ZION SOLUTIONS LLC
An EnergySolutions Company

ZION STATION RESTORATION PROJECT
FINAL STATUS SURVEY RELEASE RECORD

UNIT 1 CONTAINMENT
INCORE SUMP DISCHARGE PIPE
SURVEY UNIT 01111 (No. P125)

REVISION 1

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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
CsI	Cesium Iodide
DQA	Data Quality Assessment
DQO	Data Quality Objective
DCGL	Derived Concentration Guideline Level
EMC	Elevated Measurement Comparison
FSS	Final Status Survey
HSA	Historical Site Assessment
IC	Insignificant Contributor
ID	Internal Diameter
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
OpDCGL	Operational Derived Concentration Guideline Level
OpSOF	Operational Sum of Fraction
QAPP	Quality Assurance Project Plan
QC	Quality Control
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 01111, Unit 1 Containment Incore Sump Discharge Pipe (No. P125) has been generated for the Zion Station Restoration Project (ZSRP) 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 S1-01111AF 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 is 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 1 Containment Incore Sump Discharge Pipe (P125) is classified as MARSSIM Class 1.

Measurements were collected at 1 foot intervals inside the pipe which has a 1.61 inch Internal Diameter (ID). The Ludlum 2350-1 Data Logger paired with a Ludlum Model 44-159 Cesium Iodide (CsI) gamma detector was selected to survey 26.74 linear feet with a surface area of 1.05 m^2 to provide 100% coverage requirement for a Class 1 survey unit. Due to an obstruction (90 degree elbow), 22 measurements were taken to achieve 100% areal coverage of the accessible internal surface which equated to a surface area of 0.86 m^2.

For the FSS of the Incore Sump Discharge Pipe, 22 readings were obtained. Twenty-one (21) readings were below a Sum of Fractions (SOF) of 1.0 when compared against the Operational DCGL for embedded pipe ($OpDCGL_{EP}$) with a mean Operational SOF (OpSOF) of 0.363. Compared against the Base Case DCGL for embedded pipe ($BcDCGL_{EP}$), the mean Base Case SOF (BcSOF) was 0.049, which equated to a dose of 1.221 mrem/yr.

With the exception of a single measurement, evaluation of the data showed that none of the remaining concentration values exceeded the OpDCGL for embedded pipe or any investigational level. The single measurement that exceeded the $OpDCGL_{EP}$ could exceed an OpSOF of one without remediation as long as the survey unit passed the Sign Test and, the mean OpSOF for the survey unit did not exceed one, which was the case in survey unit 01111. Therefore, the null hypothesis was rejected and the Unit 1 Containment Incore Sump Discharge Pipe (No. P125) survey unit 01111 was acceptable for unrestricted release.

2. SURVEY UNIT DESCRIPTION

The Unit 1 Containment Incore Sump Discharge Pipe is 1.61 inch ID embedded pipe located in the concrete of the Incore Access Tunnel in Unit 1 Containment. The incore area extends below the containment slab and consists of a cylindrical area directly under the reactor vessel biological shield and a sloped tunnel. The incore area walls are 1 foot, 11.5 inches thick (23.5 inches) with a 2 foot, 6 inch under vessel area floor thickness. There is also an access tunnel with 15 inch thick walls, floor and roof. The sump is 2 ft. x 2 ft. x 2 ft. approximately 1 foot from the bend line. The pipe enters the wall at the floor above the sump making the opposite of the triangle 17 feet plus 9.5 feet or 22.5 feet. The base is 43 feet minus 30 feet and 9-inches making the hypotenuse length 25.74 feet, assuming the pipe enters the wall approximately 1 foot before sloping upward results in an estimated length of 26.74 feet (8.15 meters) and a 1.05 m^2 surface area. Twenty-seven (27) measurements were planned to be taken but only 22 feet of the pipe was accessible for survey.

3. CLASSIFICATION BASIS

Survey unit 01111 is the Unit 1 Incore Sump Discharge embedded pipe No. P125 was classified in accordance with Zion*Solutions* procedure ZS-LT-300-001-002, "*Survey Unit Classification*" (Reference 5).

Based on information from the "*Zion Station Historical Site Assessment"* (HSA), (Reference 6), the Incore Sump Discharge Pipe is located in a Class 1 area. The Under Vessel Incore area was subjected to operational conditions as well as the exercising of the incore detectors. The Unit 1 Incore Sump Discharge Pipe contained radioactive material and was classified as a Class 1 system.

4. DATA QUALITY OBJECTIVES

Final Status Survey planning and design hinges on coherence with the Data Quality Objective (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 was to demonstrate that the level of residual radioactivity in survey unit 01111 did not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity was As Low As Reasonably Achievable (ALARA).

LTP Chapter 6, section 6.5.2 discusses the process used to derive the ROC for the decommissioning of ZSRP, including the elimination of insignificant dose contributors (IC) from the initial suite. In accordance with LTP Chapter 6, Table 6-2, the ROC for Containments include: H-3, Co-60, Ni-63, Sr-90, Cs-134, Cs-137, Eu-152 and Eu-154.

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.

For the Unit 1 Incore Sump Discharge Pipe (P125), the suite of ROC and radionuclide mixture derived for the Containment concrete was considered as a reasonable and conservative mixture to apply to the Unit 1 Incore Sump Discharge Pipe (P125) for FSS planning and implementation. Table 1 reproduces the ROC from LTP Chapter 5, Table 5-2.

Final Status Survey 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 Unit 1 Incore Sump Discharge Pipe (P125) embedded pipe system from LTP Chapter 6, section 6.13 are referred to as Base Case DCGLs.

At Zion Nuclear Power Station (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 Base Case DCGL 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/yr to an Average Member of the Critical Group (AMCG).

Table 1 - Dose Significant Radionuclides and Mixture

Radionuclide	Containment % of Total Activity (normalized)(1)
H-3	0.075%
Co-60	4.72%
Cs-134	0.01%
Cs-137	68.17%
Ni-63	26.50%
Sr-90	0.05%
Eu-152	0.44%
Eu-154	0.06%

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

To ensure that the summation of dose from each source term is 25 mrem/yr or less after all FSS is completed, the BcDCGLs are reduced based on an expected, or *a priori*, fraction of the 25 mrem/yr 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 Base Case and Operational DCGLs for the Incore Sump Discharge Pipe are listed in Tables 5-11 and 5-12 of the LTP and are reproduced in Table 2 below.

Table 2 - Base Case and Operational DCGLs (pCi/m^2)

Radionuclide	Base Case Unit 1 & Unit 2 Containment Incore Sump Embedded Drain Pipe	Operational Unit 1 & Unit 2 Containment Incore Sump Embedded Drain Pipe
H-3	8.28E+09	6.62E+08
Co-60	5.47E+09	4.38E+08
Ni-63	1.40E+11	1.12E+10
Sr-90	4.98E+07	3.98E+06
Cs-134	1.05E+09	8.40E+07
Cs-137	1.37E+09	1.10E+08
Eu-152	1.28E+10	1.02E+09
Eu-154	1.11E+10	8.88E+08

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."*

The DQO process determined that H-3, Co-60, Ni-63, Sr-90, Cs-134, Cs-137, Eu-152 and Eu-154 would be the ROC in FSS unit 01111. During FSS, concentrations for HTD ROC H-3, Ni-63 and Sr-90 were to be inferred using a surrogate approach. Cs-137 is the principle surrogate radionuclide for H-3 and 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 Containment Buildings 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 LTP Table 5-15 and Table 3 below. The maximum ratios were to be used to infer HTD concentrations during FSS unless area specific ratios were determined.

