval equipment and is based on allowable access time to the tank farm of less than one hour per day. Construction, operation and maintenance activities, governed by the as low as reasonably achievable principles, are evaluated on a case-by-case basis, and may require the use of temporary shielding.

**3.3.6.1.2 Industrial Safety.** The MRS shall be designed for safe installation, operation, and maintenance in accordance with 29 CFR 1910, Subparts D, E, G, J, L, M, O, and S, as applicable.

3.3.6.1.2.1 Industrial Safety Hazards Identification. All hazards and potential safety issues associated with installation, operation, and maintenance of the MRS shall be identified and documented, including but not limited to chemical, thermal, nuclear, pneumatic, hydraulic, mechanical, and electrical hazards.

**3.3.6.2 Equipment Protection**.

**3.3.6.2.1 In-Tank Flammable Gases.** The MRS equipment operating inside waste tank 241-C-104 (within and connected to the tank dome space) shall conform to the TFC ignition source control design requirements. Compliance to these design requirements will be determined by evaluation of the proposed design by the Flammable Gas Equipment Advisory Board. Hazardous location region interpretation will also be determined by the Flammable Equipment Gas Advisory Board when specific tank applications are determined for the MRS deployment and operation.

**3.3.6.2.2 Maximum Waste Temperature Limit.** The MRS shall not cause or produce global or localized waste temperatures in excess of 149 °C (300 °F).

**3.3.6.2.3 Damage to Tank 241-C-104.** The MRS shall not damage tank 241-C-104 during a seismic event or any phase of installation, operation, or removal. Structures and portions thereof will, as a minimum, resist the effects of seismic ground motions as provided in the *Uniform Building Code*, Volume 2, Chapter 16, Division III, "Earthquake Design," for seismic zone 2B. Additional seismic requirements may be imposed on systems, structures or components designated as "safety class" or "safety significant" in the safety analysis. Damage will be defined as penetration of the tank steel liner as defined in Appendix B.

**3.3.6.3 Environmental Safety.**

**3.3.6.3.1 MRS Confinement.** The MRS shall provide confinement around tank openings utilized by the MRS.

3.3.6.3.1.1 MRS Confinement Design. The MRS design shall also provide the following features to ensure confinement of tank 241-C-104 gases:

a. Ventilation. Ventilation by means of atmospheric breathing or normal in-leakage ( see 3.1.2.1.4) of any MRS enclosure that may contain waste.

b. Isolation. Capability to be isolated from the tank atmosphere without interfering with normal tank ventilation.

c. Passive Breathing. Capability of operating in a passive breathing mode in the absence of active tank 241-C-104 ventilation.

**3.3.6.3.2 Secondary Containment and System Leak Detection.** The MRS shall have secondary containment and leak detection/alarm systems to ensure leaks are detected and contained in the MRS secondary containment (e.g., the presence of waste or liquid in the secondary containment system).

**3.3.6.3.3 Waste Pipe Gravity Drain.** The MRS process piping systems shall gravity drain into 241-C-104.

**3.3.6.3.4 Non-Radioactive Airborne Emissions**. The MRS shall be designed to comply with non-radioactive airborne emissions requirements contained in WAC 173-400 and WAC 173-460. Non-radioactive airborne emissions from other 241-C-104 WRS components,

C Farm, other tank farms, and other Hanford Site major facilities will be considered when designing the MRS to be compliant with WAC 173-400 and WAC 173-460.

**3.3.6.3.5 Radioactive Airborne Emissions**. The MRS shall be designed to comply with radioactive airborne emissions requirements contained in WAC 246-247. Radioactive airborne emissions from other 241-C-104 WRS components, C Farm, other tank farms, and other Hanford Site major facilities will be considered when designing the MRS to be compliant with WAC 246-247.

### 3.3.7 Human Performance/Human Engineering

**3.3.7.1 MRS Ease of Operation.** The 241-C-104 MRS shall be designed for easy operation by including end user input on operational features.

**3.3.7.2 Lighting.** The MRS shall light interior and exterior MRS work areas, as appropriate, in accordance with the illumination values given in Figure 11-1 of *The IESNA Lighting Handbook* (IESNA 2000). The TFC will provide in-tank overview video systems for viewing of the MRS activities.

### 3.3.8 Decontamination and Decommissioning

**3.3.8.1 Waste Pipe Flushing.** The MRS contaminated process piping systems shall permit flushing with raw (filtered river) water. See Section 3.3.1.5.

**3.3.8.2 MRS Radiological Design.** The MRS design shall minimize inaccessible pockets, crevices, blind holes, and rough surfaces that could trap contamination. Metal surface finishes of 125 arithmetic average (rms) or less are required.

**3.3.8.3 MRS Decontamination Subsystem.** The MRS decontamination subsystem and maintenance process controls shall be designed to ensure field worker exposures do not exceed acceptable working levels. A maximum residual (post decontamination) worker exposure level of 20 mrem/hr at 30 cm should be targeted. A residual exposure level of 5 mrem/hr at 30 cm, or less, is highly desirable.

**3.3.8.4 Retrieval of Failed Waste Retrieval System Equipment.** The MRS in-tank components shall be retrievable from tank 241-C-104 in the event of failure(s).

**3.3.8.5 Removability.** The MRS in-tank components shall be designed for removal from 241-C-104 after the completion of waste retrieval operations and at any time following deployment into the tank.

### 3.3.9 Nuclear Safety

Nuclear safety requirements shall be determined by the hazardous conditions associated with deployment and operation of the MRS as evaluated in the TFC hazards analysis. Required design attributes will be established during design.

## 3.4 DOCUMENTATION

See Statement of Work.

## 3.5 LOGISTICS

### 3.5.1 Maintenance

See Statement of Work.

### 3.5.2 Supply

Not applicable to this task.

### 3.5.3 Facilities and Facility Equipment

Not applicable to this task.

## 3.6 PERSONNEL AND TRAINING

See Statement of Work.

## 3.7 MAJOR COMPONENT CHARACTERISTICS

Major component characteristics will not be specified.

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# 4.0 DESIGN REQUIREMENTS VERIFICATION

## 4.1 GENERAL

Design requirements verification shall be performed on the MRS as represented in design drawings, prototypes, engineering models, etc., for the purpose of verifying that the design meets the requirements stated in Section 3.0 of this specification.

### 4.1.1 Location

Design verifications shall be conducted at the TFC facilities or at other facilities subject to the TFC approval.

### 4.1.2 Responsibility

**4.1.2.1 MRS Design.** The MRS design requirements shall be verified in accordance with this specification.

**4.1.2.2 MRS Equipment.** The MRS equipment shall be inspected and tested in accordance with this specification.

**4.1.2.3 MRS Supporting Documentation.** MRS designs and inspections shall be documented in accordance with the Statement of Work.

## 4.2 DESIGN REQUIREMENTS VERIFICATION

### 4.2.1 Design Verifications

Design requirements verifications shall be conducted in accordance with the TFC procedures.

### 4.2.2 Compliance

Design requirements verifications shall provide assurance of compliance with the requirements of this specification.

(Note: Field verification, which takes place during the construction and turnover phases of the project life cycle, is not addressed in this specification).

### 4.2.3 Design Media

Design requirements verification shall be performed on the MRS as represented in design drawings, prototypes, engineering models, etc.

### 4.2.4 Risks and Complexity

The verification method applied to each specification requirement, and the rigor to which it is applied, shall be appropriate for the risks and complexity associated with each requirement.

### 4.2.5 Verification Methods

Verification of the subsystem design shall be performed by one or more of the following methods.

- Qualification Testing. Qualification testing is a verification method consisting of tests on hardware representative of the design to verify the adequacy of specific design features under the most adverse conditions, considering the operating modes and environment associated with actual service. Qualification testing may consist of checking functional operation (i.e., demonstration), and/or more rigorous measuring of testing of specific hardware inputs and outputs to verify compliance of the design with requirements. An appropriate degree of testing rigor may include evaluating functional characteristics by use of special equipment or instrumentation, or cold testing. The evaluation of test data is an integral part of testing.

