Appendix D

SSGS Footprint
Survey Design 2

ORIGINAL

FirstEnergy

SNEC CALCULATION COVER SHEET

CALCULATION DESCRIPTION

Calculation Number	Revision Number	Effective Date	Page Number
E900-03-029	0	11-3-03	1 of 35

Subject

Balance of SSGS Footprint 2 - 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/ B. Brosey	Date	10/30/03
Technical Reviewer	P. Donnachie/ P. Donnachie	Date	10/30/03
Additional Review	A. Paynter/ A. Paynter	Date	31 Oct 03
Additional Review		Date	
SNEC Management Approval		Date	

1.0 PURPOSE

1.1 The purpose of this calculation is to develop survey design for remaining floor and wall locations, or hardware located in ***Class 1*** areas within the SSGS footprint. These areas are shown in Attachment 1-1 to 1-13, and are listed below along with the survey unit where they reside.

Impacted Survey Units	Location	Material Type	Attachments
SS14-1	Down-comer flange and opening (2 ea.) to North & South chambers of Intake Tunnels	Steel	1-1, 1-2 & 1-3
SS14-2	Down-comer flanges (2 ea. closed tops)	Steel	1-2 & 1-3
SS14-5	Valve/Pipe assembly and adjacent area of floor	Steel/Concrete	1-4
SS15	Instrument recesses in East wall (2 ea.)	Steel/Concrete	1-5
SS15	Steel beam near top of East wall (South side)	Steel/Concrete	1-6
SS14-1	Potential elevated floor area (AP-2 FSS-360)	Concrete	1-7 & 1-8
SS14-1 to 5	Static measurement points from Reference 3.1	Concrete	1-9 to 1-13

1.2 Additional locations or hardware may be added as deemed appropriate to complete the FSS for SSGS Class 1 areas.

1.3 Areas that were previously surveyed using an approved FSS survey design/survey request, need not be re-surveyed unless additional survey criteria are indicated herein.

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*

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

2.1.2 No GFPC based static measurements are included for this survey design.

2.1.3 Scanning criteria using the GFPC for these areas and hardware, are identical to those developed in Reference 3.1 and 3.2 for steel and concrete surfaces. They are:

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 ½" in depth*** should not be surveyed using the GFPC.

2.1.3.3 Steel components/hardware that exhibit extreme corrosion and are crusted or bubbled on the surface should not be scanned using the GFPC. See Section 2.2 if this is the case.

2.1.3.4 The DCGLw is ***13,000 dpm/100 cm²*** or ***983 cpm*** above background. This is the limit used for static measurement criteria.

2.1.3.5 The action level during first phase scanning is ***500 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 (983 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 ***23.9%***.

2.1.4 Any location or equipment that cannot be adequately surveyed with the GFPC as described in 2.1.3 above, should be identified for NaI scanning IAW Section 2.2.

NOTE: Scan MDC values for the GFPC instrument are listed in Section 4.19, and have been shown to be adequate for this survey work.

2.2 *Step 2 - NaI Scanning for Extremely Corroded or Painted Steel Surfaces and Concrete*

2.2.1 For locations previously identified for scanning using a 2" by 2" NaI detector.

2.2.1.1 Volumetric DCGLw values for concrete is ***4.93 pCi/g Cs-137*** (administrative limit).

2.2.1.2 The scan speed is set at ***10 cm/second*** when scanning with a ***2" by 2" NaI*** detector, and moving side to side in a serpentine pattern within a distance of 2" from the survey area. The stand-off distance (2") should be monitored frequently during the scanning process.

2.2.1.3 For areas where NaI scanning is not appropriate, hold the detector stationary near the center of the suspect region, within 2" from the surface and determine the count rate. If the area is larger than 12 in^2, take several measurements in/over the area. Record the approximate dimensions of the area and the position of the detector with respect to where the measurement(s) were taken. When access to an area does not allow the detector to be within 2" from the surface, perform a measurement at the closest location. Record the result, the actual distance from the face of the detector and the estimated size of the area.

2.2.1.4 The action level is ***300 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 ***180,000 cpm/mR/h*** (see Attachment 4-3) 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 the surface at the locations marked and shown on Attachment 1-9 to 1-13. These locations are the same locations developed in Reference 3.1 for static GFPC measurement locations.

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 3.4.

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

2.3.4 A background evaluation of non-impacted but similar materials using the same geometry as that used to count FSS locations, shall be completed before the FSS measurements are performed. Each background location shall be counted for no less than 5 minutes. A minimum of 3 different locations shall be counted.

2.3.4.1 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.

2.3.4.2 If a multi-channel analyzer system is used IAW Reference 3.4, data shall be recorded on copies of Attachment 2-1 (or equivalent).

2.3.4.3 A copy of all calibration data for the measurement system shall be included with the collected data in the close out documentation.

2.3.5 The decision error rates for NaI static points are assumed the same as previously developed for static GFPC measurements i.e., 0.05 for the α value and 0.1 for the β value (from Reference 3.1 & 3.2).

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) previously discussed. 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 (300 gross cpm NaI or 500 ncpm GFPC), scrape the surface to collect a sample for gamma scanning by removing as much material as possible over/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 biased locations where measurements indicate elevated count rates, or where measurement capability is deemed inadequate due to poor geometry.

2.4.4 Samples of concrete will be collected at the highest three (3) measurement locations as determined by NaI static measurements (Section 2.3). Three (3) additional samples will be taken from the remaining group of measurement locations at non-biased measurement points.

