Appendix A

Survey Design

ORIGINAL

FirstEnergy

SNEC CALCULATION COVER SHEET

CALCULATION DESCRIPTION

Calculation Number	Revision Number	Effective Date	Page Number
E900-03-030	0	11/17/03	1 of 64

Subject

Seal Chambers - Survey Plan

Question 1 - Is this calculation defined as "In QA Scope"? Refer to definition 3.5. Yes ☒ No ☐

Question 2 - Is this calculation defined as a "Design Calculation"? Refer to definitions 3.2 and 3.3. Yes ☒ No ☐

Question 3 - Does the calculation have the potential to affect an SSC as described in the USAR? Yes ☐ No ☒

NOTES: If a "Yes" answer is obtained for Question 1, the calculation must meet the requirements of the SNEC Facility Decommissioning Quality Assurance Plan. If a "Yes" answer is obtained for Question 2, the Calculation Originator's immediate supervisor should not review the calculation as the Technical Reviewer. If a "YES" answer is obtained for Question 3, SNEC Management approval is required to implement the calculation. Calculations that do not have the potential to affect SSC's may be implemented by the TR.

DESCRIPTION OF REVISION

APPROVAL SIGNATURES

Calculation Originator	B. Brosey/ [signature]	Date	11/14/03
Technical Reviewer	P. Donnachie/ [signature]	Date	11/17/03
Additional Review	A. Paynter/ [signature]	Date	11/17/03
Additional Review		Date	
SNEC Management Approval		Date	

1.0 PURPOSE

1.1 The purpose of this calculation is to develop survey design for three (3) Seal Chambers. These areas are ***Class 1*** survey units located in the Discharge Tunnel. They are shown in Attachment 1-1 through 1-2, and are listed below. Attachment 1-3 shows a general diagram of one of four steel downcomers located in Seal Chamber 3.

Impacted Survey Units	Location	Material Type	Attachment
SS8-1	Seal Chamber 1 – Discharge Tunnel	Concrete/Steel	1-1
SS8-2	Seal Chamber 2 – Discharge Tunnel	Concrete/Steel	1-1
SS8-3	Seal Chamber 3 – Discharge Tunnel	Concrete/Steel	1-2
Part of SS8-3	Seal Chamber 3 - Downcomer	Steel	1-3

1.2 The estimated area (in square meters) for these survey units are as shown in the following table. Seal Chamber 3 includes the external surface of the four (4) downcomers.

Seal Chamber 1	Seal Chamber 2	Seal Chamber 3
73.1	70.9	109.4

2.0 SUMMARY OF RESULTS

The following information should be used to develop a survey request for this survey design:

2.1 *Step 1 - GFPC Measurements for Concrete and Clean or Lightly Corroded Steel Surfaces*

2.1.1 A gas flow proportional counter (GFPC) shall be used in the beta detection mode for this scan survey work (Ludlum 2350-1 with a 43-68B probe).

2.1.2 The minimum required number of static survey points for each Seal Chamber is ***8*** (see Attachment 1-4 to 1-7 for locations of random start systematic grid survey points). However, because the down comers in Seal Chamber 3 are separate components, an additional ***8*** points will be established for these four components.

2.1.3 Scanning criteria using the GFPC for these areas and hardware, are identified below:

2.1.3.1 The GFPC detector must be in contact with the surface when scanning except in areas where this is not physically possible.

2.1.3.2 Areas where gouges exceed ***2" in depth*** should not be surveyed using the GFPC (see Section 2.2 for surveys of gouges > 2" in depth).

2.1.3.3 Steel components/hardware that exhibit severely corroded surfaces should not be scanned using the GFPC. See Section 2.2 if this is the case.

2.1.3.4 The GA DCGLw is ***6,407 dpm/100 cm²*** or ***646 cpm*** above background. This is the static measurement criteria.

2.1.3.5 The action level during first phase scanning is ***300 cpm*** above background. If this level is reached, the surveyor should stop and perform a count of at least ***1/2 minute*** duration to identify the actual count rate.

2.1.3.6 Areas greater than the ***DCGLw (646 ncpm)*** must be identified, bounded and documented to include an area estimate.

2.1.3.7 Other instruments of the type specified in 2.1.1 above may be used, but all instruments must demonstrate an efficiency at or above ***25.4%*** (see Attachment 2-1).

2.1.4 Any location or equipment that cannot be adequately surveyed with the GFPC as described in 2.1.2 above, should be identified for NaI scanning IAW Section 2.2.

NOTE: Scan MDC values for the GFPC instrument are listed in Section 4.15, and have been shown to be adequate for this survey work.

2.2 ***Step 2 - NaI Scanning of Extremely Corroded Steel or Rough Concrete Surfaces***

2.2.1 The purpose of NaI scanning is to locate elevated measurement locations and mark them for sampling. The following criteria apply:

2.2.1.1 Volumetric DCGLw values for concrete is ***4.78 pCi/g Cs-137*** (administrative limit).

2.2.1.2 The scan speed is set at ***5 cm/second*** when scanning with a ***2" by 2" NaI*** detector while moving side to side in a serpentine pattern over a 12" diameter area, within 2" from the surface. The stand-off distance (2") should be monitored frequently during the scanning process.

2.2.1.3 The action level is ***200 gross cpm***. The location should be clearly marked for sampling when this level is reached or exceeded. These areas shall be identified, bounded and documented.

2.2.2 The conversion factor for the NaI used in cpm/mR/h, shall not be less than ***176,080 cpm/mR/h*** (see Attachment 3-1 and 3-2) for a typical NaI instrument calibration report).

2.3 ***Step 3 - Static Measurements Using the NaI Detector***

2.3.1 These measurements are to be performed using a fixed geometry of 2" above concrete surfaces at the locations shown on Attachment 1-4 to 1-6. These locations are the same locations developed for GFPC static measurements. ***Downcomer static measurement locations shall be omitted***.

2.3.2 The detection system shall be a 2" by 2" NaI detector of the type previously used in Section 2.2 above, or may be replaced with a multi-channel analyzer system used IAW Reference 3.1.

2.3.3 The instrument(s) shall be operated in the integral (scalar) mode to allow application of counting statistics to the results.

2.3.3.1 Count times for static NaI measurements shall initially be ***5 minutes*** in duration but may be adjusted IAW the need to attain a desired MDC.

2.3.3.2 If a multi-channel analyzer system is used IAW Reference 3.1, data shall be recorded on copies of Attachment 4-1 (or equivalent).

2.3.5 The decision error rates for NaI static points is assumed the same as those developed for static GFPC measurements i.e., 0.05 for the α value and 0.1 for the β value.

2.3.6 If remediation is performed as a result of this survey work, this survey design must be revised or re-written entirely.

2.4 ***Step 4 - Sampling of Concrete and Steel Surfaces***

2.4.1 Sample concrete at any location above the action level cited is Section 2.1 (Step 1) or Section 2.2 (Step 2). A 4" long core bore sample is preferred so that the depth of penetration can be identified. However, when a core bore cannot be taken because of the quality of the concrete, or because of limited access in an area, sampling should remove the first 1" of concrete and yield a volume of at least ***200 cc*** to ensure an adequate counting MDA for Cs-137 (a 4" diameter area by 1" deep = ~200 cc).

2.4.2 For steel surfaces above the action level for either detection system (200 gross cpm NaI or 300 ncpm GFPC), scrape the surface to collect a sample for gamma scanning by removing as much material as possible in the suspect area. Document the approximate size of the area where the materials were removed. Whenever possible, obtain a volume of no less then 25 cc's (200 cc's is preferred).

2.4.3 In general, samples shall be collected at all locations where measurements indicate elevated count rates, or where measurement capability is deemed inadequate due to poor geometry.

2.4.4 One sample of concrete will be collected at the highest measured location in each Seal Chamber as determined by NaI static measurements (Section 2.3).

3.0 REFERENCES

3.1 SNEC procedure E900-OPS-4524.43, "Operation of the Portable Gamma Spectroscopy System".

3.2 ISO 7503-1, Evaluation of Surface Contamination, Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters, 1988.

3.3 SNEC Calculation No. 6900-02-028, GFPC Instrument Efficiency Loss Study.

3.4 GPU Nuclear, SNEC Facility, SSGS Footprint, Drawing, SNECRM-040, Sheet 1 & 2.

3.5 Plan SNEC Facility License Termination Plan.

3.6 SNEC Calculation No. E900-03-029, Balance of SSGS Footprint 2 – Survey Plan.

3.7 SNEC Calculation No. E900-03-027, Balance of SSGS Footprint - Survey Plan.

3.8 SNEC Calculation No. E900-03-025, SSGS Area Trench & Sump Survey Design.

3.9 SNEC procedure E900-IMP-4520.06, "Survey Unit Inspection in Support of FSS Design".

3.10 SNEC Procedure E900-IMP-4500.59, "Final Site Survey Planning and DQA".

3.11 MicroShield, Computer Radiation Shielding Code, Version 5.05-00121, Grove Engineering.

3.12 NUREG-1507, "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998.

3.13 SNEC procedure E900-IMP-4520.04, "Survey Methodology to Support SNEC License Termination".

3.14 NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual", August, 2000.

3.15 Microsoft Excel 97, Microsoft Corporation Inc., SR-2, 1985-1997.

3.16 Compass Computer Program, Version 1.0.0, Oak Ridge Institute for Science and Education.

3.17 Visual Sample Plan, Version 2.0 (or greater), Copyright 2002, Battelle Memorial Institute.

3.18 SNEC Calculation No. E900-03-012, Effective DCGL Worksheet Verification.

4.0 ASSUMPTIONS AND BASIC DATA

4.1 Remediation History

Remediation of the Seal Chambers began with removal of ground water in these semi-isolated structures. Gross decontamination followed to include the removal of contaminated hardware and piping that passed into and through these chambers. One pipe originating in the SNEC Nuclear facility, terminated in Seal Chamber 1. This is thought to be the main source of contamination entering the Discharge Tunnel. Of interest, is the fact that this pipe did not significantly contaminate Seal Chamber 1 which contained the least amount of radiological contamination of the three chambers. Instead, contaminated water and steam from the SSGS Coal Fired Steam plant passing into and through Seal Chamber 3 appears to have had a more significant impact with regard to contaminating the Seal Chamber 3 area. Seal Chamber 2 was also contaminated, but not at the level exhibited by Seal Chamber 3, which required a larger concrete removal effort. Because these chambers are below grade level, surface water in-leakage was a problem and some patching of cracked concrete was necessary to prepare these areas for final status survey work.

Surface cleaning of these areas was performed by removing a thickness of concrete in affected areas. Core bores were taken to determine the depth of the contamination and to estimate remediation effectiveness during and after this process. Remaining piping systems were sampled and gamma scanned to determine the existing concentrations. Obstructions were cut off and concrete surfaces were scraped free of scale when necessary. Remediation efforts included combinations of the following cleaning techniques:

- scabbling
- grinding and use of an oxy/acetylene torch to remove metal obstructions and pipe
- surface scraping
- water flush

4.2 Cs-137 accounts for the majority of the total activity in the modified sample result (see Attachment 5-1 and 5-2).

- The SNEC modified sample is greater than 96% Cs-137. The next most prevalent radionuclide is Ni-63 (2.6%).
- Cs-137 therefore, provides the only reasonably detectable radionuclide in this mix.

Cs-137's detection efficiency has been checked by SNEC personnel using ISO standard 7503-1 methodology (**Reference 3.2**). The SNEC facility uses only the lowest reported GFPC efficiency for any of the instruments available for the survey work as input to the survey design process. Attachment 2-1, indicates an instrument efficiency of ***0.509***. The ISO value of ***0.5*** is used as the source efficiency. A Ludlum 2350 is used to determine this value (instrument S/N 95352 - probe S/N is 94818).

NOTE
Other GFPC instruments may be used during the FSS but they must demonstrate an instrument efficiency at or above 0.509.

4.3 An GFPC detector stand-off distance of 2" is assumed to compensate for rough surfaces in the SSGS area. This factor corrects the overall efficiency by a factor of 0.33 (Reference 3.3), as shown on Attachment 6-1.

4.4 The detectors physical probe area is 126 cm^2, and the instrument is calibrated to the same source area for Cs-137. The gross activity DCGLw is taken to be 6,407 dpm/100 cm^2 x (126 cm^2 physical probe area/100 cm^2) = 8,073 x (0.964 disintegration of Cs-137/ disintegration in mix) x ε_i (0.478) x ε_s (0.5) x 0.33 (distance factor) which yields ~648 net cpm above background (Compass calculates 646 ncpm as the gross beta DCGLw). The 0.08 count per disintegration counting efficiency considers only the Cs-137 contaminant present in the sample material matrix, and is calculated by: ε_i (0.509) x ε_s (0.5) x 0.964 disintegration of Cs-137/disintegration in mix x 0.33 (efficiency loss factor due to distance from surface) = ***0.08 cts/disintegration***.

4.5 Surface defects (gouges, cracks, etc.), are present in these survey units, but a portion of the surface area is relatively smooth. Thus the average concentration of the source term will be overestimated by using a distance correction factor of 0.33 for all areas within these survey units (GFPC only).

4.6 Inaccessible areas or corroded steel surfaces, or any area where a 43-68 beta probe can not be used, will be scanned using a 2" x 2" NaI detector. These detectors are set-up and calibrated with a Cs-137 window setting typical to that described within Attachment 3-1 and 3-2, with a conversion factor equal to or greater than 176,080 cpm/mR/h.

4.7 MicroShield models of concrete slabs containing Cs-137 were developed for this survey design. Two slab models were used for scanning:

1) a 3" thick slab of concrete 12" in diameter with a density of 2/3 that of concrete to simulate an extremely rough surface (many pits and valleys), and

2) a 1" thick slab of concrete 12" in diameter to simulate a small but relatively smooth surface area.

These models assume that the majority of the activity resides in no more than the first three (3) inches of remaining concrete and that elevated areas are small in diameter. These models are based on remediation information.

4.8 The modeled concentration used was 1 pCi/g Cs-137 and the full density of concrete is assumed to be 2.35 g/cc. Then the concentration of Cs-137 in the first model is 2.35g/cc x 2/3 x 1 pCi/g or 1.6E-06 uCi/cc of Cs-137 for the rough model, and 2.35E-06 uCi/cc for the 1" slab model. The calculated MDCscan for these two models is shown in the following table for a typical 2" by 2" NaI detector.

Material/Model	Estimated BKGND (cts/min)	MDC_{SCAN} (pCi/g)
Concrete/1" Slab (2.35 g/cc)	100	Attachment 7-1 to 7-3 = 4.4
Concrete/3" Slab (1.6 g/cc)	100	Attachment 8-1 to 8-2 = 2.9

4.9 The results of the MicroShield modeling indicate that an exposure rate of approximately 7.888E-05 mR/h is obtained at a distance of 3" (2" inches from the face of the detector), from the surface of the smaller slab model, and 1.179E-04 mR/h is seen 3 inches from the surface of the thicker rough surface model. Exposure rate is measured to the center of the detector and therefore the air gap between the surface of both models is taken to be 2".

4.10 A third MicroShield model of a surface deposition containing Cs-137 was also developed for this survey design (see Attachment 9-1 to 9-8). For this scenario, the modeled area is assumed to be a 12" diameter disk source with a 1 pCi/cm^2 Cs-137 activity evenly dispersed over the surface. The source area is assumed to be a corroded steel plate or a surface deposited concrete source. This model incorporates a 2 mm thickness of iron oxide (Fe_2O_3) to simulate a corroded steel surface or a near surface deposit in concrete. The resulting mR/h value was 1.546E-05. Then the calculated pCi/cm^2 MDCscan is 22.5 pCi/cm^2 (4993 dpm/100 cm^2) for a background count rate of 100 cpm. This model is applicable for steel or concrete surface deposits.

4.11 These survey units are below grade and are surrounded by concrete walls and therefore the original GFPC related background values have been adjusted to compensate for shielding effects of these walls. This results in a conservative estimate of background.

4.12 A GFPC variability measurement set was performed in each Seal Chamber (see Attachment 10-1 to 10-3.

4.12.1 Seal Chamber 2 exhibits the largest mean unshielded GFPC value and the largest standard deviation (244 cpm ± 68.1). Using this value to calculate the MDCscan and static values will produce the most conservative result. The shielded reading for this data yields 140 cpm ± 21.8, while Seal Chamber 1 exhibits the lowest mean concentration and therefore is the closest to natural background for any of these survey units. Therefore, Seal Chamber 1 data will be used to adjust the Intake Tunnel entrance background data to compensate for the below ground shielding effect. Then:

Mean Intake Tunnel entrance data = 340 cpm ± 56.8 unshielded, and

= 255 cpm ± 33.8 shielded

Seal Chamber 1 data = 187 cpm ± 27.7 unshielded, and

= 138 cpm ± 26.2 shielded

Difference in shielded readings = 255 – 138 = 117 cpm

Mean IT entrance unshielded data corrected = 340 – 117 cpm = ***223 cpm ± 56.8***

The following correction may be used to correct the Williamsburg steel background data:

Mean Williamsburg steel data = 211 cpm ± 17.7 unshielded, and

= 200 cpm ± 18.1 shielded

Seal Chamber 3 steel data = 158 cpm ± 10.8 unshielded, and

= 153 cpm ± 8.6 shielded

Difference in shielded readings = 200 – 153 = 47 cpm

Mean Williamsburg unshielded data corrected = 211 – 47 cpm = ***164 cpm ± 17.7***

NOTE

The steel data from Seal Chamber 3 are from data points 32 to 39 on Attachment 10-3. Williamsburg steel data are shown on Attachment 10-4 and Intake Tunnel entrance non-impacted concrete background data is shown on Attachment 10-5.

4.13 The majority of the structural surface area in these chambers is concrete. However, the downcomers in Seal Chamber 3 are steel. If concrete measurements are used to estimate the MDCscan or static values for a steel surface, the result will be an elevated estimate of these values since steel has a lower background. When the data are analyzed using the WRS criteria, the correct background values will be subtracted.

4.14 For static NaI measurements of concrete, background values are determined by taking measurements at an on-site non-impacted structure (see Attachment 11-1). The mean non-impacted area value is similar to the current mean general area values in the Seal Chambers, and thus can be used to estimate static and scan MDC values.

4.15 The GFPC scan MDC calculation is determined based on a 2.2 cm/sec scan rate, a 1.38 index of sensitivity (95% correct detection probability and 60% false positive), 0.08 counts/disintegration and a 126 cm^2 probe area. In all cases, the scan MDC is less than the gross activity DCGLw for these survey units. Therefore, there is no need to add additional survey points to this survey design for purposes of meeting hot spot design criteria.

