ZION SOLUTIONS LLC
An EnergySolutions Company

ZION STATION RESTORATION PROJECT
FINAL STATUS SURVEY RELEASE RECORD

UNIT 2 STEAM TUNNEL
EMBEDDED FLOOR DRAIN PIPE
SURVEY UNIT 06210

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AMCG	Average Member of the Critical Group
BcDCGL	Base Case Derived Concentration Guideline Level
BcSOF	Base Case Sum of Fractions
cpm	Counts per Minute
dpm	Disintegrations per Minute
DQA	Data Quality Assessment
DQO	Data Quality Objective
DCGL	Derived Concentration Guideline Level
EMC	Elevated Measurement Comparison
FSS	Final Status Survey
HTD	Hard-to-Detect
IC	Insignificant Contributor
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
OpDCGL	Operational Derived Concentration Guideline Level
OpSOF	Operational Sum of Fractions
QAPP	Quality Assurance Project Plan
QC	Quality Control
ROC	Radionuclides of Concern
SOF	Sum of Fractions
TEDE	Total Effective Dose Equivalent

UCL	Upper Confidence Level
ZNPS	Zion Nuclear Power Station
ZSRP	Zion Station Restoration Project

1. EXECUTIVE SUMMARY

This Final Status Survey (FSS) Release Record for survey unit 06210, the "Unit 2 Steam Tunnel Embedded Floor Drain Pipe", has been generated for the Zion Station Restoration Project (ZSRP). The release record was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-005, *"Final Status Survey Data Reporting"* (Reference 1) and satisfies the requirements of Section 5.11 of the *"Zion Station Restoration Project License Termination Plan"* (LTP) (Reference 2).

Final Status Survey Sample Plan S3-06210AF was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-001, *"Final Status Survey Package Development"* (Reference 3) the ZSRP LTP, and guidance from NUREG-1575, *"Multi-Agency Radiation Survey and Site Investigation Manual"* (MARSSIM) (Reference 4).

Final Status Survey was conducted to demonstrate that the concentrations of residual radioactivity are equal to or below site-specific Derived Concentration Guideline Levels (DCGL) corresponding to the dose criterion in 10 CFR 20.1402. The Unit 2 Steam Tunnel Embedded Floor Drain Pipe was classified as MARSSIM Class 3.

The Unit 2 Steam Tunnel Embedded Floor Drain Pipe was surveyed with a Ludlum 2350-1 Data Logger paired with a 44-159 gamma detector. Following excavation of the northeast corner of the Steam Tunnel, the drain piping was accessed through cleanout M205. The detector was able to access 120 feet of the pipe from this access point. Readings were taken at 2-foot intervals to allow enough readings to provide for the 10% coverage requirement for a Class 3 survey unit. The total length of this piping system was 474 linear feet.

For the FSS of the Unit 2 Steam Tunnel Embedded Floor Drain Pipe, 60 readings were obtained. All of the readings were below an Operational Sum of Fractions (OpSOF) of 0.5 when compared against the Operational DCGL for embedded pipe ($OpDCGL_{EP}$) with the mean OpSOF reading of 0.002. The mean Base Case SOF (BcSOF), when compared to the Base Case DCGL for embedded pipe ($BcDCGL_{EP}$) was 0.000, which results in the dose calculated for this survey unit of 0.006 mrem/yr.

2. SURVEY UNIT DESCRIPTION

The Unit 2 Steam Tunnel Embedded Floor Drain Pipe consists of a 4-inch diameter pipe that is 474 linear feet in length. The floor of the tunnel is at 568 foot elevation, with the drain piping embedded in the concrete approximately 2 feet deep.

3. CLASSIFICATION BASIS

Survey unit 06210 was classified in accordance with Zion*Solutions* procedure ZS-LT-300-001-002, *"Survey Unit Classification"* (Reference 5).

The Turbine Building was initially classified as a Class 2 structure by the *"Zion Station Historical Site Assessment"* (HSA) (Reference 6). LTP Section 5.5.2.1.2 changed the classification of the Turbine Building basement from Class 2 to Class 3. The LTP states "The FSS units for the basements of the Turbine Building, the Crib House/Forebay, WWTF and the Circulating Water Discharge Tunnels are designated as Class 3 as defined in MARSSIM, section 2.2 in that the FSS units are expected to contain levels of residual activity at a small fraction of the DCGLs, based on site operating history and previous radiation surveys."

4. DATA QUALITY OBJECTIVES (DQO)

Final Status Survey planning and design hinges on coherence with the DQO process to ensure, through compliance with explicitly defined inputs and boundaries, that the primary objective of the survey is satisfied. The DQO process is described in the ZSRP LTP in accordance with MARSSIM. The appropriate design for a given survey will be developed using the DQO process as outlined in Appendix D of MARSSIM.

The DQO process incorporated hypothesis testing and probabilistic sampling distributions to control decision errors during data analysis. Hypothesis testing is a process based on the scientific method that compares a baseline condition to an alternate condition. The baseline condition is technically known as the null hypothesis. Hypothesis testing rests on the premise that the null hypothesis is true and that sufficient evidence must be provided for rejection. In designing the survey plan, the underlying assumption, or null hypothesis was that residual activity in the survey unit exceeded the release criteria. Rejection of the null hypothesis would indicate that residual activity within the survey unit does not exceed the release criteria. Therefore, the survey unit would satisfy the primary objective of the FSS sample plan.

The primary objective of the FSS sample plan is to demonstrate that the level of residual radioactivity in survey unit 06210 did not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity is As Low As Reasonably Achievable (ALARA).

LTP Chapter 6, section 6.5.2 discusses the process used to derive the Radionuclides of Concern (ROC) for the decommissioning of Zion Nuclear Power Station (ZNPS), including the elimination of insignificant dose contributors (IC) from the initial suite. Based upon the analysis of the mixture, it was determined that Co-60, Ni-63, Sr-90, Cs-134 and Cs-137 accounted for 99.5% of all dose in the non-activated contaminated concrete mixes.

The residual radioactivity in embedded piping located below the 588 foot grade that will remain and be subjected to FSS is discussed in LTP Chapter 2, section 2.3.3.7 and TSD

14-016, *"Description of Embedded Piping, Penetrations, and Buried Pipe to Remain in Zion End State"* (Reference 7). The DCGLs for embedded piping are listed in LTP Chapter 5, sections 5.2.7 and 5.2.8.

Due to absence of significant source term in the Turbine Building, the suite of ROC and radionuclide mixture derived for the Auxiliary Building concrete was considered as a reasonable conservative mixture to apply to the Unit 2 Steam Tunnel Embedded Floor Drain Pipe for FSS planning and implementation. Table 1 reproduces the ROC from LTP Chapter 5, Table 5-2.

Table 1 - Dose Significant Radionuclides and Mixture

Radionuclide	Auxiliary Building % of Total Activity (normalized)(1)
Co-60	0.92%
Ni-63	23.71%
Sr-90	0.05%
Cs-134	0.01%
Cs-137	75.32%

(1) Based on maximum percent of total activity from Table 20 of TSD 14-019, normalized to one for the dose significant radionuclides.