Table 3 - Surrogate Ratios for Containment

Ratios	Containment		
	Mean	Max	95%UCL
H-3/Cs-137	0.208	1.760	0.961
Ni-63/Co-60	30.623	442.317	193.910
Sr-90/Cs-137	0.002	0.021	0.010

Using the surrogate ratios in Table 3 and Equation 1 from LTP Chapter 5, section 5.2.11, an adjusted gross-gamma OpDCGL was calculated by applying the normalized gamma mixture for Eu-152, Eu-154, Cs-137, Cs-134 and Co-60, from Table 1.

For the FSS of survey unit 01111 (P125), the surrogate OpDCGLs for Co-60 and Cs-137 were computed using the maximum ratios from Table 3.

The equation for calculating a surrogate DCGL is as follows:

Equation 1

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

Where: $DCGL_{Sur}$ = Surrogate radionuclide DCGL

$DCGL_{2,3...n}$ = DCGL for radionuclides to be represented by the surrogate

R_n = Ratio of concentration (or nuclide mixture fraction) of radionuclide "n" to surrogate radionuclide

Using the OpDCGLs presented in Table 2 and the maximum ratios from Table 3, the following surrogate calculations were performed:

Equation 2

$$Surrogate_{DCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{4.38E08_{(C0-60)}}\right) + \left(\frac{442}{1.12E10_{(Ni-63)}}\right)\right]} = 2.40E07\ pCi/m^2$$

Equation 3

$$Surrogate_{DCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{1.10E08_{(Cs-137)}}\right) + \left(\frac{1.76}{6.62E08_{(H-3)}}\right) + \left(\frac{0.021}{3.98E6_{(Sr-90)}}\right)\right]} = 5.87E7\ pCi/m^2$$

The most limiting surrogate DCGL value was 2.40E+07 pCi/m^2 (Co-60). A gross gamma activity DCGL was then calculated using Equation 4:

Equation 4

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

The normalized gamma mixture from Table 1 was applied to the surrogate OpDCGLs for the gamma-emitting nuclides as follows:

Equation 5

$$Gross\ Activity\ DCGL = \frac{1}{\left(\frac{0.92874}{5.87E07} + \frac{0.06430}{2.40E07} + \frac{0.00013}{8.40E07} + \frac{0.0060}{1.02E09} + \frac{0.0008}{8.88E08}\right)} = 5.40E7\ pCi/m^2$$

A gross gamma OpDCGL of 5.40E+07 pCi/m^2 was calculated as an action level for the FSS of survey unit 01111 (P125).

The Unit 1 Incore Sump Discharge Pipe (P125) is Class 1 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 efficiency for the pipe detector was derived for the specific geometry of the 1.61-inch ID pipe.

The Unit 1 Incore Sump Discharge Pipe (P125) contains 26.74 linear feet of 1.61-inch ID piping, which equates to a surface area of 1.05 m^2. The "SeeSnake™" camera was inserted 22 feet into the pipe. Because the entire length of the pipe was not accessible due to a 90 degree elbow, it was decided to take 22 measurements which equated to 0.86 m^2 surface area. The LTP states that a FSS Class 1 survey unit shall have a minimum areal coverage of 100%. Therefore, one measurement was to be collected every 1 foot of piping traversed for a total of 22 distinct measurements over the entire accessible pathway of the piping system. For quality control (QC) purposes, a minimum of 5% of the measurements collected were to be replicated. Therefore, an additional 3 replicate measurements were collected throughout the length of the accessible surface of the piping system at locations selected at random.

Each static measurement represented the gamma activity in gross cpm for each specific measurement location. This gamma measurement value in cpm was then converted to dpm using an efficiency factor based on the calibration source in a comparable geometry. The total activity in dpm was then adjusted for the assumed total effective surface area commensurate with the pipe/penetration diameter, resulting in measurement results in units of dpm per cm^2. The total gamma surface activity for each FSS measurement was then 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 were inferred using the surrogate approach presented earlier in this release record.

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 a SOF for the measurement.

To demonstrate that the survey unit satisfies the release criteria, the ROC concentration for each systematic measurement taken in the Unit 1 Incore Sump Discharge Pipe was divided by its applicable $OpDCGL_{EP}$ to derive a OpSOF for the ROC. The OpSOF for each ROC was then summed to determine the total OpSOF for all ROC that represents the measurement. The total OpSOF for each measurement was used as the summed value (Ws) for performing the Sign Test.

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 1 Incore Sump Discharge Pipe (P125) was the Ludlum Model 2350-1 and the Model 44-159 detector. The typical instrumentation sensitivities are provided in Chapter 5 of the LTP and are reproduced below in Table 4.

Table 4 - 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 cm²)	Scan MDC (dpm/100 cm²)
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 ε_t 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)"* (Reference 10), replicate measurements were acquired at 5% of the static measurement locations.

Table 5 provides a synopsis of the survey design for the FSS of survey unit 01111.

Table 5 - Synopsis of Survey Design

Feature	Design Criteria	Basis
Survey Unit Area	0.86 m^2	$\frac{\left[\left(\frac{1.61in}{12\ in/ft}\right)*26.74ft*\pi\right]}{10.76ft^2/m^2}$
Number of Static Measurements	22	100% areal coverage, Class 1
Measurement Spacing	One measurement every foot	100% areal coverage, Class 1
DCGLs (pCi/m^2)	• H-3 - 6.62E+08 • Co-60 - 4.38E+08 • Ni-63 - 1.12E+010 • Sr-90 - 3.98E+06 • Cs-134 - 8.40E+07 • Cs-137 - 1.10E+08 • Eu-152 - 1.02E+09 • Eu-154 - 8.88E+08	Operational DCGLs for Unit 1 Incore Sump Discharge Embedded Pipe (P125), (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	>Operational $DCGL_W$	(LTP Chapter 5, Table 5-25)
Scan Survey Area Coverage	N/A	LTP 5.7.1.9
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 #S1-01111-AF, 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 P125 piping involved the insertion of a Ludlum Model 44-159 detector, a 1-inch x 1-inch CsI detector that was attached to the end of a fiber rod and transported through the pipe to the maximum deployment length, or to the location of an obstruction that prevented further insertion. 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. Video footage was tabulated at 1-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.

The detector was subjected to Pre and Post Operational Response Checks 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 source ranges established for normal background and detector source response to ensure that the detector was working properly.

Surveys of the Unit 1 Incore Sump Discharge Pipe (P125) were performed on 12/07/17. The survey was completed in 1 day. The piping was accessed on the 565 foot elevation of Unit 1 Containment through the pipe opening at the top of the ladder going under-vessel. The "SeeSnake™" camera was inserted 22 feet into the pipe. Because the entire length of the pipe was not accessible due to a 90 degree elbow, 22 measurements were taken at 1-foot intervals to obtain sufficient readings to achieve 100% areal coverage of the accessible internal surfaces of the pipe. Table 6 summarizes the data collected.

Table 6 - Survey Data Collected

Pipe run	Length surveyed	# of measurements taken	Comment
P125	22 feet	22	3 QC readings taken

The instrument and detector used for this survey are presented in Table 7. The instrument and detector were verified to be properly calibrated prior to use.

Table 7 - Instrument and Detector

Instrument/Detector Type	Serial #	Calibration Due Date
Ludlum 2350-1	304713	04/12/18
Ludlum 44-159	PR327895	04/12/18

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 1 Incore Sump Discharge Pipe (P125) FSS unit are Co-60, Cs-134, Eu-152, Eu-154 and Cs-137. H-3, Ni-63 and Sr-90 are also ROC for the Unit 1 Incore Sump Discharge Pipe P125. Ni-63 is inferred from the measured concentration of Co-60, while Sr-90 and H-3 are inferred from the measured concentration of Cs-137. The results and resultant OpSOF for the measurements taken in the Unit 1 Incore Sump Discharge Pipe (P125) are presented in Table 8 below.

