ZION SOLUTIONS LLC
An EnergySolutions Company

ZION STATION RESTORATION PROJECT
FINAL STATUS SURVEY RELEASE RECORD

TURBINE BUILDING 560 FOOT ELEVATION
EMBEDDED FLOOR DRAIN PIPE
SURVEY UNIT 06105B

PREPARED BY / DATE: Patricia Giza 9/1/2019
Radiological Engineer

REVIEWED BY / DATE: R. Massengill 9/1/2019
Radiological Engineer

APPROVED BY / DATE: D. Wojtkowiak 9/1/2019
C/LT Manager

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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
$BcDCGL_{EP}$	Embedded Pipe Base Case Derived Concentration Guideline Level
BcSOF	Base Case Sum of Fractions
C/LT	Characterization/License Termination
cpm	Counts per Minute
CsI	Cesium Iodide
dpm	Disintegrations per Minute
DQA	Data Quality Assessment
DQO	Data Quality Objective
DCGL	Derived Concentration Guideline Level
EMC	Elevated Measurement Comparison
FOV	Field-of-View
FSS	Final Status Survey
HTD	Hard-to-Detect
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
NaI	Sodium Iodide
OpDCGL	Operational Derived Concentration Guideline Level
$OpDCGL_{EP}$	Embedded Pipe Operational Derived Concentration Guideline Level
OpSOF	Operational Sum of Fractions
QAPP	Quality Assurance Project Plan

QC	Quality Control
SOF	Sum of Fractions
TEDE	Total Effective Dose Equivalent
TSD	Technical Support Document
UCL	Upper Confidence Level
WWTF	Waste Water Treatment Facility
ZNPS	Zion Nuclear Power Station
ZSRP	Zion Station Restoration Project

1. EXECUTIVE SUMMARY

This Final Status Survey (FSS) Release Record for survey unit 06105B, the embedded floor drain pipe located in the concrete floor of the Turbine Building 560 foot elevation, 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 S3-06105BF 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 embedded floor drain pipe located in the concrete floor of the Turbine Building 560 foot elevation, or Turbine Building Embedded Pipe was classified as MARSSIM Class 3.

The Turbine Building Embedded Pipe was surveyed with a Ludlum 2350-1 Data Logger paired with a 44-157 and a 44-159 gamma detector. Access to the pipe interior surfaces was achieved through pipe outlets in the two Equipment Sump Pits, the Turbine Building Floor Sump and the Fire Sump Pit. The total linear feet of embedded pipe is approximately 1,250 feet and pipe diameter ranged from an internal diameter (ID) of 4 to 10 inches. One hundred and thirty-four (134) measurements were acquired at one-foot intervals in sections of the pipe that were accessible. This resulted in an areal coverage of 11%, which provided sufficient measurements to allow for the 10% coverage requirement for a Class 3 survey unit.

Of the 134 measurements obtained in the Turbine Building embedded pipe, no measurement exceeded an Operational Sun-of-Fraction (OpSOF) of 0.5 when compared against the Operational DCGL for embedded pipe ($OpDCGL_{EP}$) in the Turbine Building. The mean Sum of Fractions (SOF) when compared against the OpDCGL was 0.011 with a maximum OpSOF of 0.028. When compared against the Base Case DCGL ($BcDCGL_{EP}$) for the Turbine Building, the mean BcSOF was 0.001, which resulted in the dose calculated for this survey unit of 0.011 mrem/yr.

2. SURVEY UNIT DESCRIPTION

The embedded drain piping in the Turbine Building consisted of 4-inch, 6-inch, 8-inch and 10-inch diameter pipe that is approximately 1,250 linear feet in length. The floor of the Turbine Building is at 560 foot elevation, with the drain piping embedded in the concrete approximately 2 feet deep.

3. CLASSIFICATION BASIS

Survey unit 06105B 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, Waste Water Treatment Facility (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 06105B 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 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 Technical Support Document (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 Turbine Building embedded 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.

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 Turbine Building embedded drain 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/yr to an Average Member of the Critical Group (AMCG). 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 (OpDCGL) 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 ZionSolutions TSD 17-004, *"Operational Derived Concentration Guideline Levels for Final Status Survey"* (Reference 8).

The Base Case and Operational DCGLs for the Turbine Building embedded drain 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 for the Turbine Building Embedded Drain Pipe

Radionuclide	Base Case Embedded Pipe DCGL pCi/m^2*	Operational Embedded Pipe DCGL pCi/m^2
Co-60	6.31E+09	2.52E+08
Cs-134	1.43E+09	5.72E+07
Cs-137	1.89E+09	7.56E+07
Ni-63	1.96E+11	7.84E+09
Sr-90	6.94E+07	2.78E+06

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 were 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 Base Case DCGL)

$$Surrogate_{DCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{1.89E+09_{(Cs-137)}}\right) + \left(\frac{0.002}{6.94E+07_{(Sr-90)}}\right)\right]} = 1.79E+09\ pCi/m^2$$

Equation 3

(Cs-137 Surrogate Operational DCGL)

$$Surrogate_{DCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{7.56E+07_{(Cs-137)}}\right) + \left(\frac{0.002}{2.78E+06_{(Sr-90)}}\right)\right]} = 7.17E+07\ pCi/m^2$$

Equation 4

(Co-60 Surrogate Base Case DCGL)

$$Surrogate_{DCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{6.31E+09_{(Co-60)}}\right) + \left(\frac{180.45}{1.96E+11_{(Ni-63)}}\right)\right]} = 9.27E+08\ pCi/m^2$$

Equation 5

(Co-60 Surrogate Operational DCGL)

$$Surrogate_{DCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{2.52E+08_{(Co-60)}}\right) + \left(\frac{180.45}{7.84E+09_{(Ni-63)}}\right)\right]} = 3.71E+07\ pCi/m^2$$

Table 4 - Surrogate Base Case and Operational DCGLs

Radionuclide	Base Case Buried Pipe DCGL pCi/m^2	Operational Buried Pipe DCGL pCi/m^2
Co-60	9.27E+08	3.71E+07
Cs-134	1.43E+09	5.72E+07
Cs-137	1.79E+09	7.17E+07

Using the radionuclide mixture from Table 1, a gross gamma OpDCGL of 1.75E+08 pCi/m^2 was calculated. The Action Level used for the FSS of this survey unit was 50% of that value or 3.56E+07 pCi/m^2.

The Turbine Building 560 foot elevation embedded drain system 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, 6-inch, 8-inch or 10-inch pipes. For a 4-inch ID pipe, each measurement has a calculated Field-of-View (FOV) of 1.08 ft^2 (0.10 m^2), for a 6-inch ID pipe, each measurement has a calculated FOV of 1.61 ft^2 (0.15 m^2), for an 8-inch ID pipe, each measurement has a calculated FOV of 2.05 ft^2 (0.19 m^2), and for a 10-inch ID pipe, each measurement has a calculated FOV of 2.58 ft^2 (0.24 m^2).