A FSS is conducted on the interior surfaces of embedded piping to demonstrate that the concentrations of residual activity are equal to or below DCGLs corresponding to the dose criterion in 10CFR20.1402 ($DCGL_{EP}$). $DCGL_{EP}$ were calculated for each of the remaining embedded pipe systems. The $DCGL_{EP}$ values for the Steam Tunnel Drain embedded pipe system from LTP Chapter 6, section 6.13 are referred to as BcDCGLs.

At ZNPS, compliance is demonstrated through the summation of dose from four distinct source terms for the end-state (basements, soils, buried pipe and groundwater). Each radionuclide-specific BcDCGL is equivalent to the level of residual radioactivity (above background levels) that could, when considered independently, result in a Total Effective Dose Equivalent (TEDE) of 25 mrem per year to an Average Member of the Critical Group (AMCG). To ensure that the summation of dose from each source term is 25 mrem/year or less after all FSS is completed, the BcDCGLs are reduced based on an expected, or a priori, fraction of the 25 mrem/year dose limit from each source term. The reduced DCGLs, or "Operational" DCGLs can be related to the BcDCGLs as an expected fraction of dose based on an a priori assessment of what the expected dose should be based on the results of site characterization, process knowledge and the extent of planned remediation. The OpDCGL is then used as the DCGL for the FSS design of the survey

unit (calculation of surrogate DCGLs, investigations levels, etc.). Details of the OpDCGLs derived for each dose component and the basis for the applied a priori dose fractions are provided in Zion*Solutions* TSD 17-004, "*Operational Derived Concentration Guideline Levels for Final Status Survey*" (Reference 8).

The BcDCGLs and OpDCGLs for the Unit 2 Steam Tunnel Embedded Floor Drain Pipe are listed in Tables 5-11 and 5-12 of the LTP.

License Termination Plan Chapter 5, section 5.5.5 discusses the alternate drilling spoils resident farmer scenario. The dose for the Unit 2 Steam Tunnel Embedded Floor Drain Pipe in this scenario is calculated to be 71.16 mrem/year using the maximum hypothetical activity that could be allowed to remain. As a conservative measure, the BcDCGLs were adjusted by a factor of 2.89 (71.16/25), which will reduce the hypothetical maximum dose to 25 mrem/year.

The Modified BcDCGLs and the OpDCGLs are reproduced in the Table 2.

Table 2 - Modified Base Case and Operational DCGLs

Radionuclide	Modified Base Case Embedded Pipe DCGL pCi/m^2 (1)	Operational Embedded Pipe DCGL pCi/m^2
Co-60	1.41E+10	1.63E+09
Cs-134	3.19E+09	3.69E+08
Cs-137	4.22E+09	4.88E+08
Ni-63	4.36E+11	5.04E+10
Sr-90	1.55E+08	1.79E+07

(1) Values represent BcDCGLs from Table 5-11 for the Steam Tunnel reduced by a factor of 2.89.

5. SURVEY DESIGN

The level of effort associated with planning a survey is based on the complexity of the survey and nature of the hazards. Guidance for preparing FSS plans is provided in procedure ZS-LT-300-001-001 *"Final Status Survey Package Development."*

During FSS, concentrations for Hard-to-Detect (HTD) ROC Ni-63 and Sr-90 are inferred using a surrogate approach. Cs-137 is the principle surrogate radionuclide for Sr-90 and Co-60 is the principle surrogate radionuclide for Ni-63. The mean, maximum and 95% Upper Confidence Level (UCL) of the surrogate ratios for concrete core samples taken in the Auxiliary Building basement were calculated in Zion*Solutions* TSD 14-019, *"Radionuclides of Concern for Soil and Basement Fill Model Source Terms"* (Reference

9) and are presented in Table 3. The maximum ratios will be used in the surrogate calculations during this FSS. Equations 2 through 5 show the results of the calculations. The results of the surrogate calculations are listed in Table 4.

Table 3 - Surrogate Ratios

Ratios	Auxiliary Building		
	Mean	Max	95%UCL
Ni-63/Co-60	44.143	180.450	154.632
Sr-90/Cs-137	0.001	0.002	0.002

The equation for calculating a surrogate DCGL is as follows:

Equation 1

$$Surrogate_{DCGL} = \frac{1}{\left[\left(\frac{1}{DCGL_{Sur}}\right) + \left(\frac{R_2}{DCGL_2}\right) + \left(\frac{R_3}{DCGL_3}\right) + \cdots \left(\frac{R_n}{DCGL_n}\right)\right]}$$

Using the Base Case and Operational DCGLs presented in Table 2 and the maximum ratios from Table 3, the following surrogate calculations were performed:

Equation 2

(Cs-137 Surrogate BcDCGL)

$$Surrogate_{DCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{4.22E09_{(Cs-137)}}\right) + \left(\frac{0.002}{1.55E08_{(Sr-90)}}\right)\right]} = 4.00E09\ pCi/m^2$$

Equation 3

(Cs-137 Surrogate OpDCGL)

$$Surrogate_{DCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{4.88E08_{(Cs-137)}}\right) + \left(\frac{0.002}{1.79E07_{(Sr-90)}}\right)\right]} = 4.63E08\ pCi/m^2$$

Equation 4

(Co-60 Surrogate BcDCGL)

$$Surrogate_{DCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{1.41E10_{(C0-60)}}\right) + \left(\frac{180.45}{4.36E11_{(Ni-63)}}\right)\right]} = 2.06E09\ pCi/m^2$$

Equation 5

(Co-60 Surrogate OpDCGL)

$$Surrogate_{DCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{1.63E9_{(C0-60)}}\right) + \left(\frac{180.45}{5.04E10_{(Ni-63)}}\right)\right]} = 2.38E08\ pCi/m^2$$

Table 4 - Surrogate Base Case and Operational DCGLs

Radionuclide	Base Case Embedded Pipe DCGL pCi/m^2	Operational Embedded Pipe DCGL pCi/m^2
Co-60	2.06E+09	2.38E+08
Cs-134	3.19E+09	3.69E+08
Cs-137	4.00E+09	4.63E+08

The survey design calculated a gross-gamma OpDCGL of 1.75E+08 pCi/m^2. The Action Level used for the surveys for this survey unit was 50% of this value: 8.74E+07 pCi/m^2. The equation for calculating Gross Activity is as follows:

Equation 6

$$Gross\ Activity\ DCGL = \frac{1}{\left(\frac{f1}{DCGL1} + \frac{f2}{DCGL2} + \frac{fN}{DCGLN}\right)}$$

The normalized gamma mixture was applied to the OpDCGLs for the gamma-emitting nuclides in Table 2 in the following equation:

Equation 7

(Gross Gamma Activity DCGL)

$$Gross\ Activity\ DCGL = \frac{1}{\left(\frac{0.98780}{4.88E08} + \frac{0.01207}{1.63E09} + \frac{0.00013}{3.69E08}\right)} = 4.92E08\ pCi/m^2$$

The Gross Activity DCGL was then used in the surrogate equation using the surrogate ratios from Table 3:

Equation 8

(Surrogate Gross Gamma Activity DCGL)

$$Surrogate_{DCGL\ (gamma)} = \frac{1}{\left[\left(\frac{1}{4.92E08}\right) + \left(\frac{180.45}{5.04E10_{(Ni-63)}}\right) + \left(\frac{0.002}{1.79E07_{(Sr-90)}}\right)\right]} = 1.75E08\ pCi/m^2$$

The Unit 2 Steam Tunnel Embedded Floor Drain Pipe is Class 3 embedded pipe. For the survey of pipe internal surfaces, areal coverage is achieved by the "area of detection" for each static measurement taken. Scanning, in the traditional context, is not applicable to the survey of pipe internal surfaces. For the survey of these pipes, the pipe detector was calibrated for the specific geometry of the 4-inch pipes. For a 4-inch Internal Diameter (ID) pipe, each measurement has a calculated Field-of-View (FOV) of 1.05 ft^2 (0.097 m^2).