Material	Value Used (cts/min)	MDC_{SCAN} (dpm/100 cm^2)
Steel (Attachment 10-3)	158	Attachment 12-1 = 1,174
Concrete (Attachment 10-2)	244	Attachment 12-2 = 1,459

NOTE: Compass does not use the 126 cm^2 probe correction factor in the MDCscan equation.

4.16 The survey units described in this survey design were inspected after remediation efforts were completed. A copy of portions of the SNEC facility post-remediation inspection report are included (see Attachment 13-1 to 13-6).

4.17 No special area characteristics including any additional residual radioactivity (not previously noted during characterization) have been identified in these survey units.

4.18 Special measurements are included for this survey design. These special measurements are NaI based static measurements that use a Cs-137 window set around the peak energy of 0.622 MeV. The specifications for these measurements are defined in Section 2.3.

4.18.1 The NaI static measurement MDC is based on a background value determined for concrete at an on-site non-impacted concrete structure (see Attachment 11-1). The MicroShield model used assumes a cylindrical source geometry with a diameter of 12" and a depth of 1". The size of the modeled area is comparable to typical elevated areas of concrete found in the SSGS area and surrounding tunnels during previous survey work (see Attachment 9-7 and 9-8).

4.18.2 A background count rate of 100 counts/min (typical) yields a MDCstatic value of ***0.713 pCi/g Cs-137***. (see Attachment 9-7 and 9-8).

4.19 Compass output is presented in Attachment 14-1 to 14-10.

4.20 The applicable SNEC site radionuclides and their associated DCGLw values are listed on Exhibit 1 of this calculation.

4.21 The survey design checklist is listed in Exhibit 2.

4.22 Diagrams shown in this survey design have been developed from Reference 3.4.

4.23 The Area Factors for this survey unit is shown below (Co-60). These values (as applicable), were input to the Compass computer program and are the same as those reported in Reference 3.5. The lower limit area factor for areas less than 1 square meter is 10.1. Area factors for values between the values listed in the following table, are interpolated from the data by Compass.

AREA (m^2)	AREA FACTOR
1	10.1
4	3.4
9	2
16	1.5
25	1.2
36	1

5.0 CALCULATIONS

5.1 All complex calculations are performed internal to applicable computer codes or within an Excel spreadsheet previously identified.

6.0 APPENDICES

6.1 **Attachment 1-1** to **1-3**, diagrams of Seal Chambers and Downcomers.

6.2 **Attachment 1-4** to **1-7**, VSP output showing static measurement points.

6.3 **Attachment 2-1**, is the calibration information for the lowest efficiency GFPC detector.

6.4 **Attachment 3-1** to **3-2**, are typical calibration sheets for a 2" by 2" NaI detection system.

6.5 **Attachment 4-1**, is a data collection sheet for a gamma-ray spectrometry system (typical).

6.6 **Attachment 5-1** to **5-2**, are calculation sheets used to determine the effective volumetric and surface concentration limits (Effective DCGL Calculator).

6.7 **Attachment 6-1**, is a calculation result for determining efficiency loss for a GFPC detector as a function of distance from a source.

6.8 **Attachment 7-1** to **7-3**, is calculation sheets to determine the scan MDC for a NaI detection system using a typical background count rate and a 12" diameter 1" thick MicroShield model.

6.9 **Attachment 8-1** to **8-2**, is calculation sheets to determine the scan MDC for a NaI detection system using a typical background count rate and a 12" diameter 3" thick MicroShield model.

6.10 **Attachment 9-1** to **9-8**, are calculation sheets used to determine the scan MDC for a NaI detection system using a typical background count rate and surface deposition model from MicroShield.

6.11 **Attachment 10-1** to **10-3**, are GFPC variability measurements from the Seal Chamber areas.

6.12 **Attachment 10-4** to **10-5**, are background measurements using a GFPC instrument in non-impacted areas.

6.13 **Attachment 11-1**, is NaI background measurements in a non-impacted area.

6.14 **Attachment 12-1** to **12-3**, are calculation sheets used to determine the scan MDC for a GFPC detection system using a typical background count rate associated with steel and concrete surfaces.

6.15 **Attachment 13-1** to **13-6**, are sections of survey unit inspection reports for the Seal Chamber areas.

6.16 **Attachment 14-1** to **14-10,** are Compass output results for the Seal Chambers.

Exhibit 1

SNEC Facility DCGL Values [a]

Radionuclide	25 mrem/y Limit Surface Area (dpm/100cm²)	25 mrem/y Limit (All Pathways) Open Land Areas (Surface & Subsurface) (pCi/g)	4 mrem/y Goal (Drinking Water) Open Land Areas [b] (Surface & Subsurface) (pCi/g)
Am-241	2.7E+01	9.9	2.3
C-14	3.7E+06	2	5.4
Co-60	7.1E+03	3.5	67
Cs-137	2.8E+04	6.6	397
Eu-152	1.3E+04	10.1	1440
H-3	1.2E+08	132	31.1
Ni-63	1.8E+06	747	1.9E+04
Pu-238	3.0E+01	1.8	0.41
Pu-239	2.8E+01	1.6	0.37
Pu-241	8.8E+02	86	19.8
Sr-90	8.7E+03	1.2	0.61

NOTES:

(a) While drinking water DCGLs will be used by SNEC to meet the drinking water 4 mrem/y goal, only the DCGL values that constitute the 25 mrem/y regulatory limit will be controlled under this LTP and the NRC's approving license amendment.

(b) Listed values are from the subsurface model. These values are the most conservative values between the two models (i.e., surface & subsurface).

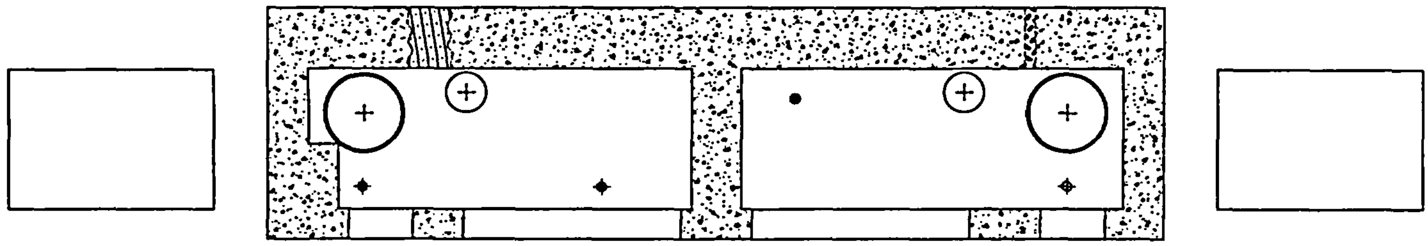
Exhibit 2

Survey Design Checklist (From Reference 3.5)

Calculation No. E900-03-030	SS8-1, SS8-2 & SS8-3		
ITEM	**REVIEW FOCUS**	**Status (Circle One)**	**Reviewer Initials & Date**
1	Has a survey design calculation number been assigned and is a survey design summary description provided?	(Yes) N/A	11/17/03
2	Are drawings/diagrams adequate for the subject area (drawings should have compass headings)?	(Yes) N/A	
3	Are boundaries properly identified and is the survey area classification clearly indicated?	(Yes) N/A	
4	Has the survey area(s) been properly divided into survey units IAW EXHIBIT 10	(Yes) N/A	
5	Are physical characteristics of the area/location or system documented?	(Yes) N/A	
6	Is a remediation effectiveness discussion included?	(Yes) N/A	
7	Have characterization survey and/or sampling results been converted to units that are comparable to applicable DCGL values?	(Yes) N/A	
8	Is survey and/or sampling data that was used for determining survey unit variance included?	(Yes) N/A	
9	Is a description of the background reference areas (or materials) and their survey and/or sampling results included along with a justification for their selection?	(Yes) N/A	
10	Are applicable survey and/or sampling data that was used to determine variability included?	(Yes) N/A	
11	Will the condition of the survey area have an impact on the survey design, and has the probable impact been considered in the design?	(Yes) N/A	
12	Has any special area characteristic including any additional residual radioactivity (not previously noted during characterization) been identified along with its impact on survey design?	(Yes) N/A	
13	Are all necessary supporting calculations and/or site procedures referenced or included?	(Yes) N/A	
14	Has an effective DCGLw been identified for the survey unit(s)?	(Yes) N/A	
15	Was the appropriate $DCGL_{EMC}$ included in the survey design calculation?	(Yes) N/A	
16	Has the statistical tests that will be used to evaluate the data been identified?	(Yes) N/A	
17	Has an elevated measurement comparison been performed (Class 1 Area)?	(Yes) N/A	
18	Has the decision error levels been identified and are the necessary justifications provided?	(Yes) N/A	
19	Has scan instrumentation been identified along with the assigned scanning methodology?	(Yes) N/A	
20	Has the scan rate been identified, and is the MDCscan adequate for the survey design?	(Yes) N/A	
21	Are special measurements e.g., in-situ gamma-ray spectroscopy required under this design, and is the survey methodology, and evaluation methods described?	(Yes) N/A	
22	Is survey instrumentation calibration data included and are detection sensitivities adequate?	(Yes) N/A	
23	Have the assigned sample and/or measurement locations been clearly identified on a diagram or CAD drawing of the survey area(s) along with their coordinates?	(Yes) N/A	
24	Are investigation levels and administrative limits adequate, and are any associated actions clearly indicated?	(Yes) N/A	
25	For sample analysis, have the required MDA values been determined.?	Yes, (N/A)	
26	Has any special sampling methodology been identified other than provided in Reference 6.3?	(Yes), N/A	11/17/03

NOTE: a copy of this completed form or equivalent, shall be included within the survey design calculation.

Seal Chambers 1 & 2

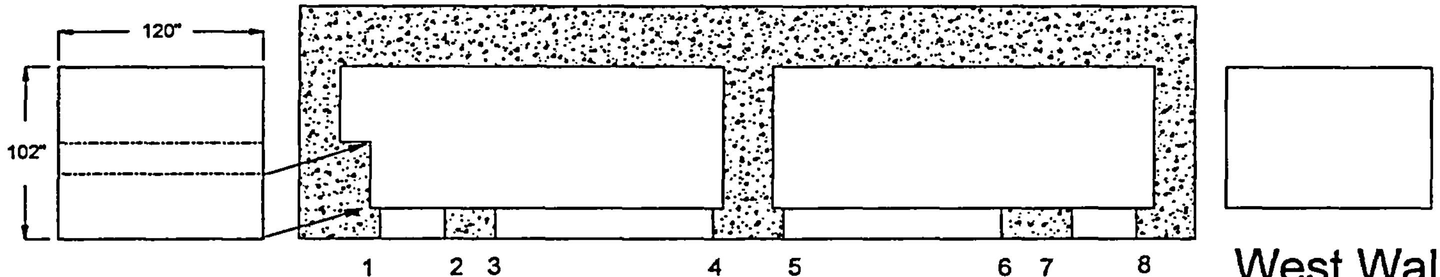


West Inner Wall

Ceiling

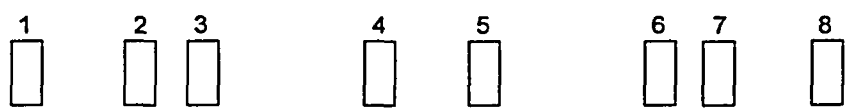
East Inner Wall

Floor

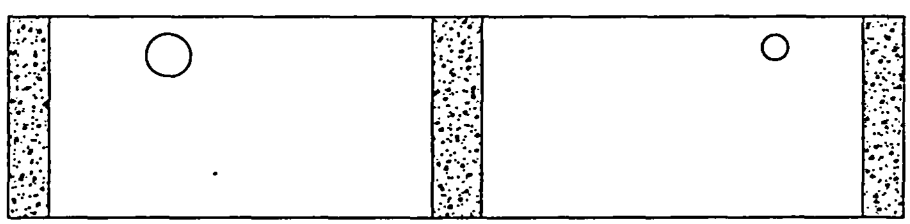


East Wall

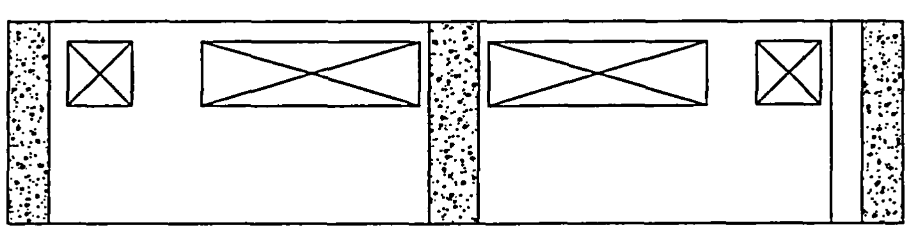
West Wall



Window End Wall Sections



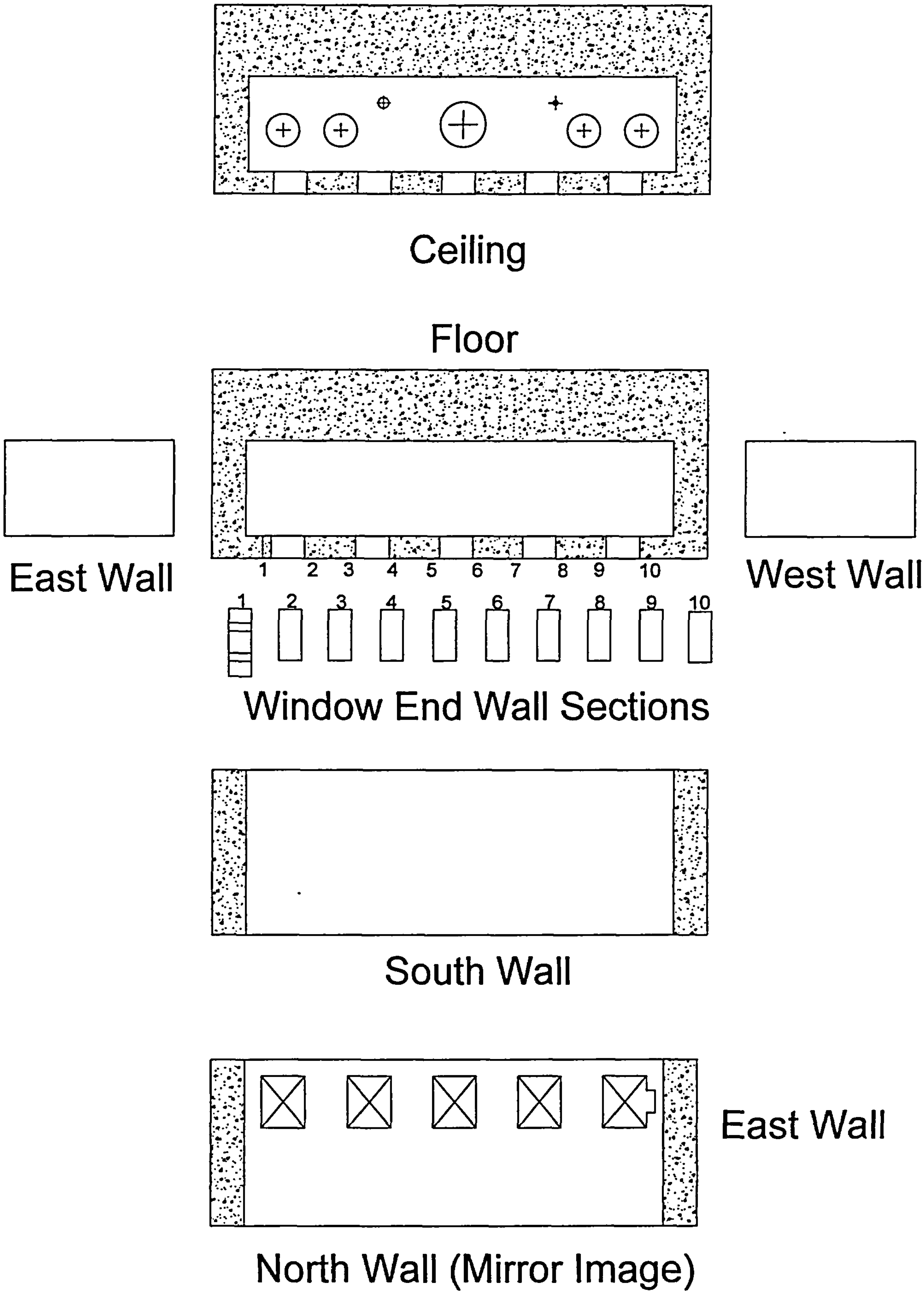
South Wall



East Wall

North Wall (Mirror Image)