2.5 *Individual Item Survey Instructions*

2.5.1 ***Down-comer flanges and openings into North and South Intake Tunnel chambers*** (refer to Attachment 1-1 and 1-2):

2.5.1.1 Use an NaI detector and scan around the edge of the flange and mark any location that is above the action level. Sample any elevated location by scraping the steel surface and/or by removing sediment from areas under the edge of the flange between the 790' El floor and the flange area.

2.5.1.2 Use an NaI detector and scan the cover plates currently located outside the SSGS footprint and sample any location that is at or above the action level.

2.5.1.3 Use an NaI detector and scan the interior of the open down-comers to at least 3' below the 790' El floor area. Sample any location above the action level by scraping the surface of these badly corroded steel surfaces.

2.5.2 ***Down-comer flanges and cover plates*** (refer to Attachment 1-2 and 1-3): Use an NaI detector and scan around the edge of the flange and the exposed surface area of the cover plate, marking any location that is above the action level. Sample any elevated location by scraping the steel surface and/or by removing sediment from pockets under the edge of the flange between the 790' El floor and the flange area, and/or in the seam between the cover plate and the flange (as practicable).

2.5.3 ***Valve/Pipe assembly and adjacent floor area*** (refer to Attachment 1-4): Use an NaI detector and scan the surface of the pipe and valve assembly. Mark and sample any elevated location by scraping off surface materials. Scan the floor area adjacent to the valve/pipe assembly with both a GFPC and NaI detector and sample any areas above the action levels.

2.5.4 ***Instrument recess into East wall (2 ea.)*** (refer to Attachment 1-5): Scan the entire surface of these recessed areas with a GFPC instrument. Mark and sample any areas above the action levels.

2.5.5 ***Steel beam near top of East wall on the South end*** (refer to Attachment 1-6): Scan the entire exposed surface of the beam with a NaI detector. Mark and sample any areas above the action level.

2.5.6 ***Potential elevated floor area (AP-2 FSS-360)*** (refer to Attachment 1-7 and 1-8): Scan the entire unmeasured surface area at this location with both a GFPC and NaI detection system. Mark and sample any areas above the action levels.

2.5.7 ***Perform static NaI measurements at the locations specified in Attachment 1-9 to 1-13 (Reference 3.1)***: Measurements are to be IAW Section 2.4.

2.6 Scan and sample other elevated areas or hardware as directed IAW these instructions.

3.0 REFERENCES

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

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

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

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

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

3.6 GPU Nuclear, SNEC Facility, SSGS Footprint, Drawing, SNECRM-041_S1_RO.

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

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

3.9 Plan SNEC Facility License Termination Plan.

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

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

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

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

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

4.0 ASSUMPTIONS AND BASIC DATA

4.1 Diagrams shown in this survey design have been developed from Reference 3.6.

4.2 Remediation History

Remediation of the SSGS Footprint began with gross decontamination of the sump areas and removal of contaminated hardware and piping systems. Surface cleaning was performed by removing a thickness of the concrete surface in affected areas. Core bores were then taken to determine the depth of the contamination and to estimate remediation effectiveness. Remaining piping systems were sampled and gamma scanned to determine the existing concentrations. Many obstructions were cut off and concrete surfaces were scraped free of paint and scale. Remediation efforts included combinations of the following cleaning techniques:

- Scabbling and power chisel
- grinding and use of an oxy/acetylene torch to remove metal obstructions
- surface scraping
- water flush

4.3 Cs-137 accounts for the majority of the total activity in the modified sample result.

- The SNEC modified sample is greater than 99% Cs-137.
- 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 3.7). 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 5-1 of Reference 3.1, indicates an instrument efficiency of ***0.478***. The ISO value of ***0.5*** is used as the source efficiency. A Ludlum 2350 is used to determine this value (instrument S/N 126218 - probe S/N is 95080).

NOTE
Other GFPC instruments may be used during the FSS but they must demonstrate an instrument efficiency at or above 0.478.

4.4 A GFPC detector stand-off distance of 2 ½" is used to compensate for rough surfaces in the SSGS area. This factor corrects the overall efficiency by a factor of 0.25 (Reference 3.8)

4.5 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 13,000 dpm/100 cm^2 x (126 cm^2 physical probe area/100 cm^2) = 16,380 x (0.996 disintegration of Cs-137/ disintegration in mix) x ε_i (0.478) x ε_s (0.5) x 0.25 (distance factor) which yields ~975 net cpm above background (Compass calculates 983 ncpm as the gross beta DCGLw). The 0.06 count per disintegration counting efficiency considers only the Cs-137 contaminant present in the sample material matrix, and is calculated by: ε_i (0.478) x ε_s (0.5) x 0.996 disintegration of Cs-137/disintegration in mix x 0.25 (efficiency loss factor due to distance from surface) = ***0.06 cts/disintegration***.

4.6 Surface defects (gouges, cracks, etc.), are present in this survey unit, but a portion of the surface area in this survey unit is relatively smooth. Thus the average concentration of the source term will be overestimated by using a distance correction factor of 0.25 for all areas within these survey units.

4.7 Inaccessible areas or corroded steel surfaces, or any area where a 43-68 beta probe can not be used, will be gamma scanned using a 2" x 2" NaI detector. The detector was set-up and calibrated with a Cs-137 window setting typical to that described within Attachment 4-1 to 4-3, with a conversion factor equal to or greater than 180,000 cpm/mR/h.