The Turbine Building 560 foot elevation embedded drain system was comprised of approximately 1,250 linear feet of 4-inch, 6-inch, 8-inch or 10-inch ID piping, which equates to a surface area of approximately 237.5 m^2. The LTP states that a FSS Class 3 survey unit shall have a minimum areal coverage of 10%. As some of the pipe was inaccessible due to blockages or pipe configuration, 1 measurement was taken every foot of all accessible pipe for a total of 134 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. This required an additional 14 measurements to be collected throughout the length of the accessible surfaces 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 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. 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 OpDCGL to derive a dose fraction. The summation of the dose fractions for each ROC produces a SOF for the measurement. When compared against the BcDCGL, the term is defined as BcSOF. When compared against the OpDCGL, the term is defined as OpSOF.

To demonstrate that each survey unit satisfies the OpDCGL, the ROC concentration for each measurement taken in the Turbine Building 560 foot Embedded 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 (W_S) for performing the Sign Test.

If the OpSOF for a random 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 $OpDCGL_{EP}$ 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 Turbine Building 560 foot Embedded Pipe was the Ludlum Model 2350-1 and either the Model 44-157 detector or the Model 44-159 detector. The typical instrumentation sensitivities are provided in Chapter 5 of the LTP and are reproduced in Table 5.

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 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/ 44-157	Gamma	1	6,300	0.212	1	1,750	N/A
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.

Table 6 - Synopsis of Survey Design

Feature	Design Criteria	Basis
Survey Unit Area	237.5 m^2	1,250 linear feet of 4, 6, 8 and 10 inch ID pipe
Number of Static Measurements	134	10% areal coverage, Class 3
Measurement Spacing	As needed to obtain sufficient measurements for 10% areal coverage (1-foot intervals in accessible areas)	10% areal coverage, Class 3
DCGLs	• Co-60 – 2.52E+08 pCi/m^2 • Cs-134 – 5.72E+07 pCi/m^2 • Cs-137 – 7.56E+07 pCi/m^2 • Ni-63 – 7.84E+09 pCi/m^2 • Sr-90 – 2.78E+06 pCi/m^2	OpDCGLs for Turbine Building Basement Drain Embedded Pipe, (LTP Chapter 5, Table 5-12)
Measurement Investigation Level	>0.5 Gross Gamma OpDCGL (3.56E+07 pCi/m^2)	(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 #S3-06105BF, which was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-001. 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).

The approach used for the radiological survey of the interior surfaces of the Turbine Building 560 foot elevation embedded drain system involved the insertion of a 1" x 1" CsI or a 2" x 2" NaI 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 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.

Daily, prior to and 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 Turbine Building 560 foot elevation embedded drain system were performed between April 18, 2016 and April 25, 2016. The floor drain system consisted of 26 floor drain openings, the floor drains from the Clean and Dirty Oil Storage tank rooms, and headers from floor drains on the upper elevations of the Turbine Building. The system terminated at one of the 4 Turbine Building basement sumps.

The See Snake and detector were inserted into the pipe from the sump openings. Because the entire length of the pipe was not available for survey, it was decided to take measurements at 1-foot intervals to obtain sufficient readings to meet the 10% coverage required for the Class 3 survey unit. Table 7 summarizes the data collected:

Table 7 - Survey Data Collected

Pipe Section	Pipe ID (in.)	Length Surveyed (ft.)	No. of Measurements Taken	Comment
U1 Equipment Drain Sump, Pipe 1	6	7	7	
U1 Equipment Drain Sump, Pipe 2	6	7	7	
U1 Equipment Drain Sump, Pipe 3	6	7	7	
TB Fire Sump, Pipe 6	4	35	35	13 QC Measurements Taken
TB Floor Drain Sump, Pipe 4	6	28	28	
TB Floor Drain Sump, Pipe 5	4	7	7	
TB Fire Sump, Pipe 7	8	14	14	
TB Fire Sump, Pipe 9	10	8	8	
TB Fire Sump, Pipe 10	10	8	8	
TB Fire Sump, Pipe 8	8	12	12	

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

Table 8 - Instrument and Detectors

Instrument/Detector Type	Serial #	Calibration Due Date
Ludlum 2350-1	304718	10/29/16
Ludlum 44-157	PR327899	10/29/16
Ludlum 44-159	PR327897	10/29/16

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 Turbine Building 560 foot elevation embedded drain system survey unit are Co-60, Cs-134 and Cs-137. Ni-63 and Sr-90 are also ROC for the Turbine Building 560 foot elevation. Ni-63 is inferred from the measured concentration of Co-60, while Sr-90 is inferred from the measured concentration of Cs-137.

All measurements were less than 50% of the OpDCGL, meeting the requirement for a Class 3 area. The mean OpSOF for all 134 measurements was 0.011.

The activity in this pipe was also compared to the $OpDCGL_B$ for the building that contains it. The results of this comparison showed that 2 of the 134 measurements were greater than 1 when compared to the $OpDCGL_B$ for the Turbine Building, with a maximum SOF of 1.17. The 2 pipes affected were the Unit 1 Equipment Drain Sump, pipe #3, position 0, and Turbine Building Floor Drain Sump, pipe #5, position 2. Revision 2 of the LTP would require that both of these pipes be grouted in accordance with Chapter 5, section 5.5.5. However, this compliance survey was performed prior to the acceptance of the grouting commitments, and since completion of the survey, the building was completely backfilled. Due to the low dose consequence, no further action was deemed necessary.

The results of the data assessment for the Turbine Building embedded floor drain pipe are provided in Attachment 2. A statistical summary of the data is presented in Table 9.

The data collected passed the Sign Test. The result of the Sign Test is provided in Attachment 3.

Table 9 - Turbine Building 560 ft. Elevation Embedded Floor Drains - Statistical Quantities - Systematic Measurement Population

Individual Measurement Metrics		
Total Number of Systematic Measurements	=	134
Number of Quality Control Measurements	=	14
Number of Judgmental/Investigational Measurements	=	0
Total Number of Measurements	=	148

Table 9 (continued) - Turbine Building 560 ft. Elevation Embedded Floor Drains - Statistical Quantities - Systematic Measurement Population

Mean Systematic Measurement OpSOF = 0.011
Max Individual Systematic Measurement OpSOF = 0.028
Number of Systematic Measurements with OpSOF >1 = 0

Statistical Quantities - Systematic Measurement Population

Radionuclide	Mean (pCi/m^2)	Max (pCi/m^2)	Min (pCi/m^2)	Standard Deviation (pCi/m^2)	$BcDCGL_{EP}$ (pCi/m^2)	Mean BcSOF
Co-60	9.73E+03	2.37E+04	5.25E+03	4.10E+03	5.98E+06	0.000
Cs-134	1.07E+02	2.61E+02	5.79E+01	4.52E+01	1.35E+06	0.000
Cs-137	8.00E+05	1.95E+06	4.32E+05	3.37E+05	1.79E+06	0.000
Ni-63(1)	1.76E+06	4.27E+06	9.48E+05	7.40E+05	1.85E+08	0.000
Sr-90(1)	1.60E+03	3.89E+03	8.63E+02	6.74E+02	6.58E+04	0.000

(1) Concentrations for Ni-63 and Sr-90 are inferred

Mean BcSOF 0.001

Assigned Dose 0.011

8. QUALITY CONTROL

In compliance with ZS-LT-01, replicate measurements were performed on 5% of the survey locations chosen at random. Fourteen (14) 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 QC analysis results.

9. INVESTIGATIONS AND RESULTS

As all measurements in the accessible pipe interior surface area were 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 134 feet of the piping was accessible for survey, therefore readings were taken at 1-foot intervals in the pipe run to obtain enough measurements to meet the 10% coverage requirement for Class 3 survey units.