  Note: As appropriate for the MRS, qualification testing to verify performance characteristics, such as waste retrieval rates, will entail cold testing in a simulated tank environment using simulated tank waste.

- Review. Review includes any design verification method based on an evaluation of the existing design information, including design media, calculations, reports, and test reports. This may consist of a review or examination of the design information, or may involve a more rigorous analysis or evaluation of the design as represented in the design information. A more rigorous review will include some form of processing accumulated results and conclusions to provide proof that verification of a requirement has been accomplished.

- Alternate Calculations. Alternate calculation is a subset of “Review” consisting of design verification of a calculation or design analysis using alternate methods of analysis to ensure correctness and applicability. The appropriateness of assumptions, input data used, and the computer program or calculation method used in the original analysis, are also reviewed.

### 4.2.6 Qualification Test Plan

A qualification test plan shall be submitted addressing MRS design features and requirements that require verification by qualification testing*. The designated verification method is shown in Table 4-1.

**4.2.6.1 Qualification Test Plan Submittal.** The qualification test plan shall be submitted prior to the start of testing for the TFC review and approval of proposed testing and acceptance criteria.

### 4.2.7 Qualification Test Plan Results

The results of the qualification testing shall be reported upon completion of testing.

**4.2.7.1 Qualification Test Report.** The qualification test report shall demonstrate successful completion of planned testing and verify compliance with the design requirements.

### 4.2.8 Test Objectives

The test objectives shall include qualifying the ability of the system in the following areas. See Statement of Work for detailed qualification testing requirements.

- Insert the retrieval equipment into the tank, and remove it without causing unfiltered radioactive airborne particles to escape from the riser.
- Dislodge, mobilize, and convey waste under fully submerged and final clean up conditions.
- Condition waste to allow pumping to the waste transfer system.
- Operate and maneuver under tank conditions.
- Monitor and control retrieval system operation.
- Decontaminate retrieval equipment to facilitate maintenance.
- Performance of maintenance activities.
- Operation in and around debris.
- Mitigation of debris transfer.

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* Proposed verification by qualification testing should entail cold testing in a simulated tank environment, using simulated tank waste. The TFC will provide a simulated waste recipe for use in qualification testing.

### 4.2.9 Review Documentation

Documentation shall be submitted to demonstrate that design requirements verification has been accomplished when the review inspection method is required (See Table 4-1).

### 4.2.10 Proposed Verification Method

All requirements shall be verified with one of the methods described. Proposed verification methods are identified in Table 4-1. Requirements designated for verification by qualification testing are also subject to review and approval.

**4.2.10.1 Proposed Verification Method Alternatives.** All changes to the proposed method in Table 4-1 shall require a justification for change and the TFC approval.

Table 4-1. Requirements Verification. (4 sheets)

| Section | Design Feature or Requirement | Qualification Testing | Review |
|---|---|---|---|
| 3.1.2.1 | Functional Interfaces | | X |
| 3.1.2.1.1 | Raw Water Limits | X* | |
| 3.1.2.1.2 | Tank C-104 Waste | X* | |
| 3.1.2.1.3 | DST Supernatant | X* | |
| 3.1.2.1.4 | Allowable Air In-Leakage | X | |
| 3.1.2.1.4.1 | Air Flow Direction | | X |
| 3.1.2.1.5.a | System Interlocks | X | |
| 3.1.2.1.5.b | In-Tank Video | | X |
| 3.1.2.2.1 | Tank Interfaces | X | |
| 3.1.2.2.2 | Waste Slurry Interface | | X |
| 3.1.2.2.3 | Supernatant Interface | | X |
| 3.1.2.2.4 | Ventilation Access | | X |
| 3.2.1.1 | Retrieve Waste from Tank C-104 | X* | |
| 3.2.1.1.1 | Retrieval Duration | X* | |
| 3.2.1.1.2.1 | Design Pressure | X* | |
| 3.2.1.1.2.2 | Flow Rate | X* | |
| 3.2.1.1.2.3 | Maximum Output Particle Size | X* | |
| 3.2.1.1.2.4 | Entrained Gas | X* | |
| 3.2.1.1.3 | Free-Standing Liquid | X* | |
| 3.2.1.1.4 | Existing In-Tank Hardware | X* | |
| 3.2.1.2 | Control and Monitor of Tank C-104 MRS | X | |
| 3.2.1.2.1 | Remote Operation | X | |
| 3.2.1.2.2 | WRS Emergency Stop Feature | X | |
| 3.2.1.2.3 | Pump Administrative Lock Controls | X | |
| 3.2.1.2.4 | Equipment Observation | X | |
| 3.2.1.3 | Decontaminate and Remove | X* | |
| 3.2.1.3.1 | Decontamination Fluid | X | |
| 3.2.1.3.2 | Radiation Measurement | X | |
| 3.2.1.3.3 | Radiation Levels | X | |
| 3.2.1.3.4 | MRS Removal | X* | |
| 3.2.2.1.1 | MRS Load Limitations | | X |
| 3.2.2.1.2 | Allowable Loads on Tank Bottom | | X |

Table 4-1. Requirements Verification. (4 sheets)

| Section | Design Feature or Requirement | Qualification Testing | Review |
|---|---|---|---|
| 3.2.2.1.3 | Riser Loads | X | |
| 3.2.2.1.3.1 | Maximum Loads | X | |
| 3.2.2.2 | Waste Transfer Covers | X | |
| 3.2.2.3 | M&C Station | | X |
| 3.2.3.1 | Reuse | | X |
| 3.2.3.2 | Equipment Connections | | X |
| 3.2.3.3 | Failure Recovery | | X |
| 3.2.3.4 | Design Life | | X |
| 3.2.4.1 | Modularity | | X |
| 3.2.4.2 | Component Accessibility | X | |
| 3.2.4.3 | Special Tools | X | |
| 3.2.4.4 | Spare Parts | | X |
| 3.2.5.1 | MRS Ex-Tank Environment | | X |
| 3.2.5.2 | In-Tank Environmental Conditions | | X |
| 3.3.1.1 | MRS Lead Usage | | X |
| 3.3.1.2 | TSCA Listed Substances | | X |
| 3.3.1.3.1 | Hydraulic Fluid | | X |
| 3.3.1.3.2 | Loss of Fluid | | X |
| 3.3.1.4 | Materials Restrictions | | X |
| 3.3.1.5 | Process Piping | | X |
| 3.3.1.6 | Process Piping Temperature | | X |
| 3.3.1.7 | Welding | | X |
| 3.3.1.8 | HEPA Filter Assemblies | | X |
| 3.3.1.8.1 | HEPA Filter Testing | X | |
| 3.3.1.9 | Confinement Boundary | X | |
| 3.3.1.10 | Electrical Codes and Standards | | X |
| 3.3.1.10.1 | Electrical Design | | X |
| 3.3.1.10.2 | Cabinet Design | | X |
| 3.3.1.11 | Ultraviolet Resistant Components | | X |
| 3.3.1.12 | Equipment Portability | X | |
| 3.3.2.1 | Radio Frequency Interference Susceptibility | X | |