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

1) a 3" thick slab of concrete 18" long by 12", wide 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 18" long and 6" wide to simulate a narrow but relatively smooth surface such as the bottom of a trench or channel.

4.9 The 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 1.567E-06 uCi/cc of Cs-137 for the rough model, and 2.35E-06 uCi/cc for the smaller slab model. A 1" thickness was modeled for the smaller slab since volumetric contamination in concrete in the SSGS Footprint area has not been seen much below 1" in concrete core bore samples. The calculated MDCscan for these two models is 2 and 4.8 pCi/g Cs-137 respectively (Reference 3.1 & 3.2).

4.10 The results of the MicroShield modeling indicate that an exposure rate of approximately 6.611E-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 1.601E-04 mR/h is seen 3 inches from the surface of the larger or 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".

4.11 A third MicroShield model of a surface deposition containing Cs-137 was also developed for this survey design (see Attachment 7-1 to 7-7 of Reference 3.1). For this scenario, the modeled area is assumed to be an 18" diameter disk source with a 1 pCi/cm^2 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 2.212E-05. Then the calculated pCi/cm^2 MDCscan is 14.5 pCi/cm^2 (3200 dpm/100 cm^2) for a background count rate of 100 cpm. For an area where background is 300 cpm the MDCscan would be 25 pCi/cm^2 (5600 dpm/100 cm^2). For a steel or concrete surface deposit this is well under the surface DCGLw for this area. For the

case where penetration into concrete is suspected, a gross count rate of 300 cpm can be used to indicate an area where sampling of volumetric materials is indicated.

4.12 The volumetric DCGLw for concrete is assumed the same as soil for the site and from Attachment 3-2, the Cs-137 volumetric DCGLw is calculated to be 4.93 pCi/g. This is the administrative limit for the SSGS area. The volumetric limit can be compared directly to the NaI scanning results. Scanning using the prescribed criteria will detect values at or above the DCGLw of 4.93 pCi/g Cs-137. When an elevated scan result is observed while scanning with the NaI, a sample will be taken. The sample will be a grab sample or a core bore sample. The sample should be collected to a minimum depth of 1" for a grab sample or 4" for a core bore sample. Core bore samples are preferred whenever possible.

4.13 This survey unit is below grade and is surrounded by concrete walls and therefore the original GFPC related background values have been corrected to compensate for the shielding effects of these walls. See Reference 3.1 and 3.2 for a full description of background corrections for GFPC instrumentation.

4.14 For static NaI measurements of concrete, background values are determined by taking measurements at an on-site non-impacted structure (see Attachment 5-1). These values are then used to conservatively estimate the static MDC values for concrete surfaces.

4.15 Area variability GFPC measurements were taken in the area to support the Reference 3.1 survey design process. These same static points are re-measured with a NaI detector IAW Section 2.3.

4.16 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), 0.06 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 (see Reference 3.1 and 3.2).

Material	Corrected BKGND (cts/min)	MDC_{SCAN} (dpm/100 cm^2)
Steel (Reference 3.1)	176 (corrected bkgnd data)	Compass = 1,671
Concrete (Reference 3.2)	298 (corrected bkgnd data)	Compass = 2,175

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

4.17 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 in Reference 3.1.

4.18 No special area characteristics including any additional residual radioactivity (not previously noted during characterization) have been identified in this survey unit.

4.19 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.

4.19.1 The NaI static measurement MDC is based on background value determined for concrete at an on-site non-impacted concrete structure (see Attachment 5-1 to 5-3). 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 elevated areas of concrete found in the SSGS area during previous survey work (see Attachment 5-1 to 5-5).

4.19.2 A background count rate of 421 counts (the highest value from Attachment 5-1), collected in 5 minutes yields a MDCstatic value of ***1.13 pCi/g***.

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 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 3.9. 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 1-13**, includes both diagrams and photos of areas and hardware to be surveyed in Class 1 locations of the SSGS Footprint.

6.2 **Attachment 2-1**, is an example of a data sheet used for gamma-ray spectroscopy work.

6.3 **Attachment 3-1** and **3-2**, is the effective DCGLw calculations for sample materials of the SSGS Footprint.

6.4 **Attachment 4-1** to **4-3**, are calibration sheets for a 2" by 2" NaI detection system.

6.5 **Attachment 5-1**, is a RadCon survey sheet documenting 5 minute NaI counts of non-impacted Intake Tunnel concrete.

6.6 **Attachment 5-2** to **5-5**, is a calculation sheet to determine the static MDC for a NaI detection system using a typical background count rate.

Exhibit 1

SNEC Facility DCGL Values [a]

Radionuclide	25 mrem/y Limit Surface Area (dpm/100cm^2)	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.