Seal Chamber 3

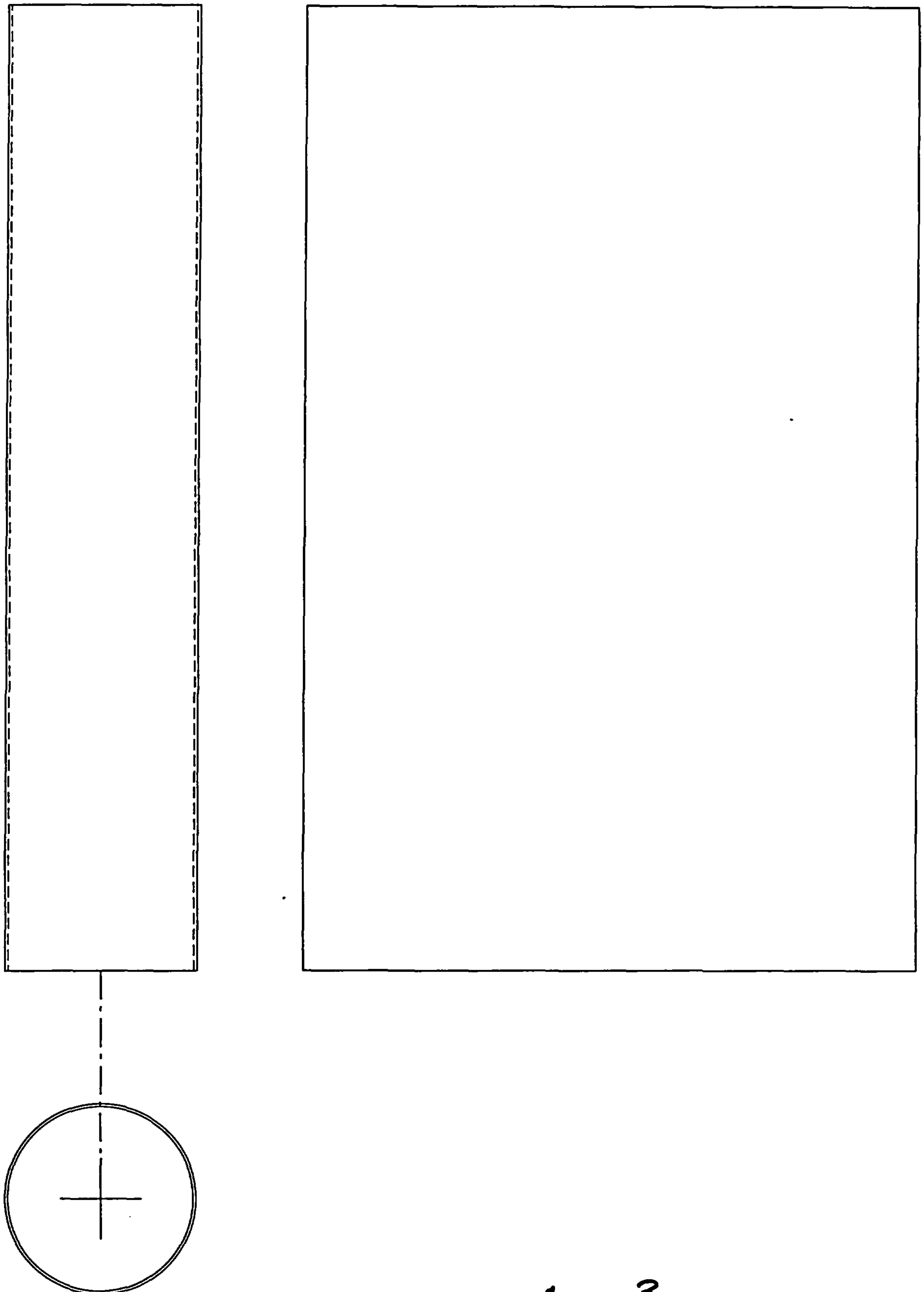


ATTACHMENT 1 . 2

Seal Chamber 3 Downcomers (4 ea)

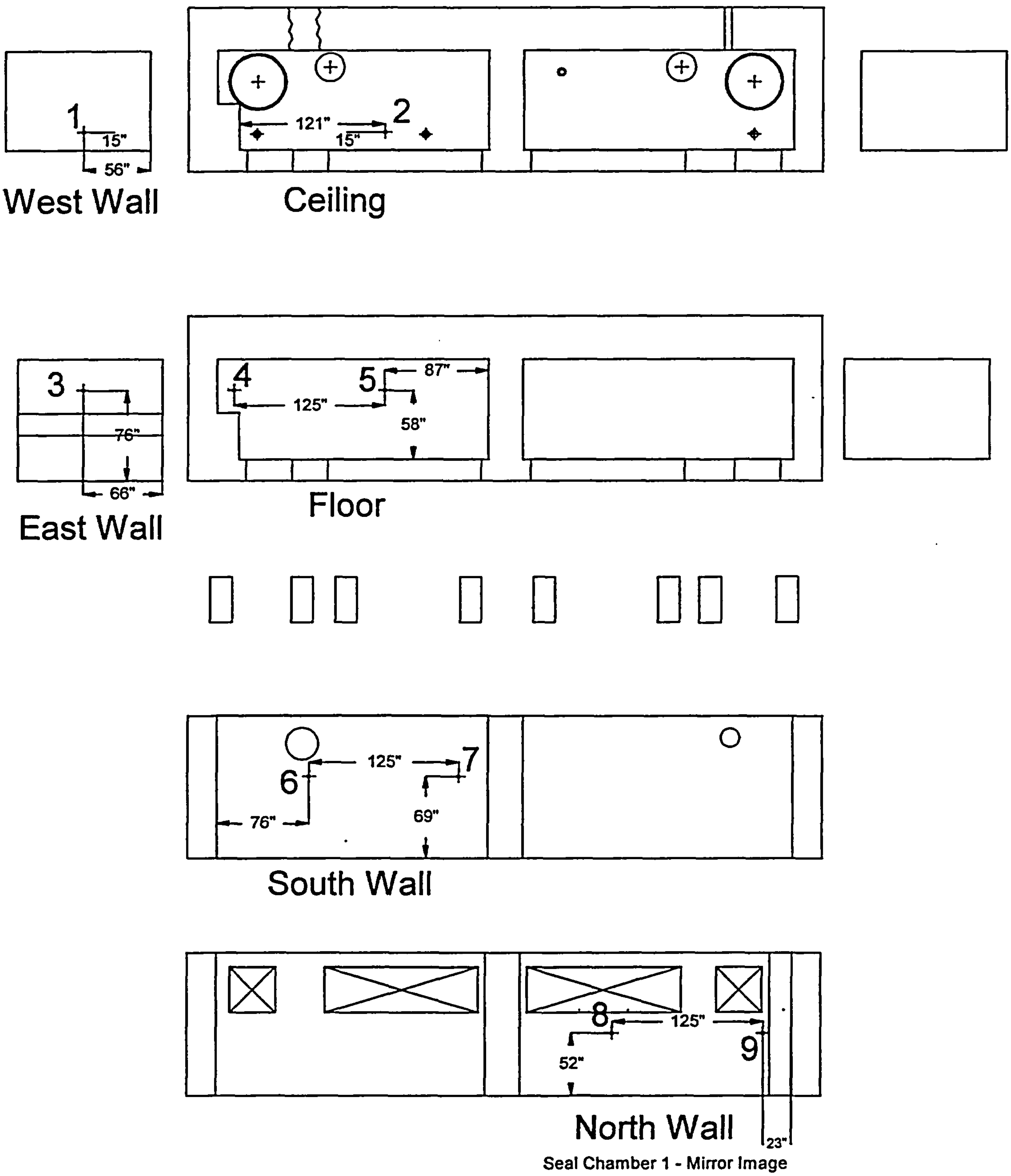
24" Downcomer Pipe

24" Downcomer Pipe - Exterior View



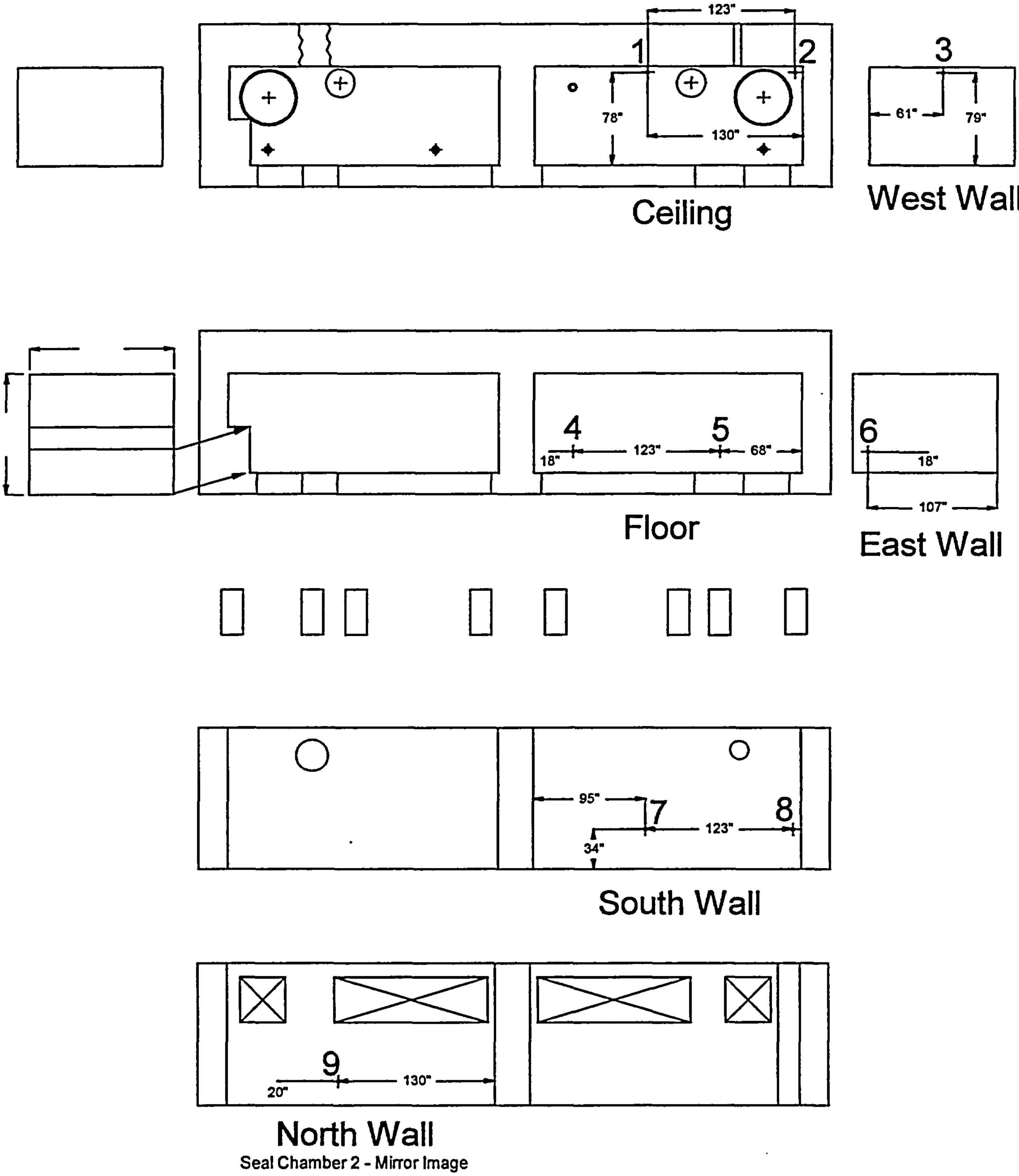
ATTACHMENT 1.3

Seal Chamber 1

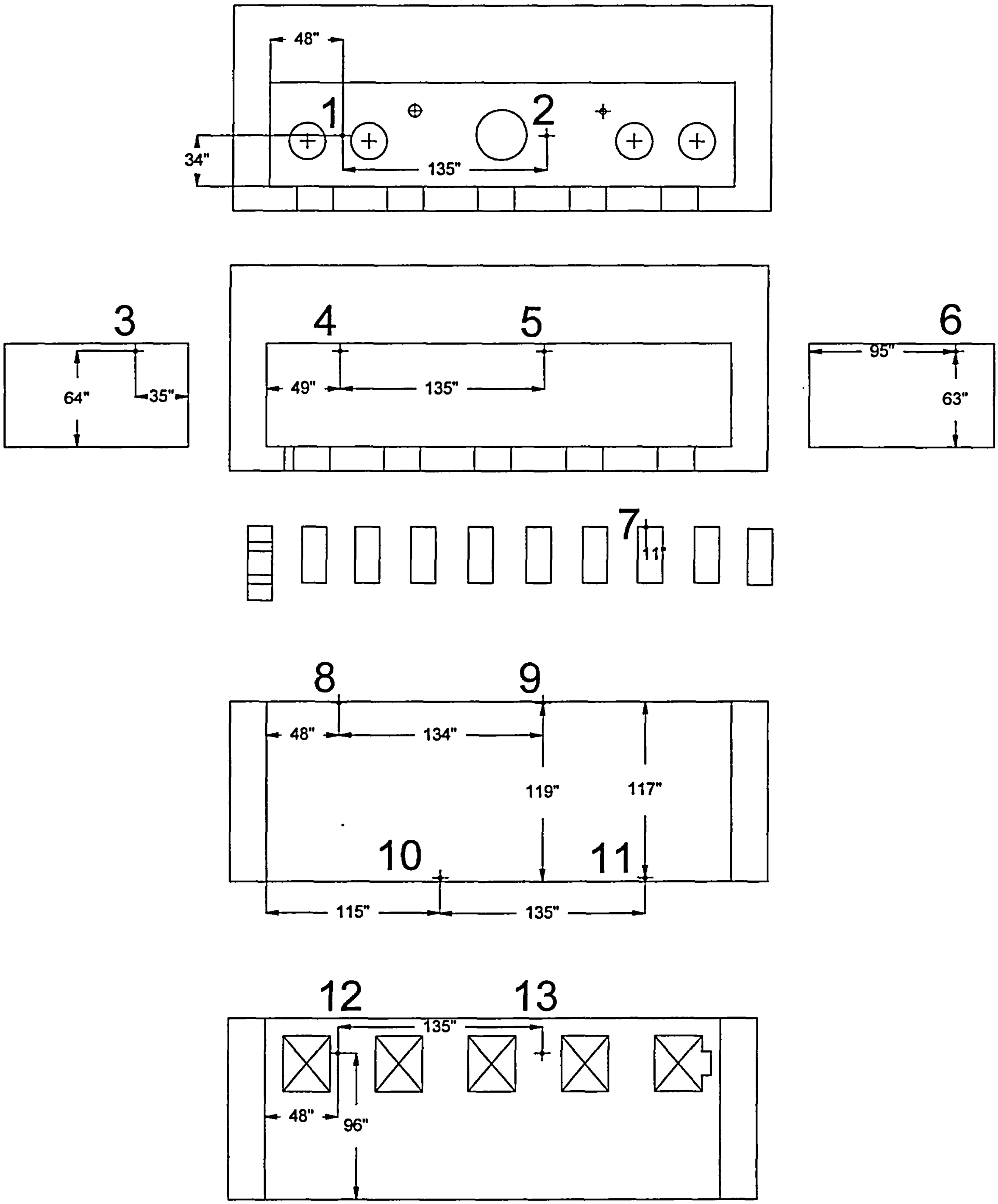


ATTACHMENT 1-4

Seal Chamber 2



Seal Chamber 3



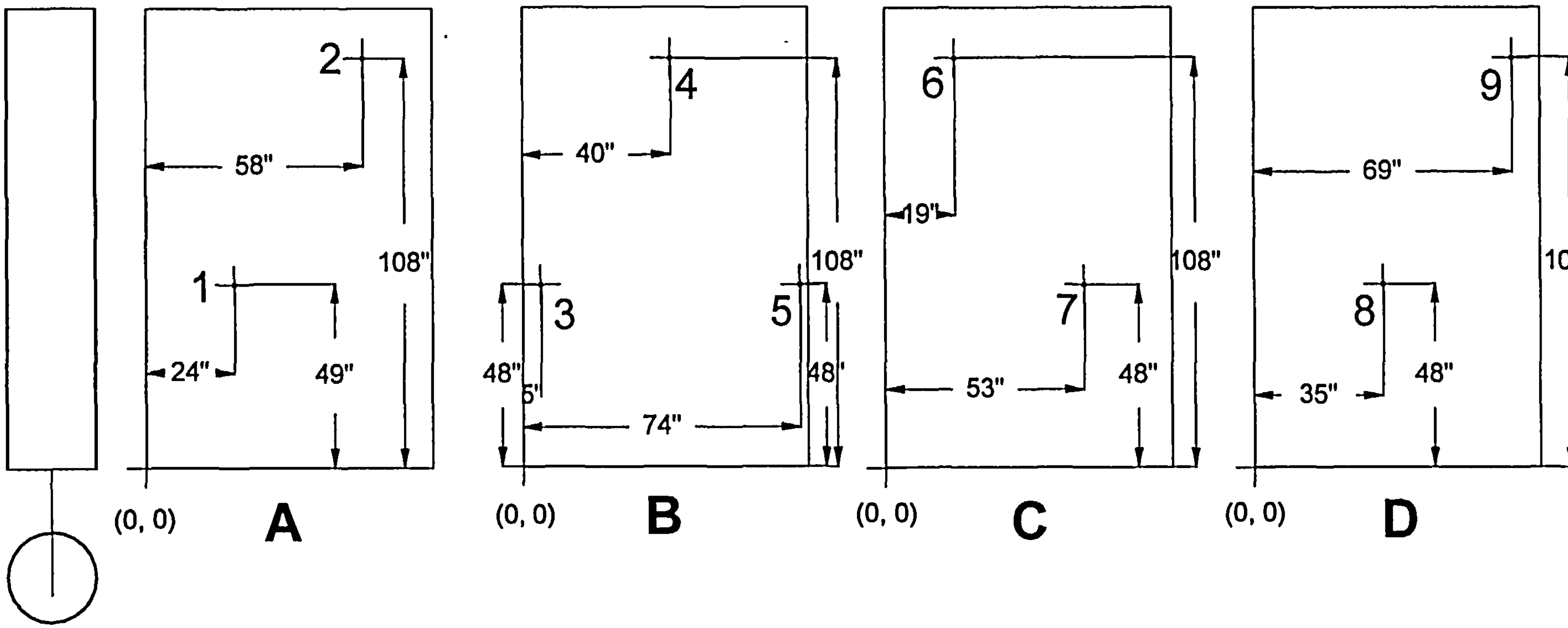
ATTACHMENT 1.6

DOWNCOMERS

Seal Chamber 3

Mark a Starting Point on Each Cylinder as (0, 0)

ATTACHMENT 1.7



ORIGINAL

GFPC Radiation Measurement Instrument Calibration Worksheet

Performed By:	R. J. Reheard	Date:	6/24/03
Instrument S/N:	95352	Probe S/N:	94818
Instrument Vendor Cal. Date:	12/20/03	Cal. Due Date:	12/20/03

Source No.	ISO 7503-1 Values "Es"	Reference Date	As in µCi (±6%)	2π β or α Emission Rate (sec-1) (±3%)	
Am-241 (GO 535) S-023	0.25	4/8/99 12:00 GMT	4.24E-01	7.43E+03	☐ Am-241
Cs-137 (GO 536) S-024	0.50	4/8/99 12:00 GMT	3.11E-01	6.89E+03	☑ Cs-137

	Source Radionuclide	Decay Date
	Cs-137	6/24/03
Decay Factor⇒	9.075E-01	

Elapsed Time (days)⇒	1538
Activity (µCi)⇒	2.821E-01
Source dpm⇒	6.262E+05
Source dpm/in Probe Area (cm^2)⇒	5.260E+05
2π Emission Rate (sec-1)⇒	6.253E+03
2π Emission Rate (min-1)⇒	3.752E+05
2π Emission Rate in Probe Area (min-1)⇒	3.151E+05