Table 4-1. Requirements Verification. (4 sheets)

| Section | Design Feature or Requirement | Qualification Testing | Review |
|---|---|---|---|
| 3.3.2.2 | Surge Protection in AC Power Circuits | | X |
| 3.3.2.3 | Surge Withstand Capability | | X |
| 3.3.2.4 | Equipment Installation and Wiring Practices | | X |
| 3.3.3 | Identification and Marking | | X |
| 3.3.4 | Workmanship | | X |
| 3.3.4.1 | Welding | | X |
| 3.3.4.2 | Electrical Components | | X |
| 3.3.4.3 | Pressurized Components | | X |
| 3.3.5 | Interchangeability | | X |
| 3.3.6.1.1 | Radiation Shielding | | X |
| 3.3.6.1.2 | Industrial Safety | | X |
| 3.3.6.1.2.1 | Industrial Safety Hazards Identification | | X |
| 3.3.6.2.1 | In-Tank Flammable Gases | | X |
| 3.3.6.2.2 | Maximum Waste Temperature Limit | | X |
| 3.3.6.2.3 | Damage to Tank C-104 | | X |
| 3.3.6.3.1 | MRS Confinement | X | |
| 3.3.6.3.1.1 | MRS Confinement Design | X | |
| 3.3.6.3.1.1.a | Ventilation | X | |
| 3.3.6.3.1.1.b | Isolation | X | |
| 3.3.6.3.1.1.c | Passive Breathing | X | |
| 3.3.6.3.2 | Secondary Containment and System Leak Detection | X | |
| 3.3.6.3.3 | Waste Pipe Gravity Drain | | X |
| 3.3.6.3.4 | Non-Radioactive Airborne Emissions | | X |
| 3.3.6.3.5 | Radioactive Airborne Emissions | | X |
| 3.3.7.1 | Ease of Operation | X | |
| 3.3.7.2 | Lighting | X | |
| 3.3.8.1 | Waste Pipe Flushing | X | |
| 3.3.8.2 | MRS Radiological Design | | X |
| 3.3.8.3 | Decontamination Subsystem | | X |
| 3.3.8.4 | Retrieval of Failed Equipment | X | |
| 3.3.8.5 | Removability | X | |

Table 4-1. Requirements Verification. (4 sheets)

| Section | Design Feature or Requirement | Qualification Testing | Review |
|---|---|---|---|
| 3.3.9 | Nuclear Safety | | X |

*Proposed verification by qualification testing should entail cold testing in a simulated tank environment, using simulated tank waste. The TFC will provide a simulated waste recipe for use in qualification testing.

## 5.0 PREPARATION FOR DELIVERY

The specific requirements of the operational readiness to proceed are contained in the Statement of Work.

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# 6.0 NOTES

## 6.1 TERMS

| | |
|---|---|
| DOE | U.S. Department of Energy |
| DST | double-shell tank |
| LDMM | Leak Detection, Monitoring and Mitigation |
| MRS | Mobile Retrieval System |
| M&C | Monitor and Control |
| NEC | National Electrical Code |
| rms | arithmetic mean |
| TBR | to be refined |
| TFC | Tank Farm Contractor |
| WRS | Waste Retrieval System |

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## 7.0 REFERENCES

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40 CFR Subchapter R, et seq., 2000, "Toxic Substances Control Act," *Code of Federal Regulations*, as amended.

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HNF-SD-WM-TSR-006, 2000, *Tank Farms Technical Safety Requirements*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

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# APPENDIX A

# HANFORD SITE DESCRIPTION

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# APPENDIX A

# HANFORD SITE DESCRIPTION

## SITE DESCRIPTION

The River Protection Project manages waste in 177 underground storage tanks at the Hanford Site. These tanks are arranged in 18 groups known as "tank farms." Each tank farm contains 2 to 18 tanks of a common design. The tank farms are located in the 200 East and 200 West Areas of the Hanford Site.

Roads provide access to each of the tank farms. Buried waste transfer lines both in and around the tank farms restrict the location of surface equipment and influence surface load limits for moving equipment. Some tank farms are adjacent to others or in areas that limit access by large cranes. A tank located in the center of a tank farm poses further limitations for heavy equipment access.

Tank 241-C-104 is located at the boundary of 241-C Tank Farm. Tank Farm 241-C, located in the 200 East Area of the Hanford Site, includes 12 tanks in a three-by-four rectangular array. The tanks are separated by 30 m (100 ft) center to center distance. Tank 241-C-104, like all tanks, is buried beneath the ground surface, with access to the interior provided by risers extending from the top of the tank to the ground surface.

Typically, the top of each tank is approximately 1.8 m (6 ft) below grade. Risers penetrating the dome of the tank provide access to the tank interior for the Mobile Retrieval System. Existing risers range from 100 to 900 mm (4 to 36 in.) in diameter. Although each tank site has some unique equipment specific to the tank, a typical instrumentation configuration is common at each farm. The instrumentation configuration is used to monitor the in-tank environment. Some of these instruments may need to remain in place when the MRS is installed so that critical monitoring can continue. If the MRS incorporates instruments necessary to perform the critical monitoring functions, the existing instruments necessary to perform critical monitoring functions could be removed and the risers used for other functions.

The soil above the tanks provides radiological shielding. Consequently, removal of the earth may be limited depending on the design justification. The terrain will be relatively level and some movement of equipment can be tolerated directly over the top of the tanks as long as the load on the ground remains below the allowable loads specified in the tank farm operating specifications. Waste retrieval heavy equipment can also be emplaced via corridors established between tanks or by portable cranes.

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# APPENDIX B

# LIMITING VELOCITIES FOR TANK LINER PENETRATION

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# APPENDIX B

## LIMITING VELOCITIES FOR TANK LINER PENETRATION

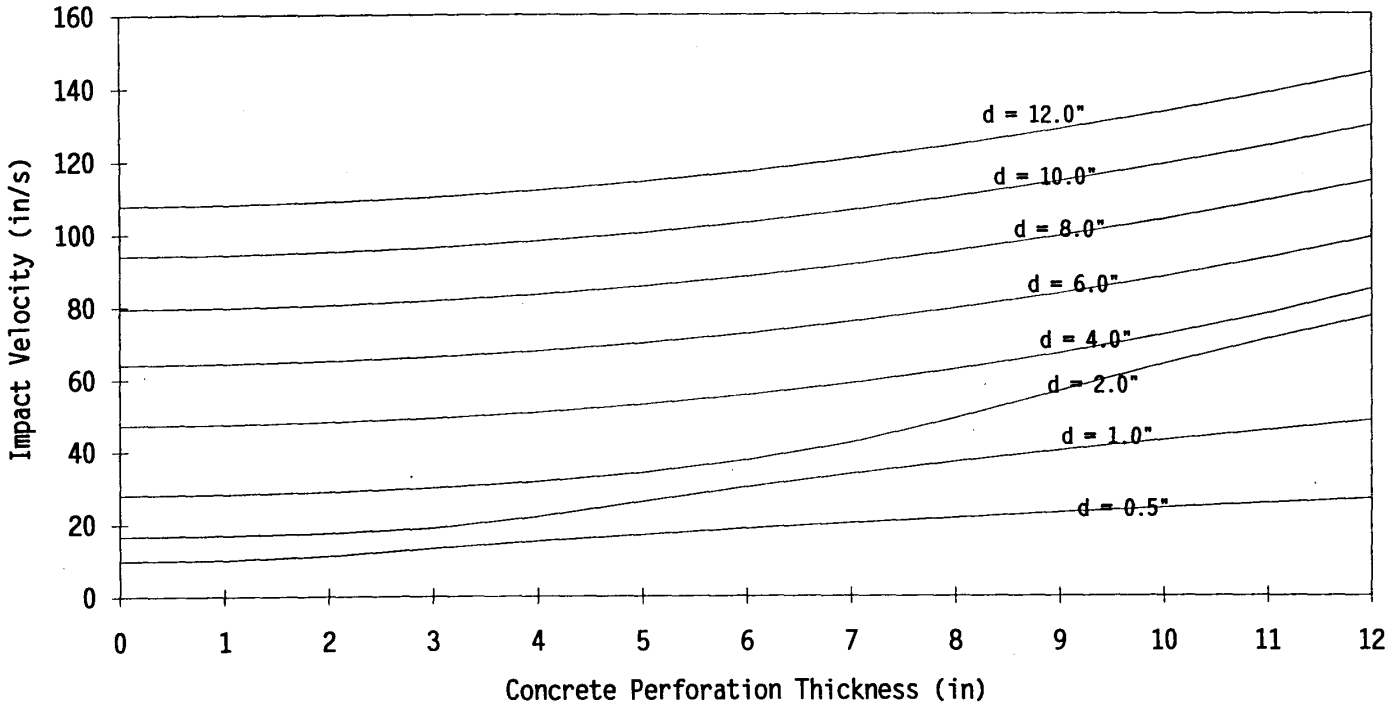
The limiting velocities for equipment (missiles) impacting the walls and floor of tank 241-C-106 are presented in the form of failure maps (Figures B-1 through B-4). The weights of the missiles are 500, 1,000, 2,000, and 3,000 lbf. The intercept of the velocity curve with the vertical axis is the impact velocity required to penetrate the steel tank liner. The thickness of the concrete behind the steel liner is 12 in. for the tank side wall and 8 in. for the tank floor (slab).