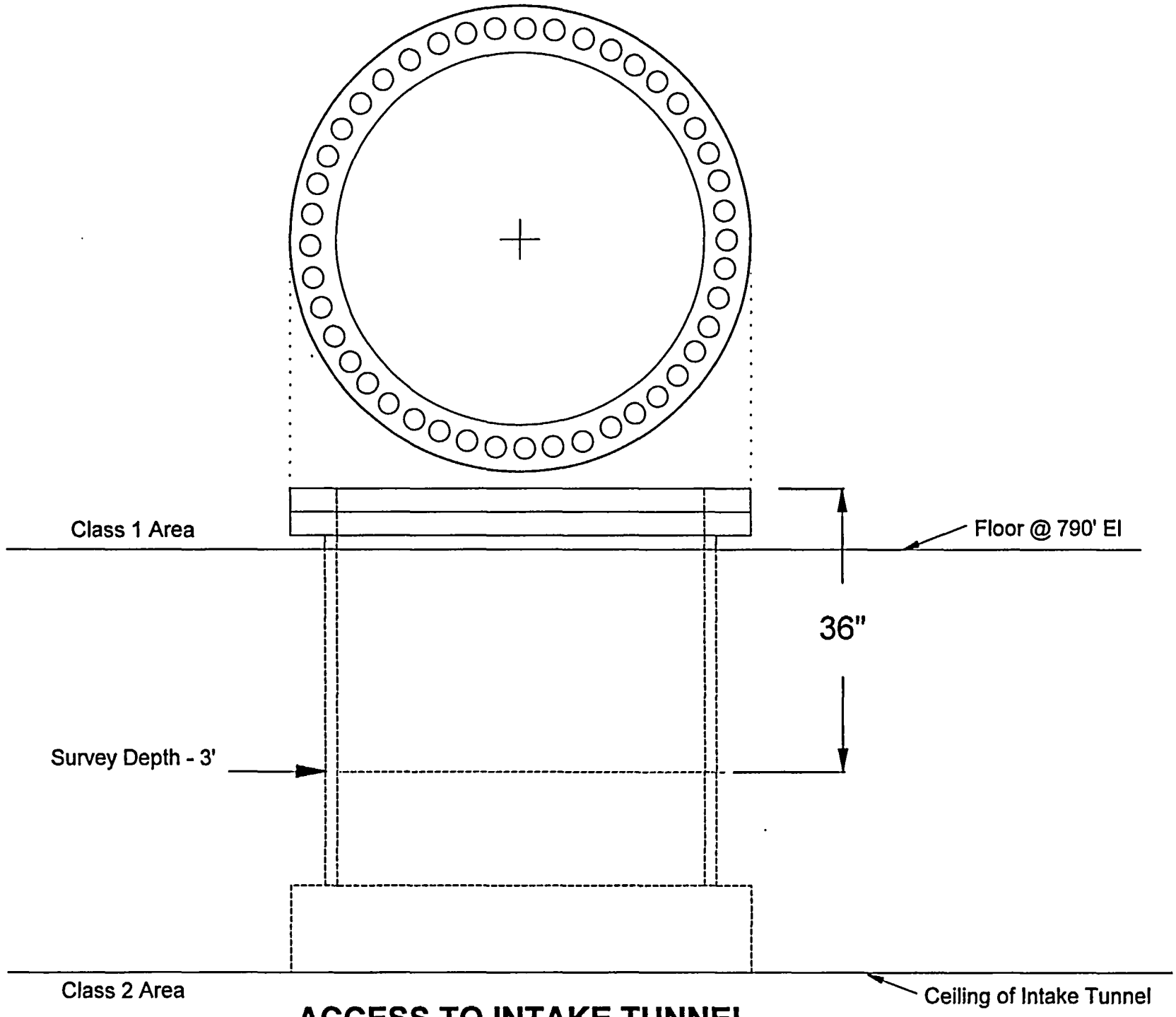
(b) Listed values are from the subsurface model. These values are the most conservative values between the two models (i.e., surface & subsurface).

Exhibit 2

Survey Design Checklist (From Reference 3.5)

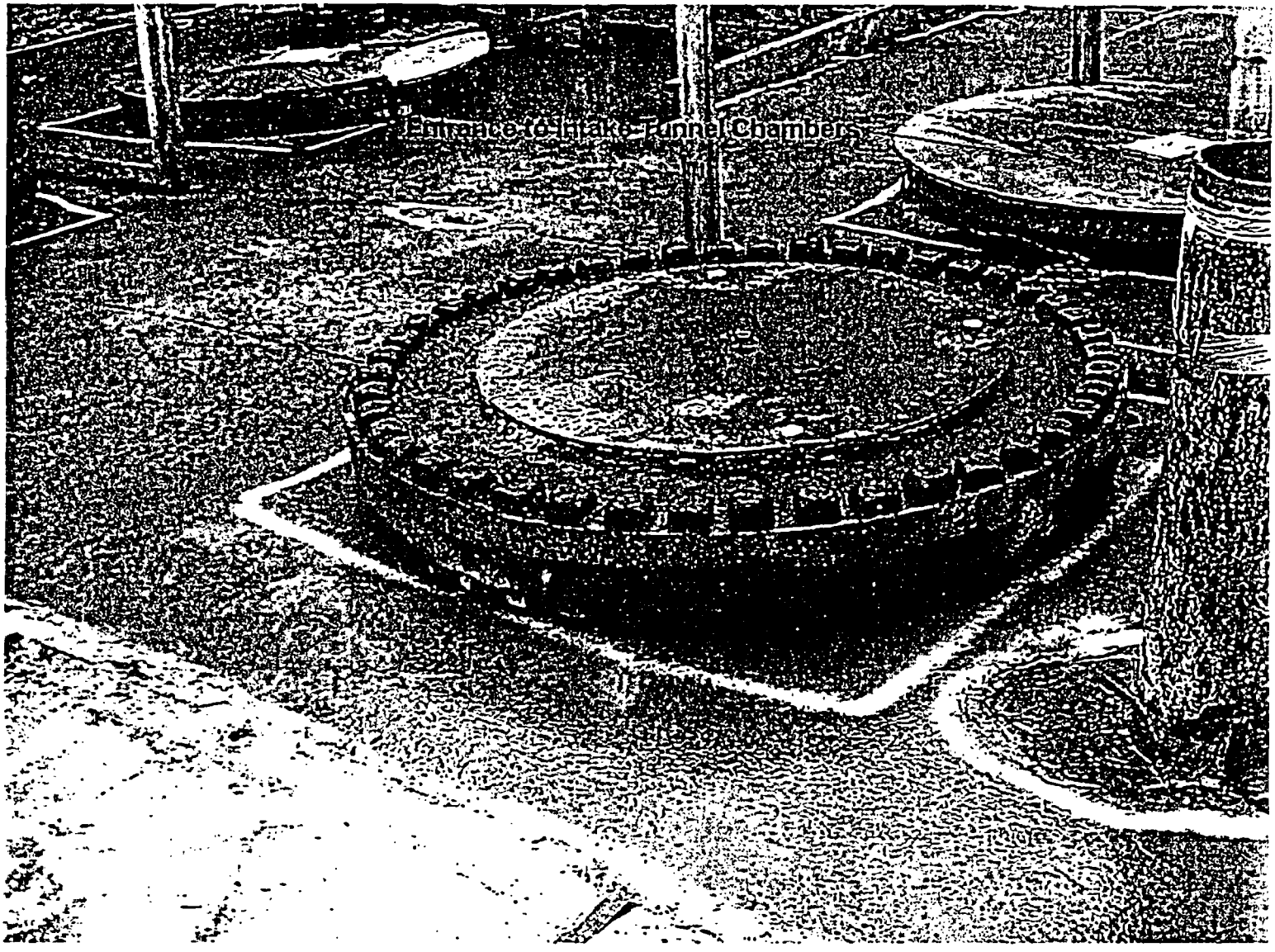
Calculation No. E900-03-029	SS14-1, SS14-2, SS14-3, SS14-4, SS14-5 & SS15		
ITEM	**REVIEW FOCUS**	**Status (Circle One)**	**Reviewer Initials & Date**
1	Has a survey design calculation number been assigned and is a survey design summary description provided?	Yes, N/A	10/30/03
2	Are drawings/diagrams 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	10/30/03