The survey instructions called for a 44-157 detector to be used for the survey. Due to the size limitation for a 4" 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 Minimum Detectable Concentration (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 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

One hundred and thirty-four (134) static measurements were taken in the Turbine Building 560 foot Embedded Pipe drain system, taken at 1-foot intervals. The total length of pipe was 1,250 feet, therefore the 10% areal survey coverage required for Class 3 survey units was met.

All of the measurements were below an OpSOF of 0.5, other than the two measurements discussed in Section 7 above. The average BcSOF for the survey unit is 0.001. 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 06105B, "Turbine Building 560 foot Embedded Pipe", is 0.011 mrem/yr TEDE, based on the average concentration of the ROC in samples used for non-parametric statistical sampling.

Survey unit 06105B, "Turbine Building 560 foot Embedded Pipe" is acceptable for unrestricted release.

15. REFERENCES

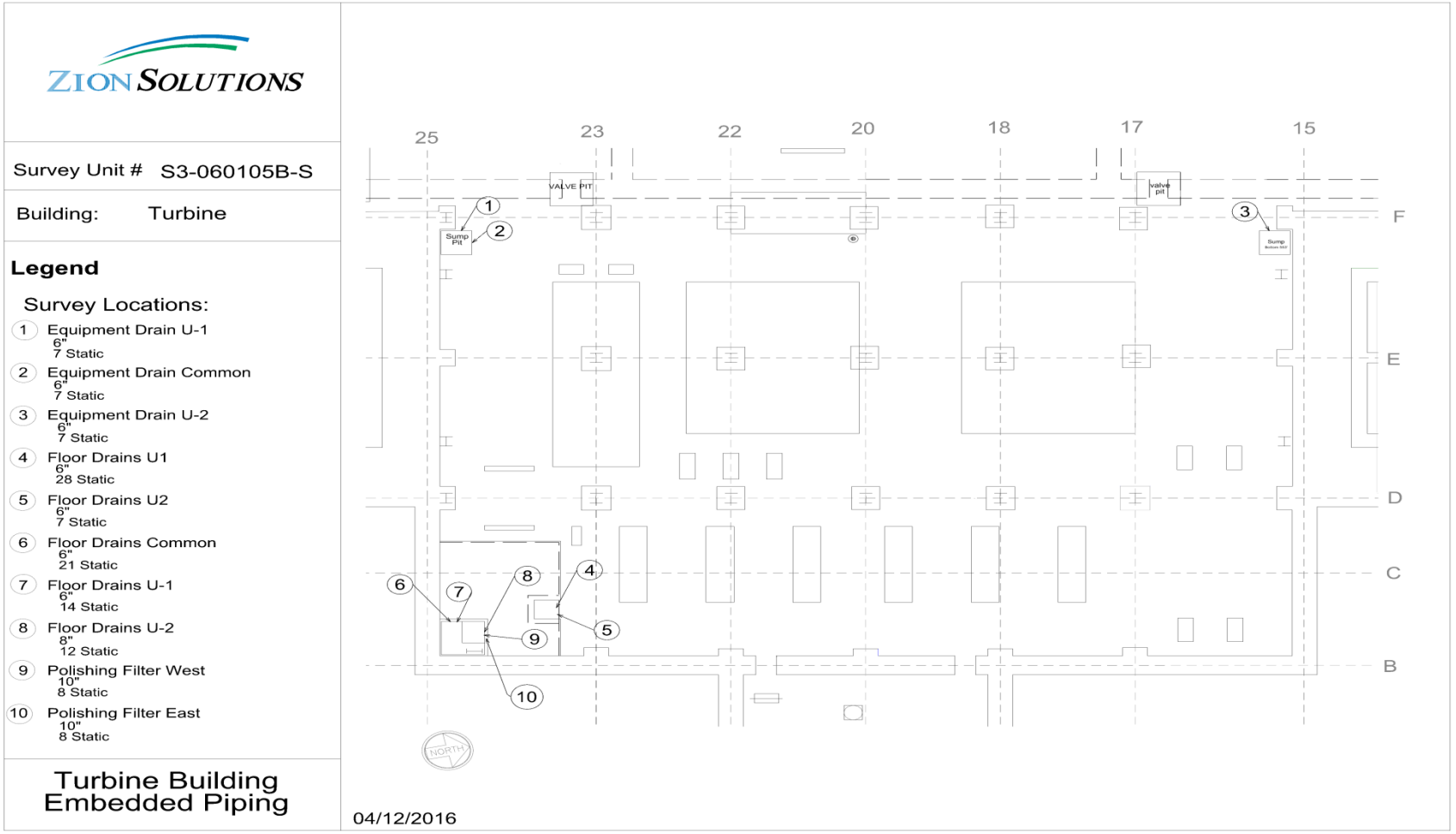
1. Zion*Solutions* procedure ZS-LT-300-001-005, "Final Status Survey Data Reporting"
2. "Zion Station Restoration Project License Termination Plan"
3. Zion*Solutions* procedure ZS-LT-300-001-001, "Final Status Survey Package Development"
4. NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation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

1. Attachment 1 - Maps
2. Attachment 2 - Sample Data
3. Attachment 3 - Sign Test
4. Attachment 4 - QC Sample Assessment
5. Attachment 5 - Graphical Presentations

ATTACHMENT 1 - MAPS

FIGURE 1


ZION SOLUTIONS
Survey Unit # S3-060105B-S
Building: Turbine
Legend
Survey Locations:
1 Equipment Drain U-1
6"
7 Static
2 Equipment Drain Common
6"
7 Static
3 Equipment Drain U-2
6"
7 Static
4 Floor Drains U1
6"
28 Static
5 Floor Drains U2
6"
7 Static
6 Floor Drains Common
6"
21 Static
7 Floor Drains U-1
6"
14 Static
8 Floor Drains U-2
8"
12 Static
9 Polishing Filter West
10"
8 Static
10 Polishing Filter East
10"
8 Static
Turbine Building
Embedded Piping
25
23
22
20
18
17
15
F
E
D
C
B
VALVE PIT
Sump Pit
NORTH
04/12/2016