Simplifying assumptions are:

- The missile is assumed to be non-deformable.
- The concrete walls and slab are assumed to be unreinforced.
- Missiles are assumed to strike normal to the surface.

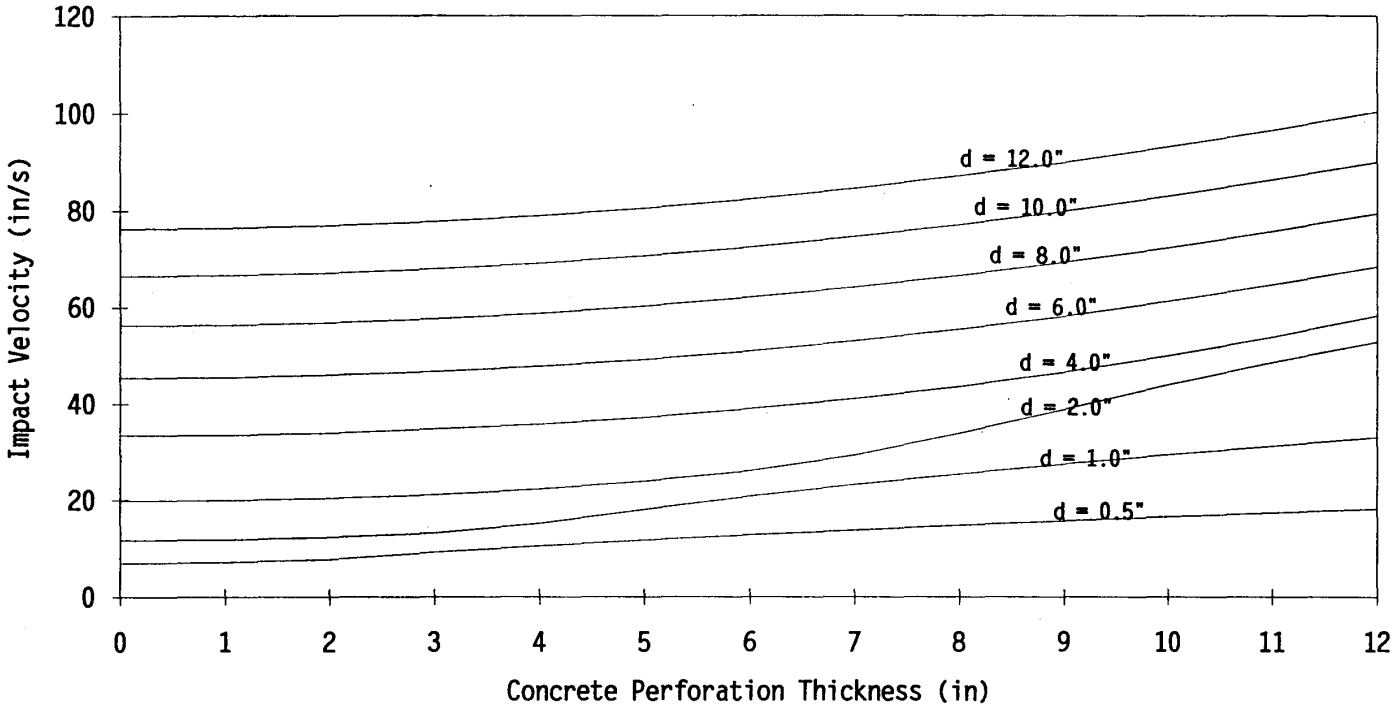
Detailed analysis is documented in WHC-SD-W340-ANAL-001, *Structural Analysis and Evaluation in Support of the Long Reach Manipulator Specification*, dated January 30, 1995. Extrapolation of this analysis to tank 241-C-104 is reasonable because tank 241-C-104 has not been exposed to the extreme thermal variations to which tank 241-C-106 has undergone.

Figure B-1. Impact Characteristics for 500-lb Missile on Tank Wall/Slab.



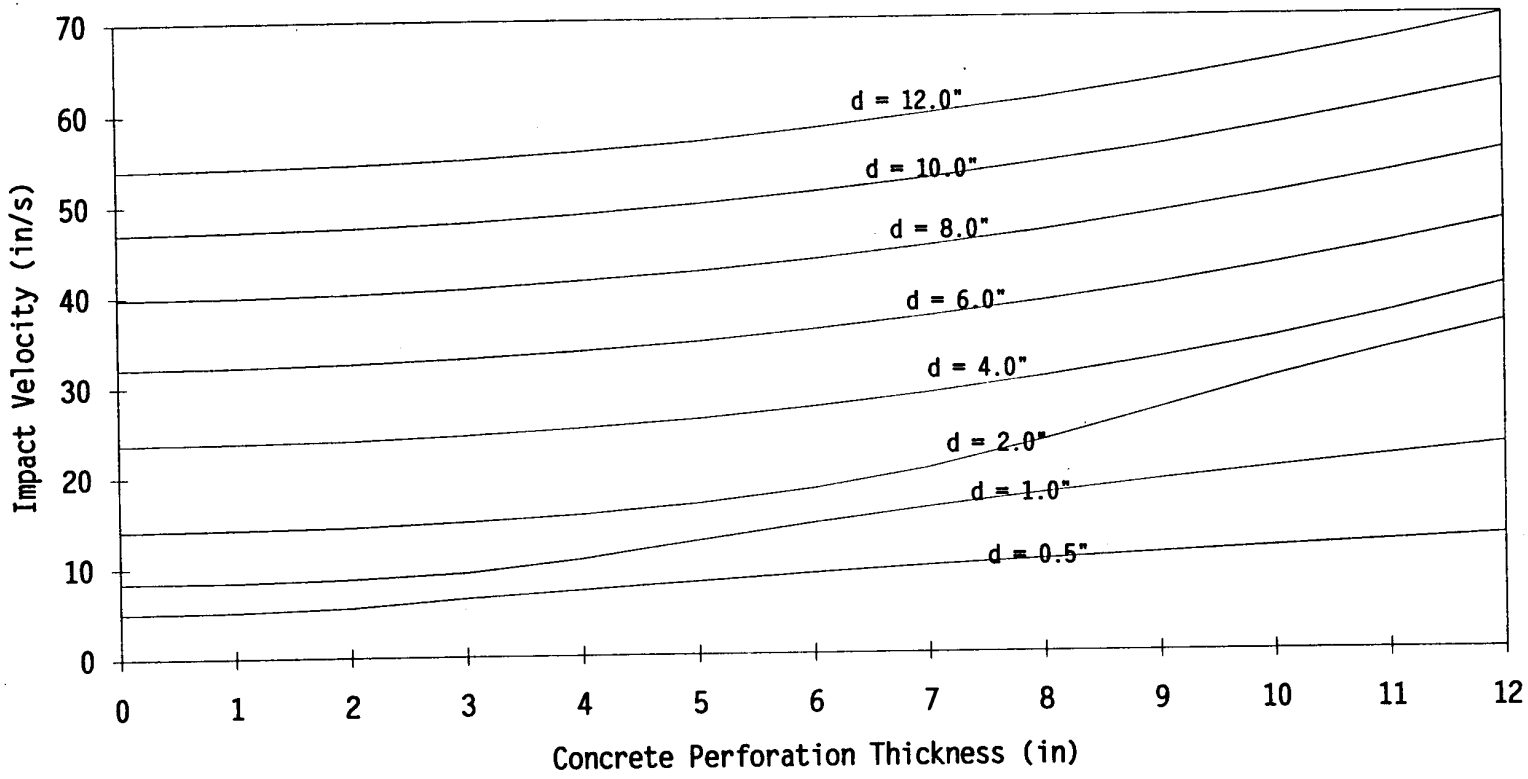

1) d represents missile diameter.
2) The tank wall concrete thickness is 12.0".
3) The tank slab concrete thickness is 6.0".
4) The ACI ultimate strength residual capacity for the tank wall is capable of sustaining an impact force of up to 400 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.
5) The ACI ultimate strength residual capacity for the tank slab is capable of sustaining an impact force of up to 183 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.