Table 8 - Unit 1 Incore Sump Discharge Pipe (P125) – Measurement Results

Measurement ID	H-3 (1) (pCi/m²)	Co-60 (pCi/m²)	Ni-63 (1) (pCi/m²)	Sr-90 (1) (pCi/m²)	Cs-134 (pCi/m²)	Cs-137 (pCi/m²)	Eu-152 (pCi/m²)	Eu-154 (pCi/m²)	OpSOF
S1-01111AF-SSM-001-GD	5.12E+08	2.01E+07	8.90E+09	6.11E+06	4.26E+04	2.91E+08	1.88E+06	2.56E+05	5.793
S1-01111AF-SSM-002-GD	7.75E+07	3.05E+06	1.35E+09	9.24E+05	6.46E+03	4.40E+07	2.84E+05	3.87E+04	0.877
S1-01111AF-SSM-003-GD	1.63E+07	6.42E+05	2.84E+08	1.95E+05	1.36E+03	9.27E+06	5.98E+04	8.16E+03	0.185
S1-01111AF-SSM-004-GD	7.28E+06	2.86E+05	1.27E+08	8.69E+04	6.07E+02	4.14E+06	2.67E+04	3.64E+03	0.082
S1-01111AF-SSM-005-GD	7.13E+06	2.81E+05	1.24E+08	8.51E+04	5.95E+02	4.05E+06	2.62E+04	3.57E+03	0.081
S1-01111AF-SSM-006-GD	5.65E+06	2.22E+05	9.82E+07	6.74E+04	4.71E+02	3.21E+06	2.07E+04	2.82E+03	0.064
S1-01111AF-SSM-007-GD	5.63E+06	2.22E+05	9.79E+07	6.72E+04	4.69E+02	3.20E+06	2.07E+04	2.82E+03	0.064
S1-01111AF-SSM-008-GD	5.36E+06	2.11E+05	9.32E+07	6.40E+04	4.47E+02	3.05E+06	1.97E+04	2.68E+03	0.061
S1-01111AF-SSM-009-GD	4.84E+06	1.90E+05	8.41E+07	5.77E+04	4.03E+02	2.75E+06	1.77E+04	2.42E+03	0.055
S1-01111AF-SSM-010-GD	4.17E+06	1.64E+05	7.25E+07	4.98E+04	3.48E+02	2.37E+06	1.53E+04	2.09E+03	0.047
S1-01111AF-SSM-011-GD	4.64E+06	1.83E+05	8.07E+07	5.54E+04	3.87E+02	2.64E+06	1.70E+04	2.32E+03	0.053
S1-01111AF-SSM-012-GD	3.89E+06	1.53E+05	6.76E+07	4.64E+04	3.24E+02	2.21E+06	1.43E+04	1.95E+03	0.044
S1-01111AF-SSM-013-GD	3.44E+06	1.35E+05	5.98E+07	4.10E+04	2.86E+02	1.95E+06	1.26E+04	1.72E+03	0.039
S1-01111AF-SSM-014-GD	3.39E+06	1.33E+05	5.90E+07	4.05E+04	2.83E+02	1.93E+06	1.24E+04	1.70E+03	0.038
S1-01111AF-SSM-015-GD	2.94E+06	1.16E+05	5.12E+07	3.51E+04	2.45E+02	1.67E+06	1.08E+04	1.47E+03	0.033
S1-01111AF-SSM-016-GD	2.99E+06	1.18E+05	5.20E+07	3.56E+04	2.49E+02	1.70E+06	1.10E+04	1.49E+03	0.034
S1-01111AF-SSM-017-GD	3.64E+06	1.43E+05	6.33E+07	4.35E+04	3.04E+02	2.07E+06	1.34E+04	1.82E+03	0.041
S1-01111AF-SSM-018-GD	4.01E+06	1.58E+05	6.97E+07	4.78E+04	3.34E+02	2.28E+06	1.47E+04	2.01E+03	0.045
S1-01111AF-SSM-019-GD	4.68E+06	1.84E+05	8.14E+07	5.58E+04	3.90E+02	2.66E+06	1.72E+04	2.34E+03	0.053
S1-01111AF-SSM-020-GD	3.86E+06	1.52E+05	6.71E+07	4.60E+04	3.22E+02	2.19E+06	1.41E+04	1.93E+03	0.044
S1-01111AF-SSM-021-GD	4.77E+06	1.87E+05	8.29E+07	5.69E+04	3.97E+02	2.71E+06	1.75E+04	2.38E+03	0.054
S1-01111AF-SSM-022-GD	1.75E+07	6.88E+05	3.04E+08	2.09E+05	1.46E+03	9.94E+06	6.41E+04	8.75E+03	0.198

(1) Concentrations for H-3, Ni-63 and Sr-90 are inferred based on the maximum ratios from LTP Chapter 5, Table 5-12

Table 9 - Unit 1 Incore Sump Discharge Pipe (P125) - Statistical Quantities - Systematic Measurement Population

Individual Measurement Metrics

Total Number of Systematic Measurements	=	22
Number of Quality Control Measurements	=	3
Number of Judgmental/Investigational Measurements	=	0
Total Number of Measurements	=	25
Mean Systematic Measurement OpSOF	=	0.363
Max Individual Systematic Measurement OpSOF	=	5.793
Number of Systematic Measurements with OpSOF >1	=	1

Statistical Quantities - Systematic Measurement Population

ROC	MEAN (pCi/m^2)	MEDIAN (pCi/m^2)	MAX (pCi/m^2)	MIN (pCi/m^2)	δ (pCi/m^2)	BcDCGL (pCi/m^2)	Avg SOF per ROC	Avg Dose per ROC (mrem/yr)
H-3	3.21E+07	4.72E+06	5.12E+08	2.94E+06	1.08E+08	8.28E+09	0.004	0.097
Co-60	1.26E+06	1.86E+05	2.01E+07	1.16E+05	4.26E+06	5.47E+09	0.000	0.006
Ni-63	5.57E+08	8.21E+07	8.90E+09	5.12E+07	1.88E+09	1.40E+11	0.004	0.100
Sr-90	3.83E+05	5.63E+04	6.11E+06	3.51E+04	1.29E+06	4.98E+07	0.008	0.192
Cs-134	2.67E+03	3.94E+02	4.26E+04	2.45E+02	9.02E+03	1.05E+09	0.000	0.000
Cs-137	1.82E+07	2.68E+06	2.91E+08	1.67E+06	6.15E+07	1.37E+09	0.013	0.332
Eu-152	1.18E+05	1.73E+04	1.88E+06	1.08E+04	3.97E+05	1.28E+10	0.000	0.000
Eu-154	1.60E+04	2.36E+03	2.56E+05	1.47E+03	5.41E+04	1.11E+10	0.000	0.000

BASE CASE SOF (BcSOF) ASSIGNED TO SURVEY UNIT (SYSTEMATIC AVG.) = 0.029

Twenty-one (21) of the 22 measurements had an OpSOF that was less than one. The mean OpSOF for all 22 samples was 0.363. One measurement exceeded the $OpDCGL_{EP}$ but was less than the $BcDCGL_{EP}$. The OpSOF for a measurement may exceed one without remediation as long as the survey unit passes the Sign Test and, the mean OpSOF for the survey unit does not exceed one. The data collected passed the Sign Test (using OpDCGLs). The result of the Sign Test is provided in Attachment 3. Once the survey data set passed the Sign Test, the mean radionuclide activity (pCi/m^2) for each ROC from the systematic measurements along with the identified single elevated measurement were compared against the BcDCGLs and an adjusted SOF was calculated in accordance with the following equation. Through the implementation of this equation (Equation 5 is a reproduction of Equation 5-6 from LTP Chapter 5, section 5.5.5), the mean BcSOF for the survey unit was adjusted by adding the SOF contribution from the elevated area to the mean to account for the additional dose.