The Unit 2 Steam Tunnel Embedded Floor Drain Pipe contains 474 linear feet of 4-inch ID piping, which equates to a surface area of 46.1 m^2. The LTP states that a FSS Class 3 survey unit shall have a minimum areal coverage of 10%. Therefore, one measurement was to be collected every 10 linear feet of piping traversed for a total of 47 distinct measurements over the entire accessible pathway of the piping system. For quality control purposes, a minimum of 5% of the measurements collected were to be replicated. This would require an additional 3 measurements to be collected throughout the length of the accessible surface of the piping system at locations selected at random.

Each static measurement represents the gamma activity in gross Counts per Minute (cpm) for each specific measurement location. This gamma measurement value in cpm was then converted to Disintegrations per Minute (dpm) using an efficiency factor based on the calibration source. The total activity in dpm is then adjusted for the assumed total effective surface area commensurate with the pipe/penetration diameter, resulting in measurement results in units of dpm per m^2. Unit conversion converted dpm to units of pCi. The measurement result, in units of pCi/m^2, represents a commensurate and conservative gamma surface activity. The total gamma surface activity for each FSS measurement is converted to a gamma measurement result (in units of pCi/m^2) for each gamma ROC based on the normalized gamma mixture from Table 1. Concentrations for HTD ROC are inferred using the surrogate approach in accordance with LTP Chapter 5. Cs-137 is the principle surrogate radionuclide for H-3 and Sr-90. Co-60 is the principle surrogate radionuclide for Ni-63. The maximum ratios from Table 3, which are reproduced from Table 5-15 of the LTP, were used in the surrogate calculations.

The "unity rule" is applied when there is more than one ROC. The measurement results for each singular ROC present in the mixture are compared against their respective DCGL to derive a dose fraction. The summation of the dose fractions for each ROC produces an OpSOF for the measurement.

To demonstrate that each survey unit satisfies the OpDCGL, the ROC concentration for each systematic measurement taken in the Unit 2 Steam Tunnel Embedded Floor Drain Pipe was divided by its applicable $OpDCGL_{EP}$ to derive an OpSOF for the ROC. The OpSOF for each ROC was then summed to determine the total OpSOF for all ROC that represents the measurement and was used as the summed value (Ws) for performing the Sign Test.

If the OpSOF for a systematic or judgmental measurement exceeded "0.5" in a Class 3 survey unit, then an investigation would be initiated in accordance with LTP Chapter 5, section 5.6.4.6 (Table 5-25). In a Class 3 FSS unit, the result of the investigation could prompt the reclassification of the survey unit (or a portion of the survey unit).

Embedded pipe survey units have a relatively small surface area, which results in OpDCGLs that are higher than the wall/floor OpDCGLs. The reason for this is that the total internal surface area of the embedded pipe survey unit in a given basement is much less than the total wall/floor surface area of the basement containing them. To eliminate the potential for activity levels in embedded pipe that could lead to releases greater than surrounding walls and floors, the following remediation and grouting action levels were applied to measurements of surface activity in embedded pipe.

- If maximum activity exceeds the $BcDCGL_{EP}$ from LTP Chapter 5, Table 5-11 (SOF >1), then remediation was performed.
- If the maximum activity in an embedded pipe exceeded the surface $OpDCGL_B$ from LTP Chapter 5, Table 5-4 in the building that contains it, but was below the $BcDCGL_{EP}$ from LTP Chapter 5, Table 5-11, then the embedded pipe was remediated or grouted.
- If an embedded pipe was remediated and the maximum activity continues to exceed the surface $OpDCGL_B$ from LTP Chapter 5, Table 5-4, but is less than the Operational $DCGL_{EP}$ from LTP Chapter 5, Table 5-12, then the embedded pipe was grouted.
- If the maximum activity was below the surface $OpDCGL_B$ from LTP Chapter 5, Table 5-4, then grouting of the pipe was not required.

The instrumentation used for the FSS of the Unit 2 Steam Tunnel Embedded Floor Drain Pipe was the Ludlum Model 2350-1 and the Model 44-159 detector.

The instrumentation sensitivities are provided in Chapter 5 of the LTP and are reproduced in Table 5.

Table 5 - Typical FSS Instrument Detection Sensitivities

Instrument /Detector	Radiation	BKGD Count Time (min.)	Typical BKGD (cpm)	Typical Instrument Efficiency (1)(2)	Count Time (min.)	Static MDC (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)
Ludlum 2350-1/ 44-159	Gamma	1	700	0.024	1	5,250	N/A

(1) Typical calibration source used is Cs-137. The efficiency is determined by counting the source with the detector in a fixed position from the source (reproducible geometry). The εt value is based on ISO-7503-1 and conditions noted for each detector.

(2) The efficiency varies for the pipe detectors depending on the pipe diameter used. The efficiency used for the table is the average efficiency value for the pipe diameters. The detectors and diameters are: Model 44-159: 2-4 in. dia., Model 44-157: 4-8 in. dia., Model 44-162: 8-12 in. diameter.

The Elevated Measurement Comparison (EMC) did not apply to this survey unit. At ZSRP, EMC only applies to soils as all other media (structural surfaces, embedded pipe, buried pipe and penetrations) will be remediated to their applicable BcDCGL.

In compliance with ZS-LT-01, *"Quality Assurance Project Plan (for Characterization and FSS)"* (QAPP) (Reference 10), replicate measurements were to be performed on 5% of the static measurement locations.

Table 6 - Synopsis of Survey Design

Feature	Design Criteria	Basis
Survey Unit Area	46.1 m^2	4 in (ID) x 474 ft (length) x π
Number of Static Measurements	47	10% areal coverage, Class 3
Measurement Spacing	As needed to obtain sufficient measurements for 10% areal coverage	10% areal coverage, Class 3
DCGLs	• Co-60 – 1.63E+09 pCi/m^2 • Cs-134 – 3.69E+08 pCi/m^2 • Cs-137 –4.88E+08 pCi/m^2 • Ni-63 –5.04E+10 pCi/m^2 • Sr-90 –1.79E+07 pCi/m^2	Operational DCGLs for Unit 1 and Unit 2 Steam Tunnel Drain Embedded Pipe, (LTP Chapter 5, Table 5-12)
HTD ROC Analysis	Gross Gamma DCGL adjusted for HTD based on the isotopic mixture	LTP 5.7.1.9
Measurement Investigation Level	>0.5 Gross Gamma Operational DCGL	(LTP Chapter 5, Table 5-25)
Scan Survey Area Coverage	N/A	LTP 5.7.1.9
Quality Control (QC)	replicate measurements will be performed on 5% of the static measurement locations	QAPP

6. SURVEY IMPLEMENTATION

Survey instructions for this FSS were incorporated into and performed in accordance with FSS Sample Plan S3-06210AF, which was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-001, "*Final Status Survey Package Development*." The FSS unit was inspected and controlled in accordance with Zion*Solutions* procedure ZS-LT-300-001-003, "*Isolation and Control for Final Status Survey*" (Reference 11).