Probe Area (cm^2)
126

Record of 1 Minute Source & Background Counting Results

☑ Check if using ISO 7503-1 Value

No.	OW Source Gross CPM	OW Background CPM	OW Source Net CPM
1	1.61E+05	175	1.608E+05
2	1.61E+05	201	1.604E+05
3	1.60E+05	180	1.601E+05
4	1.60E+05	161	1.602E+05
5	1.61E+05	145	1.607E+05
6	1.60E+05	176	1.603E+05
7	1.60E+05	183	1.602E+05
8	1.61E+05	184	1.604E+05
9	1.60E+05	204	1.602E+05
10	1.61E+05	190	1.607E+05
	Mean⇒	179.9	1.604E+05

RESULTS
Counts/Emission (εi)
50.9%
2π Emission/Disintigration (εs)
50.0%
Counts/Disintigration (εt)
25.4%

Approved: JW Kim / [signature]

Date: 6/25/03

Calibration Calculation Sheet Verification Date⇒	December-02
B. Brosey/P. Donnachie⇒	December-02

ATTACHMENT 2.1

Duratek

CALIBRATION CERTIFICATE

Duratek Instrument Services
628 Gallaher Road
Kingston, TN 37763
Phone: (865) 376-8337
Fax: (865) 376-8331

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Duratek Instrument Services		Manufacturer: Ludlum
Address: 628 Gallaher Rd Kingston, TN 37763		Detector Model: 44-10
Contact Name: Thomas Scott		Serial Number: 206280
Customer Purchase Order Number: N/A	Work Order Number: 2003-01086	Evaluation Method: Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION			
1) Source Nuclide: Cs^{137}	Serial Number: 019455	Activity: 5μCi nominal	Certification Date: N/A (Used for Plateau Only)
2) Source Nuclide: Cs^{137}	Serial Number: 049711	Activity: Variable	Certification Date: 04/09/03

Scaler Information		Precision Test	mR/Hr (Source #2)
2350-1	#129440	Count 1	2.00
Due Date	04/30/04	Count 2	2.02
Threshold	T=100 (10mV)	Count 3	2.01
Cable Length	5ft.	Average	2.01
N/A	N/A	Tolerance ±10%	All counts within ±10% of Average
N/A	N/A	Pass/Fail	Pass
N/A	N/A		

Low Sample Activity (400uR/hr): Using Source #2 = 68,962	High Sample Activity (2mR/hr) Using Source #2 = 247,213	Dead Time (DT): 1.717419E-05	Calibration Constant (CC): 5.738530E+10

ATTACHMENTS			DETECTOR DATA: DOSE RATE PROBES (mR/Hr)			
Detector Setup Report	YES ✓	NO	Desired Exposure	Tolerance ±10%	As Found	As Left
Barcode Report	YES ✓	NO	0.400	0.360-0.440	N/A	.401
Voltage Plateau:	YES ✓	NO	1	0.90-1.10	N/A	.943
High Voltage:	950V		2	1.8-2.2	N/A	2.01

COMMENTS

Detectors set up with a 2350-1 may be used with any 2350-1 provided that the setup parameters are scanned into the 2350-1 prior to use with that specific detector
Calibrated with 5ft. Cable

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: [signature]	Reviewed By: [signature]	Date: 11-4-03
Certification Date: 10/31/03		Certification Due: 10/31/04

ATTACHMENT 3 - 1

LUDLUM MODEL 44-10 HIGH VOLTAGE PLATEAU DATA SHEET

Serial Number: 206280

HIGH VOLTAGE	SOURCE (6 second count)
772	8199
773	9919
774	11198
775	12865
776	14141
777	14548
778	14514
779	15155
780	14859
781	14096
782	13438

Detector plateau performed using Cs137 #019456 5uCi nominal value button source

Detector Parameters for Peaking

Parameter	Setting	Setting
Threshold (10mV/100)	642	612
Window (On)	40	100
High Voltage	779	779
CPM/mR/Hr	101,180	176,080
Background CPM	22	51

CPM/mR/Hr conversion performed using Cs137 #049711 Certification Date: 04/09/03

FWHM values performed with Cs137 #019455 (Threshold = 642 and Window = 40)

$FWHM = \frac{665 - 615}{662} \times 100\%$	7.55%

Detector peaked for Cs^{137} using Ludlum peaking procedure and threshold setting of 642 and window setting of 40. As left threshold setting is 612 and window at 100 as requested by John Duskin. 2350-1 #129440 calibration due 04/30/04 used for peaking 44-10 detector.

Performed By: [signature] **Date:** 10/31/03

Reviewed By: [signature] **Date:** 11-4-03

ATTACHMENT 3 - 2

FirstEnergy

SNEC FACILITY GAMMA-RAY SPECTROMETRY DATA SHEET

SURVEY REQUEST No.____________________ DATE ________: TIME________

AREA IDENTIFICATION OR DESCRIPTION:

Photos Taken? ☐ YES ☐ NO	Photo ID No. ⇒		Time Photos Taken ⇒	

Sketch of Measurement Location(s)	No.	ID/File No.	662 keV ROI		1332 keV ROI	
			Net CTS	Peak Visible?	Net CTS	Peak Visible?
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					

Repeat Count Numbers:	*Comments:*

Measurement Performed By (Print/Sign): Date:

Reviewed By (Print/Sign): Date:

Effective DCGL Calculator for Cs-137 (dpm/100 cm^2)

Gross Activity DCGLw		Gross Activity Administrative Limit	
8543	dpm/100 cm^2	6407	dpm/100 cm^2

25.0 mrem/y TEDE Limit

SAMPLE NO(s)⇒ Discharge Tunnel Surface Area

Cs-137 Limit		Cs-137 Administrative Limit	
8233	dpm/100 cm^2	6174	dpm/100 cm^2

SNEC AL	75%

	Isotope	Sample Input (pCi/g, uCi, etc.)	% of Total	Individual Limits (dpm/100 cm^2)	Allowed dpm/100 cm^2	mrem/y TEDE	Beta dpm/100 cm^2	Alpha dpm/100 cm^2	
1	Am-241	3.10E+00	0.129%	27	11.00	10.19	N/A	11.00	Am-241
2	C-14		0.000%	3,700,000	0.00	0.00	0.00	N/A	C-14
3	Co-60	9.54E+00	0.396%	7,100	33.85	0.12	33.85	N/A	Co-60
4	Cs-137	2.32E+03	96.364%	28,000	8232.58	7.35	8232.6	N/A	Cs-137
5	Eu-152		0.000%	13,000	0.00	0.00	0.00	N/A	Eu-152
6	H-3		0.000%	120,000,000	0.00	0.00	Not Detectable	N/A	H-3
7	Ni-63	6.34E+01	2.633%	1,800,000	224.98	0.00	Not Detectable	N/A	Ni-63
8	Pu-238	9.19E-01	0.038%	30	3.26	2.72	N/A	3.26	Pu-238
9	Pu-239	1.43E+00	0.059%	28	5.07	4.53	N/A	5.07	Pu-239
10	Pu-241		0.000%	880	0.00	0.00	Not Detectable	N/A	Pu-241
11	Sr-90	9.15E+00	0.380%	8,700	32.47	0.09	32.47	N/A	Sr-90
			100.000%		8543	25.0	8299	19	
					Maximum Permissible dpm/100 cm^2				

24 of 64

ATTACHMENT 5-1

Effective DCGL Calculator for Cs-137 (in pCi/g)

SNEC AL	75%

Total Activity Limit DCGLw		Administrative Limit	
6.62	pCi/g	4.97	pCi/g

SAMPLE NUMBER(s)⇒ Discharge Tunnel Volumetric

Cs-137 Limit		Cs-137 Administrative Limit	
6.38	pCi/g	4.78	pCi/g

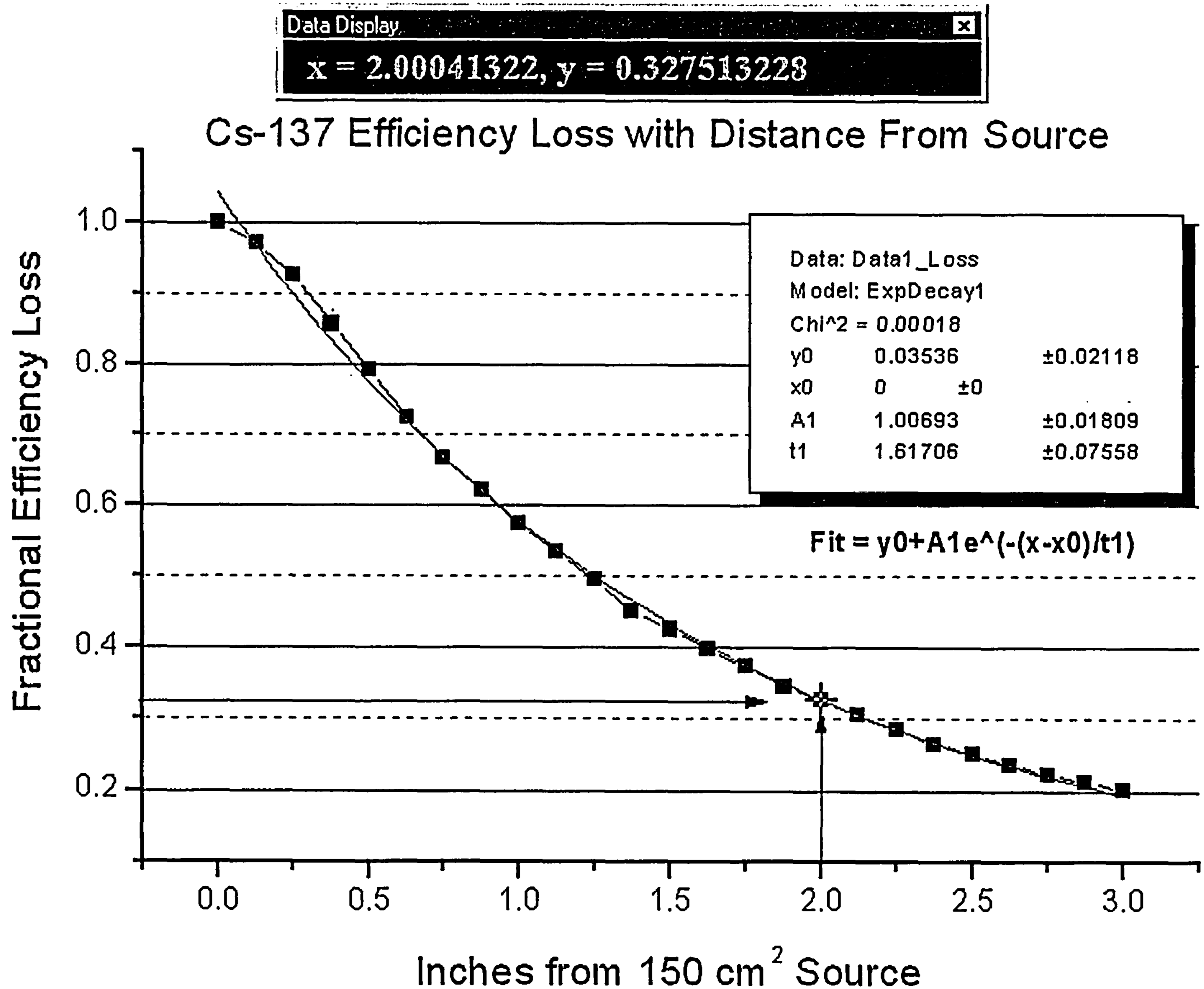
36366.82%	25.0	mrem/y TEDE Limit
2844.37%	4.0	mrem/y Drinking Water (DW) Limit

☑ Check for 25 mrem/y

	Isotope	Sample Input (pCi/g, uCi, etc.)	% of Total	25 mrem/y TEDE Limits (pCi/g)	4 mrem/y DW Limits (pCi/g)	A - Allowed pCi/g for 25 mrem/y TEDE	B - Allowed pCi/g for 4 mrem/y DW	Value Checked from Column A or B	This Sample mrem/y TEDE	This Sample mrem/y DW	
1	Am-241	3.100	0.129%	9.9	2.3	0.01	0.11	0.01	7.83	5.39	Am-241
2	C-14		0.000%	2.0	5.4	0.00	0.00	0.00	0.00	0.00	C-14
3	Co-60	9.540	0.396%	3.5	67.0	0.03	0.34	0.03	68.14	0.57	Co-60
4	Cs-137	2320.00	96.364%	6.6	397	6.38	81.56	6.38	8787.88	23.38	Cs-137
5	Eu-152		0.000%	10.1	1440	0.00	0.00	0.00	0.00	0.00	Eu-152
6	H-3		0.000%	132	31.1	0.00	0.00	0.00	0.00	0.00	H-3
7	Ni-63	63.40	2.633%	747	19000	0.17	2.23	0.17	2.12	0.01	Ni-63
8	Pu-238	0.919	0.038%	1.8	0.41	0.00	0.03	0.00	12.76	8.97	Pu-238
9	Pu-239	1.430	0.059%	1.6	0.37	0.00	0.05	0.00	22.34	15.46	Pu-239
10	Pu-241		0.000%	86	19.8	0.00	0.00	0.00	0.00	0.00	Pu-241
11	Sr-90	9.150	0.380%	1.2	0.61	0.03	0.32	0.03	190.63	60.00	Sr-90
		2.41E+03	100.000%			6.62	84.64	6.62	9091.704	113.775	
						Maximum Permissible pCi/g (25 mrem/y)	Maximum Permissible pCi/g (4 mrem/y)		To Use This Information, Sample Input Units Must Be In pCi/g		

ATTACHMENT 5.2

1



ATTACHMENT 6-1

NaI Scan MDC Calculation - 1" Thick Slab

$b := 100$ $\quad p := 0.5$ $\quad HS_d := 30.48$ $\quad SR := 5$ $\quad d := 1.38$

$Conv := 176.080$ $\quad MS_{output} := 7.888 \cdot 10^{-5}$ $\quad O_i := \frac{HS_d}{SR}$

$O_i = 6.096$ *Observation Interval (seconds)*

$$b_i := \frac{(b \cdot O_i)}{60}$$

$$MDCR_i := \left(d \cdot \sqrt{b_i}\right) \cdot \frac{60}{O_i}$$

$MDCR_i = 43.294$ *net counts per minute*

$$MDCR_{surveyor} := \frac{MDCR_i}{\sqrt{p}}$$

$MDCR_{surveyor} = 61.228$ *net counts per minute*

$$MDER := \frac{MDCR_{surveyor}}{Conv}$$

$MDER = 0.348$ μR/h

$$MDC_{scan} := \frac{MDER}{MS_{output} \cdot 1 \cdot 10^3}$$

$MDC_{scan} = 4.408$ pCi/g

ATTACHMENT 7.1

where:

b = background in counts per minute

b_i = background counts in observation interval

Conv = NaI manufacturers reported response to energy of contaminant (cpm/uR/h)

d = index of sensitivity (Table 6.5 MARSSIM), 1.38 = 95% of correct detection's, 60% false positives

HS_d = hot spot diameter (in centimeters)

MDC_{scan} = Minimum Detectable Concentration for scanning (pCi/g)

$MDCR_i$ = Minimum Detectable Count Rate (ncpm)

$MDCR_{surveyor}$ = $MDCR_i$ corrected by human performance factor (ncpm)

MDER = Minimum Detectable Exposure Rate (uR/h)

MS_{output} = MicroShield output exposure rate for 1 pCi/g of contaminant (mR/h)

O_i = obervation Interval (seconds)

p = human performance factor

SR = scan rate in centimeters per second

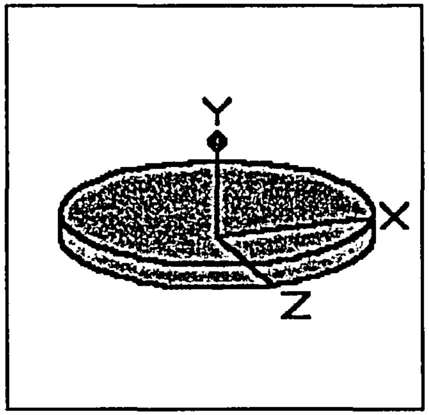
ATTACHMENT 7.2

MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page	: 1
DOS File	: SLAB3.MS5
Run Date	: November 12, 2003
Run Time	: 1:43:03 PM
Duration	: 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 12" Cylinder
Description: Cs-137 @ 1 pCi/g in 1" Thick Slab
Geometry: 8 - Cylinder Volume - End Shields



ATTACHMENT 7.3

Source Dimensions

Height	2.54 cm	1.0 in
Radius	15.24 cm	6.0 in

Dose Points

A	X	Y	Z
#1	0 cm 0.0 in	10.16 cm 4.0 in	0 cm 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	113.097 in³	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	4.1201e-009	1.5245e+002	2.2231e-006	8.2255e-002
Cs-137	4.3553e-009	1.6115e+002	2.3500e-006	8.6950e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	40
Circumferential	40
Y Direction (axial)	40

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.156e+00	6.355e-06	7.682e-06	5.293e-08	6.399e-08
0.0322	5.823e+00	1.222e-05	1.486e-05	9.832e-08	1.196e-07
0.0364	2.119e+00	6.726e-06	8.749e-06	3.821e-08	4.971e-08
0.6616	1.372e+02	3.202e-02	4.057e-02	6.207e-05	7.865e-05
TOTALS:	1.483e+02	3.204e-02	4.060e-02	6.226e-05	7.888e-05

NaI Scan MDC Calculation - 3" Thick Slab, Partial Density

$b := 100$ $p := 0.5$ $HS_d := 30.48$ $SR := 5$ $d := 1.38$

$Conv := 176.080$ $MS_{output} := 1.179 \cdot 10^{-4}$ $O_i := \frac{HS_d}{SR}$

$O_i = 6.096$ *Observation Interval (seconds)*

$$b_i := \frac{(b \cdot O_i)}{60}$$

$$MDCR_i := \left(d \cdot \sqrt{b_i}\right) \cdot \frac{60}{O_i}$$

$MDCR_i = 43.294$ *net counts per minute*

$$MDCR_{surveyor} := \frac{MDCR_i}{\sqrt{p}}$$

$MDCR_{surveyor} = 61.228$ *net counts per minute*

$$MDER := \frac{MDCR_{surveyor}}{Conv}$$

$MDER = 0.348$ μR/h

$$MDC_{scan} := \frac{MDER}{MS_{output} \cdot 1 \cdot 10^3}$$

$MDC_{scan} = 2.949$ pCi/g

ATTACHMENT 6.1

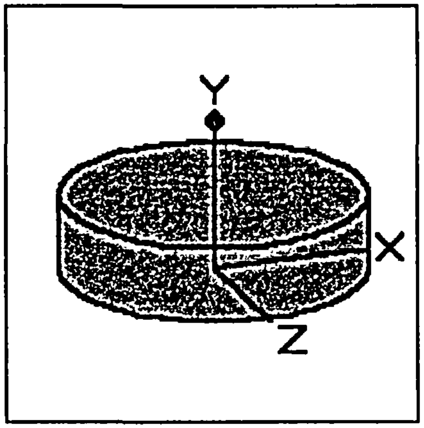
MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page	: 1
DOS File	: SLAB4.MS5
Run Date	: November 12, 2003
Run Time	: 1:51:28 PM
Duration	: 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

ATTACHMENT 8-2

Case Title: 12" Cylinder
Description: Cs-137 @ 1 pCi/g in 3" Thick Slab - Partial Density
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	7.62 cm	3.0 in
Radius	15.24 cm	6.0 in

Dose Points

A	X	Y	Z
# 1	0 cm	15.24 cm	0 cm
	0.0 in	6.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	339.292 in³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	8.4156e-009	3.1138e+002	1.5136e-006	5.6003e-002
Cs-137	8.8960e-009	3.2915e+002	1.6000e-006	5.9200e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	40
Circumferential	40
Y Direction (axial)	40

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	6.446e+00	6.306e-06	7.619e-06	5.253e-08	6.346e-08
0.0322	1.189e+01	1.212e-05	1.473e-05	9.756e-08	1.186e-07
0.0364	4.328e+00	6.676e-06	8.687e-06	3.793e-08	4.936e-08
0.6616	2.802e+02	4.228e-02	6.072e-02	8.197e-05	1.177e-04

Sodium Iodide Scan MDC Over a Plane Source

A scan MDC for a NaI detector is subject to the following input data:

1) The rate of movement of the detector over the surface

2) The height of the detector over the surface

3) The size of the NaI detector being used

4) The density of any surface contaminant that covers the source term

5) The radionuclide being measured

6) The background level in the area including that from the type of materials being surveyed

7) The surveyors efficiency (usually taken to be 50%)

8) The discriminator level setting of the count rate instrument

9) The plausible radionuclide mix for the area and its detectable gamma emission rate per unit area representing a valid surface model.