Equation 6

$$SOF_{EP/PN} = \sum_{i=1}^{n} \frac{Mean\ Conc_{EP/PN\ ROC_i}}{BcDCGL_{EP/PN\ ROC_i}} + \frac{\left(Elev\ Conc_{EP/PN\ ROC_i} - Mean\ Conc_{EP/PN\ ROC_i}\right)}{\left[BcDCGL_{EP/PN\ ROC_i} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$SOF_{EP/PN}$	=	SOF for embedded pipe or penetration survey unit within a basement using BcDCGLs
$Mean\ Conc_{EP/PN\ ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of embedded pipe or penetrations in survey unit for each ROC_i
$BcDCGL_{EP/PN\ ROCi}$	=	BcDCGL for embedded pipe or penetration for each ROC_i
$Elev\ Conc_{EP/PN\ ROCi}$	=	Concentration for ROC_i in any identified elevated area (systematic or judgmental)
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	surface area of FSS unit

The surface area of the accessible portion of the pipe (SA_{SU}) is 0.86 m^2. The surface area of the elevated area is 0.036 m^2. The adjustment made to the mean BcSOF due to the one elevated measurement was 0.020.

The activity in this pipe was also compared to the $OpDCGL_B$ for the building in which it resides. According to Table 5-20 of the LTP, the Unit 1 Incore Sump Discharge Pipe (P125) will be included with the Unit 1 Containment. The results of this comparison show

that thirteen (13) measurements were greater than a SOF of 1 when compared to the $OpDCGL_B$ for the Unit 1 Containment Building. The pipe was grouted accordingly.

The SOF adjustment for the elevated measurement equaled 0.020. This value is then added to the mean SOF for the Unit 1 Incore Sump Discharge Pipe (P125) FSS unit of 0.029, resulting in an adjusted total mean BcSOF for the Unit 1 Incore Sump Discharge Pipe (P125) of 0.049. This SOF equates to a dose of 1.221 mrem/yr. This value is the dose assigned to the survey unit based on the average of the systematic measurements adjusted for the dose contribution of the identified elevated area.

8. QUALITY CONTROL

In compliance with ZS-LT-01, "*Quality Assurance Project Plan (for Characterization and FSS)*," (QAPP) replicate measurements were performed on 5% of the survey locations chosen at random. Three (3) replicate measurements were taken. Using the acceptance criteria specified in section 4.1.2 of ZS-LT-01, there was acceptable agreement between the replicate readings and the original readings. Refer to Attachment 4 for QC analysis results.

9. INVESTIGATIONS AND RESULTS

No investigations were required or performed.

10. REMEDIATION AND RESULTS

No remediation was performed in this pipe.

11. CHANGES FROM THE SURVEY PLAN

The actual configuration of the pipe was different than the drawings used to perform survey design. This fact was not discovered until the survey commenced. In actuality, the actual length of the pipe was 23 feet. There was one foot of pipe (1 measurement) that was not acquired as it was located on a 90 degree elbow. Only 22 feet of the piping was accessible for survey. Measurements were taken at one (1) foot intervals in the pipe to achieve 100% coverage of accessible internal surfaces.

The survey instructions called for a 44-157 detector to be used for the survey. This was a typographical error in the sample plan as 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 1. All measurement results were individually reviewed and validated. The number of measurements was sufficient to

meet the requirement of 100% areal coverage of accessible surfaces. The instrumentation used to perform the FSS was in calibration, capable of detecting the activity with an adequate minimum detectable concentration (MDC) and successfully response checked prior to and following use. An adequate number of replicate measurements were taken and the results met 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

Twenty-two (22) static measurements were taken in the Unit 1 Incore Sump Discharge Pipe (P125), at 1-foot intervals. The accessible length of pipe was 22 feet; therefore 100% areal survey coverage was achieved.

The Sign Test was passed, and the Null Hypothesis was rejected. Twenty-one (21) of the 22 measurements had an OpSOF that was less than one. The mean OpSOF for all 22 samples was 0.363. One measurement exceeded the exceeded the $OpDCGL_{EP}$ but was less than the $BcDCGL_{EP}$. The SOF adjustment for the elevated measurement equals 0.020. This value is then added to the mean BcSOF for the Unit 1 Incore Sump Discharge Pipe (P125) FSS unit of 0.029 resulting in an adjusted total SOF for the Unit 1 Incore Sump Discharge Pipe (P125) of 0.049. This SOF equates to a dose of 1.221 mrem/yr.

Survey unit 01111 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 - Figure 1