"Field Logs" (ZS-LT-300-001-001 Attachment 14) were used to document field activities and other information pertaining to the performance of the FSS. Daily briefings were conducted to discuss the expectations for job performance and to review safety aspects of the job.

The approach used for the radiological survey of the interior surfaces of the Unit 2 Steam Tunnel Embedded Floor Drain Pipe involved the insertion of a 1" x 1" CsI detector that was attached to the See Snake camera system and transported through the pipe to the maximum deployment length, or to a location of drain drop. A simple "push-pull" methodology was used, whereby the position of the detector in the piping system could be easily determined in a reproducible manner. Footage was tabulated on the See Snake, then measurements were obtained at 2 foot intervals while backing out of the pipe section.

A background value was also determined for the detector/instrument combination to be used prior to deployment. The background value was obtained at the location where the pre-use response check of the instrument was performed. The background value was primarily used to ensure that the detector had not become cross-contaminated by any previous use. Background was not subtracted from any measurement.

Daily prior to use and daily following use, each detector was subjected to an Operational Response Check in accordance with procedure ZS-LT-300-001-006, *"Radiation Surveys of Pipe Interiors Using Sodium/Cesium Iodide Detectors"* (Reference 12). The Daily Operational Response Check compared the background response and the response to check sources ranges established for normal background and detector source response to ensure that the detector was working properly.

Surveys of the Unit 2 Steam Tunnel Embedded Floor Drain Pipe were performed on April 30, 2018. The survey was completed in 1 day. The piping was accessed through the "Y" cleanout position (M205) located in the northeast corner of the Unit 2 Steam Tunnel. The See Snake and detector were inserted 120 feet into the pipe. Because the entire length of the pipe was not available for survey, it was decided to take measurements at 2 foot intervals to obtain sufficient readings to meet the 10% coverage required for the Class 3 survey unit. The Survey Design called for 47 readings to be taken at 10 foot intervals. Table 7 summarizes the data collected:

Table 7 - Survey Data Collected

Pipe Run	Length Surveyed	# of Measurements Taken	Comment
M205	120	60	3 QC readings taken

The instrument and detector used for this survey are presented in Table 8. The instrument and detector were verified to be properly calibrated prior to use.

Table 8 - Instrument and Detector

Instrument/Detector Type	Serial #	Calibration Due Date
Ludlum 2350-1	304708	05/01/18
Ludlum 44-159	PR327896	05/01/18

Daily prior to use (Pre-Test) and daily upon completion of surveys (Post-Test), response checks were performed in accordance with procedure ZS-LT-300-001-006 for each detector and data logger pairing. In addition, all instruments and detectors were physically inspected for mechanical damage as part of the response check process. During the FSS, no instances were encountered where an instrument and/or detector failed a Pre or Post response check or were found to be physically damaged during the inspection.

7. SURVEY RESULTS

After completion of the FSS measurements in the pipe, the sample plan was reviewed to confirm the completeness of the survey and the survey data was validated in accordance with procedure ZS-LT-300-001-004, "*Final Status Survey Data Assessment*" (Reference 13). Data processing includes converting measurement data into reporting units, validating instrument applicability and sensitivity, calculating relevant statistical quantities, and verification that all DQO have been met. In accordance with the procedure, a preliminary Data Assessment was prepared.

The primary gamma emitting ROC for the FSS of the Unit 2 Steam Tunnel Floor Drains FSS unit are Co-60, Cs-134 and Cs-137. Ni-63 and Sr-90 are also ROC for the Unit 2 Steam Tunnel Floor Drains. Ni-63 is inferred from the measured concentration of Co-60, while Sr-90 is inferred from the measured concentration of Cs-137. The ROC concentrations and OpSOF for each measurement taken in the Unit 2 Steam Tunnel Embedded Floor Drain Pipe are presented in Attachment 2. A statistical summary of the data is presented in Table 9.

Table 9 - Unit 2 Steam Tunnel Embedded Floor Drain Pipe – Measurement Results

Individual Measurement Metrics

Total Number of Systematic Measurements	=	60
Number of Quality Control Measurements	=	3
Number of Judgmental/Investigational Measurements	=	0
Total Number of Measurements	=	63
Mean Systematic Measurement OpSOF	=	0.002
Max Individual Systematic Measurement OpSOF	=	0.003
Number of Systematic Measurements with OpSOF >1	=	0

Statistical Quantities - Systematic Measurement Population

ROC	MEAN (pCi/m^2)	MEDIAN (pCi/m^2)	MAX (pCi/m^2)	MIN (pCi/m^2)	ST DEV (pCi/m^2)	BcDCGL (pCi/m^2)	Avg SOF per ROC	Avg Dose per ROC (mrem/yr)
Co-60	1.19E+04	1.16E+04	1.56E+04	9.87E+03	1.33E+03	1.41E+10	0.000	0.000
Cs-134	1.29E+02	1.26E+02	1.70E+02	1.07E+02	1.45E+01	3.19E+09	0.000	0.000
Cs-137	9.73E+05	9.47E+05	1.28E+06	8.08E+05	1.09E+05	4.22E+09	0.000	0.006
Ni-63	2.15E+06	2.09E+06	2.81E+06	1.78E+06	2.41E+05	4.36E+11	0.000	0.000
Sr-90	1.95E+03	1.89E+03	2.55E+03	1.62E+03	2.18E+02	1.55E+08	0.000	0.000

BASE CASE SOF (BcSOF) ASSIGNED TO SURVEY UNIT (SYSTEMATIC AVG.) = 0.000
DOSE ASSIGNED TO SURVEY UNIT (SYSTEMATIC AVG.) = 0.006

All measurements were less than 50% of the OpDCGL, meeting the requirement for a Class 3 area. The data collected passed the Sign Test. The result of the Sign Test is provided in Attachment 3.

The activity in this pipe was also compared to the $OpDCGL_B$ for the building that contains it. According to Table 5-20 of the LTP, the Steam Tunnel drains are included with the Turbine Building. The results of this comparison showed that the $OpSOF_B$ for all of the measurements were less than one when compared to the $OpDCGL_B$ for the Turbine Building, with a maximum SOF of 0.770. Consequently, grouting of the Unit 2 Steam Tunnel Embedded Floor Drain Pipe was not required.

8. QUALITY CONTROL

In compliance with ZS-LT-01, replicate measurements were performed on 5% of the survey locations chosen at random. Three (3) replicate measurements were taken. Using the acceptance criteria specified ZS-LT-01, *"Quality Assurance Project Plan (QAPP) for Characterization and Final Status Survey"*, there was acceptable agreement between the replicate readings and the original readings. Refer to Attachment 4 for quality control analysis results.

9. INVESTIGATIONS AND RESULTS

As all measurements in the accessible pipe interior surface area was below an OpSOF of 0.5, no investigations were required or performed.