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

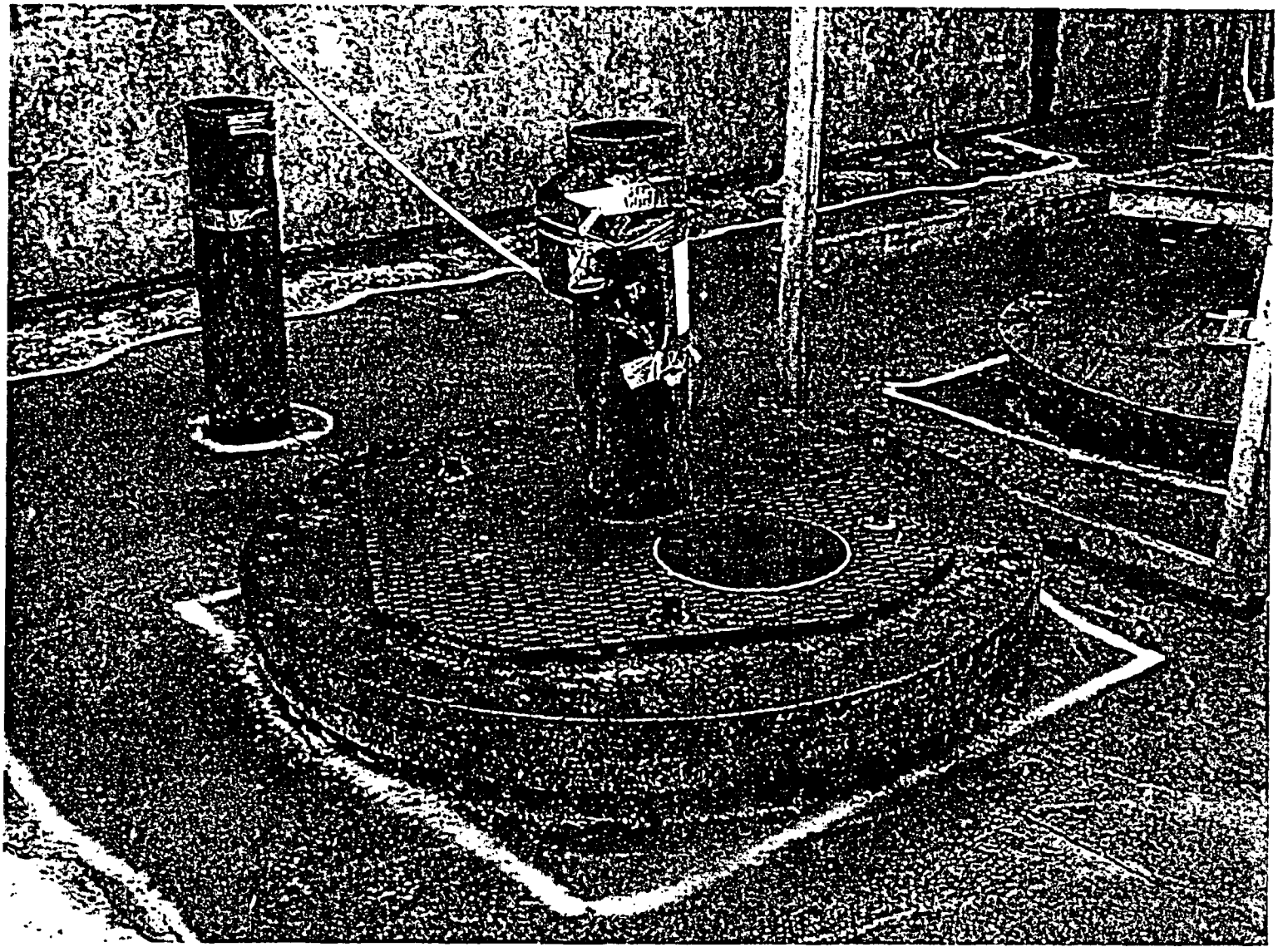