ATTACHMENT 2 - SAMPLE DATA

TURBINE BUILDING 560 FOOT ELEVATION EMBEDDED FLOOR DRAIN PIPE MEASUREMENTS

PIPE	GROSS GAMMA	Co-60	Cs-134	Cs-137	Ni-63	Sr-90	OpSOF
U1 Eq Drain Sump Pipe 1 Position 0	6.49E+05	7.80E+03	8.59E+01	6.41E+05	1.41E+06	1.28E+03	0.009
U1 Eq Drain Sump Pipe 1 Position 1	6.73E+05	8.09E+03	8.91E+01	6.65E+05	1.46E+06	1.33E+03	0.009
U1 Eq Drain Sump Pipe 1 Position 2	6.54E+05	7.86E+03	8.66E+01	6.46E+05	1.42E+06	1.29E+03	0.009
U1 Eq Drain Sump Pipe 1 Position 3	6.69E+05	8.04E+03	8.86E+01	6.61E+05	1.45E+06	1.32E+03	0.009
U1 Eq Drain Sump Pipe 1 Position 4	7.15E+05	8.60E+03	9.47E+01	7.06E+05	1.55E+06	1.41E+03	0.010
U1 Eq Drain Sump Pipe 1 Position 5	7.00E+05	8.42E+03	9.27E+01	6.91E+05	1.52E+06	1.38E+03	0.010
U1 Eq Drain Sump Pipe 1 Position 6	6.96E+05	8.37E+03	9.22E+01	6.88E+05	1.51E+06	1.38E+03	0.010
U1 Eq Drain Sump Pipe 2 Position 0	7.68E+05	9.23E+03	1.02E+02	7.59E+05	1.67E+06	1.52E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 1	7.46E+05	8.97E+03	9.88E+01	7.37E+05	1.62E+06	1.47E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 2	7.45E+05	8.96E+03	9.87E+01	7.36E+05	1.62E+06	1.47E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 3	7.75E+05	9.32E+03	1.03E+02	7.66E+05	1.68E+06	1.53E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 4	7.70E+05	9.26E+03	1.02E+02	7.61E+05	1.67E+06	1.52E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 5	7.79E+05	9.37E+03	1.03E+02	7.70E+05	1.69E+06	1.54E+03	0.011
U1 Eq Drain Sump Pipe 2 Position 6	7.84E+05	9.43E+03	1.04E+02	7.74E+05	1.70E+06	1.55E+03	0.011
U1 Eq Drain Sump Pipe 3 Position 0	1.97E+06	2.37E+04	2.61E+02	1.95E+06	4.27E+06	3.89E+03	0.028
U1 Eq Drain Sump Pipe 3 Position 0	1.01E+06	1.21E+04	1.34E+02	9.98E+05	2.19E+06	2.00E+03	0.014
U1 Eq Drain Sump Pipe 3 Position 1	6.70E+05	8.06E+03	8.87E+01	6.62E+05	1.45E+06	1.32E+03	0.009
U1 Eq Drain Sump Pipe 3 Position 2	6.41E+05	7.71E+03	8.49E+01	6.33E+05	1.39E+06	1.27E+03	0.009
U1 Eq Drain Sump Pipe 3 Position 3	6.41E+05	7.71E+03	8.49E+01	6.33E+05	1.39E+06	1.27E+03	0.009
U1 Eq Drain Sump Pipe 3 Position 4	6.52E+05	7.84E+03	8.63E+01	6.44E+05	1.41E+06	1.29E+03	0.009
U1 Eq Drain Sump Pipe 3 Position 5	6.46E+05	7.77E+03	8.55E+01	6.38E+05	1.40E+06	1.28E+03	0.009
TB Fire Sump Pipe 6, Position 0	1.15E+06	1.38E+04	1.52E+02	1.14E+06	2.50E+06	2.27E+03	0.016
TB Fire Sump Pipe 6, Position 1	1.07E+06	1.29E+04	1.42E+02	1.06E+06	2.32E+06	2.11E+03	0.015
TB Fire Sump Pipe 6, Position 2	1.11E+06	1.33E+04	1.47E+02	1.10E+06	2.41E+06	2.19E+03	0.016
TB Fire Sump Pipe 6, Position 3	1.09E+06	1.31E+04	1.44E+02	1.08E+06	2.37E+06	2.15E+03	0.015
TB Fire Sump Pipe 6, Position 4	1.18E+06	1.42E+04	1.56E+02	1.17E+06	2.56E+06	2.33E+03	0.017
TB Fire Sump Pipe 6, Position 5	1.11E+06	1.33E+04	1.47E+02	1.10E+06	2.41E+06	2.19E+03	0.016
TB Fire Sump Pipe 6, Position 6	1.09E+06	1.31E+04	1.44E+02	1.08E+06	2.37E+06	2.15E+03	0.015
TB Fire Sump Pipe 6, Position 7	1.13E+06	1.36E+04	1.50E+02	1.12E+06	2.45E+06	2.23E+03	0.016
TB Fire Sump Pipe 6, Position 8	1.06E+06	1.27E+04	1.40E+02	1.05E+06	2.30E+06	2.09E+03	0.015
TB Fire Sump Pipe 6, Position 9	9.22E+05	1.11E+04	1.22E+02	9.11E+05	2.00E+06	1.82E+03	0.013
TB Fire Sump Pipe 6, Position 10	1.10E+06	1.32E+04	1.46E+02	1.09E+06	2.39E+06	2.17E+03	0.016
TB Fire Sump Pipe 6, Position 11	1.13E+06	1.36E+04	1.50E+02	1.12E+06	2.45E+06	2.23E+03	0.016