10. REMEDIATION AND RESULTS

No remediation was performed in this piping survey unit.

11. CHANGES FROM THE SURVEY PLAN

Only 120 feet of the piping was accessible for survey, therefore readings were taken at 2-foot intervals in the pipe run to obtain enough measurements to meet the 10% coverage requirement for a Class 3 survey unit.

The survey instructions called for a 44-157 detector to be used for the survey. Due to the size limitation for a 4-inch pipe, the smaller 44-159 detector was used instead.

12. DATA QUALITY ASSESSMENT (DQA)

In accordance with procedure ZS-LT-300-001-004, the DQOs, sample design, and data were reviewed for completeness, accuracy, and consistency. Documentation was complete and legible. The FSS unit was properly classified as Class 3. All measurement results were individually reviewed and validated. The number of measurements was sufficient to meet the requirement of 10% areal coverage of accessible surfaces. The

instrumentation used to perform the FSS were in calibration, capable of detecting the activity with an adequate MDC and successfully response checked prior to and following use. An adequate number of replicate measurements were taken and the results meet the acceptance criteria as specified in the QAPP.

The data for Gross Gamma Activity is represented graphically through a frequency plot and a quantile plot. All graphical representations are provided in Attachment 5.

13. ANOMALIES

No anomalies were observed during the performance or analyses of the survey.

14. CONCLUSION

Sixty (60) static measurements were taken in the Unit 2 Steam Tunnel Embedded Floor Drain Pipe, taken at 2-foot intervals. The accessible length of pipe was 120 feet, therefore the areal coverage requirement of 10% for a Class 3 survey unit was met.

All of the measurements were below an OpSOF of 0.5. The average OpSOF for the survey unit was 0.002. The requirements for a Class 3 survey unit have been met.

The Sign Test was passed, and the Null Hypothesis was rejected. A Retrospective Power Curve showed that adequate power was achieved.

The dose contribution from embedded pipe in survey unit 06210, "Unit 2 Steam Tunnel Embedded Floor Drain Pipe", is 0.006 mrem/yr TEDE, based on the average concentration of the ROC in samples used for non-parametric statistical sampling.

Survey unit 06210, "Unit 2 Steam Tunnel Embedded Floor Drain Pipe" is acceptable for unrestricted release.

15. REFERENCES

1. Zion*Solutions* procedure ZS-LT-300-001-005, "Final Status Survey Data Reporting"
2. Zion Station Restoration Project License Termination Plan
3. Zion*Solutions* procedure ZS-LT-300-001-001, "Final Status Survey Package Development"
4. NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual"
5. Zion*Solutions* procedure ZS-LT-300-001-002, "Survey Unit Classification"
6. "Zion Station Historical Site Assessment"

7. Zion*Solutions* TSD 14-016, "Description of Embedded Piping, Penetrations, and Buried Pipe to Remain in Zion End State"
8. Zion*Solutions* TSD 17-004, "Operational Derived Concentration Guideline Levels for Final Status Survey"
9. Zion*Solutions* TSD 14-019, "Radionuclides of Concern for Soil and Basement Fill Model Source Terms"
10. Zion*Solutions* procedure ZS-LT-01, "Quality Assurance Project Plan (for Characterization and FSS)"
11. Zion*Solutions* procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey"
12. Zion*Solutions* procedure ZS-LT-300-001-006, "Radiation Surveys of Pipe Interiors Using Sodium/Cesium Iodide Detectors"
13. Zion*Solutions* procedure ZS-LT-300-001-004, "Final Status Survey Data Assessment"

16. ATTACHMENTS

Attachment 1 - Figures

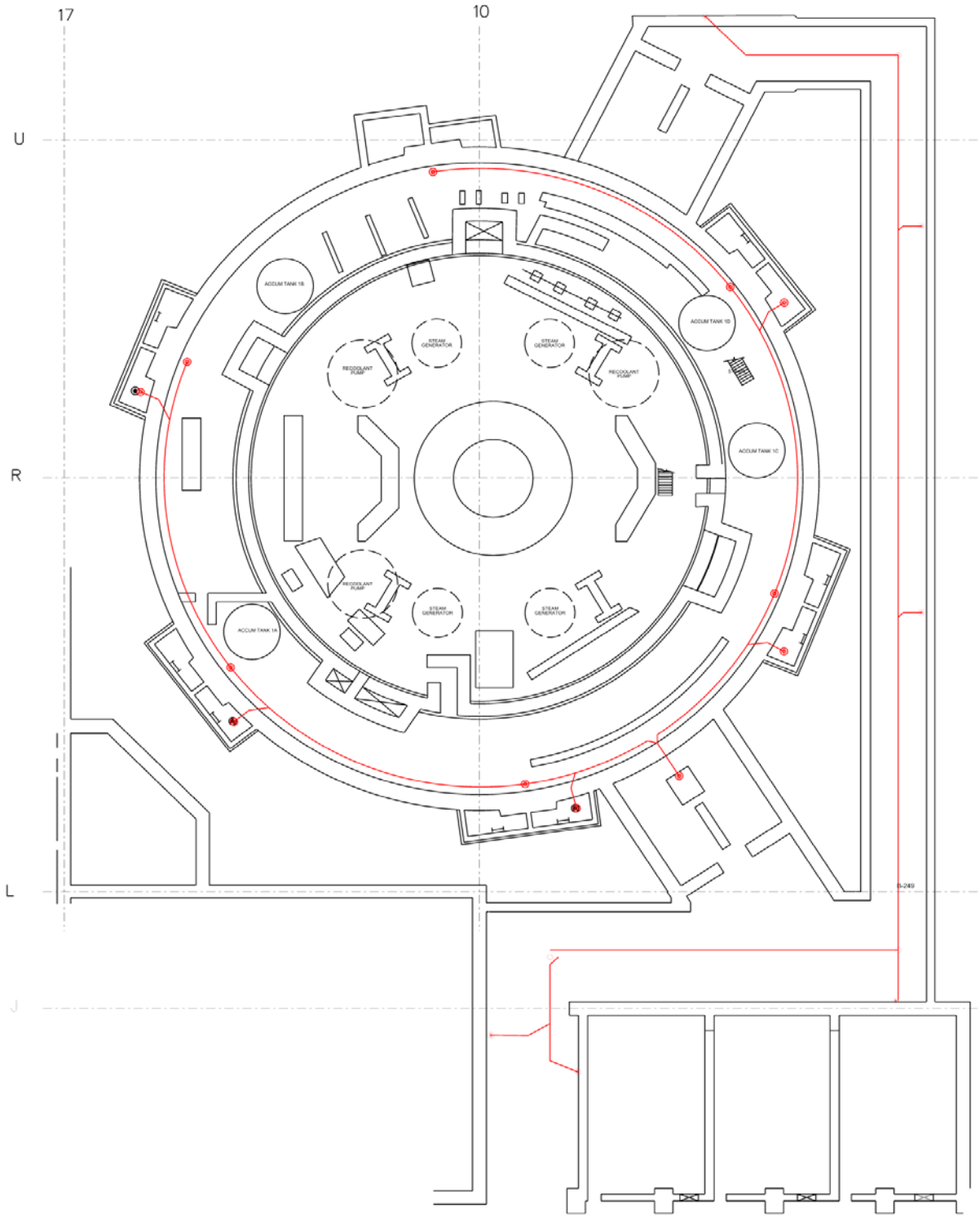
Attachment 2 - Sample Data

Attachment 3 - Sign Test

Attachment 4 - QC Sample Assessment

Attachment 5 - Graphical Presentations

ATTACHMENT 1 - FIGURES


17
10
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ACCUM TANK 1B
ACCUM TANK 1D
ACCUM TANK 1C
ACCUM TANK 1A
STEAM GENERATOR
STEAM GENERATOR
STEAM GENERATOR
STEAM GENERATOR
RECIRCULANT PUMP
RECIRCULANT PUMP
RECIRCULANT PUMP