Attachment 2 - Sample Data

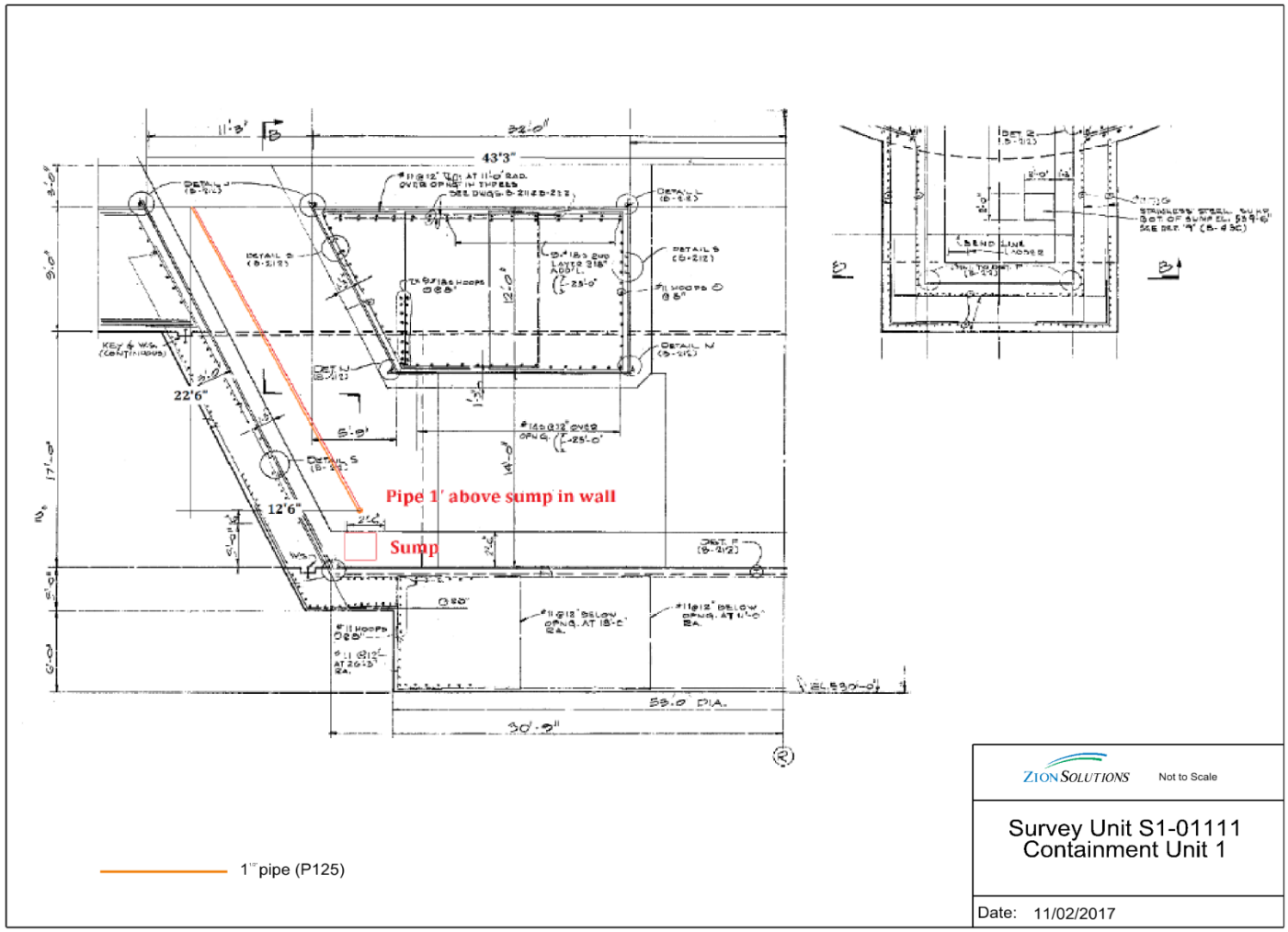
Attachment 3 - Sign Test

Attachment 4 - QC Data

Attachment 5 - Graphical Presentations

ATTACHMENT 1
FIGURE 1

FIGURE 1


43'3"
22'6"
12'6"
Pipe 1' above sump in wall
Sump
1" pipe (P125)
ZION SOLUTIONS
Not to Scale
Survey Unit S1-01111
Containment Unit 1
Date: 11/02/2017

ATTACHMENT 2 - SAMPLE DATA

Unit 1 Incore Sump Discharge Pipe (embedded – 1.5 in diameter)

Sample ID	Feet into Pipe	Gamma Result (pCi/m^2)	ROC	Gamma Mixture/HTD Ratio	Activity per ROC (pCi/m^2)	CTMT $OpDCGL_{EP}$ (pCi/m^2)	Nuclide OpSOF	$OpSOF_{EP}$	CTMT $BcDCGL_{EP}$ (pCi/m^2)	Nuclide BcSOF (pCi/m^2)	$BcSOF_{EP}$
S1-01111AF-SSM-001-GD	0	3.13E+08	H-3	1.76	5.12E+08	6.62E+08	0.773	5.793	8.28E+09	0.062	0.464
			Co-60	0.06431	2.01E+07	4.38E+08	0.046		5.47E+09	0.004	
			Ni-63	442.00	8.90E+09	1.12E+10	0.794		1.40E+11	0.064	
			Sr-90	0.021	6.11E+06	3.98E+06	1.534		4.98E+07	0.123	
			Cs-134	0.00014	4.26E+04	8.40E+07	0.001		1.05E+09	0.000	
			Cs-137	0.92875	2.91E+08	1.10E+08	2.643		1.37E+09	0.212	
			Eu-152	0.00599	1.88E+06	1.02E+09	0.002		1.28E+10	0.000	
			Eu-154	0.00082	2.56E+05	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-002-GD	1	4.74E+07	H-3	1.76	7.75E+07	6.62E+08	0.117	0.877	8.28E+09	0.009	0.070
			Co-60	0.06431	3.05E+06	4.38E+08	0.007		5.47E+09	0.001	
			Ni-63	442.00	1.35E+09	1.12E+10	0.120		1.40E+11	0.010	
			Sr-90	0.021	9.24E+05	3.98E+06	0.232		4.98E+07	0.019	
			Cs-134	0.00014	6.46E+03	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	4.40E+07	1.10E+08	0.400		1.37E+09	0.032	
			Eu-152	0.00599	2.84E+05	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	3.87E+04	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-003-GD	2	9.98E+06	H-3	1.76	1.63E+07	6.62E+08	0.025	0.185	8.28E+09	0.002	0.015
			Co-60	0.06431	6.42E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	2.84E+08	1.12E+10	0.025		1.40E+11	0.002	
			Sr-90	0.021	1.95E+05	3.98E+06	0.049		4.98E+07	0.004	
			Cs-134	0.00014	1.36E+03	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	9.27E+06	1.10E+08	0.084		1.37E+09	0.007	
			Eu-152	0.00599	5.98E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	8.16E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-004-GD	3	4.45E+06	H-3	1.76	7.28E+06	6.62E+08	0.011	0.082	8.28E+09	0.001	0.007
			Co-60	0.06431	2.86E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	1.27E+08	1.12E+10	0.011		1.40E+11	0.001	
			Sr-90	0.021	8.69E+04	3.98E+06	0.022		4.98E+07	0.002	
			Cs-134	0.00014	6.07E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	4.14E+06	1.10E+08	0.038		1.37E+09	0.003	
			Eu-152	0.00599	2.67E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	3.64E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-005-GD	4	4.36E+06	H-3	1.76	7.13E+06	6.62E+08	0.011	0.081	8.28E+09	0.001	0.006
			Co-60	0.06431	2.81E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	1.24E+08	1.12E+10	0.011		1.40E+11	0.001	
			Sr-90	0.021	8.51E+04	3.98E+06	0.021		4.98E+07	0.002	
			Cs-134	0.00014	5.95E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	4.05E+06	1.10E+08	0.037		1.37E+09	0.003	
			Eu-152	0.00599	2.62E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	3.57E+03	8.88E+08	0.000		1.11E+10	0.000	

Unit 1 Incore Sump Discharge Pipe (embedded – 1.5 in diameter) (continued)

Sample ID	Feet into Pipe	Gamma Result (pCi/m^2)	ROC	Gamma Mixture/HTD Ratio	Activity per ROC (pCi/m^2)	CTMT $OpDCGL_{EP}$ (pCi/m^2)	Nuclide OpSOF	$OpSOF_{EP}$	CTMT $BcDCGL_{EP}$ (pCi/m^2)	Nuclide BcSOF (pCi/m^2)	$BcSOF_{EP}$
S1-01111AF-SSM-006-GD	5	3.45E+06	H-3	1.76	5.65E+06	6.62E+08	0.009	0.064	8.28E+09	0.001	0.005
			Co-60	0.06431	2.22E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	9.82E+07	1.12E+10	0.009		1.40E+11	0.001	
			Sr-90	0.021	6.74E+04	3.98E+06	0.017		4.98E+07	0.001	
			Cs-134	0.00014	4.71E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	3.21E+06	1.10E+08	0.029		1.37E+09	0.002	
			Eu-152	0.00599	2.07E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.82E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-007-GD	6	3.45E+06	H-3	1.76	5.63E+06	6.62E+08	0.009	0.064	8.28E+09	0.001	0.005
			Co-60	0.06431	2.22E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	9.79E+07	1.12E+10	0.009		1.40E+11	0.001	
			Sr-90	0.021	6.72E+04	3.98E+06	0.017		4.98E+07	0.001	
			Cs-134	0.00014	4.69E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	3.20E+06	1.10E+08	0.029		1.37E+09	0.002	
			Eu-152	0.00599	2.07E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.82E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-008-GD	7	3.28E+06	H-3	1.76	5.36E+06	6.62E+08	0.008	0.061	8.28E+09	0.001	0.005
			Co-60	0.06431	2.11E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	9.32E+07	1.12E+10	0.008		1.40E+11	0.001	
			Sr-90	0.021	6.40E+04	3.98E+06	0.016		4.98E+07	0.001	
			Cs-134	0.00014	4.47E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	3.05E+06	1.10E+08	0.028		1.37E+09	0.002	
			Eu-152	0.00599	1.97E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.68E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-009-GD	8	2.96E+06	H-3	1.76	4.84E+06	6.62E+08	0.007	0.055	8.28E+09	0.001	0.004
			Co-60	0.06431	1.90E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	8.41E+07	1.12E+10	0.008		1.40E+11	0.001	
			Sr-90	0.021	5.77E+04	3.98E+06	0.015		4.98E+07	0.001	
			Cs-134	0.00014	4.03E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.75E+06	1.10E+08	0.025		1.37E+09	0.002	
			Eu-152	0.00599	1.77E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.42E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-010-GD	9	2.55E+06	H-3	1.76	4.17E+06	6.62E+08	0.006	0.047	8.28E+09	0.001	0.004
			Co-60	0.06431	1.64E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	7.25E+07	1.12E+10	0.006		1.40E+11	0.001	
			Sr-90	0.021	4.98E+04	3.98E+06	0.013		4.98E+07	0.001	
			Cs-134	0.00014	3.48E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.37E+06	1.10E+08	0.022		1.37E+09	0.002	
			Eu-152	0.00599	1.53E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.09E+03	8.88E+08	0.000		1.11E+10	0.000	