PIPE	GROSS GAMMA	Co-60	Cs-134	Cs-137	Ni-63	Sr-90	OpSOF
TB Fire Sump Pipe 6, Position 12	1.09E+06	1.31E+04	1.44E+02	1.08E+06	2.37E+06	2.15E+03	0.015
TB Fire Sump Pipe 6, Position 13	1.06E+06	1.27E+04	1.40E+02	1.05E+06	2.30E+06	2.09E+03	0.015
TB Fire Sump Pipe 6, Position 14	1.19E+06	1.43E+04	1.58E+02	1.18E+06	2.58E+06	2.35E+03	0.017
TB Fire Sump Pipe 6, Position 15	1.20E+06	1.44E+04	1.59E+02	1.19E+06	2.60E+06	2.37E+03	0.017
TB Fire Sump Pipe 6, Position 16	1.27E+06	1.53E+04	1.68E+02	1.25E+06	2.76E+06	2.51E+03	0.018
TB Fire Sump Pipe 6, Position 17	1.21E+06	1.45E+04	1.60E+02	1.20E+06	2.63E+06	2.39E+03	0.017
TB Fire Sump Pipe 6, Position 18	1.16E+06	1.39E+04	1.54E+02	1.15E+06	2.52E+06	2.29E+03	0.016
TB Fire Sump Pipe 6, Position 19	1.19E+06	1.43E+04	1.58E+02	1.18E+06	2.58E+06	2.35E+03	0.017
TB Fire Sump Pipe 6, Position 20	9.91E+05	1.19E+04	1.31E+02	9.79E+05	2.15E+06	1.96E+03	0.014
TB Fire Sump Pipe 6, Position 21	1.17E+06	1.41E+04	1.55E+02	1.16E+06	2.54E+06	2.31E+03	0.017
TB Fire Sump Pipe 6, Position 22	1.19E+06	1.43E+04	1.58E+02	1.18E+06	2.58E+06	2.35E+03	0.017
TB Fire Sump Pipe 6, Position 23	1.25E+06	1.50E+04	1.66E+02	1.23E+06	2.71E+06	2.47E+03	0.018
TB Fire Sump Pipe 6, Position 24	1.22E+06	1.47E+04	1.62E+02	1.21E+06	2.65E+06	2.41E+03	0.017
TB Fire Sump Pipe 6, Position 25	1.27E+06	1.53E+04	1.68E+02	1.25E+06	2.76E+06	2.51E+03	0.018
TB Fire Sump Pipe 6, Position 26	1.21E+06	1.45E+04	1.60E+02	1.20E+06	2.63E+06	2.39E+03	0.017
TB Fire Sump Pipe 6, Position 27	1.28E+06	1.54E+04	1.70E+02	1.26E+06	2.78E+06	2.53E+03	0.018
TB Fire Sump Pipe 6, Position 28	1.42E+06	1.71E+04	1.88E+02	1.40E+06	3.08E+06	2.81E+03	0.020
TB Fire Sump Pipe 6, Position 29	1.26E+06	1.52E+04	1.67E+02	1.24E+06	2.73E+06	2.49E+03	0.018
TB Fire Sump Pipe 6, Position 30	1.23E+06	1.48E+04	1.63E+02	1.22E+06	2.67E+06	2.43E+03	0.017
TB Fire Sump Pipe 6, Position 31	1.30E+06	1.56E+04	1.72E+02	1.28E+06	2.82E+06	2.57E+03	0.018
TB Fire Sump Pipe 6, Position 32	1.11E+06	1.33E+04	1.47E+02	1.10E+06	2.41E+06	2.19E+03	0.016
TB Fire Sump Pipe 6, Position 33	1.44E+06	1.73E+04	1.91E+02	1.42E+06	3.12E+06	2.84E+03	0.020
TB Fire Sump Pipe 6, Position 34	1.38E+06	1.66E+04	1.83E+02	1.36E+06	2.99E+06	2.73E+03	0.019
TB FD Sump Pipe 4 Position 0	6.22E+05	7.48E+03	8.24E+01	6.14E+05	1.35E+06	1.23E+03	0.009
TB FD Sump Pipe 4 Position 1	6.15E+05	7.39E+03	8.14E+01	6.08E+05	1.33E+06	1.22E+03	0.009
TB FD Sump Pipe 4 Position 2	6.02E+05	7.24E+03	7.97E+01	5.95E+05	1.31E+06	1.19E+03	0.008
TB FD Sump Pipe 4 Position 3	6.05E+05	7.27E+03	8.01E+01	5.98E+05	1.31E+06	1.20E+03	0.009
TB FD Sump Pipe 4 Position 4	6.26E+05	7.53E+03	8.29E+01	6.18E+05	1.36E+06	1.24E+03	0.009
TB FD Sump Pipe 4 Position 5	6.25E+05	7.52E+03	8.28E+01	6.17E+05	1.36E+06	1.23E+03	0.009
TB FD Sump Pipe 4 Position 6	6.22E+05	7.48E+03	8.24E+01	6.14E+05	1.35E+06	1.23E+03	0.009
TB FD Sump Pipe 4 Position 7	6.28E+05	7.55E+03	8.32E+01	6.20E+05	1.36E+06	1.24E+03	0.009
TB FD Sump Pipe 4 Position 8	6.03E+05	7.25E+03	7.99E+01	5.96E+05	1.31E+06	1.19E+03	0.009
TB FD Sump Pipe 4 Position 9	5.85E+05	7.03E+03	7.75E+01	5.78E+05	1.27E+06	1.16E+03	0.008
TB FD Sump Pipe 4 Position 10	6.10E+05	7.33E+03	8.08E+01	6.03E+05	1.32E+06	1.21E+03	0.009

PIPE	GROSS GAMMA	Co-60	Cs-134	Cs-137	Ni-63	Sr-90	OpSOF
TB FD Sump Pipe 4 Position 11	6.43E+05	7.73E+03	8.51E+01	6.35E+05	1.40E+06	1.27E+03	0.009
TB FD Sump Pipe 4 Position 12	6.18E+05	7.43E+03	8.18E+01	6.10E+05	1.34E+06	1.22E+03	0.009
TB FD Sump Pipe 4 Position 13	6.01E+05	7.23E+03	7.96E+01	5.94E+05	1.30E+06	1.19E+03	0.008
TB FD Sump Pipe 4 Position 14	6.11E+05	7.35E+03	8.09E+01	6.04E+05	1.33E+06	1.21E+03	0.009
TB FD Sump Pipe 4 Position 15	5.91E+05	7.11E+03	7.83E+01	5.84E+05	1.28E+06	1.17E+03	0.008
TB Fire Sump Pipe 6, Position 15	1.20E+06	1.44E+04	1.59E+02	1.19E+06	2.60E+06	2.37E+03	0.017
TB FD Sump Pipe 4 Position 16	6.43E+05	7.73E+03	8.51E+01	6.35E+05	1.40E+06	1.27E+03	0.009
TB FD Sump Pipe 4 Position 17	5.95E+05	7.15E+03	7.88E+01	5.88E+05	1.29E+06	1.18E+03	0.008
TB FD Sump Pipe 4 Position 18	5.65E+05	6.79E+03	7.48E+01	5.58E+05	1.23E+06	1.12E+03	0.008
TB FD Sump Pipe 4 Position 19	6.02E+05	7.24E+03	7.97E+01	5.95E+05	1.31E+06	1.19E+03	0.008
TB FD Sump Pipe 4 Position 20	6.21E+05	7.47E+03	8.22E+01	6.13E+05	1.35E+06	1.23E+03	0.009
TB FD Sump Pipe 4 Position 21	6.21E+05	7.47E+03	8.22E+01	6.13E+05	1.35E+06	1.23E+03	0.009
TB FD Sump Pipe 4 Position 22	5.97E+05	7.18E+03	7.91E+01	5.90E+05	1.30E+06	1.18E+03	0.008
TB FD Sump Pipe 4 Position 23	6.14E+05	7.38E+03	8.13E+01	6.07E+05	1.33E+06	1.21E+03	0.009
TB FD Sump Pipe 4 Position 24	5.92E+05	7.12E+03	7.84E+01	5.85E+05	1.28E+06	1.17E+03	0.008
TB FD Sump Pipe 4 Position 25	6.05E+05	7.27E+03	8.01E+01	5.98E+05	1.31E+06	1.20E+03	0.009
TB FD Sump Pipe 4 Position 26	6.07E+05	7.30E+03	8.04E+01	6.00E+05	1.32E+06	1.20E+03	0.009
TB FD Sump Pipe 4 Position 27	6.18E+05	7.43E+03	8.18E+01	6.10E+05	1.34E+06	1.22E+03	0.009
TB FD Sump Pipe 5 Position 0	1.61E+06	1.94E+04	2.13E+02	1.59E+06	3.49E+06	3.18E+03	0.023
TB FD Sump Pipe 5 Position 1	1.64E+06	1.97E+04	2.17E+02	1.62E+06	3.56E+06	3.24E+03	0.023
TB FD Sump Pipe 5 Position 2	1.79E+06	2.15E+04	2.37E+02	1.77E+06	3.88E+06	3.54E+03	0.025
TB FD Sump Pipe 5 Position 3	1.42E+06	1.71E+04	1.88E+02	1.40E+06	3.08E+06	2.81E+03	0.020
TB FD Sump Pipe 5 Position 4	1.38E+06	1.66E+04	1.83E+02	1.36E+06	2.99E+06	2.73E+03	0.019
TB FD Sump Pipe 5 Position 5	1.46E+06	1.76E+04	1.93E+02	1.44E+06	3.17E+06	2.88E+03	0.021
TB FD Sump Pipe 5 Position 6	1.38E+06	1.66E+04	1.83E+02	1.36E+06	2.99E+06	2.73E+03	0.019
TB Fire Sump Pipe 7, Position 0	5.95E+05	7.15E+03	7.88E+01	5.88E+05	1.29E+06	1.18E+03	0.008
TB Fire Sump Pipe 7, Position 1	5.71E+05	6.87E+03	7.56E+01	5.64E+05	1.24E+06	1.13E+03	0.008
TB Fire Sump Pipe 7, Position 2	5.75E+05	6.91E+03	7.61E+01	5.68E+05	1.25E+06	1.14E+03	0.008
TB Fire Sump Pipe 7, Position 3	5.68E+05	6.83E+03	7.52E+01	5.61E+05	1.23E+06	1.12E+03	0.008
TB Fire Sump Pipe 7, Position 4	5.93E+05	7.13E+03	7.85E+01	5.86E+05	1.29E+06	1.17E+03	0.008
TB Fire Sump Pipe 7, Position 5	5.77E+05	6.94E+03	7.64E+01	5.70E+05	1.25E+06	1.14E+03	0.008
TB Fire Sump Pipe 7, Position 6	5.35E+05	6.43E+03	7.08E+01	5.28E+05	1.16E+06	1.06E+03	0.008
TB Fire Sump Pipe 7, Position 7	5.47E+05	6.58E+03	7.24E+01	5.40E+05	1.19E+06	1.08E+03	0.008
TB Fire Sump Pipe 7, Position 8	5.26E+05	6.32E+03	6.97E+01	5.20E+05	1.14E+06	1.04E+03	0.009