ACCESS TO INTAKE TUNNEL

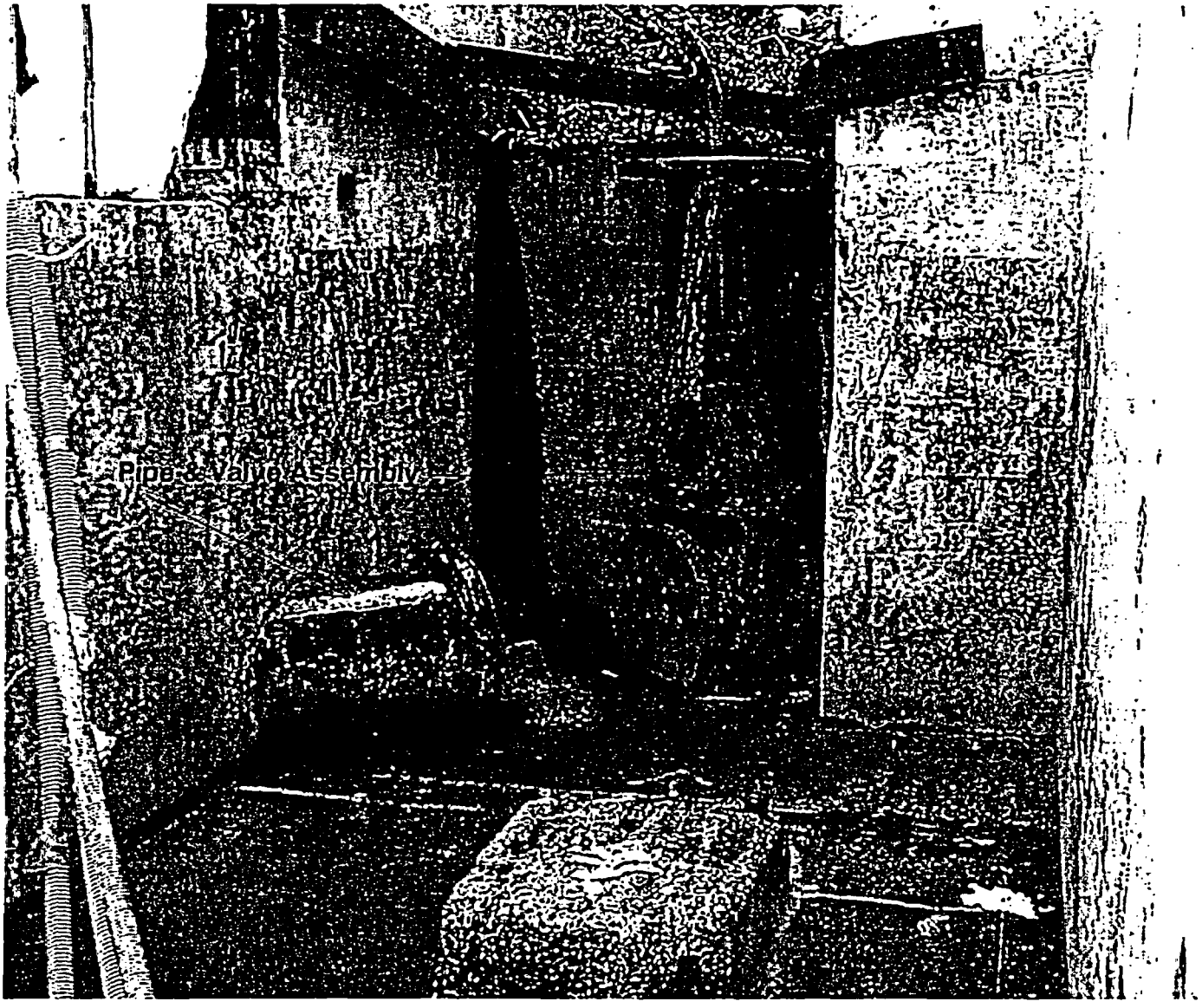
ATTACHMENT 1 . 1