Unit 1 Incore Sump Discharge Pipe (embedded – 1.5 in diameter) (continued)

Sample ID	Feet into Pipe	Gamma Result (pCi/m^2)	ROC	Gamma Mixture/HTD Ratio	Activity per ROC (pCi/m^2)	CTMT $OpDCGL_{EP}$ (pCi/m^2)	Nuclide OpSOF	$OpSOF_{EP}$	CTMT $BcDCGL_{EP}$ (pCi/m^2)	Nuclide BcSOF (pCi/m^2)	$BcSOF_{EP}$
S1-01111AF-SSM-011-GD	10	2.84E+06	H-3	1.76	4.64E+06	6.62E+08	0.007	0.053	8.28E+09	4.64E+06	0.004
			Co-60	0.06431	1.83E+05	4.38E+08	0.000		5.47E+09	1.83E+05	
			Ni-63	442.00	8.07E+07	1.12E+10	0.007		1.40E+11	8.07E+07	
			Sr-90	0.021	5.54E+04	3.98E+06	0.014		4.98E+07	5.54E+04	
			Cs-134	0.00014	3.87E+02	8.40E+07	0.000		1.05E+09	3.87E+02	
			Cs-137	0.92875	2.64E+06	1.10E+08	0.024		1.37E+09	2.64E+06	
			Eu-152	0.00599	1.70E+04	1.02E+09	0.000		1.28E+10	1.70E+04	
			Eu-154	0.00082	2.32E+03	8.88E+08	0.000		1.11E+10	2.32E+03	
S1-01111AF-SSM-012-GD	11	2.38E+06	H-3	1.76	3.89E+06	6.62E+08	0.006	0.044	8.28E+09	3.89E+06	0.004
			Co-60	0.06431	1.53E+05	4.38E+08	0.000		5.47E+09	1.53E+05	
			Ni-63	442.00	6.76E+07	1.12E+10	0.006		1.40E+11	6.76E+07	
			Sr-90	0.021	4.64E+04	3.98E+06	0.012		4.98E+07	4.64E+04	
			Cs-134	0.00014	3.24E+02	8.40E+07	0.000		1.05E+09	3.24E+02	
			Cs-137	0.92875	2.21E+06	1.10E+08	0.020		1.37E+09	2.21E+06	
			Eu-152	0.00599	1.43E+04	1.02E+09	0.000		1.28E+10	1.43E+04	
			Eu-154	0.00082	1.95E+03	8.88E+08	0.000		1.11E+10	1.95E+03	
S1-01111AF-SSM-013-GD	12	2.10E+06	H-3	1.76	3.44E+06	6.62E+08	0.005	0.039	8.28E+09	3.44E+06	0.003
			Co-60	0.06431	1.35E+05	4.38E+08	0.000		5.47E+09	1.35E+05	
			Ni-63	442.00	5.98E+07	1.12E+10	0.005		1.40E+11	5.98E+07	
			Sr-90	0.021	4.10E+04	3.98E+06	0.010		4.98E+07	4.10E+04	
			Cs-134	0.00014	2.86E+02	8.40E+07	0.000		1.05E+09	2.86E+02	
			Cs-137	0.92875	1.95E+06	1.10E+08	0.018		1.37E+09	1.95E+06	
			Eu-152	0.00599	1.26E+04	1.02E+09	0.000		1.28E+10	1.26E+04	
			Eu-154	0.00082	1.72E+03	8.88E+08	0.000		1.11E+10	1.72E+03	
S1-01111AF-SSM-014-GD	13	2.07E+06	H-3	1.76	3.39E+06	6.62E+08	0.005	0.038	8.28E+09	3.39E+06	0.003
			Co-60	0.06431	1.33E+05	4.38E+08	0.000		5.47E+09	1.33E+05	
			Ni-63	442.00	5.90E+07	1.12E+10	0.005		1.40E+11	5.90E+07	
			Sr-90	0.021	4.05E+04	3.98E+06	0.010		4.98E+07	4.05E+04	
			Cs-134	0.00014	2.83E+02	8.40E+07	0.000		1.05E+09	2.83E+02	
			Cs-137	0.92875	1.93E+06	1.10E+08	0.018		1.37E+09	1.93E+06	
			Eu-152	0.00599	1.24E+04	1.02E+09	0.000		1.28E+10	1.24E+04	
			Eu-154	0.00082	1.70E+03	8.88E+08	0.000		1.11E+10	1.70E+03	
S1-01111AF-SSM-015-GD	14	1.80E+06	H-3	1.76	2.94E+06	6.62E+08	0.004	0.033	8.28E+09	2.94E+06	0.003
			Co-60	0.06431	1.16E+05	4.38E+08	0.000		5.47E+09	1.16E+05	
			Ni-63	442.00	5.12E+07	1.12E+10	0.005		1.40E+11	5.12E+07	
			Sr-90	0.021	3.51E+04	3.98E+06	0.009		4.98E+07	3.51E+04	
			Cs-134	0.00014	2.45E+02	8.40E+07	0.000		1.05E+09	2.45E+02	
			Cs-137	0.92875	1.67E+06	1.10E+08	0.015		1.37E+09	1.67E+06	
			Eu-152	0.00599	1.08E+04	1.02E+09	0.000		1.28E+10	1.08E+04	
			Eu-154	0.00082	1.47E+03	8.88E+08	0.000		1.11E+10	1.47E+03	

Unit 1 Incore Sump Discharge Pipe (embedded – 1.5 in diameter) (continued)