ATTACHMENT 2 - SAMPLE DATA

Unit 2 Steam Tunnel Embedded Floor Drain Pipe – Measurement Data

POSITION	FEET INTO PIPE	GROSS GAMMA (pCi/m^2)	Co-60 (pCi/m^2)	Cs-134 (pCi/m^2)	Cs-137 (pCi/m^2)	Ni-63 (pCi/m^2)	Sr-90 (pCi/m^2)	$OpSOF_{EP}$	$OpSOF_B$
Position #0	120	1.13E+06	1.37E+04	1.49E+02	1.12E+06	2.47E+06	2.24E+03	0.002	0.676
Position #1	118	1.18E+06	1.42E+04	1.54E+02	1.16E+06	2.56E+06	2.32E+03	0.003	0.701
Position #2	116	1.16E+06	1.40E+04	1.52E+02	1.15E+06	2.52E+06	2.29E+03	0.003	0.691
Position #3	114	1.08E+06	1.30E+04	1.41E+02	1.07E+06	2.35E+06	2.13E+03	0.002	0.642
Position #4	112	1.03E+06	1.24E+04	1.34E+02	1.01E+06	2.23E+06	2.03E+03	0.002	0.611
Position #5	110	9.66E+05	1.17E+04	1.27E+02	9.54E+05	2.10E+06	1.91E+03	0.002	0.575
Position #6	108	9.38E+05	1.13E+04	1.23E+02	9.26E+05	2.04E+06	1.85E+03	0.002	0.559
Position #7	106	9.01E+05	1.09E+04	1.18E+02	8.90E+05	1.96E+06	1.78E+03	0.002	0.537
Position #8	104	9.43E+05	1.14E+04	1.24E+02	9.31E+05	2.05E+06	1.86E+03	0.002	0.562
Position #9	102	1.00E+06	1.21E+04	1.31E+02	9.90E+05	2.18E+06	1.98E+03	0.002	0.597
Position #10	100	9.11E+05	1.10E+04	1.19E+02	9.00E+05	1.98E+06	1.80E+03	0.002	0.543
Position #11	98	9.22E+05	1.11E+04	1.21E+02	9.10E+05	2.01E+06	1.82E+03	0.002	0.549
Position #12	96	9.32E+05	1.12E+04	1.22E+02	9.21E+05	2.03E+06	1.84E+03	0.002	0.555
Position #13	94	9.82E+05	1.18E+04	1.29E+02	9.70E+05	2.14E+06	1.94E+03	0.002	0.585
Position #14	92	1.02E+06	1.23E+04	1.34E+02	1.01E+06	2.22E+06	2.02E+03	0.002	0.608
Position #15	90	8.85E+05	1.07E+04	1.16E+02	8.74E+05	1.93E+06	1.75E+03	0.002	0.527
Position #16	88	9.23E+05	1.11E+04	1.21E+02	9.12E+05	2.01E+06	1.82E+03	0.002	0.550
Position #17	86	9.20E+05	1.11E+04	1.21E+02	9.09E+05	2.00E+06	1.82E+03	0.002	0.548
Position #18	84	9.13E+05	1.10E+04	1.20E+02	9.02E+05	1.99E+06	1.80E+03	0.002	0.544
Position #19	82	8.94E+05	1.08E+04	1.17E+02	8.83E+05	1.95E+06	1.77E+03	0.002	0.532
Position #20	80	9.41E+05	1.14E+04	1.23E+02	9.30E+05	2.05E+06	1.86E+03	0.002	0.561
Position #21	78	9.59E+05	1.16E+04	1.26E+02	9.47E+05	2.09E+06	1.89E+03	0.002	0.571
Position #22	76	9.71E+05	1.17E+04	1.27E+02	9.59E+05	2.11E+06	1.92E+03	0.002	0.578
Position #23	74	9.99E+05	1.21E+04	1.31E+02	9.87E+05	2.18E+06	1.97E+03	0.002	0.595
Position #24	72	9.59E+05	1.16E+04	1.26E+02	9.47E+05	2.09E+06	1.89E+03	0.002	0.571
Position #25	70	9.13E+05	1.10E+04	1.20E+02	9.02E+05	1.99E+06	1.80E+03	0.002	0.544

Unit 2 Steam Tunnel Embedded Floor Drain Pipe – Measurement Data (continued)

POSITION	FEET INTO PIPE	GROSS GAMMA (pCi/m^2)	Co-60 (pCi/m^2)	Cs-134 (pCi/m^2)	Cs-137 (pCi/m^2)	Ni-63 (pCi/m^2)	Sr-90 (pCi/m^2)	$OpSOF_{EP}$	$OpSOF_B$
Position #26	68	1.03E+06	1.25E+04	1.36E+02	1.02E+06	2.25E+06	2.04E+03	0.002	0.616
Position #27	66	1.04E+06	1.25E+04	1.36E+02	1.02E+06	2.26E+06	2.05E+03	0.002	0.617
Position #28	64	1.22E+06	1.47E+04	1.60E+02	1.20E+06	2.65E+06	2.40E+03	0.003	0.725
Position #29	62	1.13E+06	1.36E+04	1.48E+02	1.12E+06	2.46E+06	2.23E+03	0.002	0.673
Position #30	60	1.15E+06	1.39E+04	1.51E+02	1.13E+06	2.50E+06	2.27E+03	0.003	0.684
Position #31	58	1.19E+06	1.44E+04	1.57E+02	1.18E+06	2.60E+06	2.36E+03	0.003	0.712
Position #32	56	1.29E+06	1.56E+04	1.70E+02	1.28E+06	2.81E+06	2.55E+03	0.003	0.770
Position #33	54	1.20E+06	1.44E+04	1.57E+02	1.18E+06	2.60E+06	2.36E+03	0.003	0.713
Position #34	52	1.07E+06	1.29E+04	1.40E+02	1.05E+06	2.32E+06	2.11E+03	0.002	0.636
Position #35	50	1.15E+06	1.39E+04	1.51E+02	1.13E+06	2.50E+06	2.27E+03	0.003	0.684
Position #36	48	1.02E+06	1.23E+04	1.33E+02	1.00E+06	2.21E+06	2.01E+03	0.002	0.606
Position #37	46	1.13E+06	1.37E+04	1.49E+02	1.12E+06	2.47E+06	2.24E+03	0.002	0.676
Position #38	44	9.27E+05	1.12E+04	1.22E+02	9.16E+05	2.02E+06	1.83E+03	0.002	0.552
Position #39	42	9.13E+05	1.10E+04	1.20E+02	9.02E+05	1.99E+06	1.80E+03	0.002	0.544
Position #40	40	9.32E+05	1.12E+04	1.22E+02	9.21E+05	2.03E+06	1.84E+03	0.002	0.555
Position #41	38	1.03E+06	1.25E+04	1.35E+02	1.02E+06	2.25E+06	2.04E+03	0.002	0.615
Position #42	36	1.04E+06	1.26E+04	1.37E+02	1.03E+06	2.27E+06	2.06E+03	0.002	0.622
Position #43	34	1.03E+06	1.24E+04	1.35E+02	1.01E+06	2.24E+06	2.03E+03	0.002	0.612
Position #44	32	1.00E+06	1.21E+04	1.31E+02	9.89E+05	2.18E+06	1.98E+03	0.002	0.596
Position #45	30	9.97E+05	1.20E+04	1.31E+02	9.85E+05	2.17E+06	1.97E+03	0.002	0.594
Position #46	28	8.71E+05	1.05E+04	1.14E+02	8.60E+05	1.90E+06	1.72E+03	0.002	0.519
Position #47	26	8.46E+05	1.02E+04	1.11E+02	8.36E+05	1.84E+06	1.67E+03	0.002	0.504
Position #48	24	8.78E+05	1.06E+04	1.15E+02	8.67E+05	1.91E+06	1.73E+03	0.002	0.523
Position #49	22	8.92E+05	1.08E+04	1.17E+02	8.81E+05	1.94E+06	1.76E+03	0.002	0.531
Position #50	20	9.41E+05	1.14E+04	1.23E+02	9.30E+05	2.05E+06	1.86E+03	0.002	0.561