Since it is necessary to know these parameters before calculating the MDC scan, the following information/assumptions will be used to identify initial MDC scan results for a 2" by 2" NaI detector under select site conditions.

Basic Instrument Assumptions

1) Scanning is performed using a 2" by 2" NaI detector operated with in a window set around the Cs-137 peak area (~100 keV width).

2) The background count rate is primarily due to naturally occurring radionuclides found in site structural materials plus ambient cosmic interactions.

3) Scanning speed is initially assumed to be 0.05 meters/second at a distance of 2" above the surface from the face of the detector. For a 2" by 2" NaI detector this is the same as being 3" from the center of the detector volume.

4) The initial observation interval is 6.1 seconds.

5) Level of performance for first stage scanning is 95% for the true positive rate, and 60% for the false positive rate which yields a d' value of 1.38. Second stage scanning is reviewed on page 2 of this Attachment.

Basic Modeling Assumptions

1) Corrosion materials on steel surfaces have a density the same as iron oxide (5.1 g/cc) with a nominal thickness of 2 mm.
2) The areal hot spot size is assumed to be ~0.073 m^2.
3) The modeling diameter is 0.3048 meters (12" diameter circle).
4) The distance of the detector above the surface is assumed to be ~5 centimeters.
5) A surface is uniformly contaminated within the modeled area.

Scan Rate Determination

Signal Detection Theory. Personnel conducting radiological surveys for residual contamination must interpret the audible output of a portable survey instrument to determine when the signal (or "clicks") exceed the background level by a margin sufficient to conclude that contamination is present. It is difficult to detect low levels of contamination because both the signal and the background vary widely. Signal detection theory provides a framework for the task of deciding whether the audible output of the survey meter during scanning is due to background or signal plus background levels. An index of sensitivity *(d')* that represents the distance between the means of the background and background plus signal in units of their common standard deviation, can be calculated for various decision errors (correct detection and false positive rate).

As an example, for a correct detection rate of 95% (complement of a false negative rate of 5%) and a false positive rate of 5%, *d'* is 3.29 (similar to the static MDC for the same decision error rates). The index of sensitivity is independent of human factors, and therefore, the ability of an ideal observer (theoretical construct), may be used to determine the minimum *d'* that can be achieved for particular decision errors. The ideal observer makes optimal use of the available information to maximize the percent correct responses, providing an effective upper bound against which to compare actual surveyors. Table 6.5 lists selected values of *d'*.

Two Stages of Scanning. The framework for determining the scan MDC is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication, rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. In the first component, characterized by continuous movement of the probe, the surveyor has only a brief look at potential sources, determined by the scan speed. The surveyor's willingness to decide that a signal is present at this stage is likely to be liberal, in that the surveyor should respond positively on scant evidence, since the only cost of a false positive is a little time. The second component occurs only after a positive response was made at the first stage. This response is marked by the surveyor interrupting his scanning and holding the probe stationary for a period of time, while comparing the instrument output signal during that time to the background counting rate. Owing to the longer observation interval, sensitivity is relatively high. For this decision, the criterion should be more strict, since the cost of a yes decision is to spend considerably more time taking a static measurement.

Table 6.5 Values of d' for Selected True Positive and False Positive Proportions

False Positive	True Positive Proportion							
Proportion	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0.05	1.90	2.02	2.16	2.32	2.48	2.68	2.92	3.28
0.10	1.54	1.66	1.80	1.96	2.12	2.32	2.56	2.92
0.15	1.30	1.42	1.56	1.72	1.88	2.08	2.32	2.68
0.20	1.10	1.22	1.36	1.52	1.68	1.88	2.12	2.48
0.25	0.93	1.06	1.20	1.35	1.52	1.72	1.96	2.32
0.30	0.78	0.91	1.05	1.20	1.36	1.56	1.80	2.16
0.35	0.64	0.77	0.91	1.06	1.22	1.42	1.66	2.02
0.40	0.51	0.64	0.78	0.93	1.10	1.30	1.54	1.90
0.45	0.38	0.52	0.66	0.80	0.97	1.17	1.41	1.77
0.50	0.26	0.38	0.52	0.68	0.84	1.04	1.28	1.64
0.55	0.12	0.26	0.40	0.54	0.71	0.91	1.15	1.51
0.60	0.00	0.13	0.27	0.42	0.58	0.82	1.02	1.38

Since scanning can be divided into two stages, it is necessary to consider the survey's scan sensitivity for each of these stages. Typically, the minimum detectable count rate (MDCR) associated with the first scanning stage will be greater due to the brief observation intervals of continuous monitoring-provided that the length of the pause during the second stage is significantly longer. Typically, observation intervals during the first stage are on the order of 1 or 2 seconds, while the second stage pause may be several seconds long. The greater value of MDCR from each of the scan stages is used to determine the scan sensitivity for the surveyor.

Determination of MDCR and Use of Surveyor Efficiency. The minimum detectable number of net source counts in the interval is given by s . Therefore, for an ideal observer, the number of i source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in d') as shown in Equation 6-8 (MARSSIM):

Prior to performing field measurements, an investigator must evaluate the detection sensitivity of the equipment proposed for use to ensure that levels below the DCGL can be detected (see Section 4.3). After a direct measurement has been made, it is then necessary to determine whether or not the result can be distinguished from the instrument background response of the measurement system. The terms that are used in this manual to define detection sensitivity for fixed point counts and sample analyses are:

Critical level (L_C)

Detection limit (L_D)

Minimum detectable concentration (MDC)

The critical level (L_C) is the level, in counts, at which there is a statistical probability (with a C predetermined level of confidence) of incorrectly identifying a measurement system background value as being greater than background. *Any response above this level is considered to be greater than background.*

The detection limit (L_D) is an a priori estimate of the detection capability of a D measurement system, and is also reported in units of counts. The minimum detectable concentration (MDC) is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as Bq/kg. The following discussion provides an overview of the derivation contained in the well known publication by Currie (Currie 1968) followed by a description of how the resulting formulae should be used. Publications by Currie (Currie 1968, NRC 1984) and Altshuler and Pasternack (Altshuler and Pasternak 1963) provide details of the derivations involved.

The two parameters of interest for a detector system with a background response greater than zero are:

L_C - the net response level, in counts, at which the detector output can be considered "above background"
L_D - the net response level, in counts, that can be expected to be seen with a detector with a fixed level of certainty

Assuming that a system has a background response and that random uncertainties and systematic uncertainties are accounted for separately, these parameters can be calculated using Poisson statistics. For these calculations, two types of decision errors should be considered. A Type I error (or "false positive") occurs when a detector response is considered to be above background when, in fact, only background radiation is present. A Type II error (or "false negative") occurs when a detector response is considered to be background when in fact radiation is present at levels above background. The probability of a Type I error is referred to as a (alpha) and is associated with L_C; the probability of a Type II error is referred to as ß (beta) and is associated L_D. *Figure 6.2 (MARSSIM) graphically illustrates the relationship of these terms with respect to each other and* to a normal background distribution.

NaI Scan MDC Calculation - Surface Deposition

$b := 100$ $p := 0.5$ $HS_d := 30.48$ $SR := 5$ $d := 1.38$

$Conv := 176.080$ $MS_{output} := 1.546 \cdot 10^{-5}$ $O_i := \frac{HS_d}{SR}$

$O_i = 6.096$ *Observation Interval (seconds)*

$$b_i := \frac{(b \cdot O_i)}{60}$$

$$MDCR_i := \left(d \cdot \sqrt{b_i}\right) \cdot \frac{60}{O_i}$$

$MDCR_i = 43.294$ *net counts per minute*

$$MDCR_{surveyor} := \frac{MDCR_i}{\sqrt{p}}$$

$MDCR_{surveyor} = 61.228$ *net counts per minute*

$$MDER := \frac{MDCR_{surveyor}}{Conv}$$

$MDER = 0.348$ μR/h

$$MDC_{scan} := \frac{MDER}{MS_{output} \cdot 1 \cdot 10^3}$$

$MDC_{scan} = 22.492$ pCi/cm²

$MDC_{scan} \cdot 222 = 4993$ *dpm/100 cm²*

where:

b = background in counts per minute

b_i = background counts in observation interval

Conv = NaI manufacturers or calibration information reported response to energy of contaminant (cpm/uR/h)

d = index of sensitivity (Table 6.5 MARSSIM), 1.38 = 95% of correct detection's, 60% false positives

HS_d = hot spot diameter (in centimeters)

MDC_{scan} = Minimum Detectable Concentration for scanning (pCi/cm^2)

$MDCR_i$ = Minimum Detectable Count Rate (ncpm)

$MDCR_{surveyor}$ = $MDCR_i$ corrected by human performance factor (ncpm)

MDER = Minimum Detectable Exposure Rate (uR/h)

MS_{output} = MicroShield output exposure rate for 1 pCi/cm^2 of contaminant (mR/h)

O_i = obervation Interval (seconds)

p = human performance factor

SR = scan rate in centimeters per second

MicroShield v5.05 (5.05-00121)
GPU Nuclear

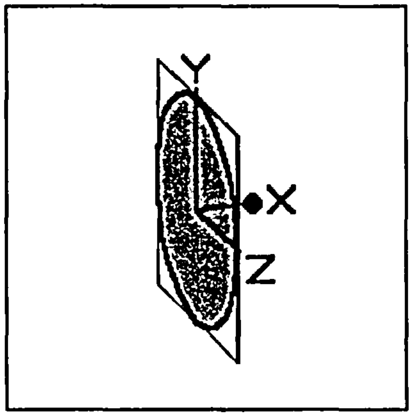
Page	: 1
DOS File	: DISK.MS5
Run Date	: November 12, 2003
Run Time	: 2:29:58 PM
Duration	: 00:00:00

File Ref: ______
Date: ______
By: ______
Checked: ______

ATTACHMENT 9.6

37 of 64

Case Title: Disk
Description: Cs-137 Surface Source with Fe_2O_3 @ 0.2 cm
Geometry: 3 - Disk



Source Dimensions

Radius	15.24 cm	6.0 in

Dose Points

A	X	Y	Z
# 1	7.82 cm	0 cm	0 cm
	3.1 in	0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Shield 1	.2 cm	Iron Oxide	5.1
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Ba-137m	6.9026e-010	2.5540e+001	9.4600e-007	3.5002e-002
Cs-137	7.2966e-010	2.6997e+001	1.0000e-006	3.7000e-002

Buildup
The material reference is : Shield 1

Integration Parameters

Radial	40
Circumferential	40

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	5.287e-01	1.526e-08	1.733e-08	1.271e-10	1.443e-10
0.0322	9.755e-01	3.442e-08	3.921e-08	2.770e-10	3.155e-10
0.0364	3.550e-01	7.533e-08	8.847e-08	4.280e-10	5.026e-10
0.6616	2.298e+01	7.279e-03	7.973e-03	1.411e-05	1.546e-05
TOTALS:	2.484e+01	7.279e-03	7.973e-03	1.411e-05	1.546e-05

NaI Static Measurement MDC Calculation [redacted]

Use when Background Count Time ≠ Sample Count Time

$B := 100$ $T_{SB} := 5$ $T_B := 5$ $MSO := 7.888 \cdot 10^{-5}$ $CF := 176080$

$Ci := 4.3553 \cdot 10^{-9}$

$K := CF \cdot \frac{MSO}{\left(Ci \cdot 2.22 \cdot 10^{12}\right)}$ $K = 1.437 \cdot 10^{-3}$ $Mass := 4355.3$

$R_B := \frac{B}{T_B}$ *Background counting rate*

$L_C := 2.33 \cdot \sqrt{B}$ *Calculation of critical level (page 6-34 of MARSSIM)*

$L_C = 23.3$ *Critical level*

$L_C + B = 123.3$ *Any count above this value should be regarded at being greater than background (page 6-37 of MARSSIM).*

$L_D := 3 + 4.65 \cdot \sqrt{B}$

$L_D = 49.5$ *Detection limit*

$$MDC := \frac{\left[3 + 3.29 \cdot \sqrt{R_B \cdot T_{SB} \cdot \left(1 + \frac{T_{SB}}{T_B}\right)}\right]}{K \cdot T_{SB}}$$

$\frac{MDC}{2.22} = 3.106 \cdot 10^{3}$ **Results in pCi** $\frac{\left(\frac{MDC}{2.22}\right)}{Mass} = 0.713$ $\frac{pCi}{g}$

ATTACHMENT 9 - 7

where:

B = background count in time T_B (counts)
CF = conversion factor for instrument calibration (cpm/mR/h)
Ci = number of curies in MicroShield model
K = instrument efficiency and other correction factors used to convert to appropriate units
L_C = critical level (in counts)
L_D = detection limit (in counts)
Mass = mass of model in grams
MDC = Minimum Detectable Concentration (pCi/g)
MSO = MicroShield output in mR/h
R_B = background count rate (cpm)
T_{SB} = sample count time (in minutes)
T_B = background count time (in minutes)

SEAL CHAMBER No. 1

JG1135	Instrument 126218	95080	SS8-1							FSS-407	BHB
No.	Location	Date	Time	Detector	Counts	Count Time (sec)	Mode	Designator		Shielded	Unshielded
2	SS8-1 FP1S	11/3/2003	9:57	1	1.49E+02	60	SCL	Shielded	β	1.49E+02	
3	SS8-1 FP1U	11/3/2003	9:58	1	1.76E+02	60	SCL	Unshielded	β		1.76E+02
4	SS8-1 FP2S	11/3/2003	10:00	1	1.87E+02	60	SCL	Shielded	β	1.87E+02	
5	SS8-1 FP2U	11/3/2003	10:01	1	1.84E+02	60	SCL	Unshielded	β		1.84E+02
6	SS8-1 FP3S	11/3/2003	10:02	1	1.63E+02	60	SCL	Shielded	β	1.63E+02	
7	SS8-1 FP3U	11/3/2003	10:04	1	1.77E+02	60	SCL	Unshielded	β		1.77E+02
8	SS8-1 FP4S	11/3/2003	10:05	1	1.05E+02	60	SCL	Shielded	β	1.05E+02	
9	SS8-1 FP4U	11/3/2003	10:06	1	1.66E+02	60	SCL	Unshielded	β		1.66E+02
10	SS8-1 FP5S	11/3/2003	10:07	1	1.18E+02	60	SCL	Shielded	β	1.18E+02	
11	SS8-1 FP5U	11/3/2003	10:08	1	1.86E+02	60	SCL	Unshielded	β		1.86E+02
12	SS8-1 FP6S	11/3/2003	10:10	1	1.21E+02	60	SCL	Shielded	β	1.21E+02	
13	SS8-1 FP6U	11/3/2003	10:11	1	2.59E+02	60	SCL	Unshielded	β		2.59E+02
14	SS8-1 FP7S	11/3/2003	10:12	1	1.08E+02	60	SCL	Shielded	β	1.08E+02	
15	SS8-1 FP7U	11/3/2003	10:13	1	1.89E+02	60	SCL	Unshielded	β		1.89E+02
16	SS8-1 FP8S	11/3/2003	10:14	1	1.35E+02	60	SCL	Shielded	β	1.35E+02	
17	SS8-1 FP8U	11/3/2003	10:15	1	1.90E+02	60	SCL	Unshielded	β		1.90E+02
18	SS8-1 FP9S	11/3/2003	10:23	1	1.38E+02	60	SCL	Shielded	β	1.38E+02	
19	SS8-1 FP9U	11/3/2003	10:24	1	1.55E+02	60	SCL	Unshielded	β		1.55E+02
20	SS8-1FP10S	11/3/2003	10:25	1	1.03E+02	60	SCL	Shielded	β	1.03E+02	
21	SS8-1FP10U	11/3/2003	10:26	1	2.05E+02	60	SCL	Unshielded	β		2.05E+02
22	SS8-1FP11S	11/3/2003	10:28	1	1.20E+02	60	SCL	Shielded	β	1.20E+02	
23	SS8-1FP11U	11/3/2003	10:29	1	1.67E+02	60	SCL	Unshielded	β		1.67E+02
24	SS8-1FP12S	11/3/2003	10:30	1	1.23E+02	60	SCL	Shielded	β	1.23E+02	
25	SS8-1FP12U	11/3/2003	10:31	1	1.91E+02	60	SCL	Unshielded	β		1.91E+02
26	SS8-1FP13S	11/3/2003	10:33	1	1.49E+02	60	SCL	Shielded	β	1.49E+02	
27	SS8-1FP13U	11/3/2003	10:34	1	1.77E+02	60	SCL	Unshielded	β		1.77E+02
28	SS8-1FP14S	11/3/2003	10:35	1	1.22E+02	60	SCL	Shielded	β	1.22E+02	
29	SS8-1FP14U	11/3/2003	10:36	1	1.54E+02	60	SCL	Unshielded	β		1.54E+02
30	SS8-1FP15S	11/3/2003	10:38	1	1.34E+02	60	SCL	Shielded	β	1.34E+02	
31	SS8-1FP15U	11/3/2003	10:39	1	1.65E+02	60	SCL	Unshielded	β		1.65E+02
32	SS8-1FP16S	11/3/2003	10:40	1	1.53E+02	60	SCL	Shielded	β	1.53E+02	
33	SS8-1FP16U	11/3/2003	10:41	1	2.37E+02	60	SCL	Unshielded	β		2.37E+02
34	SS8-1FP17S	11/3/2003	10:43	1	1.78E+02	60	SCL	Shielded	β	1.78E+02	
35	SS8-1FP17U	11/3/2003	10:44	1	1.74E+02	60	SCL	Unshielded	β		1.74E+02
36	SS8-1FP18S	11/3/2003	10:46	1	1.81E+02	60	SCL	Shielded	β	1.81E+02	
37	SS8-1FP18U	11/3/2003	10:47	1	2.19E+02	60	SCL	Unshielded	β		2.19E+02
								Minimum ⇒		**1.03E+02**	**1.54E+02**
								Maximum ⇒		**1.87E+02**	**2.59E+02**
								Mean ⇒		**1.38E+02**	**1.87E+02**
								Sigma ⇒		**2.62E+01**	**2.77E+01**

