

## EXECUTIVE SUMMARY

The Hanford Site Tank Farm Technical Safety Requirements (TSR) requires dome load controls. The procedural requirement for the dome load controls is TFC-ENG-FAC SUP-C-10, "Control of Dome Loading" with the basis for the dome load limits from RPP-20473 "Design and Dome Load Criteria for Hanford Waste Storage Tanks". The monitoring of the tanks dome by survey is required to physically verify the structural integrity of the tanks as deflection is key indicator of structural integrity. A Problem Evaluation Report (PER) PER-2004-4048 identifies the lack of a documented design basis and protocol program to conduct Single Shell Tank (SST) dome surveys.

This RPP-26516 establishes the basis and protocol for the SST Dome Survey Program. The goal of this program is to monitor the elevation of the tank and tank dome deflection to determine if settlement of the tank is occurring or if excess deflection of the tank dome is occurring. The surveys should be performed as requested by engineering or in accordance with this document.

**TABLE OF CONTENTS**

**1.0 INTRODUCTION..... 1**

**2.0 BACKGROUND ..... 1**

**3.0 DOME DEFLECTION SURVEY PROGRAM ..... 3**

**3.1 General..... 4**

**3.2 Survey Equipment ..... 5**

**3.3 Survey Tolerance and Errors ..... 5**

**3.4 Survey Control Monuments and Benchmarks..... 6**

**3.5 Frequency ..... 6**

**3.6 Expected Deflection ..... 6**

**3.7 Survey Data ..... 7**

**3.8 Survey Data Sheets Disposition ..... 8**

**4.0 REFERENCES..... 9**

**Table of Appendices**

**Appendix A: Sample Survey Data Sheet.....14**

**Table of Tables**

**Table 1: SST Dome Load Record Data Documents.....8**

**Abbreviations and Acronyms**

SST	Single Shell Tank
MOP	Management Observation Program
PER	Problem Evaluation Report
PLS	Professional Land Surveyor

## 1.0 INTRODUCTION

The Hanford Site Tank Farm Technical Safety Requirements (TSR) requires dome load controls. The procedural requirement for the dome load controls is TFC-ENG-FAC SUP-C-10, "Control of Dome Loading" with the basis for the dome load limits from RPP-20473 "Design and Dome Load Criteria for Hanford Waste Storage Tanks". The monitoring of the tanks dome by survey is required to physically verify the structural integrity of the tanks as deflection is key indicator of structural integrity. A Problem Evaluation Report (PER) PER-2004-4048 identifies the lack of a documented design basis and protocol program to conduct Single Shell Tank (SST) dome surveys.

This RPP-26516 establishes the basis and protocol for the SST Dome Survey Program. The goal of this program is to monitor the elevation of the tank and tank dome deflection to determine if settlement of the tank is occurring or if excess deflection of the tank dome is occurring. The surveys should be performed as requested by engineering or in accordance with this document.

## 2.0 BACKGROUND

Twelve single shell tank farms are located on the Hanford site. Each of these tank farms has between four and eighteen 100 series tanks located in each farm for a total of one hundred and thirty three tanks. Each SST has a primary steel liner and reinforced concrete surrounding the steel liner. The top portion of the reinforced concrete is called the tank dome. The SST dome is reinforced concrete.

The tank dome is buried to a depth of five to ten feet as measured from the tank dome apex. This soil cover prevents direct measurement of dome deflection. Numerous steel pipe risers are attached to the tank dome and are extended through the structural backfill to the surface. Survey benchmarks attached to these risers will be used to measure any deflection of the tank dome. At the bottoms of the risers concrete anchors were used to anchor the steel pipe to the concrete. Any deflection of the tank dome or tank settlement will cause a change in elevation of the tank benchmarks which are directly attached to the tank dome.

The SST's were constructed from 1943 through 1964. During this time horizontal and vertical survey control monuments were installed to control and record the location and elevations of the tanks and components. The location of bench marks and control monuments are shown in the supporting documents as listed in Table 1. Over the years, some of these original control monuments have been destroyed.

There is no apparent excessive deflection and no deflection greater than .02 ft. (.24 inch), however some data does appear to show dome deflection upward. The evaluation of the survey data has been performed by the responsible engineer on a case by case basis over the years. All SST were evaluated in FY2004 and FY2005 and this data can be found in the IDMS system under the non-record files for RPP-26516.