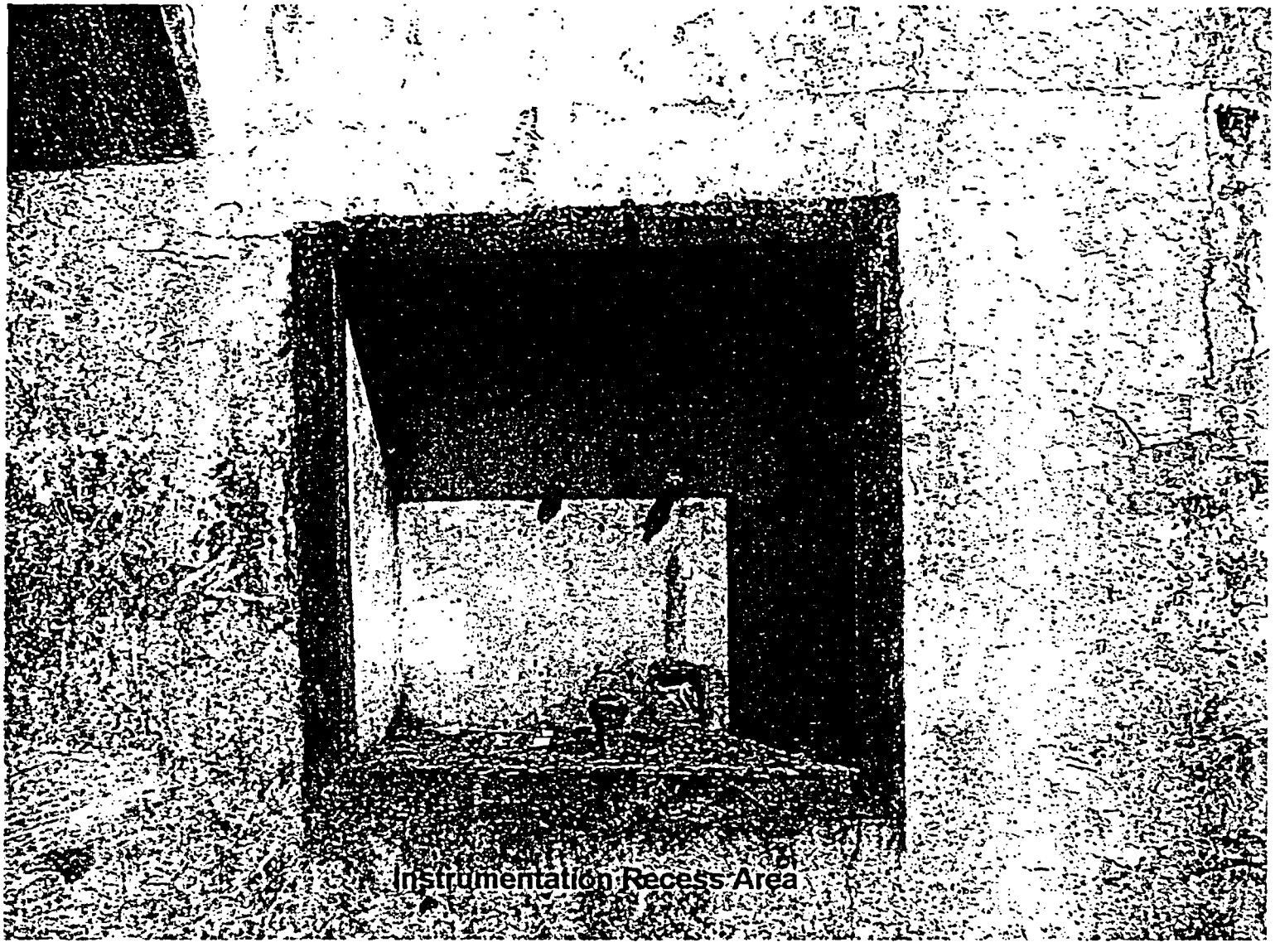
ATTACHMENT 1 . 2



ATTACHMENT 1 . 3

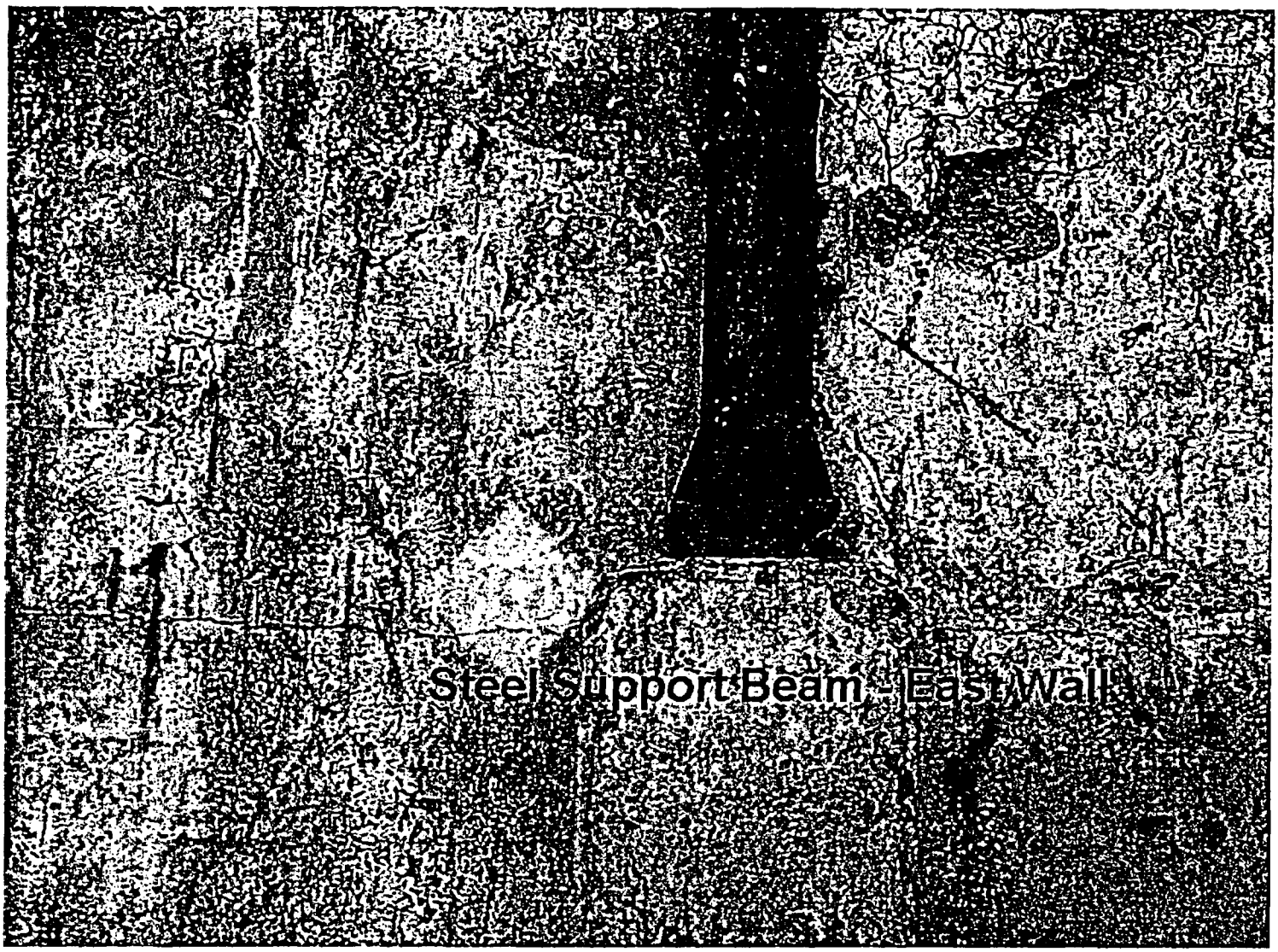