SEAL CHAMBER No. 2

BN8487	Instrument 126179	94819	SS8-2							FSS-409	BHB
No.	Location	Date	Time	Detector	Counts	Count Time (sec)	Mode	Designator		Shielded	Unshielded
4	SS8-2FP2S	11/3/2003	10:02	1	1.38E+02	60	SCL	Shielded	β	1.38E+02	
5	SS8-2FP2U	11/3/2003	10:03	1	2.09E+02	60	SCL	Unshielded	β		2.09E+02
6	SS8-2FP3S	11/3/2003	10:06	1	1.18E+02	60	SCL	Shielded	β	1.18E+02	
7	SS8-2FP3U	11/3/2003	10:07	1	2.27E+02	60	SCL	Unshielded	β		2.27E+02
8	SS8-2FP4S	11/3/2003	10:09	1	1.15E+02	60	SCL	Shielded	β	1.15E+02	
9	SS8-2FP4U	11/3/2003	10:10	1	3.06E+02	60	SCL	Unshielded	β		3.06E+02
10	SS8-2FP5S	11/3/2003	10:11	1	1.18E+02	60	SCL	Shielded	β	1.18E+02	
11	SS8-2FP5U	11/3/2003	10:13	1	2.53E+02	60	SCL	Unshielded	β		2.53E+02
12	SS8-2FP6S	11/3/2003	10:15	1	1.19E+02	60	SCL	Shielded	β	1.19E+02	
13	SS8-2FP6U	11/3/2003	10:16	1	2.24E+02	60	SCL	Unshielded	β		2.24E+02
14	SS8-2FP7S	11/3/2003	10:18	1	1.30E+02	60	SCL	Shielded	β	1.30E+02	
15	SS8-2FP7U	11/3/2003	10:19	1	3.97E+02	60	SCL	Unshielded	β		3.97E+02
16	SS8-2FP8S	11/3/2003	10:22	1	1.48E+02	60	SCL	Shielded	β	1.48E+02	
17	SS8-2FP8U	11/3/2003	10:23	1	3.12E+02	60	SCL	Unshielded	β		3.12E+02
18	SS8-2FP9S	11/3/2003	10:25	1	1.42E+02	60	SCL	Shielded	β	1.42E+02	
19	SS8-2FP9U	11/3/2003	10:26	1	2.70E+02	60	SCL	Unshielded	β		2.70E+02
20	SS8-2FP10S	11/3/2003	10:28	1	1.04E+02	60	SCL	Shielded	β	1.04E+02	
21	SS8-2FP10U	11/3/2003	10:29	1	1.32E+02	60	SCL	Unshielded	β		1.32E+02
22	SS8-2FP11S	11/3/2003	10:31	1	1.32E+02	60	SCL	Shielded	β	1.32E+02	
23	SS8-2FP11U	11/3/2003	10:33	1	2.91E+02	60	SCL	Unshielded	β		2.91E+02
24	SS8-2FP12S	11/3/2003	10:34	1	1.63E+02	60	SCL	Shielded	β	1.63E+02	
25	SS8-2FP12U	11/3/2003	10:36	1	1.90E+02	60	SCL	Unshielded	β		1.90E+02
26	SS8-2FP13S	11/3/2003	10:38	1	1.61E+02	60	SCL	Shielded	β	1.61E+02	
27	SS8-2FP13U	11/3/2003	10:39	1	1.98E+02	60	SCL	Unshielded	β		1.98E+02
28	SS8-2FP14S	11/3/2003	10:42	1	1.64E+02	60	SCL	Shielded	β	1.64E+02	
29	SS8-2FP14U	11/3/2003	10:43	1	1.87E+02	60	SCL	Unshielded	β		1.87E+02
30	SS8-2FP15S	11/3/2003	10:48	1	1.74E+02	60	SCL	Shielded	β	1.74E+02	
31	SS8-2FP15U	11/3/2003	10:50	1	3.20E+02	60	SCL	Unshielded	β		3.20E+02
32	SS8-2FP16S	11/3/2003	10:52	1	1.41E+02	60	SCL	Shielded	β	1.41E+02	
33	SS8-2FP16U	11/3/2003	10:53	1	1.71E+02	60	SCL	Unshielded	β		1.71E+02
34	SS8-2FP17S	11/3/2003	10:55	1	1.69E+02	60	SCL	Shielded	β	1.69E+02	
35	SS8-2FP17U	11/3/2003	10:56	1	2.16E+02	60	SCL	Unshielded	β		2.16E+02
								Minimum ⇒		1.04E+02	1.32E+02
								Maximum ⇒		1.74E+02	3.97E+02
								Mean ⇒		1.40E+02	2.44E+02
								Sigma ⇒		2.18E+01	6.81E+01

ATTACHMENT 10.2

SEAL CHAMBER No. 3

BB7173	Instrument 126188	SS8-3	SS8-3							FSS-395	BHB
No.	Location	Date	Time	Detector	Counts	Count Time (sec)	Mode	Designator		Shielded	Unshielded
2	SS8-3 FP1S	10/29/2003	8:38	1	1.53E+02	60	SCL	Shielded	β	1.53E+02	
3	SS8-3 FP1S	10/29/2003	8:40	1	2.47E+02	60	SCL	Unshielded	β		2.47E+02
4	SS8-3 FP2S	10/29/2003	8:42	1	1.67E+02	60	SCL	Shielded	β	1.67E+02	
5	SS8-3 FP2S	10/29/2003	8:43	1	2.43E+02	60	SCL	Unshielded	β		2.43E+02
6	SS8-3 FP3S	10/29/2003	8:46	1	1.98E+02	60	SCL	Shielded	β	1.98E+02	
7	SS8-3 FP3S	10/29/2003	8:47	1	2.36E+02	60	SCL	Unshielded	β		2.36E+02
8	SS8-3 FP4S	10/29/2003	8:49	1	1.73E+02	60	SCL	Shielded	β	1.73E+02	
9	SS8-3 FP4S	10/29/2003	8:50	1	2.28E+02	60	SCL	Unshielded	β		2.28E+02
10	SS8-3 FP5S	10/29/2003	8:51	1	1.96E+02	60	SCL	Shielded	β	1.96E+02	
11	SS8-3 FP5S	10/29/2003	8:52	1	2.53E+02	60	SCL	Unshielded	β		2.53E+02
12	SS8-3 FP6S	10/29/2003	8:55	1	2.15E+02	60	SCL	Shielded	β	2.15E+02	
13	SS8-3 FP6S	10/29/2003	8:56	1	2.95E+02	60	SCL	Unshielded	β		2.95E+02
14	SS8-3 FP7S	10/29/2003	8:58	1	1.87E+02	60	SCL	Shielded	β	1.87E+02	
15	SS8-3 FP7S	10/29/2003	8:59	1	2.20E+02	60	SCL	Unshielded	β		2.20E+02
16	SS8-3 FP8S	10/29/2003	9:01	1	1.71E+02	60	SCL	Shielded	β	1.71E+02	
17	SS8-3 FP8S	10/29/2003	9:02	1	2.41E+02	60	SCL	Unshielded	β		2.41E+02
18	SS8-3 FP9S	10/29/2003	9:04	1	1.82E+02	60	SCL	Shielded	β	1.82E+02	
19	SS8-3 FP9S	10/29/2003	9:05	1	2.55E+02	60	SCL	Unshielded	β		2.55E+02
20	SS8-3 FP10S	10/29/2003	9:48	1	1.71E+02	60	SCL	Shielded	β	1.71E+02	
21	SS8-3 FP10S	10/29/2003	9:49	1	2.23E+02	60	SCL	Unshielded	β		2.23E+02
22	SS8-3 FP11S	10/29/2003	9:51	1	2.04E+02	60	SCL	Shielded	β	2.04E+02	
23	SS8-3 FP11S	10/29/2003	9:52	1	2.65E+02	60	SCL	Unshielded	β		2.65E+02
24	SS8-3 FP12S	10/29/2003	9:53	1	1.84E+02	60	SCL	Shielded	β	1.84E+02	
25	SS8-3 FP12S	10/29/2003	9:55	1	2.13E+02	60	SCL	Unshielded	β		2.13E+02
26	SS8-3 FP13S	10/29/2003	9:56	1	2.07E+02	60	SCL	Shielded	β	2.07E+02	
27	SS8-3 FP13S	10/29/2003	9:58	1	2.56E+02	60	SCL	Unshielded	β		2.56E+02
28	SS8-3 FP14S	10/29/2003	9:59	1	2.11E+02	60	SCL	Shielded	β	2.11E+02	
29	SS8-3 FP14S	10/29/2003	10:00	1	2.56E+02	60	SCL	Unshielded	β		2.56E+02
30	SS8-3 FP15S	10/29/2003	10:02	1	2.24E+02	60	SCL	Shielded	β	2.24E+02	
31	SS8-3 FP15S	10/29/2003	10:03	1	2.78E+02	60	SCL	Unshielded	β		2.78E+02
32	SS8-3 FP16S	10/29/2003	10:04	1	1.58E+02	60	SCL	Shielded	β	1.58E+02	
33	SS8-3 FP16S	10/29/2003	10:06	1	1.64E+02	60	SCL	Unshielded	β		1.64E+02
34	SS8-3 FP17S	10/29/2003	10:08	1	1.47E+02	60	SCL	Shielded	β	1.47E+02	
35	SS8-3 FP17S	10/29/2003	10:10	1	1.53E+02	60	SCL	Unshielded	β		1.53E+02
36	SS8-3 FP18S	10/29/2003	10:13	1	1.61E+02	60	SCL	Shielded	β	1.61E+02	
37	SS8-3 FP18S	10/29/2003	10:14	1	1.70E+02	60	SCL	Unshielded	β		1.70E+02
38	SS8-3 FP19S	10/29/2003	10:16	1	1.44E+02	60	SCL	Shielded	β	1.44E+02	
39	SS8-3 FP19S	10/29/2003	10:17	1	1.46E+02	60	SCL	Unshielded	β		1.46E+02
40	SS8-3 FP20S	10/29/2003	10:21	1	2.30E+02	60	SCL	Shielded	β	2.30E+02	
41	SS8-3 FP20S	10/29/2003	10:22	1	2.68E+02	60	SCL	Unshielded	β		2.68E+02
42	SS8-3 FP21S	10/29/2003	10:25	1	2.14E+02	60	SCL	Shielded	β	2.14E+02	
43	SS8-3 FP21S	10/29/2003	10:27	1	2.95E+02	60	SCL	Unshielded	β		2.95E+02
44	SS8-3 FP22S	10/29/2003	10:30	1	2.35E+02	60	SCL	Shielded	β	2.35E+02	
45	SS8-3 FP22S	10/29/2003	10:31	1	2.87E+02	60	SCL	Unshielded	β		2.87E+02
46	SS8-3 FP23S	10/29/2003	10:34	1	1.92E+02	60	SCL	Shielded	β	1.92E+02	
47	SS8-3 FP23S	10/29/2003	10:35	1	2.20E+02	60	SCL	Unshielded	β		2.20E+02
48	SS8-3 FP24S	10/29/2003	10:37	1	2.24E+02	60	SCL	Shielded	β	2.24E+02	
49	SS8-3 FP24S	10/29/2003	10:39	1	3.04E+02	60	SCL	Unshielded	β		3.04E+02
								Minimum ⇒		1.44E+02	1.46E+02
								Maximum ⇒		2.35E+02	3.04E+02
								Mean ⇒		1.90E+02	2.38E+02
								Sigma ⇒		2.72E+01	4.43E+01

Williamsburg Steel Background Measurements SR-48

37122N21	Instrument 95348	RJR9291	Time	Detector	Counts	Count Time (sec)	Mode	Designator		FSS-004	BHB
0	BKGND	11/14/2002	6:47	1	6.54E+03	1800	SCL	Inital Background	β	Steel CF(cpm) ⇒	0
1	Source Check	11/14/2002	9:54	1	1.70E+05	60	SCL	Source	β	Shielded	Unshielded
2	STEELA1S	11/14/2002	10:32	1	2.13E+02	60	SCL	Shielded	β	2.13E+02	
3	STEELA1U	11/14/2002	10:33	1	2.04E+02	60	SCL	Unshielded	β		2.04E+02
4	STEELA2S	11/14/2002	10:37	1	2.03E+02	60	SCL	Shielded	β	2.03E+02	
5	STEELA2U	11/14/2002	10:38	1	2.25E+02	60	SCL	Unshielded	β		2.25E+02
6	STEELA3S	11/14/2002	10:39	1	1.85E+02	60	SCL	Shielded	β	1.85E+02	
7	STEELA3U	11/14/2002	10:40	1	2.09E+02	60	SCL	Unshielded	β		2.09E+02
8	STEELA4S	11/14/2002	10:42	1	2.03E+02	60	SCL	Shielded	β	2.03E+02	
9	STEELA4U	11/14/2002	10:43	1	1.67E+02	60	SCL	Unshielded	β		1.67E+02
10	STEELA5S	11/14/2002	10:44	1	1.55E+02	60	SCL	Shielded	β	1.55E+02	
11	STEELA5U	11/14/2002	10:45	1	2.26E+02	60	SCL	Unshielded	β		2.26E+02
12	STEELA6S	11/14/2002	10:46	1	1.92E+02	60	SCL	Shielded	β	1.92E+02	
13	STEELA6U	11/14/2002	10:47	1	1.95E+02	60	SCL	Unshielded	β		1.95E+02
14	STEELA7S	11/14/2002	10:48	1	1.96E+02	60	SCL	Shielded	β	1.96E+02	
15	STEELA7U	11/14/2002	10:50	1	2.01E+02	60	SCL	Unshielded	β		2.01E+02
16	STEELA8S	11/14/2002	10:51	1	2.15E+02	60	SCL	Shielded	β	2.15E+02	
17	STEELA8U	11/14/2002	10:52	1	2.38E+02	60	SCL	Unshielded	β		2.38E+02
18	STEELA9S	11/14/2002	10:53	1	2.00E+02	60	SCL	Shielded	β	2.00E+02	
19	STEELA9U	11/14/2002	10:54	1	1.92E+02	60	SCL	Unshielded	β		1.92E+02
20	STEELA10S	11/14/2002	10:56	1	1.83E+02	60	SCL	Shielded	β	1.83E+02	
21	STEELA10U	11/14/2002	10:57	1	2.25E+02	60	SCL	Unshielded	β		2.25E+02
22	STEELA11S	11/14/2002	10:58	1	1.95E+02	60	SCL	Shielded	β	1.95E+02	
23	STEELA11U	11/14/2002	10:59	1	2.15E+02	60	SCL	Unshielded	β		2.15E+02
24	STEELA12S	11/14/2002	11:00	1	1.77E+02	60	SCL	Shielded	β	1.77E+02	
25	STEELA12U	11/14/2002	11:01	1	2.34E+02	60	SCL	Unshielded	β		2.34E+02
26	STEELA13S	11/14/2002	11:03	1	2.02E+02	60	SCL	Shielded	β	2.02E+02	
27	STEELA13U	11/14/2002	11:05	1	2.18E+02	60	SCL	Unshielded	β		2.18E+02
28	STEELA14S	11/14/2002	11:06	1	1.89E+02	60	SCL	Shielded	β	1.89E+02	
29	STEELA14U	11/14/2002	11:07	1	1.99E+02	60	SCL	Unshielded	β		1.99E+02
30	STEELA15S	11/14/2002	11:08	1	2.16E+02	60	SCL	Shielded	β	2.16E+02	
31	STEELA15U	11/14/2002	11:09	1	2.15E+02	60	SCL	Unshielded	β		2.15E+02
32	STEELA16S	11/14/2002	11:10	1	1.88E+02	60	SCL	Shielded	β	1.88E+02	
33	STEELA16U	11/14/2002	11:11	1	2.05E+02	60	SCL	Unshielded	β		2.05E+02
34	STEELA17S	11/14/2002	11:13	1	2.12E+02	60	SCL	Shielded	β	2.12E+02	
35	STEELA17U	11/14/2002	11:14	1	2.11E+02	60	SCL	Unshielded	β		2.11E+02
36	STEELA18S	11/14/2002	11:15	1	2.00E+02	60	SCL	Shielded	β	2.00E+02	
37	STEELA18U	11/14/2002	11:16	1	1.93E+02	60	SCL	Unshielded	β		1.93E+02
38	STEELA19S	11/14/2002	11:17	1	1.84E+02	60	SCL	Shielded	β	1.84E+02	
39	STEELA19U	11/14/2002	11:18	1	2.09E+02	60	SCL	Unshielded	β		2.09E+02
40	STEELA20S	11/14/2002	11:19	1	1.94E+02	60	SCL	Shielded	β	1.94E+02	
41	STEELA20U	11/14/2002	11:20	1	2.30E+02	60	SCL	Unshielded	β		2.30E+02
42	STEELA21S	11/14/2002	11:22	1	2.10E+02	60	SCL	Shielded	β	2.10E+02	
43	STEELA21U	11/14/2002	11:23	1	1.93E+02	60	SCL	Unshielded	β		1.93E+02