The standard for each tank farm includes the following:

- A minimum of two control monuments in the area of each tank farm
- A benchmark located on annulus risers on each of the tanks to monitor tank settlement.
- A benchmark located over the tank dome to monitor dome deflection

The SST dome survey program applies to the following 100 series SST's located in twelve tank farms for a total of 131 tanks:

#### A TANK FARM

- 241-A-101, 241-A-102, 241-A-103, 241-A-104, 241-A-105, 241-A-106

#### AX TANK FARM

- 241-AX-101, 241-AX-102, 241-AX-103, 241-AX-104

#### B TANK FARM

- 241-B-101, 241-B-102, 241-B-103, 241-B-104, 241-B-105, 241-B-106, 241-B-107, 241-B-108, 241-B-109, 241-B-110, 241-B-111, 241-B-112

#### BX TANK FARM

- 241-BX-101, 241-BX-102, 241-BX-103, 241-BX-104, 241-BX-105, 241-BX-106, 241-BX-107, 241-BX-108, 241-BX-109, 241-BX-110, 241-BX-111, 241-BX-112

#### BY TANK FARM

- 241-BY-101, 241-BY-102, 241-BY-103, 241-BY-104, 241-BY-105, 241-BY-106, 241-BY-107, 241-BY-108, 241-BY-109, 241-BY-110, 241-BY-111, 241-BY-112

#### C TANK FARM

- 241-C-101, 241-C-102, 241-C-103, 241-C-104, 241-C-105, 241-C-106, 241-C-107, 241-C-108, 241-C-109, 241-C-110, 241-C-111, 241-C-112

#### S TANK FARM

- 241-S-101, 241-S-102, 241-S-103, 241-S-104, 241-S-105, 241-S-106, 241-S-107, 241-S-108, 241-S-109, 241-S-110, 241-S-111, 241-S-112

#### SX TANK FARM

- 241-SX-101, 241-SX-102, 241-SX-103, 241-SX-104, 241-SX-105, 241-SX-106, 241-SX-107, 241-SX-108, 241-SX-109, 241-SX-110, 241-SX-111, 241-SX-112, 241-SX-113, 241-SX-114, 241-SX-115

#### T TANK FARM

- 241-T-101, 241-T-102, 241-T-103, 241-T-104, 241-T-105, 241-T-106, 241-T-107, 241-T-108, 241-T-109, 241-T-110, 241-T-111, 241-T-112

#### TX TANK FARM

- 241-TX-101, 241-TX-102, 241-TX-103, 241-TX-104, 241-TX-105, 241-TX-106, 241-TX-107, 241-TX-108, 241-TX-109, 241-TX-110, 241-TX-111, 241-TX-112, 241-TX-113, 241-TX-114, 241-TX-115, 241-TX-116, 241-TX-117, 241-TX-118

#### TY TANK FARM

- 241-TY-101, 241-TY-102, 241-TY-103, 241-TY-104, 241-TY-105, 241-TY-106

#### U TANK FARM

- 241-U-101, 241-U-102, 241-U-103, 241-U-104, 241-U-105, 241-U-106, 241-U-107, 241-U-108, 241-U-109, 241-U-110, 241-U-111, 241-U-112

### **3.0 DOME DEFLECTION SURVEY PROGRAM**

All control survey work for locating control monuments and performing dome elevation surveys will be performed using best survey industry practices. The Washington Administrative Code WAC 332-130 and the Revised Code of Washington RCW Title 58 shall be used as guidance. However, since this is not establishing boundaries or land office corners, no specific Washington state laws or DOE regulations govern the performance of tank dome elevation surveys.

Closure on all survey level loops shall not exceed 0.02 feet with a level of accuracy of three significant figures. Each survey should be performed in a similar fashion as its previous survey in order to maintain consistency.

All surveying activities will be supervised by a Professional Land Surveyor (PLS) licensed in the State of Washington. The PLS shall abide by the Revised Code of Washington (RCW), Chapter 18.43, *ENGINEERS AND LAND SURVEYORS* and the Washington Administrative Code (WAC), Chapter 196-27A, *RULES OF PROFESSIONAL CONDUCT AND PRACTICE*.

### 3.1 General

In general, the survey activity will include the following:

#### Pre-Survey Planning

- 1 Propose a schedule to perform the necessary survey of each of the tank farms within the required periods. Obtain CH2M HILL approval of the schedule.
- 2 Determine the tank(s) to be surveyed and obtain the Tank Survey Record for each tank. The tank survey record will include the relevant tank, control benchmark and monument information.
- 3 Verify that the survey instrument accuracy is within the required tolerances. The survey instrument used must have a horizontal sensitivity of 3.0 seconds of arc, or better and the elevation staff shall have a least count scale equivalent to 0.01 feet or less.