Sample ID	Feet into Pipe	Gamma Result (pCi/m²)	ROC	Gamma Mixture/HTD Ratio	Activity per ROC (pCi/m²)	CTMT $OpDCGL_{EP}$ (pCi/m²)	Nuclide OpSOF	$OpSOF_{EP}$	CTMT $BcDCGL_{EP}$ (pCi/m²)	Nuclide BcSOF (pCi/m²)	$BcSOF_{EP}$
S1-01111AF-SSM-016-GD	15	1.83E+06	H-3	1.76	2.99E+06	6.62E+08	0.005	0.034	8.28E+09	0.000	0.003
			Co-60	0.06431	1.18E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	5.20E+07	1.12E+10	0.005		1.40E+11	0.000	
			Sr-90	0.021	3.56E+04	3.98E+06	0.009		4.98E+07	0.001	
			Cs-134	0.00014	2.49E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	1.70E+06	1.10E+08	0.015		1.37E+09	0.001	
			Eu-152	0.00599	1.10E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.49E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-017-GD	16	2.23E+06	H-3	1.76	3.64E+06	6.62E+08	0.006	0.041	8.28E+09	0.000	0.003
			Co-60	0.06431	1.43E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	6.33E+07	1.12E+10	0.006		1.40E+11	0.000	
			Sr-90	0.021	4.35E+04	3.98E+06	0.011		4.98E+07	0.001	
			Cs-134	0.00014	3.04E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.07E+06	1.10E+08	0.019		1.37E+09	0.002	
			Eu-152	0.00599	1.34E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.82E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-018-GD	17	2.45E+06	H-3	1.76	4.01E+06	6.62E+08	0.006	0.045	8.28E+09	0.000	0.004
			Co-60	0.06431	1.58E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	6.97E+07	1.12E+10	0.006		1.40E+11	0.000	
			Sr-90	0.021	4.78E+04	3.98E+06	0.012		4.98E+07	0.001	
			Cs-134	0.00014	3.34E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.28E+06	1.10E+08	0.021		1.37E+09	0.002	
			Eu-152	0.00599	1.47E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.01E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-019-GD	18	2.86E+06	H-3	1.76	4.68E+06	6.62E+08	0.007	0.053	8.28E+09	0.001	0.004
			Co-60	0.06431	1.84E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	8.14E+07	1.12E+10	0.007		1.40E+11	0.001	
			Sr-90	0.021	5.58E+04	3.98E+06	0.014		4.98E+07	0.001	
			Cs-134	0.00014	3.90E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.66E+06	1.10E+08	0.024		1.37E+09	0.002	
			Eu-152	0.00599	1.72E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.34E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-020-GD	19	2.36E+06	H-3	1.76	3.86E+06	6.62E+08	0.006	0.044	8.28E+09	0.000	0.003
			Co-60	0.06431	1.52E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	6.71E+07	1.12E+10	0.006		1.40E+11	0.000	
			Sr-90	0.021	4.60E+04	3.98E+06	0.012		4.98E+07	0.001	
			Cs-134	0.00014	3.22E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	2.19E+06	1.10E+08	0.020		1.37E+09	0.002	
			Eu-152	0.00599	1.41E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.93E+03	8.88E+08	0.000		1.11E+10	0.000	

Unit 1 Incore Sump Discharge Pipe (embedded – 1.5 in diameter) (continued)

Sample ID	Feet into Pipe	Gamma Result (pCi/m^2)	ROC	Gamma Mixture/HTD Ratio	Activity per ROC (pCi/m^2)	CTMT $OpDCGL_{EP}$ (pCi/m^2)	Nuclide OpSOF	$OpSOF_{EP}$	CTMT $BcDCGL_{EP}$ (pCi/m^2)	Nuclide BcSOF (pCi/m^2)	$BcSOF_{EP}$
S1-01111AF-SSM-021-GD	20	2.92E+06	H-3	1.76	2.99E+06	6.62E+08	0.005	0.054	8.28E+09	0.001	0.004
			Co-60	0.06431	1.18E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	5.20E+07	1.12E+10	0.005		1.40E+11	0.001	
			Sr-90	0.021	3.56E+04	3.98E+06	0.009		4.98E+07	0.001	
			Cs-134	0.00014	2.49E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	1.70E+06	1.10E+08	0.015		1.37E+09	0.002	
			Eu-152	0.00599	1.10E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.49E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-SSM-022-GD	21	1.07E+07	H-3	1.76	1.87E+05	4.38E+08	0.000	0.198	8.28E+09	0.002	0.016
			Co-60	0.06431	8.29E+07	1.12E+10	0.007		5.47E+09	0.000	
			Ni-63	442.00	5.69E+04	3.98E+06	0.014		1.40E+11	0.002	
			Sr-90	0.021	3.97E+02	8.40E+07	0.000		4.98E+07	0.004	
			Cs-134	0.00014	2.71E+06	1.10E+08	0.025		1.05E+09	0.000	
			Cs-137	0.92875	1.75E+04	1.02E+09	0.000		1.37E+09	0.007	
			Eu-152	0.00599	2.38E+03	8.88E+08	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.75E+07	6.62E+08	0.026		1.11E+10	0.000	
S1-01111AF-QSM-007-GD	6	3.32E+06	H-3	1.76	5.43E+06	6.62E+08	0.008	0.061	8.28E+09	0.001	0.005
			Co-60	0.06431	2.14E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	9.44E+07	1.12E+10	0.008		1.40E+11	0.001	
			Sr-90	0.021	6.48E+04	3.98E+06	0.016		4.98E+07	0.001	
			Cs-134	0.00014	4.53E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	3.09E+06	1.10E+08	0.028		1.37E+09	0.002	
			Eu-152	0.00599	1.99E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	2.72E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-QSM-013-GD	12	2.13E+06	H-3	1.76	3.48E+06	6.62E+08	0.005	0.039	8.28E+09	0.000	0.003
			Co-60	0.06431	1.37E+05	4.38E+08	0.000		5.47E+09	0.000	
			Ni-63	442.00	6.06E+07	1.12E+10	0.005		1.40E+11	0.000	
			Sr-90	0.021	4.16E+04	3.98E+06	0.010		4.98E+07	0.001	
			Cs-134	0.00014	2.90E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	1.98E+06	1.10E+08	0.018		1.37E+09	0.001	
			Eu-152	0.00599	1.28E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	1.74E+03	8.88E+08	0.000		1.11E+10	0.000	
S1-01111AF-QSM-021-GD	21	4.17E+06	H-3	1.76	6.81E+06	6.62E+08	0.010	0.077	8.28E+09	0.001	0.006
			Co-60	0.06431	2.68E+05	4.38E+08	0.001		5.47E+09	0.000	
			Ni-63	442.00	1.18E+08	1.12E+10	0.011		1.40E+11	0.001	
			Sr-90	0.021	8.12E+04	3.98E+06	0.020		4.98E+07	0.002	
			Cs-134	0.00014	5.68E+02	8.40E+07	0.000		1.05E+09	0.000	
			Cs-137	0.92875	3.87E+06	1.10E+08	0.035		1.37E+09	0.003	
			Eu-152	0.00599	2.50E+04	1.02E+09	0.000		1.28E+10	0.000	
			Eu-154	0.00082	3.41E+03	8.88E+08	0.000		1.11E+10	0.000	

ATTACHMENT 3
SIGN TEST

Sign Test - Unit 1 Containment Basement Under Vessel Area

Survey Area 01111 Survey Area Unit 1 Containment Under Vessel
Survey Unit P125 Survey Unit Incore Sump Discharge Pipe (embedded)
Classification 1 Type I Error 0.05 Number of Measurements 22

#	SOF (Ws)	1-Ws	Sign
1	5.793	(4.79)	-1
2	0.877	0.12	+1
3	0.185	0.82	+1
4	0.082	0.92	+1
5	0.081	0.92	+1
6	0.064	0.94	+1
7	0.064	0.94	+1
8	0.061	0.94	+1
9	0.055	0.95	+1
10	0.047	0.95	+1
11	0.053	0.95	+1
12	0.044	0.96	+1
13	0.039	0.96	+1
14	0.038	0.96	+1
15	0.033	0.97	+1
16	0.034	0.97	+1
17	0.041	0.96	+1
18	0.045	0.95	+1
19	0.053	0.95	+1
20	0.044	0.96	+1
21	0.054	0.95	+1
22	0.198	0.80	+1

Number of positive differences (S+) 21

Critical Value 15

The Survey Unit MEETS the Acceptance Criteria

ATTACHMENT 4
QC DATA

Unit 1 Incore Sump Discharge Pipe (P125) – QC Agreement

Duplicate Sample Assessment Form

Survey Unit #: 01111A	Survey Unit # P125	Survey Unit Name:	U1 In Core Sump Discharge Pipe
Sample Plan#:	S101111A-F		

Sample Description: Comparison of replicate measurements collected from measurement location #s 6, 12 and 20. The standard measurements were S1-01111A-FSSM-006-GD, S1-01111A-FSSM-012-GD and S1-01111A-FSSM-020-GD. The comparison measurments were S1-01111A-FQSM-006-GD, S1-01111A-FQSM-012-GD and S1-01111A-FQSM-020-GD.