PIPE	GROSS GAMMA	Co-60	Cs-134	Cs-137	Ni-63	Sr-90	OpSOF
TB Fire Sump Pipe 7, Position 9	5.24E+05	6.30E+03	6.94E+01	5.18E+05	1.14E+06	1.04E+03	0.007
TB Fire Sump Pipe 7, Position 10	5.22E+05	6.28E+03	6.91E+01	5.16E+05	1.13E+06	1.03E+03	0.007
TB Fire Sump Pipe 7, Position 11	5.97E+05	7.18E+03	7.91E+01	5.90E+05	1.30E+06	1.18E+03	0.008
TB Fire Sump Pipe 7, Position 12	5.95E+05	7.15E+03	7.88E+01	5.88E+05	1.29E+06	1.18E+03	0.008
TB Fire Sump Pipe 7, Position 13	5.59E+05	6.72E+03	7.40E+01	5.52E+05	1.21E+06	1.10E+03	0.008
TB Fire Sump Pipe 9, Position 0	4.60E+05	5.53E+03	6.09E+01	4.54E+05	9.98E+05	9.09E+02	0.006
TB Fire Sump Pipe 9, Position 1	4.52E+05	5.43E+03	5.99E+01	4.47E+05	9.81E+05	8.93E+02	0.006
TB Fire Sump Pipe 9, Position 2	4.65E+05	5.59E+03	6.16E+01	4.59E+05	1.01E+06	9.19E+02	0.007
TB Fire Sump Pipe 9, Position 3	4.57E+05	5.50E+03	6.05E+01	4.51E+05	9.92E+05	9.03E+02	0.006
TB Fire Sump Pipe 9, Position 4	4.51E+05	5.42E+03	5.97E+01	4.46E+05	9.79E+05	8.91E+02	0.006
TB Fire Sump Pipe 9, Position 5	4.57E+05	5.50E+03	6.05E+01	4.51E+05	9.92E+05	9.03E+02	0.006
TB Fire Sump Pipe 9, Position 6	4.59E+05	5.52E+03	6.08E+01	4.53E+05	9.96E+05	9.07E+02	0.006
TB Fire Sump Pipe 9, Position 7	4.47E+05	5.37E+03	5.92E+01	4.42E+05	9.70E+05	8.83E+02	0.006
TB Fire Sump Pipe 10, Position 0	4.57E+05	5.50E+03	6.05E+01	4.51E+05	9.92E+05	9.03E+02	0.006
TB Fire Sump Pipe 10, Position 1	4.60E+05	5.53E+03	6.09E+01	4.54E+05	9.98E+05	9.09E+02	0.006
TB Fire Sump Pipe 10, Position 2	4.50E+05	5.41E+03	5.96E+01	4.45E+05	9.76E+05	8.89E+02	0.006
TB Fire Sump Pipe 10, Position 3	4.45E+05	5.35E+03	5.89E+01	4.40E+05	9.66E+05	8.79E+02	0.006
TB Fire Sump Pipe 10, Position 4	4.47E+05	5.37E+03	5.92E+01	4.42E+05	9.70E+05	8.83E+02	0.006
TB Fire Sump Pipe 10, Position 5	4.56E+05	5.48E+03	6.04E+01	4.50E+05	9.89E+05	9.01E+02	0.006
TB Fire Sump Pipe 10, Position 6	4.67E+05	5.62E+03	6.18E+01	4.61E+05	1.01E+06	9.23E+02	0.007
TB Fire Sump Pipe 10, Position 7	4.37E+05	5.25E+03	5.79E+01	4.32E+05	9.48E+05	8.63E+02	0.006
TB Fire Sump Pipe 8, Position 0	5.06E+05	6.08E+03	6.70E+01	5.00E+05	1.10E+06	1.00E+03	0.007
TB Fire Sump Pipe 8, Position 1	5.10E+05	6.13E+03	6.75E+01	5.04E+05	1.11E+06	1.01E+03	0.007
TB Fire Sump Pipe 8, Position 2	5.14E+05	6.18E+03	6.81E+01	5.08E+05	1.12E+06	1.02E+03	0.007
TB Fire Sump Pipe 8, Position 3	5.27E+05	6.34E+03	6.98E+01	5.21E+05	1.14E+06	1.04E+03	0.007
TB Fire Sump Pipe 8, Position 4	5.32E+05	6.40E+03	7.04E+01	5.26E+05	1.15E+06	1.05E+03	0.008
TB Fire Sump Pipe 8, Position 5	5.62E+05	6.76E+03	7.44E+01	5.55E+05	1.22E+06	1.11E+03	0.008
TB Fire Sump Pipe 8, Position 6	5.66E+05	6.81E+03	7.50E+01	5.59E+05	1.23E+06	1.12E+03	0.008
TB Fire Sump Pipe 8, Position 7	5.93E+05	7.13E+03	7.85E+01	5.86E+05	1.29E+06	1.17E+03	0.008
TB Fire Sump Pipe 8, Position 8	5.81E+05	6.99E+03	7.69E+01	5.74E+05	1.26E+06	1.15E+03	0.008
TB Fire Sump Pipe 8, Position 9	5.99E+05	7.20E+03	7.93E+01	5.92E+05	1.30E+06	1.18E+03	0.008
TB Fire Sump Pipe 8, Position 10	6.20E+05	7.45E+03	8.21E+01	6.12E+05	1.35E+06	1.22E+03	0.009
TB Fire Sump Pipe 8, Position 11	6.00E+05	7.21E+03	7.95E+01	5.93E+05	1.30E+06	1.19E+03	0.008

ATTACHMENT 3 - SIGN TEST

Sign Test Turbine Building 560 Foot Elevation Embedded Floor Drain Pipe

Survey Area	06100			Description	Turbine Building
Survey Unit	06105B			Description	560 ft. Embedded Floor Pipe
Classification	3	Type I Error	0.05	# of Measurements	134