#### Field Work

- 4 Within 48 hours of a scheduled survey, the subcontractor shall contact the Buyer's Technical Representative for the purposes of confirming the survey site availability and ensuring that current environmental conditions will be acceptable for performing the services.
- 5 Visual check of the control monuments for signs of visible damage or other signs indicating questionable integrity.
- 6 Performance of the primary level loop survey for each tank: (from a primary control monument, turn through one bench mark on each tank closing on a control monument).
- 7 Performance of the secondary level loop survey for each tank: (begin at a bench mark on the tank which was part of the primary level loop, and then turn through all available bench marks on that tank closing on another bench mark which was part of the primary level loop).
- 8 If deflections are in excess of 0.02 feet perform notifications per *Section 3.3 Post Survey*

#### Tank Survey Record & Field Survey Notes

- 9 Update the Tank Survey Record for each tank.
- 10 Within 2 weeks following the completion of the survey, send the completed field survey notes and updated Tank Survey Record to the Buyer's Technical Representative. The field survey notes are to include the tank numbers surveyed, the date of the survey, crew names, the environmental conditions including

approximate temperature and wind speed and identification of the survey equipment used (including calibration date if applicable).

### 3.2 Survey Equipment

The following requirements are necessary to ensure that the required survey tolerances are met:

- The survey instrument used shall have a horizontal angular accuracy of 3.0 second of arc, or better.
- The survey instrument shall have a compensator setting accuracy of +/- 0.3 second.
- The elevation staff shall have a least count scale equivalent to 0.01 feet or less.
- All surveys shall be performed in accordance with the survey equipment manufacturer's recommendations to maintain the required accuracy.

Currently, some in-farm work requires the use of fresh air respirators. The use of this type of Personal Protective Equipment PPE limits the surveyor's ability to visually take level readings. Alternates to optical equipment should be considered such as a digital level or laser scanning.

### 3.3 Survey Tolerance and Errors

A decrease in benchmark elevation between surveys indicates that a dome deflection may have occurred or other survey errors have occurred. It is expected that the surveys should be repeatable to  $\pm 0.01$  feet ( $\pm 0.12$  inch). If a deflection has changed more than  $\pm 0.02$  feet since the last survey, the survey must be repeated to verify the accuracy of the results. Items to check if the tolerance of  $\pm 0.02$  feet is exceeded are as follows:

- Calibration of survey equipment.
- Appropriate survey procedures have been followed.
- Determination if control monuments have been disturbed or there are other signs indicating questionable integrity.
- Tank benchmarks have been damaged.

If a dome deflection has decreased by more than 0.02 feet and rechecking of the survey and survey data has been performed, then immediately notify the Civil/Structural Discipline Lead Engineer and SST Engineering so the condition can be documented in the Problem Evaluation and Reporting (PER) system.

### 3.4 Survey Control Monuments and Benchmarks

Although the tank farm control monuments are not required to meet geodetic control requirements, they all are to be referenced back to the geodetic control for the site.

- As dome surveys are performed, the conditions of the benchmarks are reviewed. If a control monument or benchmark is damaged or of questionable integrity, notify the Civil/Structural Discipline Lead Engineer and Retrieval/Closure Engineering so the condition can be documented in the PER system.
- If applicable, establish the location and elevation of all new monuments or benchmarks. New benchmarks or monuments shall be evaluated to validate consistency with the historic survey data.
- See drawing H-2-68529 for standard bench mark and monument designs.

### 3.5 Frequency

Tank Dome Surveys are to be performed on a 3 years  $\pm$ 4 months frequency except for tanks S, SX, T, C, U, BX, and BY which are every 2 years  $\pm$ 4 months due to the amount of activity in these farms. Additional surveys may be required when tank dome loading significantly changes or there is increased work activity in the tank farm. Dome survey frequency shall be determined by the structural Discipline Lead Engineer.

### 3.6 Expected Deflection

Deflection of the tank dome of up to approximately  $\frac{1}{2}$  inch is within dome load limits per RPP-RPT-25608 Rev. 0. Significant load is required to achieve this degree of deflection. All survey data should be reviewed by the responsible tank farm engineer and evaluated for tank settlement and for dome deflection. Measurable deflection of approximately  $\frac{1}{4}$  inch could be expected but deflection in excess of  $\frac{1}{4}$  inch should be reviewed by the Civil/Structural Discipline Lead Engineer.