Unit 2 Steam Tunnel Embedded Floor Drain Pipe – Measurement Data (continued)

POSITION	FEET INTO PIPE	GROSS GAMMA (pCi/m^2)	Co-60 (pCi/m^2)	Cs-134 (pCi/m^2)	Cs-137 (pCi/m^2)	Ni-63 (pCi/m^2)	Sr-90 (pCi/m^2)	$OpSOF_{EP}$	$OpSOF_B$
Position #51	18	9.64E+05	1.16E+04	1.26E+02	9.52E+05	2.10E+06	1.90E+03	0.002	0.574
Position #52	16	9.16E+05	1.11E+04	1.20E+02	9.05E+05	2.00E+06	1.81E+03	0.002	0.546
Position #53	14	8.18E+05	9.87E+03	1.07E+02	8.08E+05	1.78E+06	1.62E+03	0.002	0.487
Position #54	12	8.55E+05	1.03E+04	1.12E+02	8.44E+05	1.86E+06	1.69E+03	0.002	0.509
Position #55	10	8.34E+05	1.01E+04	1.09E+02	8.24E+05	1.82E+06	1.65E+03	0.002	0.497
Position #56	8	8.94E+05	1.08E+04	1.17E+02	8.83E+05	1.95E+06	1.77E+03	0.002	0.532
Position #57	6	8.46E+05	1.02E+04	1.11E+02	8.36E+05	1.84E+06	1.67E+03	0.002	0.504
Position #58	4	8.69E+05	1.05E+04	1.14E+02	8.58E+05	1.89E+06	1.72E+03	0.002	0.518
Position #59	2	8.41E+05	1.01E+04	1.10E+02	8.31E+05	1.83E+06	1.66E+03	0.002	0.501

ATTACHMENT 3 - SIGN TEST

Sign Test - Unit 2 Steam Tunnel Embedded Floor Drain Pipe

Survey Area	06000	Survey Area	Unit 2 Steam Tunnel		
Survey Unit	06210	Survey Unit	Floor Drain Pipe (embedded)		
Classification	3	Type I Error	0.05	Number of Measurements	60

#	SOF (Ws)	1-Ws	Sign	#	SOF (Ws)	1-Ws	Sign
1	0.002	1.00	-1	31	0.003	1.00	+1
2	0.003	1.00	+1	32	0.003	1.00	+1
3	0.003	1.00	+1	33	0.003	1.00	+1
4	0.002	1.00	+1	34	0.003	1.00	+1
5	0.002	1.00	+1	35	0.002	1.00	+1
6	0.002	1.00	+1	36	0.003	1.00	+1
7	0.002	1.00	+1	37	0.002	1.00	+1
8	0.002	1.00	+1	38	0.002	1.00	+1
9	0.002	1.00	+1	39	0.002	1.00	+1
10	0.002	1.00	+1	40	0.002	1.00	+1
11	0.002	1.00	+1	41	0.002	1.00	+1
12	0.002	1.00	+1	42	0.002	1.00	+1
13	0.002	1.00	+1	43	0.002	1.00	+1
14	0.002	1.00	+1	44	0.002	1.00	+1
15	0.002	1.00	+1	45	0.002	1.00	+1
16	0.002	1.00	+1	46	0.002	1.00	+1
17	0.002	1.00	+1	47	0.002	1.00	+1
18	0.002	1.00	+1	48	0.002	1.00	+1
19	0.002	1.00	+1	49	0.002	1.00	+1
20	0.002	1.00	+1	50	0.002	1.00	+1
21	0.002	1.00	+1	51	0.002	1.00	+1
22	0.002	1.00	+1	52	0.002	1.00	+1
23	0.002	1.00	+1	53	0.002	1.00	+1
24	0.002	1.00	+1	54	0.002	1.00	+1
25	0.002	1.00	+1	55	0.002	1.00	+1
26	0.002	1.00	+1	56	0.002	1.00	+1
27	0.002	1.00	+1	57	0.002	1.00	+1
28	0.002	1.00	+1	58	0.002	1.00	+1
29	0.003	1.00	+1	59	0.002	1.00	+1
30	0.002	1.00	+1	60	0.002	1.00	+1

Number of positive differences (S+) 60

Critical Value 36

The Survey Unit MEETS the Acceptance Criteria

ATTACHMENT 4 - QC SAMPLE ASSESSMENT

Unit 2 Steam Tunnel Embedded Drain Pipe – QC Agreement

Survey Unit # 06210 Survey Unit Name Unit 2 Steam Tunnel Embedded Floor Drain

Sample Plan # S3-06210A-F

Sample Description: Comparison of replicate measurements collected from four measurement locations accessed from cleanout M205.

STANDARD				COMPARISON		
ID	Activity Value (pCi/m^2)	+20% (pCi/m^2)	-20% (pCi/m^2)	ID	Activity Value (pCi/m^2)	Acceptable (Y/N)
98' into pipe	9.22E+05	1.11E+06	7.37E+05	98' into pipe	8.69E+05	Y
70' into pipe	9.13E+05	1.10E+06	7.30E+05	70' into pipe	9.43E+05	Y
28' into pipe	8.71E+05	1.04E+06	6.97E+05	28' into pipe	8.44E+05	Y

Comments/Corrective Actions: There was acceptable agreement between the standard measurement and the replicate measurement. Based on the professional judgment of the Radiological Engineer, the same conclusion was reached for each measurement. No further action is necessary.

The acceptance criteria for replicate static measurements and scan surveys are that the same conclusion is reached for each measurement. This is defined as $\pm$ 20% of the standard.