Figure B-2. Impact Characteristics for 1000-lb Missile on Tank Wall/Slab.



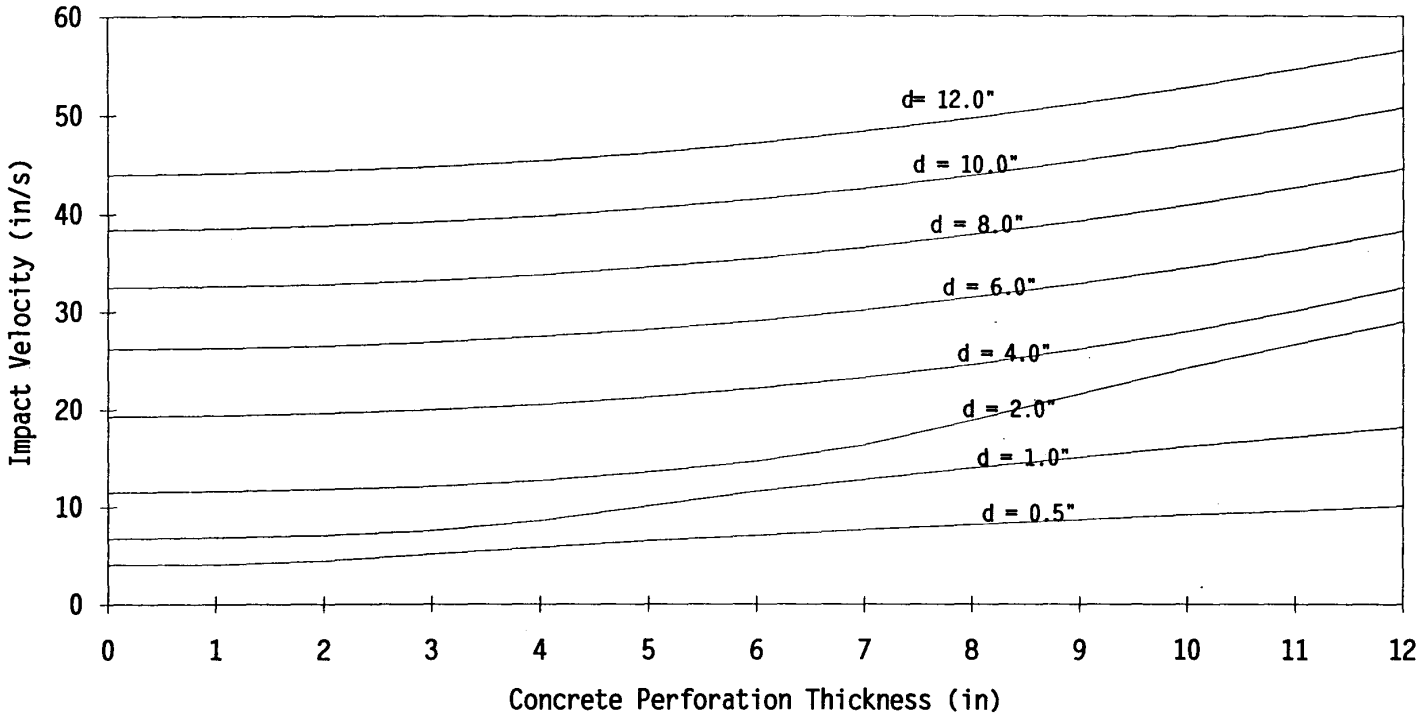

Notes:
1) d represents missile diameter.
2) The tank wall concrete thickness is 12.0".
3) The tank slab concrete thickness is 6.0".
4) The ACI ultimate strength residual capacity for the tank wall is capable of sustaining an impact force of up to 400 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.
5) The ACI ultimate strength residual capacity for the tank slab is capable of sustaining an impact force of up to 183 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.

Figure B-3. Impact Characteristics for 2000-lb Missile on Tank Wall/Slab.




Notes:
1) d represents missile diameter.
2) The tank wall concrete thickness is 12.0".
3) The tank slab concrete thickness is 6.0".
4) The ACI ultimate strength residual capacity for the tank wall is capable of sustaining an impact force of up to 400 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.
5) The ACI ultimate strength residual capacity for the tank slab is capable of sustaining an impact force of up to 183 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.

Figure B-4. Impact Characteristics for 3000-lb Missile on Tank Wall/Slab.




Notes:
1) d represents missile diameter.
2) The tank wall concrete thickness is 12.0".
3) The tank slab concrete thickness is 6.0".
4) The ACI ultimate strength residual capacity for the tank wall is capable of sustaining an impact force of up to 400 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.
5) The ACI ultimate strength residual capacity for the tank slab is capable of sustaining an impact force of up to 183 kips, which exceeds the largest 'factored' impact force of 102 kips required to perforate the steel liner.