Dome deflection can be determined by subtracting the elevation at the center of the dome from the elevation at the perimeter of the tank. Settlement of the tank can be determined by subtracting the most current elevation at the perimeter of the tank from the first, or oldest, survey elevation at the perimeter of the tank.

### 3.7 Survey Data

The Tank Survey Record will contain the following information for each tank:

#### Tank Benchmark Specific information

The following information shall be recorded on the data sheet for each tank benchmark

<b>Tank Number</b>	<b>Riser / Pit Number</b>		
<b>Date</b>	<b>Current Elevation</b>	<b>Δ From Previous Elevation</b>	<b>Total Δ Original Elevation</b>

The Survey field notes shall include the following information:

- Tank number
- Survey date
- Crew names
- Weather including approximate temperature and wind speed
- Control Monuments used and shall indicate if signs of damage or other signs indicating questionable integrity were observed.
- Survey equipment used

Deflection of the tank dome of up to approximately  $\frac{1}{2}$  inch is within dome load limits per RPP-RPT-25608 Rev. 0. Significant load is required to achieve this degree of deflection. All survey data should be reviewed by the responsible tank farm engineer and evaluated for tank settlement and for dome deflection. Measurable deflection of approximately  $\frac{1}{4}$  inch could be expected but deflection in excess of  $\frac{1}{4}$  inch should be reviewed by the Civil/Structural Discipline Lead Engineer.

Dome deflection can be determined by subtracting the elevation at the center of the dome from the elevation at the perimeter of the tank. Settlement of the tank can be determined by subtracting the most current elevation at the perimeter of the tank from the first, or oldest, survey elevation at the perimeter of the tank.

### 3.8 Survey Data Sheets Disposition

Once the survey data is complete for a tank, the respective *Tank Farm Historic Dome Load Record Data* document needs to be modified to include the new survey data and a copy of the dome load log for that specific tank. See *Table 1* for the listing of documents for each SST farm. Retrieval/Closure Engineering is responsible for the upkeep of these *Record Data* documents.

**Table 2. SST Dome Load Record Data Documents**

RPP No.	TITLE DESCRIPTION
RPP-20444	241-A Tank Farm Historic Dome Load Record Data
RPP-20445	241-AX Tank Farm Historic Dome Load Record Data
RPP-20446	241-B Tank Farm Historic Dome Load Record Data
RPP-20447	241-BX Tank Farm Historic Dome Load Record Data
RPP-20448	241-BY Tank Farm Historic Dome Load Record Data
RPP-20449	241-C Tank Farm Historic Dome Load Record Data
RPP-20450	241-S Tank Farm Historic Dome Load Record Data
RPP-20451	241-SX Tank Farm Historic Dome Load Record Data
RPP-20452	241-T Tank Farm Historic Dome Load Record Data
RPP-20453	241-TX Tank Farm Historic Dome Load Record Data
RPP-20454	241-TY Tank Farm Historic Dome Load Record Data
RPP-20455	241-U Tank Farm Historic Dome Load Record Data

#### 4.0 REFERENCES

- HNF-SD-WM-TSR-006, *Tank Farm Technical Safety Requirements*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20444, *241-A Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20445, *241-AX Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20446, *241-B Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20447, *241-BX Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20448, *241-BY Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20449, *241-C Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20450, *241-S Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20451, *241-SX Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20452, *241-T Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20453, *241-TX Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20454, *241-TY Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20455, *241-U Tank Farm Historic Dome Load Record Data*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-20473, *Design and Dome Load Criteria for Hanford Waste Storage Tanks*, CH2M Hill Hanford Group, Inc., Richland, Washington.
- RPP-11802, *SST Analysis of Record*, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-RPT-25608, *Increased Concentrated Loads Report*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

TFC-ENG-FACSUP-C-10, *Control of Dome Loading*, CH2M Hill Hanford Group, Inc., Richland, Washington.

A1.0

**SAMPLE SURVEY DATA SHEET**

<b>SURVEY DATA SHEET</b>		<b>DATE:</b>	
<b>TANK NUMBER</b>	241-__-__		
<b>CREW</b>	<b>Name / Print</b>	<b>Initial</b>	
<b>SURVEY EQUIP</b>			
<b>WEATHER</b>			
<b>TEMP.</b>			
		<b>Riser / Pit Number:</b>	
<b>Original Survey Date</b>	<b>Original Elevation</b>		
<b>Last Survey Date</b>	<b>Elevation From Last Survey</b>		
<b>Date</b>	<b>Current Elevation</b>	<b>Δ From Last Survey</b>	<b>Total Δ Original Elevation</b>