Intake Tunnel Concrete Background Measurements - GFPC											
	Instrument 126188	RR9291	Time	Detector	Counts	Count Time (sec)	Mode	Designator		FSS-337	BHB
2	INTAK E 1P	10/2/2003	13:04	1	2.46E+02	60	SCL	Shielded	β	2.46E+02	
3	INTAK E 1U	10/2/2003	13:05	1	3.37E+02	60	SCL	Unshielded	β		3.37E+02
4	INTAK N 1P	10/2/2003	13:06	1	2.35E+02	60	SCL	Shielded	β	2.35E+02	
5	INTAK N 1U	10/2/2003	13:07	1	2.77E+02	60	SCL	Unshielded	β		2.77E+02
6	INTAK XN 1P	10/2/2003	13:09	1	2.85E+02	60	SCL	Shielded	β	2.85E+02	
7	INTAK XN 1U	10/2/2003	13:10	1	4.30E+02	60	SCL	Unshielded	β		4.30E+02
8	INTAK T 1P	10/2/2003	13:12	1	2.49E+02	60	SCL	Shielded	β	2.49E+02	
9	INTAK T 1U	10/2/2003	13:13	1	3.86E+02	60	SCL	Unshielded	β		3.86E+02
10	INTAK S 1P	10/2/2003	13:15	1	2.73E+02	60	SCL	Shielded	β	2.73E+02	
11	INTAK S 1U	10/2/2003	13:16	1	2.95E+02	60	SCL	Unshielded	β		2.95E+02
12	INTAK W 1P	10/2/2003	13:17	1	1.98E+02	60	SCL	Shielded	β	1.98E+02	
13	INTAK W 1U	10/2/2003	13:18	1	2.90E+02	60	SCL	Unshielded	β		2.90E+02
14	INTAK XS 1P	10/2/2003	13:20	1	2.98E+02	60	SCL	Shielded	β	2.98E+02	
15	INTAK XS 1U	10/2/2003	13:21	1	3.65E+02	60	SCL	Unshielded	β		3.65E+02
										Shielded	Unshielded
								Minimum ⇒		1.98E+02	2.77E+02
								Maximum ⇒		2.98E+02	4.30E+02
								Mean ⇒		2.55E+02	3.40E+02
								Sigma ⇒		3.38E+01	5.68E+01

Intake Tunnel Concrete Background Measurements - NaI

	Instrument 126188	RR9291	Time	Detector	Counts	Count Time (sec)	Mode	Designator		FSS-337
1	INTAK T 1	10/2/2003	13:23	4	5.70E+01	60	SCL	@ 4"'	γ	5.70E+01
2	INTAK E 1	10/2/2003	13:24	4	1.70E+02	60	SCL	@ 4"'	γ	1.70E+02
3	INTAK N 1	10/2/2003	13:26	4	8.60E+01	60	SCL	@ 4"'	γ	8.60E+01
4	INTAK XN 1	10/2/2003	13:27	4	6.30E+01	60	SCL	@ 4"'	γ	6.30E+01
5	INTAK S 1	10/2/2003	13:29	4	1.04E+02	60	SCL	@ 4"'	γ	1.04E+02
6	INTAK W 1	10/2/2003	13:30	4	1.08E+02	60	SCL	@ 4"'	γ	1.08E+02
7	INTAK XS 1	10/2/2003	13:31	4	8.40E+01	60	SCL	@ 4"'	γ	8.40E+01

Minimum ⇒	**5.70E+01**
Maximum ⇒	**1.70E+02**
Mean ⇒	**9.60E+01**
Sigma ⇒	**3.77E+01**

Beta Scan Measurement MDC Calculation

Steel in Seal Chamber 3

$\varepsilon_i := .509 \cdot .33 \cdot .96364$ $\varepsilon_s := .5$ $b := 158$ $p := 0.5$ $W_d := 8.8$ $S_r := 2.2$ $d := 1.38$

$A := 100$

$\frac{W_d}{S_r} = 4$ *Observation Interval (seconds)*

$O_i := \frac{W_d}{S_r}$ *Observation Interval (seconds)*

$\varepsilon_i = \varepsilon_i \cdot \varepsilon_s$

$\varepsilon_i = 0.081$

$b_i := \frac{(b \cdot O_i)}{60}$

$b_i = 10.5$ *Counts in observation Interval*

$C := \frac{1}{\left(\varepsilon_i \cdot \varepsilon_s \cdot \frac{A}{100}\right)\sqrt{p}}$

$C = 17.474$

$MDCR_i := \left(d \cdot \sqrt{b_i}\right) \cdot \frac{60}{O_i}$

$MDCR_i = 67.2$ *net counts per minute*

$MDCR_i + b = 225.182$ *gross counts per minute*

$\frac{MDCR_i}{O_i} = 16.8$ *net counts per minute in observation interval*

$MDC_{scan} := C \cdot MDCR_i$

$MDC_{scan} = 1.174 \cdot 10^3$ *dpm per 100 cm^2*

Beta Scan Measurement MDC Calculation

Concrete in Seal Chambers

$\varepsilon_i := .509 \cdot .33 \cdot .96364$ $\varepsilon_s := .5$ $b := 244$ $p := 0.5$ $W_d := 8.8$ $S_r := 2.2$ $d := 1.38$

$A := 100$

$\frac{W_d}{S_r} = 4$ *Observation Interval (seconds)* $O_i := \frac{W_d}{S_r}$ *Observation Interval (seconds)*

$\varepsilon_i := \varepsilon_i \cdot \varepsilon_s$

$\varepsilon_i = 0.081$

$b_i := \frac{(b \cdot O_i)}{60}$

$b_i = 16.3$ *Counts in observation Interval*

$C := \frac{1}{\left(\varepsilon_i \cdot \varepsilon_s \cdot \frac{A}{100}\right)\sqrt{p}}$

$C = 17.474$

$MDCR_i := \left(d \cdot \sqrt{b_i}\right) \cdot \frac{60}{O_i}$

$MDCR_i = 83.5$ *net counts per minute*

$MDCR_i + b = 327.487$ *gross counts per minute*

$\frac{MDCR_i}{O_i} = 20.9$ *net counts per minute in observation interval*

$MDC_{scan} := C \cdot MDCR_i$

$MDC_{scan} = 1.459 \cdot 10^3$ *dpm per 100 cm²*

where:

b = background counts per minute
b_i= background counts in observation interval
p = human performance factor
W_d = detector width in centimeters
S_r = scan rate in centimeters per second
d = index of sensitivity (Table 6.5 MARSSIM), 1.38 = 95% of correct detection's, 60% false positives
MDC_{scan} = Minimum Detectable Concentration for scanning (dpm/100 square centimeters)
C = constant used to convert MDCR to MDC
ε_i = instrument efficiency (counts/emission)
ε_s = source efficiency (emissions/disintegration)
A = instrument physical probe area (in square centimeters)

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title: Survey Unit Inspection in Support of FSS Design		Revision No. 0

ORIGINAL

EXHIBIT 3

Surface Measurement Test Area (SMTA) Data Sheet

SECTION 1 - DESCRIPTION

SMTA Number	SMTA - SS8-1-1	Survey Unit Number	SS8-1		
SMTA Location	Seal Chamber West wall				
Survey Unit Inspector	JDuskin	Date	11/6/03	Time	1420

SECTION 2 - CALIPER INFORMATION & PERSONNEL INVOLVED

Caliper Manufacturer	Mitutoyo	Caliper Model Number	C		
Caliper Serial Number	763893	Calibration Due Date (as applicable)	NA		
Rad Con Technician	NA	Date	N/A	Time	NA
Survey Unit Inspector Approval	JDuskin / [signature]	Date	11/6/03		

SECTION 3 - MEASUREMENT RESULTS

SMTA Grid Map & Measurement Results in Units of mm (Insert Results in White Blocks Below)

1: 0.0	7: 0.3	13: 1.9	19: 0.9	25: 2.0	31: 1.0
2: 1.0	8: 0.1	14: 0.4	20: 0.5	26: 0.9	32: 0.8
3: 0.2	9: 0.3	15: 0.4	21: 0.4	27: 0.6	33: 1.2
4: 1.2	10: 7.6	16: 1.1	22: 0.4	28: 7.3	34: 9.6
5: 1.7	11: 1.4	17: 5.8	23: 6.2	29: 5.3	35: 1.0
6: 0.5	12: 6.1	18: 0.3	24: 0.1	30: 0.2	36: 1.3

Average Measurement 1.6 mm

Comments

Surface Roughness of the SMTA, is typical or Rougher than the Remainder of the Survey unit

Additional Measurements Required

SS8-1-001 13.7 mm (2"x3")
SS8-1-002 35.2mm (3"x4")
SS8-1-003 53.1 mm (36X64")
SS8-1-004 41.89mm (12' x6")
SS8-1-005 27.4 (8"x5")

ATTACHMENT 13 - 1

ORIGINAL

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title Survey Unit Inspection in Support of FSS Design		Revision No. 0

EXHIBIT 3

Surface Measurement Test Area (SMTA) Data Sheet

SECTION 1 - DESCRIPTION

SMTA Number	SMTA - 558-2-1	Survey Unit Number	558-2		
SMTA Location	SEAL Chamber #32, 11-11-03				
Survey Unit Inspector	JDUSKIN / [signature]	Date	11/11/03	Time	1400

SECTION 2 - CALIPER INFORMATION & PERSONNEL INVOLVED

Caliper Manufacturer	Mitutoyo	Caliper Model Number	CD-6" CS		
Caliper Serial Number	763893	Calibration Due Date (as applicable)	NA		
Rad Con Technician	NA	Date	NA	Time	NA
Survey Unit Inspector Approval	JDUSKIN / [signature]	Date	11/11/03		

SECTION 3 - MEASUREMENT RESULTS

SMTA Grid Map & Measurement Results in Units of mm (Insert Results in White Blocks Below)

1: 25.8	7: 11.5	13: 24.2	19: 9.7	25: 17.3	31: 21.3
2: 9.8	8: 5.4	14: 2.0	20: 4.5	26: 4.7	32: 0.8
3: 4.1	9: 4.0	15: 29.0	21: 18.1	27: 18.4	33: 28.2
4: 11.5	10: 9.4	16: 4.9	22: 1.7	28: 29.1	34: 26.7
5: 9.7	11: 8.1	17: 5.5	23: 15.1	29: 20.3	35: 25.3
6: 7.3	12: 7.6	18: 3.0	24: 7.1	30: 6.8	36: 3.9

Average Measurement ~~13.3~~ 12.3 (11/11/03) mm

Comments

Surface Roughness of The SMTA is Typical or Rougher than the Remainder of the Survey unit

Additional Measurements Required

	mm	
558-2-001	44.25	(44"x4")
558-2-002	81.2	(8"x4")
558-2-003	68.0	(12"x4")
558-2-004	72.8	(12"x8")

ATTACHMENT 13.2

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title Survey Unit Inspection in Support of FSS Design		Revision No. 0

ORIGINAL

EXHIBIT 3

Surface Measurement Test Area (SMTA) Data Sheet

SECTION 1 - DESCRIPTION			
SMTA Number	SMTA - SS8-3-1	Survey Unit Number	SS8-3
SMTA Location	SEAL Chamber #3		
Survey Unit Inspector	JDuskin	Date 11/10/03	Time 1400

SECTION 2 - CALIPER INFORMATION & PERSONNEL INVOLVED			
Caliper Manufacturer	Mitutoyo	Caliper Model Number	CD-6" CS
Caliper Serial Number	0763893	Calibration Due Date (as applicable)	N/A
Rad Con Technician	NA	Date NA	Time NA
Survey Unit Inspector Approval	JDuskin / JDK	Date	11/10/03

SECTION 3 - MEASUREMENT RESULTS

SMTA Grid Map & Measurement Results in Units of mm (Insert Results in White Blocks Below)

1: 28.5	7: 16.9	13: 10.4	19: 17.1	25: 31.5	31: 16.7
2: 44.9	8: 16.7	14: 20.9	20: 20.2	26: 22.2	32: 25.6
3: 32.4	9: 17.9	15: 7.7	21: 25.9	27: 18.3	33: 23.1
4: 32.4	10: 8.2	16: 16.0	22: 27.3	28: 27.0	34: 19.9
5: 20.9	11: 11.5	17: 30.9	23: 25.2	29: 19.2	35: 16.8
6: 25.0	12: 13.0	18: 26.3	24: 25.1	30: 26.1	36: 23.4

Average Measurement 21.97 mm

Comments

SMTA Roughness is TYPICAL of The Remainder of The Survey unit.

Additional Measurements Required

SMTA 11/11/03
SS8-3-001 > 128mm 64' x 2"
SS8-3-002 > 128 mm 11/10/03 24 x 2"
SS8-3-003 28.8mm 9" x 11"

ATTACHMENT 13.3

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title Survey Unit Inspection in Support of FSS Design		Revision No. 0

ORIGINAL

EXHIBIT 1

Survey Unit Inspection Check Sheet

SECTION 1 - SURVEY UNIT INSPECTION DESCRIPTION			
Survey Unit #	SS8-1	Survey Unit Location	SEAL Chamber #1
Date 11/6/03	Time 1425	Inspection Team Members	J DUSKIN

SECTION 2 - SURVEY UNIT INSPECTION SCOPE			
Inspection Requirements (Check the appropriate Yes/No answer.)	Yes	No	N/A
1. Have sufficient surveys (i.e., post remediation, characterization, etc.) been obtained for the survey unit?	✓		
2. Do the surveys (from Question 1) demonstrate that the survey unit will most likely pass the FSS?	✓		
3. Is the physical work (i.e., remediation & housekeeping) in or around the survey unit complete?	✓		
4. Have all tools, non-permanent equipment, and material not needed to perform the FSS been removed?	✓		
5. Are the survey surfaces relatively free of loose debris (i.e., dirt, concrete dust, metal filings, etc.)?	✓		
6. Are the survey surfaces relatively free of liquids (i.e., water, moisture, oil, etc.)? RESIDUAL WATER to be Removed PRIOR TO SURVEY	✓		
7. Are the survey surfaces free of all paint, which has the potential to shield radiation?	✓		
8. Have the Surface Measurement Test Areas (SMTA) been established? (Refer to Exhibit 2 for instructions.)	✓		
9. Have the Surface Measurement Test Areas (SMTA) data been collected? (Refer to Exhibit 2 for instructions.)	✓		
10. Are the survey surfaces easily accessible? (No scaffolding, high reach, etc. is needed to perform the FSS) ①	✓		
11. Is lighting adequate to perform the FSS?	✓		
12. Is the area industrially safe to perform the FSS? (Evaluate potential fall & trip hazards, confined spaces, etc.)	✓		
13. Have photographs been taken showing the overall condition of the area?	✓		
14. Have all unsatisfactory conditions been resolved?	✓		

NOTE: If a "No" answer is obtained above, the inspector should immediately correct the problem or initiate corrective actions through the responsible site department, as applicable. Document actions taken and/or justifications in the "Comments" section below. Attach additional sheets as necessary.

Comments: ① SURVEY UNIT IS CONFINED SPACE

Attachment 13-4

Survey Unit Inspector (print/sign)	J DUSKIN / [signature]	Date	11/6/03
Survey Designer (print/sign)	J.P. Donnachie / [signature] for Brosey	Date	11/17/03

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title Survey Unit Inspection in Support of FSS Design		Revision No. 0

EXHIBIT 1

Survey Unit Inspection Check Sheet

SECTION 1 - SURVEY UNIT INSPECTION DESCRIPTION			
Survey Unit #	SS8-2	Survey Unit Location	SEAL Chamber #2
Date 11/13/03	Time 1630	Inspection Team Members	J Duskin

SECTION 2 - SURVEY UNIT INSPECTION SCOPE

Inspection Requirements (Check the appropriate Yes/No answer.)	Yes	No	N/A
1. Have sufficient surveys (i.e., post remediation, characterization, etc.) been obtained for the survey unit?	✓		
2. Do the surveys (from Question 1) demonstrate that the survey unit will most likely pass the FSS?	✓		
3. Is the physical work (i.e., remediation & housekeeping) in or around the survey unit complete?	✓		
4. Have all tools, non-permanent equipment, and material not needed to perform the FSS been removed?	✓		
5. Are the survey surfaces relatively free of loose debris (i.e., dirt, concrete dust, metal filings, etc.)?	✓		
6. Are the survey surfaces relatively free of liquids (i.e., water, moisture, oil, etc.)?	✓		
7. Are the survey surfaces free of all paint, which has the potential to shield radiation?	✓		
8. Have the Surface Measurement Test Areas (SMTA) been established? (Refer to Exhibit 2 for instructions.)	✓		
9. Have the Surface Measurement Test Areas (SMTA) data been collected? (Refer to Exhibit 2 for instructions.)	✓		
10. Are the survey surfaces easily accessible? (No scaffolding, high reach, etc. is needed to perform the FSS)	✓		
11. Is lighting adequate to perform the FSS?	✓		
12. Is the area industrially safe to perform the FSS? (Evaluate potential fall & trip hazards, confined spaces, etc.)	✓		
13. Have photographs been taken showing the overall condition of the area?	✓		
14. Have all unsatisfactory conditions been resolved?	✓		

NOTE: If a "No" answer is obtained above, the inspector should immediately correct the problem or initiate corrective actions through the responsible site department, as applicable. Document actions taken and/or justifications in the "Comments" section below. Attach additional sheets as necessary.

Comments: SURVEY UNIT IS WITHIN A CONFINED SPACE.