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# APPENDIX C

# REQUIREMENTS TRACEABILITY

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# APPENDIX C

## REQUIREMENTS TRACEABILITY

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.0 | Requirements | N/A | Header |
| 3.1 | MRS and MRS Monitor and Control Subsystem Definition | N/A | Background information. |
| 3.1.1 | Subsystem/Component Diagrams | Background information | System design will be determined by performance based service contract. |
| 3.1.2 | Interface Definition | N/A | Header |
| 3.1.2.1 | Functional Interfaces | H-2-820748, Rev. 2<br>H-2-818562, Rev. 6 | |
| 3.1.2.1.1 | Raw Water Limits | TBR | The actual amount of water that the WDOE will allow is undecided. |
| 3.1.2.1.2 | 241-C-104 Waste | RPP-8144, Rev. 0 | Background information. |
| 3.1.2.1.3 | Double-Shell Tank Supernatant | RPP-8144, Rev. 0 | |
| 3.1.2.1.4 | MRS Allowable Air In-Leakage | | Information provided by Ed Dalpiaz. |
| 3.1.2.1.4.1 | Air Flow Direction | TBR | |
| 3.1.2.1.5 | MRS Control System Interfaces | N/A | Header |
| 3.1.2.1.5.a | System Interlocks | Engineering Judgment | Will be defined as a result of pre-conceptual design activity. |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.1.2.1.5.b | In-Tank Video | Engineering Judgment | |
| 3.1.2.2 | Physical Interfaces | N/A | Header |
| 3.1.2.2.1 | Tank Interfaces | H-2-73344, Rev. 4 | |
| 3.1.2.2.2 | Waste Transfer Interface | H-2-32420, H-2-32446 | |
| 3.1.2.2.3 | Supernatant Interface | Engineering Judgment | |
| 3.1.2.2.4 | Ventilation Access | TBR | |
| 3.1.3 | Major Component List | N/A | Design and construction shall meet existing laws, regulations, and accepted industry practices. |
| 3.2 | Characteristics | N/A | Header |
| 3.2.1 | Performance Characteristics | N/A | Header |
| 3.2.1.1 | Retrieve Waste from Tank 241-C-104 | HNF-SD-WM-SP-012, Rev. 2 | |
| 3.2.1.1.1 | Retrieval Duration | RPP-7807, Rev. 0 | |
| 3.2.1.1.2 | Slurried Waste Output | RPP-8144, Rev. 0 | |
| 3.2.1.1.2.1 | Design Pressure | RPP-8144, Rev. 0 | |
| 3.2.1.1.2.2 | Flow Rate | Engineering Judgment | |
| 3.2.1.1.2.3 | Maximum Output Particle Size | Internal Memo LMHC 74710-97-SAK-025 | |
| 3.2.1.1.2.4 | Entrained Gas | HNF-1903, Rev. 0 | |
| 3.2.1.1.3 | Free-Standing Liquid | RPP-8144, Rev. 0 | |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.2.1.1.4 | Existing In-Tank Hardware | RPP-8144, Rev. 0 | These excluded items are not significant contributors to the residual hazardous materials and radiation at tank closure. |
| 3.2.1.2 | Control and Monitor of 241-C-104 MRS | N/A | Header |
| 3.2.1.2.1 | Remote Operation | Engineering Judgment | Done to meet ALARA principles promulgated via HNF-IP-0842, Vol. VII, Sections 12.3 and 12.4 |
| 3.2.1.2.2 | WRS Emergency Stop Feature | Internal Memo LMHC 74710-97-SAK-025 | |
| 3.2.1.2.3 | Waste Retrieval (Transfer) Pump Administrative Lock Controls | HNF-IP-1266, Chapter 5.20, Rev 2f | |
| 3.2.1.2.4 | Equipment Observation | Engineering Judgment | |
| 3.2.1.3 | Decontaminate and Remove the MRS | N/A | Header |
| 3.2.1.3.1 | Decontamination Fluid | Internal Memo LMHC 74710-97-SAK-025 | |
| 3.2.1.3.2 | Radiation Measurement | Engineering Judgment | Email from Dave Smet |
| 3.2.1.3.3 | Radiation Levels | Engineering Judgment | Email from Dave Smet |
| 3.2.1.3.4 | MRS Removal | RPP-8144, Rev. 0 | |
| 3.2.2 | Physical Characteristics | N/A | Header |
| 3.2.2.1 | Load Limitations | N/A | Header |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.2.2.1.1 | MRS Load Limitations | HNF-IP-1266, Chapter 5.16, Rev. 3a. | |
| 3.2.2.1.2 | Allowable Loads on Tank Bottom | WHC-SD-W340-ANAL-001, Rev. 1, Section 3.3. | |
| 3.2.2.1.3 | Riser Loads | Engineering Judgment | Will be defined as a result of preconceptual design. |
| 3.2.2.1.3.1 | Maximum Loads | WHC-SD-W320-ANAL-003, Rev. 0, Appendix D | |
| 3.2.2.2 | Waste Transfer Covers | Engineering Judgment | |
| 3.2.2.3 | 241-C-104 MRS M&C | HNF-S-0574, Rev. 2 | |
| 3.2.3 | Reliability | N/A | Header |
| 3.2.3.1 | Reuse | DOE GPG-FM-004, Section 2.8 | |
| 3.2.3.2 | Equipment Connections | Engineering Judgment | |
| 3.2.3.3 | Failure Recovery | DOE GPG-FM-004, Section 2.1 | |
| 3.2.3.4 | Design Life | DOE GPG-FM-004, Section 2.8 | |
| 3.2.4 | Maintainability | N/A | Header |
| 3.2.4.1 | Modularity | Engineering Judgment | |
| 3.2.4.2 | Component Accessibility | Engineering Judgment | |
| 3.2.4.3 | Special Tools | Engineering Judgment | |
| 3.2.4.4 | Spare Parts | | See Statement of Work |
| 3.2.5 | Environmental Conditions | N/A | Header |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.2.5.1 | MRS Ex-Tank Environment | UBC, ASCE 7-95 | |
| 3.2.5.2 | In-Tank Environment | RPP-8144, Rev. 0 | |
| 3.3 | Design and Construction | N/A | Header |
| 3.3.1 | Materials, Processes, and Parts | N/A | Header |
| 3.3.1.1 | MRS Lead Usage | HNF-IP-0842, Volume IX, Section 4.24 | This section of the RPP Administration outlines the CHG Lead Control Program. |
| 3.3.1.2 | TSCA Listed Substances | HNF-IP-0842, Volume VI, Section 2.6 | |
| 3.3.1.3 | MRS In-Tank Equipment Hydraulic Fluid | N/A | Header |
| 3.3.1.3.1 | Hydraulic Fluid | Internal Memo 7E310-94-037 | |
| 3.3.1.3.2 | Loss of Fluid | Internal Memo 7E310-94-037 | |
| 3.3.1.4 | Materials Restrictions | HNF-IP-1266, Rev. 2 | |
| 3.3.1.5 | Process Piping | ASME B31.3-1996 | |
| 3.3.1.6 | Process Piping Temperature | HNF-4712, Rev. 0 | |
| 3.3.1.7 | Welding | ANSI/AWS D1.1, D1.2 | |
| 3.3.1.8 | MRS HEPA Filter Assemblies | ASME N509 | |
| 3.3.1.8.1 | MRS HEPA Filter Testing | ASME N510 | |
| 3.3.1.9 | MRS Confinement Boundary | Engineering Judgment | Information provided by Ed Dalpiaz. |
| 3.3.1.10 | Electrical Codes and Standards | N/A | Header |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.3.1.10.1 | Electrical Design | Underwriter's Laboratory Standards | |
| 3.3.1.10.2 | Cabinet Design | UL508A Standard | |
| 3.3.1.11 | Ultraviolet Resistant Components | Engineering Judgment | |
| 3.3.1.12 | MRS Equipment Portability | ANSI/ASME B30.20 | |
| 3.3.2 | Electromagnetic Radiation | HNF-2962, Rev. 0, Engineering Judgment | |
| 3.3.2.1 | Radio Frequency Interference Susceptibility | ANSI/IEEE C37.90.1 | |
| 3.3.2.2 | Surge Protection in AC Power Circuits | IEEE C62.41 | |
| 3.3.2.3 | Surge Withstand Capability | ANSI/IEEE C37.90.1 | |
| 3.3.2.4 | Equipment Installation and Wiring Practices | IEEE STD-518, Section 6 | |
| 3.3.3 | Identification and Marking | HNF-IP-0842, Vol. II, Section 6.1 | |
| 3.3.4 | Workmanship | N/A | Header |
| 3.3.4.1 | Welding | ANSI/AWS D1.1, D1.2 | |
| 3.3.4.2 | Electrical Components | NEC Standards | |
| 3.3.4.3 | Pressurized Components | ASME B&PV | |
| 3.3.5 | Interchangeability | N/A | Header |
| 3.3.6 | Safety | N/A | Header |
| 3.3.6.1 | Personnel Safety | N/A | Header |
| 3.3.6.1.1 | Radiation Shielding | Engineering Judgment | |
| 3.3.6.1.2 | Industrial Safety | 29 CFR 1910 | |
| 3.3.6.1.2.1 | Industrial Safety Hazards Identification | 29 CFR 1910 | |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.3.6.2 | Equipment Protection | N/A | Header |
| 3.3.6.2.1 | In-Tank Flammable Gases | Flammable Gas Equipment Advisory Board Recommendation. | |
| 3.3.6.2.2 | Maximum Waste Temperature Limit | HNF-4712, Rev. 0 | |
| 3.3.6.2.3 | Damage to Tank 241-C-104 | WHC-SD-W340-ANAL-001, Rev. 1 | |
| 3.3.6.3 | Environmental Safety | N/A | Header. |
| 3.3.6.3.1 | MRS Confinement | Engineering Judgment | |
| 3.3.6.3.1.1 | MRS Confinement Design | Engineering Judgment | |
| 3.3.6.3.1.1.a | Ventilation | Engineering Judgment | |
| 3.3.6.3.1.1.b | Isolation | Engineering Judgment | |
| 3.3.6.3.1.1.c | Passive Breathing | Engineering Judgment | |
| 3.3.6.3.2 | Secondary Containment and System Leak Detection | HNF-2919, Rev. 1, Section 2 | |
| 3.3.6.3.3 | Waste Pipe Gravity Drain | Engineering Judgment | |
| 3.3.6.3.4 | Non-Radioactive Airborne Emissions | HNF-2919, Rev. 1, Appendix B | |
| 3.3.6.3.5 | Radioactive Airborne Emissions | WAC 246-247 | |
| 3.3.7 | Human Performance/Human Engineering | N/A | Design and construction shall meet existing laws, regulations, and accepted industry practices. |
| 3.3.7.1 | MRS Ease of Operation | Engineering Judgment | |
| 3.3.7.2 | Lighting | IESNA 2000 | |