#	SOF (Ws)	1-Ws	Sign
0	0.0092	0.9908	+1
1	0.0095	0.9905	+1
2	0.0092	0.9908	+1
3	0.0094	0.9906	+1
4	0.0101	0.9899	+1
5	0.0099	0.9901	+1
6	0.0098	0.9902	+1
7	0.0108	0.9892	+1
8	0.0105	0.9895	+1
9	0.0105	0.9895	+1
10	0.0109	0.9891	+1
11	0.0109	0.9891	+1
12	0.0110	0.9890	+1
13	0.0111	0.9889	+1
14	0.0278	0.9722	+1
15	0.0142	0.9858	+1
16	0.0095	0.9905	+1
17	0.0090	0.9910	+1
18	0.0090	0.9910	+1
19	0.0092	0.9908	+1
20	0.0091	0.9909	+1
21	0.0162	0.9838	+1
22	0.0151	0.9849	+1
23	0.0157	0.9843	+1
24	0.0154	0.9846	+1
25	0.0166	0.9834	+1
26	0.0157	0.9843	+1
27	0.0154	0.9846	+1
28	0.0092	0.9908	+1

#	SOF (Ws)	1-Ws	Sign
63	0.0088	0.9912	+1
64	0.0089	0.9911	+1
65	0.0085	0.9915	+1
66	0.0083	0.9917	+1
67	0.0086	0.9914	+1
68	0.0091	0.9909	+1
69	0.0087	0.9913	+1
70	0.0085	0.9915	+1
71	0.0086	0.9914	+1
72	0.0083	0.9917	+1
73	0.0091	0.9909	+1
74	0.0084	0.9916	+1
75	0.0080	0.9920	+1
76	0.0085	0.9915	+1
77	0.0088	0.9912	+1
78	0.0088	0.9912	+1
79	0.0084	0.9916	+1
80	0.0087	0.9913	+1
81	0.0084	0.9916	+1
82	0.0085	0.9915	+1
83	0.0086	0.9914	+1
84	0.0087	0.9913	+1
85	0.0227	0.9773	+1
86	0.0231	0.9769	+1
87	0.0252	0.9748	+1
88	0.0200	0.9800	+1
89	0.0195	0.9805	+1
90	0.0206	0.9794	+1
91	0.0195	0.9805	+1

Sign Test (continued)

#	SOF (Ws)	1-Ws	Sign
29	0.0159	0.9841	+1
30	0.0150	0.9850	+1
31	0.0130	0.9870	+1
32	0.0155	0.9845	+1
33	0.0159	0.9841	+1
34	0.0154	0.9846	+1
35	0.0150	0.9850	+1
36	0.0168	0.9832	+1
37	0.0169	0.9831	+1
38	0.0179	0.9821	+1
39	0.0171	0.9829	+1
40	0.0164	0.9836	+1
41	0.0168	0.9832	+1
42	0.0140	0.9860	+1
43	0.0165	0.9835	+1
44	0.0168	0.9832	+1
45	0.0176	0.9824	+1
46	0.0172	0.9828	+1
47	0.0179	0.9821	+1
48	0.0171	0.9829	+1
49	0.0181	0.9819	+1
50	0.0200	0.9800	+1
51	0.0178	0.9822	+1
52	0.0173	0.9827	+1
53	0.0183	0.9817	+1
54	0.0157	0.9843	+1
55	0.0203	0.9797	+1
56	0.0195	0.9805	+1
57	0.0088	0.9912	+1
58	0.0087	0.9913	+1
59	0.0085	0.9915	+1
60	0.0085	0.9915	+1
61	0.0088	0.9912	+1
62	0.0088	0.9912	+1

#	SOF (Ws)	1-Ws	Sign
92	0.0084	0.9916	+1
93	0.0081	0.9919	+1
94	0.0081	0.9919	+1
95	0.0080	0.9920	+1
96	0.0084	0.9916	+1
97	0.0081	0.9919	+1
98	0.0075	0.9925	+1
99	0.0077	0.9923	+1
100	0.0074	0.9926	+1
101	0.0074	0.9926	+1
102	0.0074	0.9926	+1
103	0.0084	0.9916	+1
104	0.0084	0.9916	+1
105	0.0079	0.9921	+1
106	0.0065	0.9935	+1
107	0.0064	0.9936	+1
108	0.0066	0.9934	+1
109	0.0064	0.9936	+1
110	0.0064	0.9936	+1
111	0.0064	0.9936	+1
112	0.0065	0.9935	+1
113	0.0063	0.9937	+1
114	0.0064	0.9936	+1
115	0.0065	0.9935	+1
116	0.0063	0.9937	+1
117	0.0063	0.9937	+1
118	0.0063	0.9937	+1
119	0.0064	0.9936	+1
120	0.0066	0.9934	+1
121	0.0062	0.9938	+1
122	0.0071	0.9929	+1
123	0.0072	0.9928	+1
124	0.0073	0.9927	+1
125	0.0074	0.9926	+1

Sign Test (continued)

#	SOF (Ws)	1-Ws	Sign
126	0.0075	0.9925	+1
127	0.0079	0.9921	+1
128	0.0080	0.9920	+1
129	0.0084	0.9916	+1
130	0.0082	0.9918	+1
131	0.0084	0.9916	+1
132	0.0087	0.9913	+1
133	0.0085	0.9915	+1

Number of Positive Differences (S+) = 134

Critical Value = 77

Survey Unit Meets the Acceptance Criteria

ATTACHMENT 4 - QC SAMPLE ASSESSMENT

Turbine Building 560 ft. Embedded Drain Pipe – QC Agreement

Location	Reading (pCi/m^2)	QC Reading (pCi/m^2)	+20%	-20%	QC Pass
TB Fire Sump Pipe 6, Position 0	1.15E+06	1.14E+06	1.38E+06	9.20E+05	Yes
TB Fire Sump Pipe 6, Position 1	1.07E+06	1.22E+06	1.28E+06	8.56E+05	Yes
TB Fire Sump Pipe 6, Position 2	1.11E+06	1.04E+06	1.33E+06	8.88E+05	Yes
TB Fire Sump Pipe 6, Position 3	1.09E+06	1.18E+06	1.31E+06	8.72E+05	Yes
TB Fire Sump Pipe 6, Position 4	1.18E+06	1.13E+06	1.42E+06	9.44E+05	Yes
TB Fire Sump Pipe 6, Position 5	1.11E+06	1.14E+06	1.33E+06	8.88E+05	Yes
TB Fire Sump Pipe 6, Position 6	1.09E+06	1.15E+06	1.31E+06	8.72E+05	Yes
TB Fire Sump Pipe 6, Position 7	1.13E+06	1.15E+06	1.36E+06	9.04E+05	Yes
TB Fire Sump Pipe 6, Position 8	1.06E+06	1.13E+06	1.27E+06	8.48E+05	Yes
TB Fire Sump Pipe 6, Position 9	9.22E+05	1.07E+06	1.11E+06	7.38E+05	Yes
TB Fire Sump Pipe 6, Position 10	1.10E+06	1.08E+06	1.32E+06	8.80E+05	Yes
TB Fire Sump Pipe 6, Position 11	1.13E+06	9.01E+05	1.36E+06	9.04E+05	No
TB Fire Sump Pipe 6, Position 12	1.09E+06	1.09E+06	1.31E+06	8.72E+05	Yes
TB Fire Sump Pipe 6, Position 0	1.15E+06	1.11E+06	1.38E+06	9.20E+05	Yes

One measurement out of the 13 QC measurements taken did not fall within the range of ±20% of the original measurement. The detector successfully passed the required post-use source and quality checks. Twelve (12) of the 13 QC measurements taken with the same detector fell within the range of ±20% of the original measurement and, the measurement that did fall outside low was essentially just below the lower range limit (-20.3%). No further action was deemed necessary.