Standard Measurement				Duplicate		
ID	Activity Value (pCi/m^2)	+20% (pCi/m^2)	-20% (pCi/m^2)	ID	Activity Value (pCi/m^2)	Acceptable (Y/N)
S1-01111A-FSSM-006-GD	3.45E+06	4.13E+06	2.76E+06	S1-01111A-FQSM-006-GD	3.32E+06	Y
S1-01111A-FSSM-012-GD	2.10E+06	2.52E+06	1.68E+06	S1-01111A-FQSM-012-GD	2.13E+06	Y
S1-01111A-FSSM-020-GD	2.92E+06	3.50E+06	2.33E+06	S1-01111A-FQSM-020-GD	4.17E+06	Y

Comments/Corrective Actions: The 1st two replicate measurement results (S1-01111A-FQSM-006-GD and S1-01111A-FQSM-012-GD) are in acceptable agreement (within ± 20%). The 3rd replicate measurement S1-01111A-FSSM-020 result is outside of the acceptance range (+30%). This is expectedly due to the detector not being positioned exactly over the original location resulting in the higher value. In accordance with section 4.1.2 of the QAPP, a replicate measurement is in agreement if, based on the professional judgment of the Radiological Engineer, that the same conclusion is reached for the replicate measurement location as with the standard. In the case of S1-01111A-FQSM-020-GD, this is true. No further investigation is necessary.

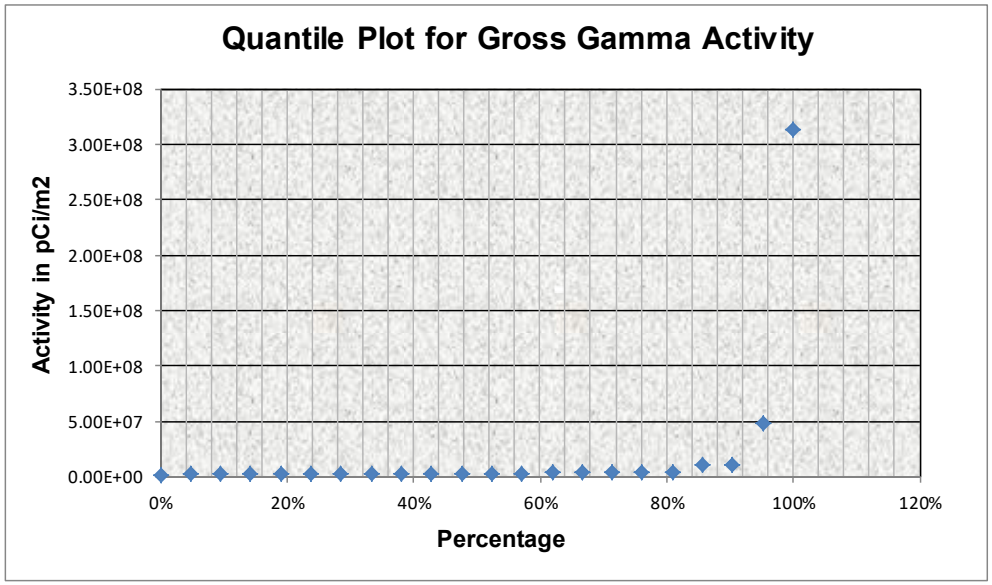
The acceptance criteria for replicate static measurements and scan surveys is that the same conclusion is reached for each measurement. This is defined as ± 20% of the standard

Performed by: Date: Reviewed by: Date:

ATTACHMENT 5
GRAPHICAL PRESENTATIONS

QUANTILE PLOT FOR GROSS GAMMA ACTIVITY

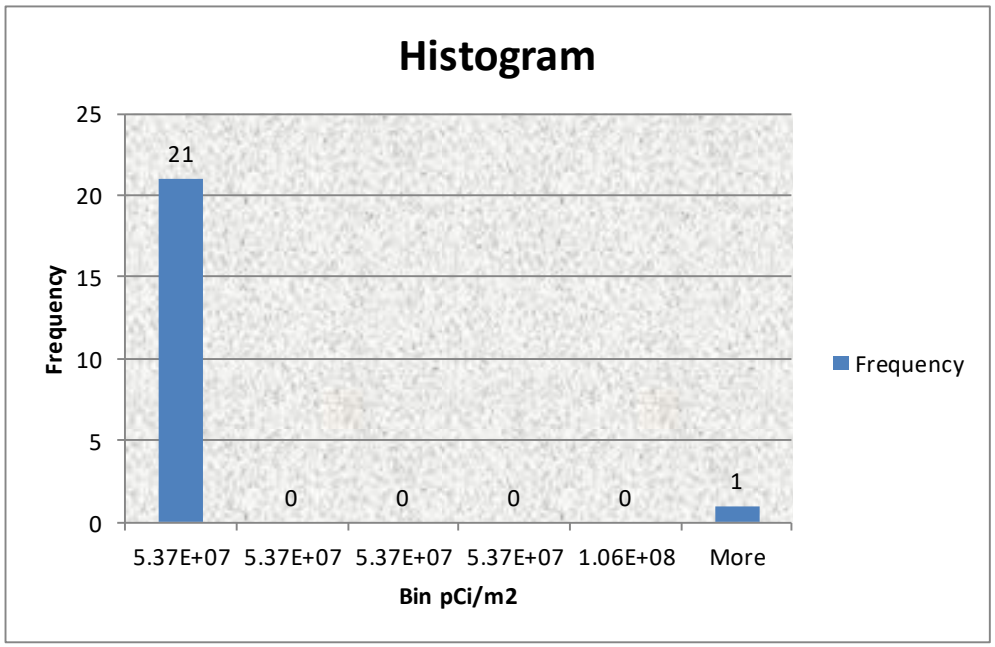
Survey Unit: S101111A
Survey Unit Name: Unit 1-In-Core Sump Drain Pipe (No. P125)
Mean: 1.96E+07 pCi/m2



Point	ross Gamm	Rank	Percent
15	1.80E+06	22	0%
16	1.83E+06	21	5%
14	2.07E+06	20	10%
13	2.10E+06	19	14%
17	2.23E+06	18	19%
20	2.36E+06	17	24%
12	2.38E+06	16	29%
18	2.45E+06	15	33%
10	2.55E+06	14	38%
11	2.84E+06	13	43%
19	2.86E+06	12	48%
21	2.92E+06	11	52%
9	2.96E+06	10	57%
8	3.28E+06	9	62%
7	3.45E+06	8	67%
6	3.45E+06	7	71%
5	4.36E+06	6	76%
4	4.45E+06	5	81%
3	9.98E+06	4	86%
22	1.07E+07	3	90%
2	4.74E+07	2	95%
1	3.13E+08	1	100%

HISTOGRAM FOR GROSS GAMMA ACTIVITY

Survey Unit: S101111A
Survey Unit Name: Unit 1 In-Core Sump Drain Pipe (P125)
Mean: 1.96E+07 pCi/m2
Median: 2.89E+06 pCi/m2
ST DEV: 6.62E+07
Skew: 4.54E+00



Bin	*Frequency*
5.37E+07	21
5.37E+07	0
5.37E+07	0
5.37E+07	0
1.06E+08	0
More	1