| Section | Function/Requirement Title | Source Documents | Remarks |
|---|---|---|---|
| 3.3.8 | Decontamination and Decommissioning | N/A | Header |
| 3.3.8.1 | Waste Pipe Flushing | Engineering Judgment | |
| 3.3.8.2 | MRS Radiological Design | Engineering Judgment | |
| 3.3.8.3 | MRS Decontamination Subsystem | Engineering Judgment | |
| 3.3.8.4 | Retrieval of Failed Waste Retrieval System Equipment | Internal Memo LMHC 74710-97-SAK-025 | |
| 3.3.8.5 | Removability | Internal Memo LMHC 74710-97-SAK-025 | |
| 3.3.9 | Nuclear Safety | HNF-IP-0842, Volume IV, Section 6.10 | |
| 3.4 | Documentation | N/A | See Statement of Work. |
| 3.5 | Logistics | N/A | Header |
| 3.5.1 | Maintenance | N/A | See Statement of Work. |
| 3.5.2 | Supply | N/A | Not applicable to this task. |
| 3.5.3 | Facilities and Facility Equipment | N/A | Not applicable to this task. |
| 3.6 | Personnel and Training | N/A | See Statement of Work. |
| 3.7 | Major Component Characteristics | N/A | Design and construction shall meet existing laws, regulations, and accepted industry practices. |
| Appendix A | Hanford Site Description | RPP-8144, Rev. 0 | |
| Appendix B | Limiting Velocities for Tank Liner Penetration | WHC-SD-W340-ANAL-001, Rev. 1 | |