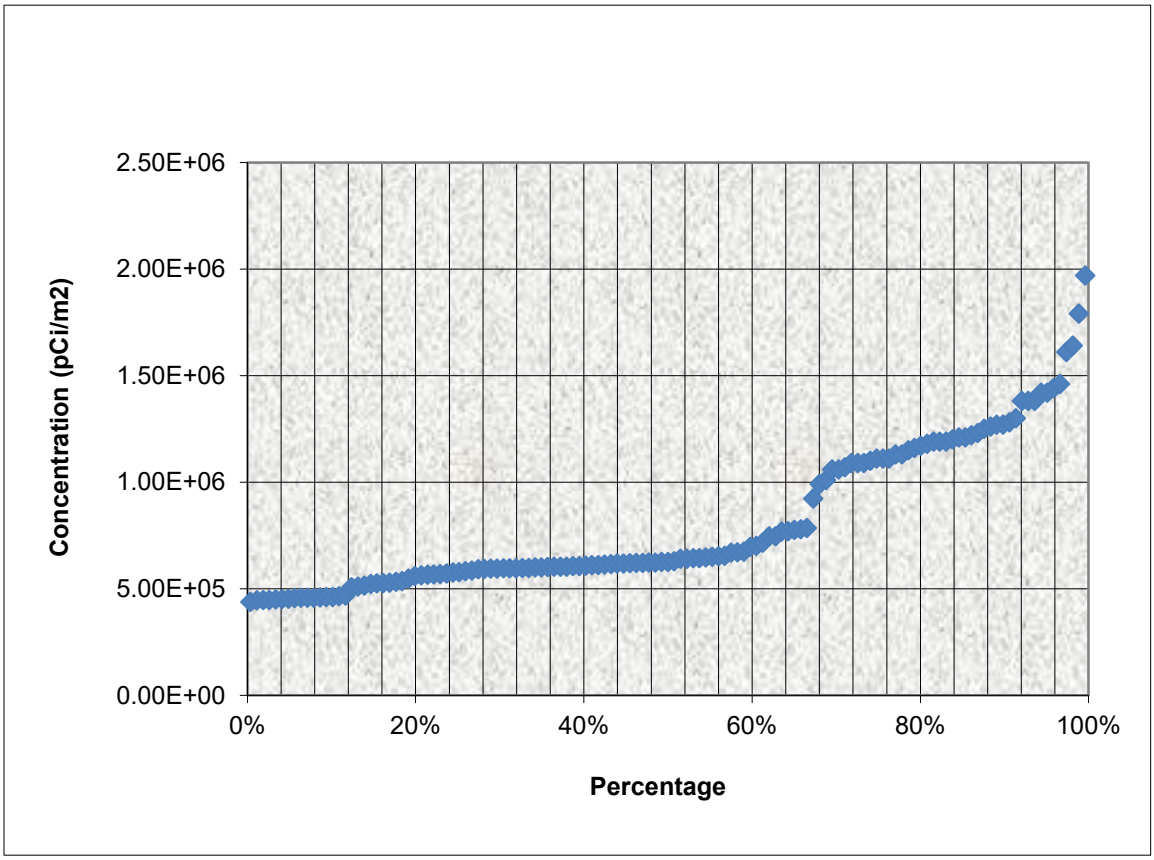
ATTACHMENT 5 - GRAPHICAL PRESENTATIONS

QUANTILE PLOT FOR GROSS GAMMA

Survey Unit: **S3-06105B-F**

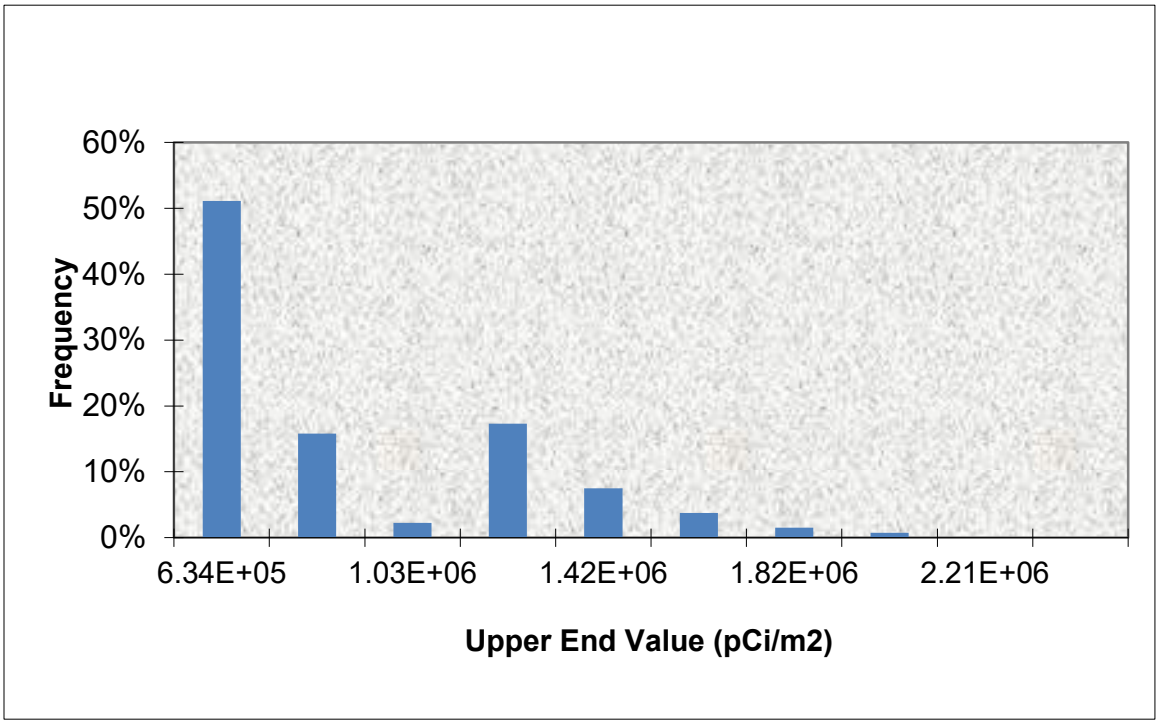
Survey Unit Name: **Turbine Building 560 ft Embedded Pipe**

Mean: 8.06E+05 pCi/m2



HISTOGRAM FOR GROSS GAMMA

Survey Unit:	**S3-06105B-F**	
Survey Unit Name:	**Turbine Building 560 ft Embedded Pipe**	
Mean:	8.06E+05	pCi/m2
Median:	8.26E+05	pCi/m2
ST DEV:	3.41E+05	
Skew:	1.06E+00	



Upper Value	Observation Frequency	Observation %
6.34E+05	68	51%
8.31E+05	21	16%
1.03E+06	3	2%
1.23E+06	23	17%
1.42E+06	10	8%
1.62E+06	5	4%
1.82E+06	2	2%
2.01E+06	1	1%
2.21E+06	0	0%
2.41E+06	0	0%
TOTAL	133	100%

Retrospective Power Curve