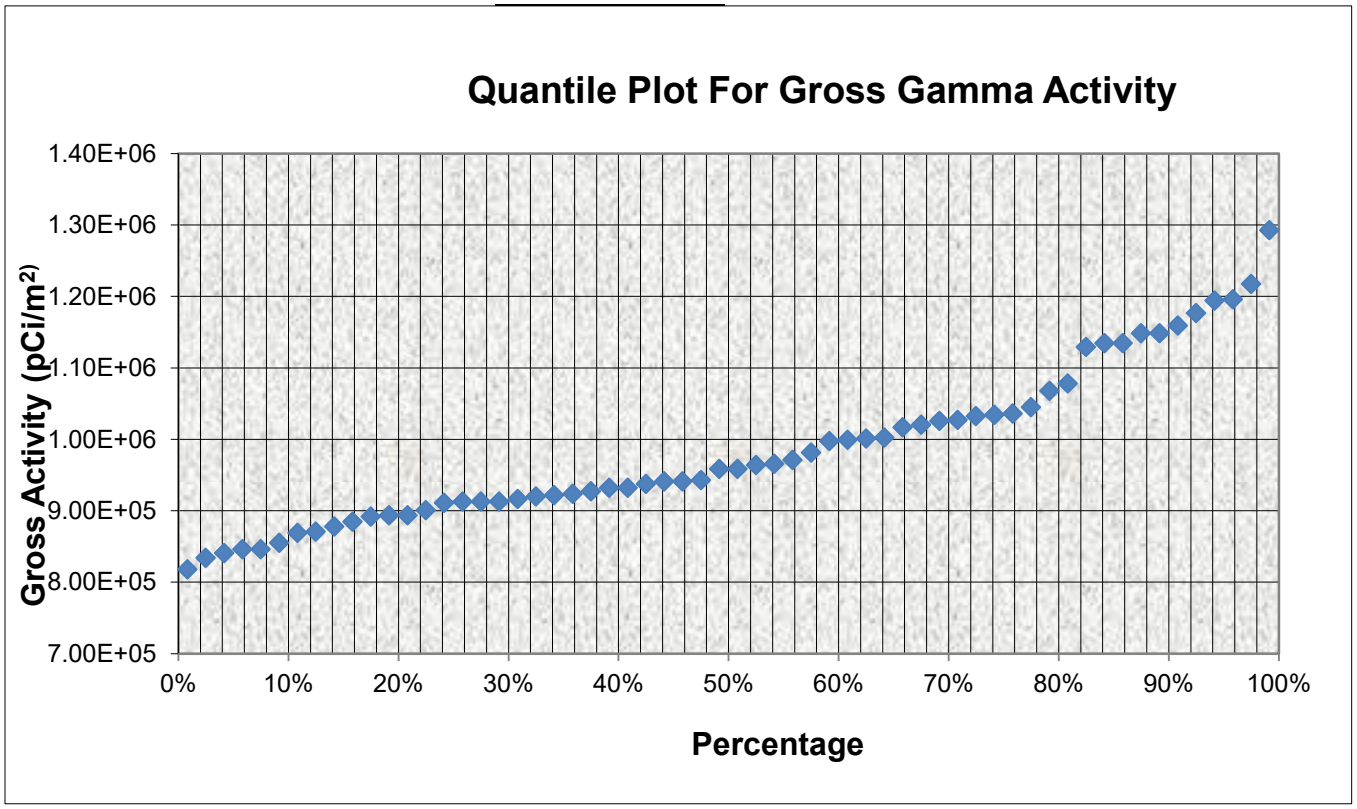
ATTACHMENT 5 - GRAPHICAL PRESENTATIONS

QUANTILE PLOT for Gross Gamma Activity

Survey Unit: S3-06210

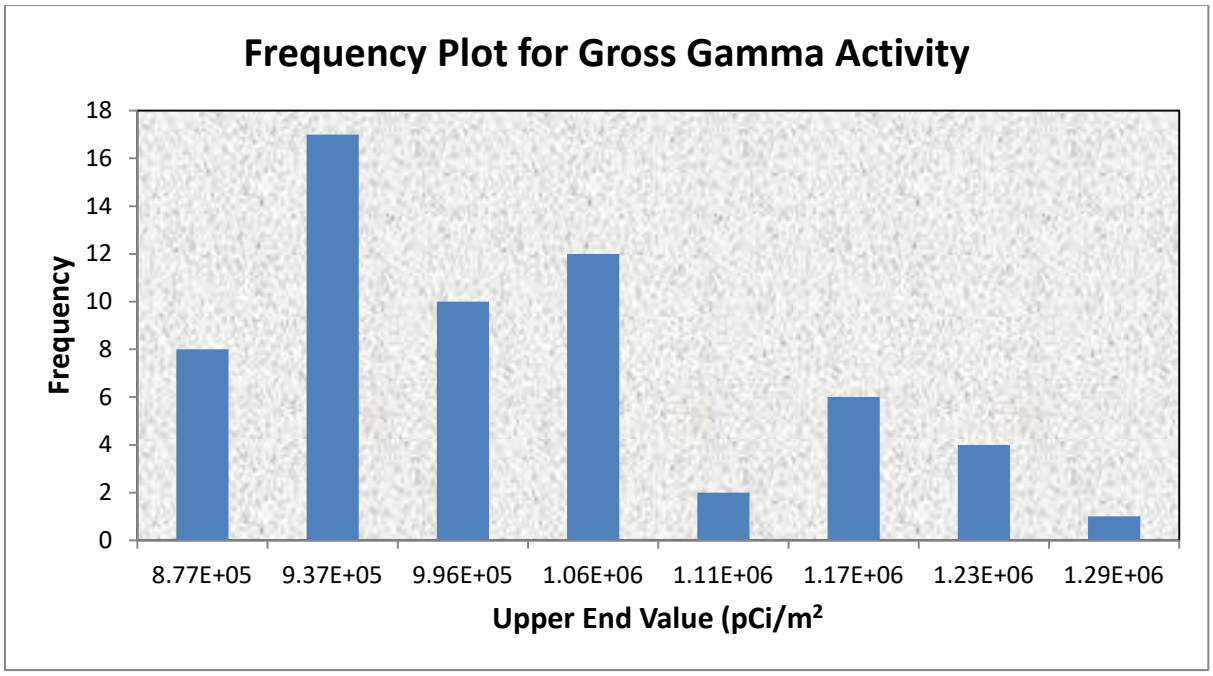
Survey Unit Name: Unit 2 Steam Tunnel Drains Embedded Pipe

Mean: 9.85E+05



Histogram for Gross Gamma Activity

Survey Unit:	S3-06210	
Survey Unit Name:	Unit 2 Steam Tunnel Drains Embedded Pipe	
Mean:	9.85E+05	pCi/m^2
Median:	9.59E+05	pCi/m^2
ST DEV:	1.11E+05	pCi/m^2
Skew:	8.05E-01	pCi/m^2



Upper Value	Observation Frequency	Observation %
8.77E+05	8	13%
9.37E+05	17	28%
9.96E+05	10	17%
1.06E+06	12	20%
1.11E+06	2	3%
1.17E+06	6	10%
1.23E+06	4	7%
1.29E+06	1	2%
TOTAL	60	100%

Retrospective Power Curve for Survey Unit 06210