Attachment 13-5

Survey Unit Inspector (print/sign)	J Duskin / [signature]	Date	11/13/03
Survey Designer (print/sign)	J.P. Donnachie Jr / [signature] for Brosey	Date	11/17/03

ORIGINAL

SAXTON NUCLEAR	Saxton Nuclear Experimental Corporation Facility Policy and Procedure Manual	Number E900-IMP-4520.06
Title **Survey Unit Inspection in Support of FSS Design**		Revision No. 0

EXHIBIT 1

Survey Unit Inspection Check Sheet

SECTION 1 - SURVEY UNIT INSPECTION DESCRIPTION					
Survey Unit #	SS 8-3	Survey Unit Location	SEAL Chamber #3		
Date	11/13/03	Time	1400	Inspection Team Members	JDUSKIN

SECTION 2 - SURVEY UNIT INSPECTION SCOPE			
Inspection Requirements (Check the appropriate Yes/No answer.)	Yes	No	N/A
1. Have sufficient surveys (i.e., post remediation, characterization, etc.) been obtained for the survey unit?	✓		
2. Do the surveys (from Question 1) demonstrate that the survey unit will most likely pass the FSS?	✓		
3. Is the physical work (i.e., remediation & housekeeping) in or around the survey unit complete?	✓		
4. Have all tools, non-permanent equipment, and material not needed to perform the FSS been removed?	✓		
5. Are the survey surfaces relatively free of loose debris (i.e., dirt, concrete dust, metal filings, etc.)?	✓		
6. Are the survey surfaces relatively free of liquids (i.e., water, moisture, oil, etc.)?	✓		
7. Are the survey surfaces free of all paint, which has the potential to shield radiation?	✓		
8. Have the Surface Measurement Test Areas (SMTA) been established? (Refer to Exhibit 2 for instructions.)	✓		
9. Have the Surface Measurement Test Areas (SMTA) data been collected? (Refer to Exhibit 2 for instructions.)	✓		
10. Are the survey surfaces easily accessible? (No scaffolding, high reach, etc. is needed to perform the FSS)	✓		
11. Is lighting adequate to perform the FSS?	✓		
12. Is the area industrially safe to perform the FSS? (Evaluate potential fall & trip hazards, confined spaces, etc.) ①	✓		
13. Have photographs been taken showing the overall condition of the area?	✓		
14. Have all unsatisfactory conditions been resolved?	✓		

NOTE: If a "No" answer is obtained above, the inspector should immediately correct the problem or initiate corrective actions through the responsible site department, as applicable. Document actions taken and/or justifications in the "Comments" section below. Attach additional sheets as necessary.

Comments: ① - SURVEY UNIT IS CONFINED SPACE, ENTRY BY PERMIT ONLY

Attachment 13-6

Survey Unit Inspector (print/sign)	JDUSKIN / [signature]	Date	11/13/03
Survey Designer (print/sign)	J.P. Donnachie Jr / [signature] for Brosey	Date	11/13/03

Site Report

Site Summary

Site Name: Seal Chambers 1, 2 and 3

Planner(s): BHB

Contaminant Summary

NOTE: Surface soil DCGLw units are pCi/g.
Building surface DCGLw units are dpm/100 cm².

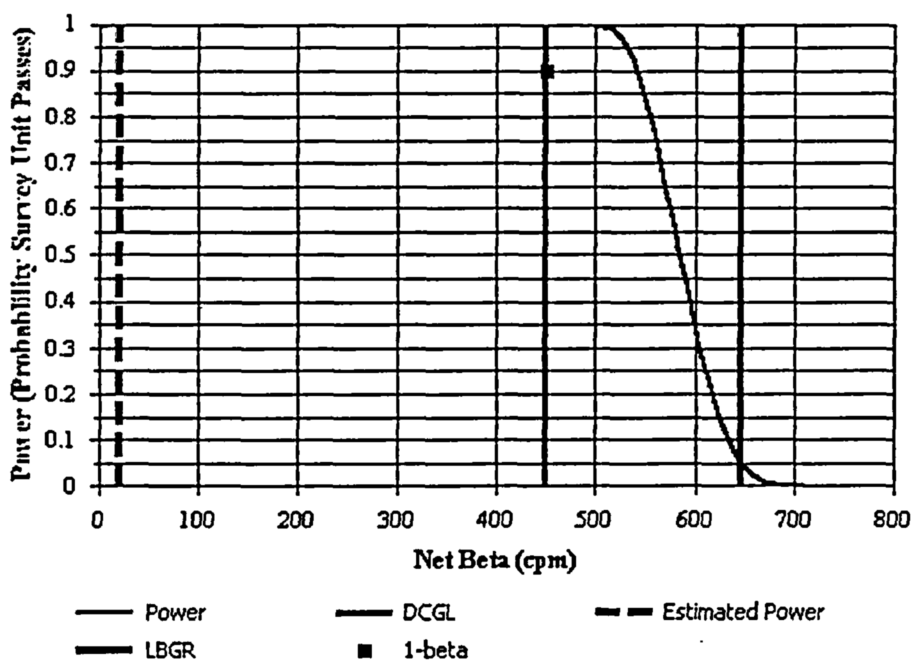
Contaminant	Type	DCGLw	Screening Value Used?	Area (m²)	Area Factor
Gross Activity	Building Surface	6,407	No	36	1
				25	1.2
				16	1.5
				9	2
				4	3.4
				1	10.1

Building Surface Survey Plan

Survey Plan Summary

Site:	Seal Chambers 1, 2 and 3		
Planner(s):	BHB		
Survey Unit Name:	Seal Chamber 1		
Comments:			
Area (m²):	73	Classification:	1
Selected Test:	WRS	Estimated Sigma (cpm):	68.1
DCGL (cpm):	646	Sample Size (N/2):	8
LBGR (cpm):	450	Estimated Conc. (cpm):	21
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.100	EMC Sample Size (N):	8

Prospective Power Curve



ATTACHMENT 14-2

Building Surface Survey Plan

Contaminant Summary

Contaminant	DCGLw (dpm/100 cm²)
Gross Activity	6,407

Beta Instrumentation Summary

Gross Beta DCGLw (dpm/100 cm²): 6,407
Total Efficiency: 0.08
Gross Beta DCGLw (cpm): 646

ID	Type	Mode	Area (cm²)
11	GFPC	Beta	126

Contaminant	Energy[1]	Fraction[2]	Inst. Eff.	Surf. Eff.	Total Eff.
Gross Activity	187.87	1.0000	0.16	0.50	0.0810

[1] Average beta energy (keV) [N/A indicates alpha emission]
[2] Activity fraction

Gross Survey Unit Mean (cpm): 244 ± 68 (1-sigma)
Count Time (min): 1

Material	Number of BKG Counts	Average (cpm)	Standard Deviation (cpm)	MDC (dpm/100 cm²)
Concrete	7	223	56.8	719

ATTACHMENT 14-3

COMPASS - DQO Wizard for Building Surface Assessment

Elevated Measurement Comparison (EMC) for Beta

Follow the order of each tab below to perform the EMC.

1) Enter Scanning Instrument Efficiencies | 2) Enter Scan MDC Parameters | **3) View EMC Results**

Scan MDC Required per Contaminant

Contaminant	DCGLw*	Area Factor	Scan MDC Required*
Gross Activity	6,407	1.99	12,750

Statistical Design

N/2:	8
Bounded Area (m^2):	9.1
Area Factor:	1.99
DCGLw*:	6,407
Scan MDC Required*:	12,750

Hot Spot Design

Actual Scan MDC*:	1,411
Area Factor:	N/A
Bounded Area (m^2):	N/A
Post-EMC N/2:	8

* dpm/100 cm^2

COMPASS

No additional samples are required because the actual scan MDC is less than the DCGLw for each contaminant.

OK

☑ Enable Trainin

v1.0.0

ATTACHMENT 14.4

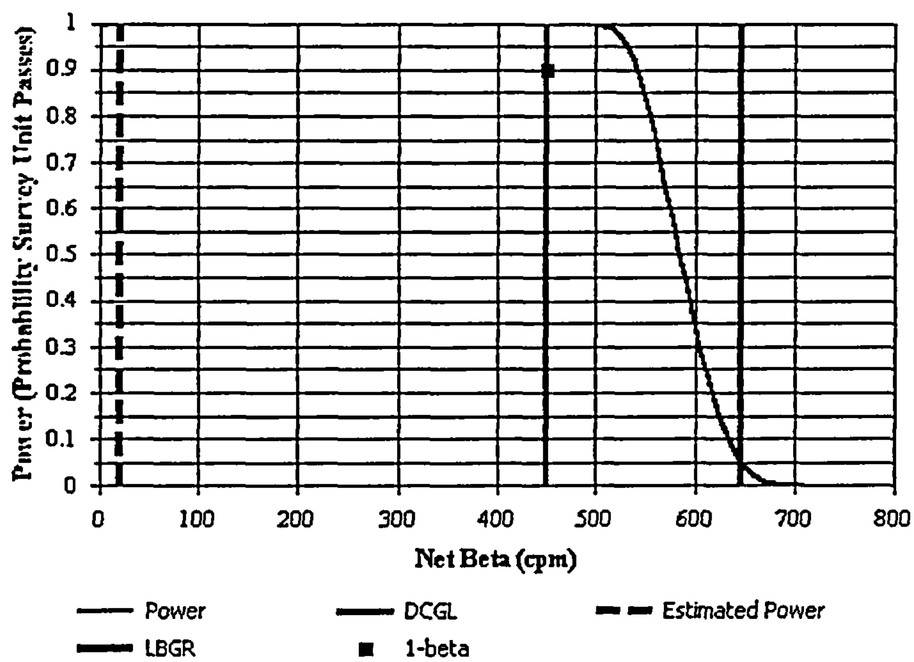
58 of 64

Building Surface Survey Plan

Survey Plan Summary

Site:	Seal Chambers 1, 2 and 3		
Planner(s):	BHB		
Survey Unit Name:	Seal Chamber 2		
Comments:			
Area (m²):	71	Classification:	1
Selected Test:	WRS	Estimated Sigma (cpm):	68.1
DCGL (cpm):	646	Sample Size (N/2):	8
LBGR (cpm):	450	Estimated Conc. (cpm):	21
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.100	EMC Sample Size (N):	8

Prospective Power Curve



ATTACHMENT 14 - 5

Building Surface Survey Plan

Contaminant Summary

Contaminant	DCGLw (dpm/100 cm²)
Gross Activity	6,407

Beta Instrumentation Summary

Gross Beta DCGLw (dpm/100 cm²): 6,407
Total Efficiency: 0.08
Gross Beta DCGLw (cpm): 646

ID	Type	Mode	Area (cm²)
11	GFPC	Beta	126

Contaminant	Energy[1]	Fraction[2]	Inst. Eff.	Surf. Eff.	Total Eff.
Gross Activity	187.87	1.0000	0.16	0.50	0.0810

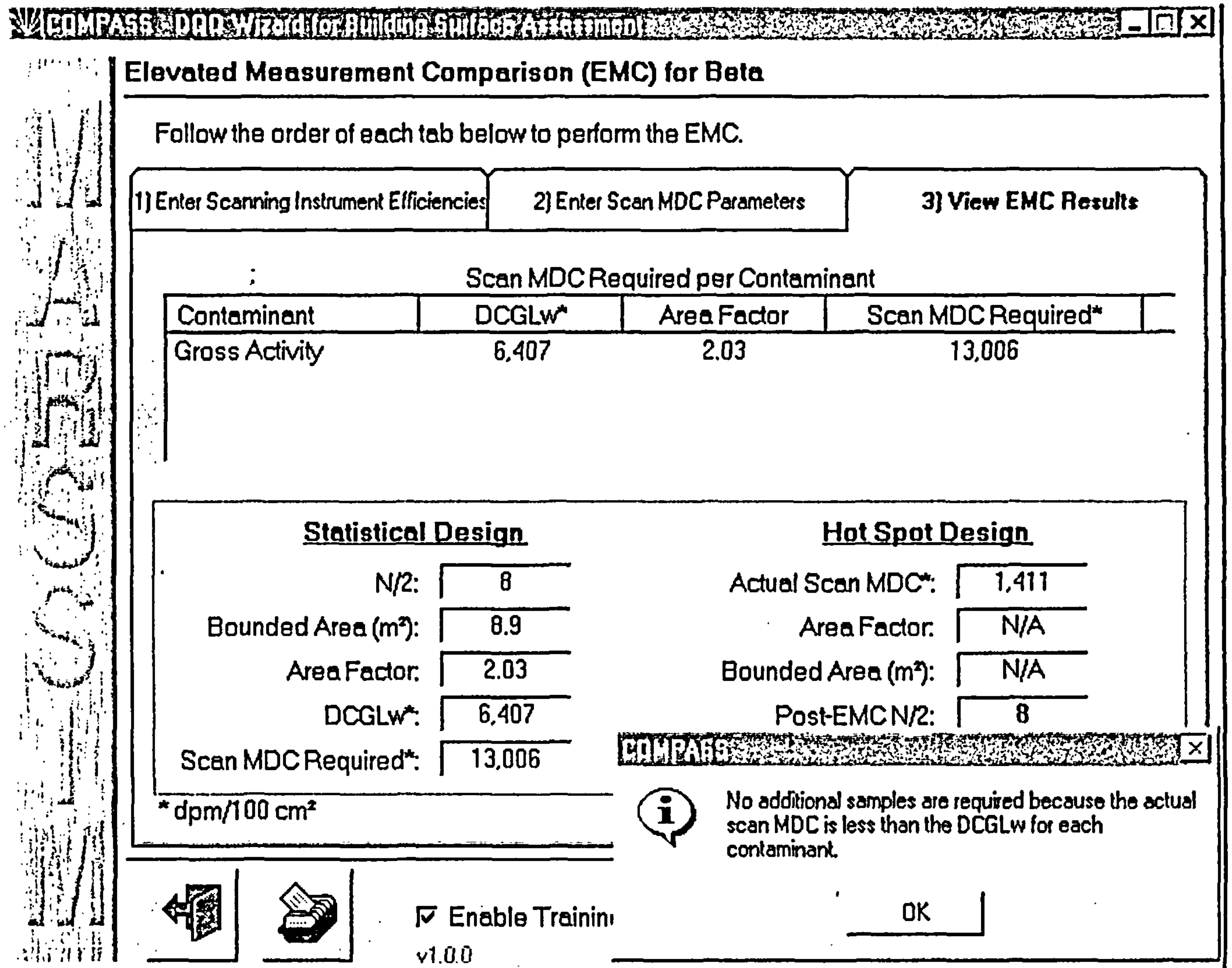
[1] Average beta energy (keV) [N/A indicates alpha emission]
[2] Activity fraction

Gross Survey Unit Mean (cpm): 244 ± 68 (1-sigma)
Count Time (min): 1

Material	Number of BKG Counts	Average (cpm)	Standard Deviation (cpm)	MDC (dpm/100 cm²)
Concrete	7	223	56.8	719

ATTACHMENT 14-6

ATTACHMENT 14.7

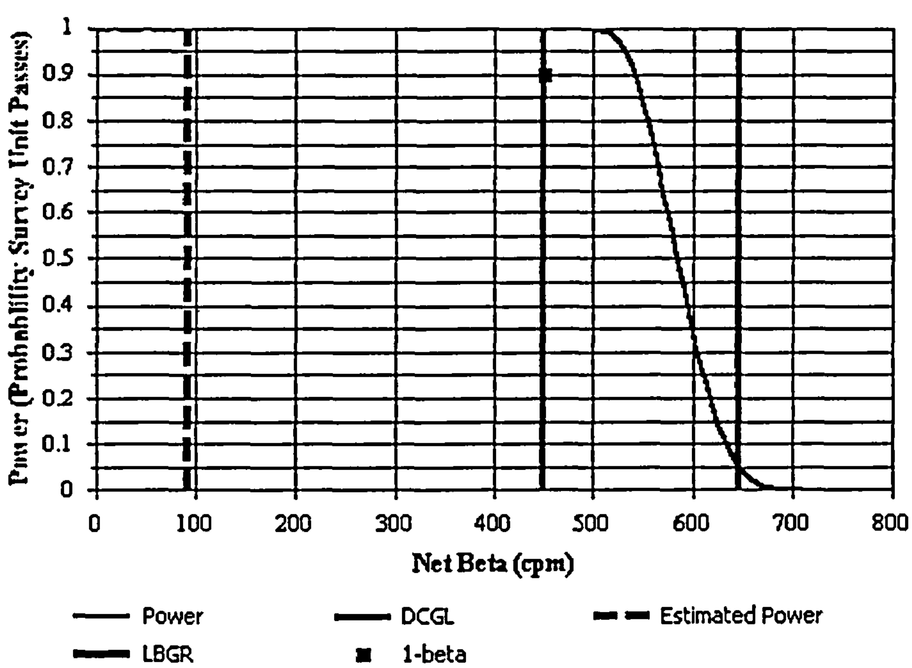


Building Surface Survey Plan

Survey Plan Summary

Site:	Seal Chambers 1, 2 and 3		
Planner(s):	BHB		
Survey Unit Name:	Seal Chamber 3		
Comments:			
Area (m²):	109	Classification:	1
Selected Test:	WRS	Estimated Sigma (cpm):	68.1
DCGL (cpm):	646	Sample Size (N/2):	8
LBGR (cpm):	450	Estimated Conc. (cpm):	91.5
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.100	EMC Sample Size (N):	8

Prospective Power Curve



ATTACHMENT 14 - 8

Building Surface Survey Plan

Contaminant Summary

Contaminant	DCGLw (dpm/100 cm²)
Gross Activity	6,407

Beta Instrumentation Summary

Gross Beta DCGLw (dpm/100 cm²): 6,407
Total Efficiency: 0.08
Gross Beta DCGLw (cpm): 646

ID	Type	Mode	Area (cm²)
11	GFPC	Beta	126

Contaminant	Energy[1]	Fraction[2]	Inst. Eff.	Surf. Eff.	Total Eff.
Gross Activity	187.87	1.0000	0.16	0.50	0.0810

[1] Average beta energy (keV) [N/A indicates alpha emission]
[2] Activity fraction

Gross Survey Unit Mean (cpm): 244 ± 68 (1-sigma)
Count Time (min): 1

Material	Number of BKG Counts	Average (cpm)	Standard Deviation (cpm)	MDC (dpm/100 cm²)
Steel	4	152.5	8.3	599

ATTACHMENT 14.10

COMPASS - DQO Wizard for Building Surface Assessment

Elevated Measurement Comparison (EMC) for Beta

Follow the order of each tab below to perform the EMC.

1) Enter Scanning Instrument Efficiencies | 2) Enter Scan MDC Parameters | **3) View EMC Results**

Scan MDC Required per Contaminant

Contaminant	DCGLw*	Area Factor	Scan MDC Required*
Gross Activity	6,407	1.66	10,636

Statistical Design

N/2:	8
Bounded Area (m²):	13.7
Area Factor:	1.66
DCGLw*:	6,407
Scan MDC Required*:	10,636

Hot Spot Design

Actual Scan MDC*:	1,167
Area Factor:	N/A
Bounded Area (m²):	N/A
Post-EMC N/2:	8

* dpm/100 cm²

COMPASS

No additional samples are required because the actual scan MDC is less than the DCGLw for each contaminant.

OK

☑ Enable Training

v1.0.0