# APPENDIX D

# CROSS WALK BETWEEN C-106 AND C-104

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## APPENDIX D

## CROSS WALK BETWEEN C-106 AND C-104

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 1.0 | Scope | 1.0 | Scope |
| 1.1 | Introduction | 1.1 | Introduction |
| 1.2 | Background | 1.1 | Background |
| 1.3 | Description of Services | 1.2 | Description of Services |
| 2.0 | Applicable Documents | 2.0 | Applicable Documents |
| 2.1 | Government Documents | 2.1, 2.2 | DOE Documents, CFR |
| 2.2 | Non-Government Documents | 2.3,2.4 | Codes and Standards, Miscellaneous Documents |
| 3.0 | Requirements | 3.0 | Requirements |
| 3.1 | MRS and MRS M&C Subsystem Definition | 3.1 | Item Definition |
| 3.1.1 | Subsystem/Component Diagrams | 3.1.1 | Item Diagrams |
| 3.1.2 | Interface Definition | 3.1.2 | Interface Definition |
| 3.1.2.1 | Functional Interfaces | 3.1.2.1 | Functional Interfaces |
| 3.1.2.1.1 | Raw Water Limits | 3.1.2.1.3, 3.1.2.1.5, 3.2.1.3.2 | Water Input, De-mineralized Water Input, Maximum Water Volume Usage |
| 3.1.2.1.2 | 241-C-104 Waste | 3.1.2.1.4 | Slurried Waste Output |
| 3.1.2.1.3 | Double-Shell Tank Supernatant | | |
| 3.1.2.1.4 | MRS Allowable Air In-Leakage | | |
| 3.1.2.1.4.1 | Air Flow Direction | | |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.1.2.1.5 | MRS Control System Interfaces | 3.1.2.2.2 | Control System Interfaces |
| 3.1.2.1.5.a | System Interlocks | 3.1.2.2.2.1 | System Shut-down Interlocks |
| 3.1.2.1.5.b | In-Tank Video | | |
| 3.1.2.2 | Physical Interfaces | | |
| 3.1.2.2.1 | Tank Interfaces | 3.1.2.2.3, 3.1.2.2.3.4 | Tank Interfaces, Riser Interfaces |
| 3.1.2.2.2 | Waste Transfer Interface | 3.1.2.2.4 | Waste Transfer Interface |
| 3.1.2.2.3 | Supernatant Interface | | |
| 3.1.2.2.4 | Ventilation Access | | |
| 3.1.3 | Major Component List | 3.1.3 | Major Component List |
| 3.2 | Characteristics | 3.2 | Characteristics |
| 3.2.1 | Performance Characteristics | | |
| 3.2.1.1 | Retrieve Waste from Tank 241-C-104 | 3.2.1.3 | Remove Waste from C-106 |
| 3.2.1.1.1 | Retrieval Duration | | |
| 3.2.1.1.2 | Slurried Waste Output | 3.2.1.3.3 | Slurried Waste Output |
| 3.2.1.1.2.1 | Design Pressure | | |
| 3.2.1.1.2.2 | Flow Rate | | |
| 3.2.1.1.2.3 | Maximum Output Particle Size | 3.2.1.2.5 | Maximum Output Particle size |
| 3.2.1.1.2.4 | Entrained Gas | 3.2.1.3.7 | Entrained Gas |
| 3.2.1.1.3 | Free-Standing Liquid | | |
| 3.2.1.1.4 | Existing In-Tank Hardware | 3.2.1.2.3 | Existing In-Tank Hardware |
| 3.2.1.2 | Control and Monitor of 241-C-104 WRS | 3.2.1.4 | Control and Monitor of the WRS |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.2.1.2.1 | Remote Operation | 3.2.1.2.1 | Remote Operation |
| 3.2.1.2.2 | WRS Emergency Stop Feature | 3.2.1.4.2 | WRS Emergency Stop Feature |
| 3.2.1.2.3 | Pump Administrative Lock Controls | 3.2.1.4.3 | Pump Administrative Lock Controls |
| 3.2.1.2.4 | Equipment Observation | | |
| 3.2.1.3 | Decontaminate and Remove the MRS | | |
| 3.2.1.3.1 | Decontamination Fluid | | |
| 3.2.1.3.2 | Radiation Measurement | | |
| 3.2.1.3.3 | Radiation Levels | | |
| 3.2.1.3.4 | MRS Removal | | |
| 3.2.2 | Physical Characteristics | 3.2.2 | Physical Characteristics |
| 3.2.2.1 | Load Limitations | | |
| 3.2.2.1.1 | MRS Load Limitations | 3.2.2.2 | MRS Load Limitations |
| 3.2.2.1.2 | Allowable Loads on Tank Bottom | 3.2.2.7 | Allowable Loads on Tank Bottom |
| 3.2.2.1.3 | Riser Loads | | |
| 3.2.2.1.3.1 | Maximum Loads | | |
| 3.2.2.2 | Waste Transfer Covers | 3.2.2.9 | Waste Transfer System Covers |
| 3.2.2.3 | 241-C-104 MRS M&C | | |
| 3.2.3 | Reliability | 3.2.3 | Reliability |
| 3.2.3.1 | Reuse | | |
| 3.2.3.2 | Equipment Connections | | |
| 3.2.3.3 | Failure Recovery | | |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.2.3.4 | Design Life | | |
| 3.2.4 | Maintainability | 3.2.4 | Maintainability |
| 3.2.4.1 | Modulatory Component Repair | | |
| 3.2.4.2 | Component Accessibility | | |
| 3.2.4.3 | Special Tools | | |
| 3.2.4.4 | Spare Parts | | |
| 3.2.5 | Environmental Conditions | 3.2.5 | Environmental Conditions |
| 3.2.5.1 | MRS Ex-Tank Environment | 3.2.5.1 | Ex-Tank Environment |
| 3.2.5.2 | In-Tank Environment | 3.2.5.2 | In-Tank Environment |
| 3.3 | Design and Construction | 3.3 | Design and Construction |
| 3.3.1 | Materials, Processes, and Parts | 3.3.1 | Materials, Processes, and Parts |
| 3.3.1.1 | MRS Lead Usage | 3.2.2.3 | MRS Lead Usage |
| 3.3.1.2 | TSCA Listed Substances | 3.2.2.4 | TSCA Listed Substances |
| 3.3.1.3 | MRS In-Tank Equipment Hydraulic Fluid | 3.2.2.5 | WRS In-Tank Equipment Hydraulic Fluid |
| 3.3.1.3.1 | Hydraulic Fluid | 3.2.2.5.1 | Buyer Approval Hydraulic Fluid |
| 3.3.1.3.2 | Loss of Fluid | 3.2.2.5.2 | Loss of Fluid |
| 3.3.1.4 | Materials Restrictions | 3.2.1.3.1 | Materials Restrictions |
| 3.3.1.5 | Process Piping | 3.3.1.1 | Process Piping |
| 3.3.1.6 | Process Piping Temperature | 3.2.1.2.4 | Process Piping Temperature |
| 3.3.1.7 | Welding | 3.3.1.2 | Welding |
| 3.3.1.8 | MRS HEPA Filter Assemblies | 3.2.1.5, 3.2.1.6 | HEPA Filter Radiation Measurement, HEPA Filter Leak Test |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.3.1.8.1 | MRS HEPA Filter Testing | | |
| 3.3.1.9 | MRS Confinement Boundary | | |
| 3.3.1.10 | Electrical Codes and Standards | | |
| 3.3.1.10.1 | Electrical Design | | |
| 3.3.1.10.2 | Cabinet Design | | |
| 3.3.1.11 | Ultraviolet Resistant Components | | |
| 3.3.1.12 | MRS Equipment Portability | 3.2.2.1 | Below-the-Hook Lifting Device Requirements |
| 3.3.2 | Electromagnetic Radiation | 3.3.2 | Electromagnetic Radiation |
| 3.3.2.1 | Radio Frequency Interference Susceptibility | | |
| 3.3.2.2 | Surge Protection in AC Power Circuits | | |
| 3.3.2.3 | Surge Withstand Capability | | |
| 3.3.2.4 | Equipment Installation and Wiring Practices | | |
| 3.3.3 | Identification and Marking | 3.3.3 | Identification and Marking |
| 3.3.4 | Workmanship | 3.3.5 | Workmanship and Interchangeability |
| 3.3.4.1 | Welding | | |
| 3.3.4.2 | Electrical Components | | |
| 3.3.4.3 | Pressurized Components | | |
| 3.3.5 | Interchangeability | 3.3.5 | Workmanship and Interchangeability |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.3.6 | Safety | 3.3.6 | Safety |
| 3.3.6.1 | Personnel Safety | | |
| 3.3.6.1.1 | Radiation Shielding | 3.3.6.2 | Radiation Shielding |
| 3.3.6.1.2 | Industrial Safety | 3.3.6.4 | Industrial Safety |
| 3.3.6.1.2.1 | Industrial Safety Hazards Identification | | |
| 3.3.6.2 | Equipment Protection | | |
| 3.3.6.2.1 | In-Tank Flammable Gases | 3.3.6.1 | In-Tank Flammable Gases |
| 3.3.6.2.2 | Maximum Waste Temperature Limit | 3.2.1.2.7 | Maximum Waste Temperature Limit |
| 3.3.6.2.3 | Damage to Tank 241-C-104 | 3.2.2.8, 3.3.4 | Damage to Tank C-106, Seismic Events |
| 3.3.6.3 | Environmental Safety | | |
| 3.3.6.3.1 | MRS Confinement | | |
| 3.3.6.3.1.1 | MRS Confinement Design | | |
| 3.3.6.3.1.1.a | Ventilation | | |
| 3.3.6.3.1.1.b | Isolation | | |
| 3.3.6.3.1.1.c | Passive Breathing | | |
| 3.3.6.3.2 | Secondary Containment and System Leak Detection | 3.2.1.2.6 | System Leak Detection |
| 3.3.6.3.3 | Waste Pipe Gravity Drain | | |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 3.3.6.3.4 | Non-Radioactive Airborne Emissions | 3.2.1, 3.2.1.3.6 | Performance, Release of Tank Waste to the Environment |
| 3.3.6.3.5 | Radioactive Airborne Emissions | | |
| 3.3.7 | Human Performance/Human Engineering | 3.3.8 | Human Performance/Human Engineering |
| 3.3.7.1 | MRS Ease of Operation | | |
| 3.3.7.2 | Lighting | | |
| 3.3.8 | Decontamination and Decommissioning | 3.2.1.7 | Decontamination and Removal of the WRS |
| 3.3.8.1 | Waste Pipe Flushing | 3.2.1.7.1 | Waste Pipe Flushing |
| 3.3.8.2 | MRS Radiological Design | | |
| 3.3.8.3 | MRS Decontamination Subsystem | | |
| 3.3.8.4 | Retrieval of Failed Waste Retrieval System Equipment | 3.2.1.7.5 | Retrieval of Failed Equipment |
| 3.3.8.5 | Removability | 3.2.1.7.6 | Removability |
| 3.3.9 | Nuclear Safety | | |
| 3.4 | Documentation | 3.4 | Documentation |
| 3.5 | Logistics | 3.5 | Logistics |
| 3.5.1 | Maintenance | 3.5.1 | Maintenance |
| 3.5.2 | Supply | 3.5.2 | Supply |
| 3.5.3 | Facilities and Facility Equipment | 3.5.3 | Facilities and Facility Equipment |
| 3.6 | Personnel and Training | 3.6, 3.6.1, 3.6.2 | Personnel and Training |
| 3.7 | Major Component Characteristics | 3.7 | Major Component Characteristics |
| 4.0 | Design Requirements Verification | | |

| Section # of RPP-7420, Draft, Requirements | Section Subject of RPP-7420, Draft | Corresponding Section # in HNF-S-0574, Rev. 2 | Corresponding Section Subject in HNF-S-0574, Rev. 2 |
|---|---|---|---|
| 4.1 | General | | |
| 4.1.1 | Location | | |
| 4.1.2 | Responsibility | | |
| 4.1.2.1 | MRS Design | | |
| 4.1.2.2 | MRS Equipment | | |
| 4.1.2.3 | MRS Supporting Documentation | | |
| 4.2 | Design Requirements Verification | | |
| 4.2.1 | Design Verifications | | |
| 4.2.2 | Compliance | | |
| 4.2.3 | Design Media | | |
| 4.2.4 | Risks and Complexity | | |
| 4.2.5 | Verification Methods | | |
| 4.2.6 | Qualification Test Plan | | |
| 4.2.6.1 | Qualification Test Plan Submittal | | |
| 4.2.7 | Qualification Test Plan Results | | |
| 4.2.7.1 | Qualification Test Plan Report | | |
| 4.2.8 | Test Objectives | | |
| 4.2.9 | Review Documentation | | |
| 4.2.10 | Proposed Verification Method | | |
| 4.2.10.1 | Proposed Verification Method Alternatives | | |
| 5.0 | Preparation for Delivery | 5.0 | Operational Readiness Review |
| 6.0 | Notes | | |

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|---|---|---|---|
| 6.1 | Definitions | | |
| 6.2 | Terms | | |
| 7.0 | References | | |

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