ATTACHMENT 1.4

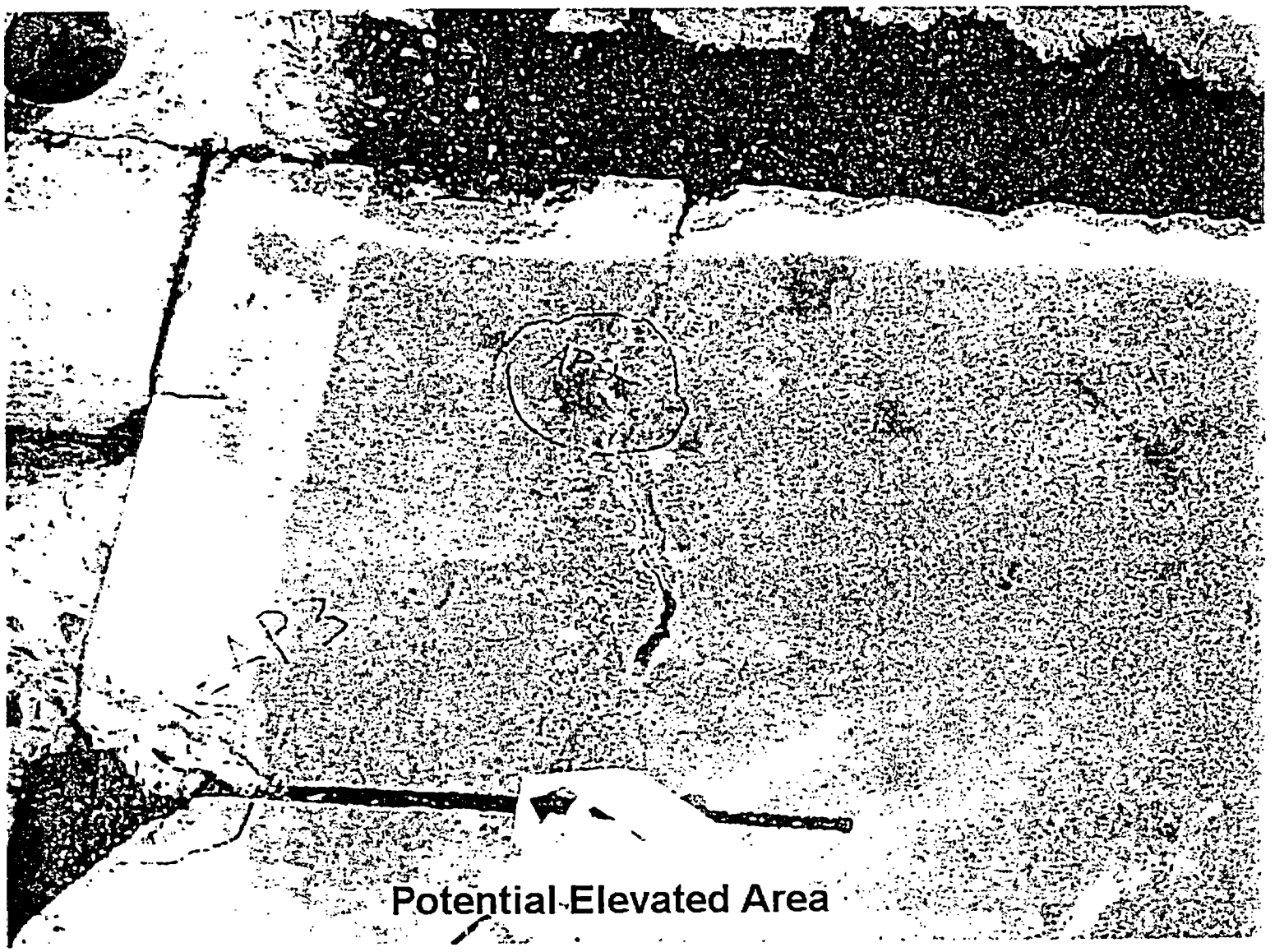


ATTACHMENT 1 . 5

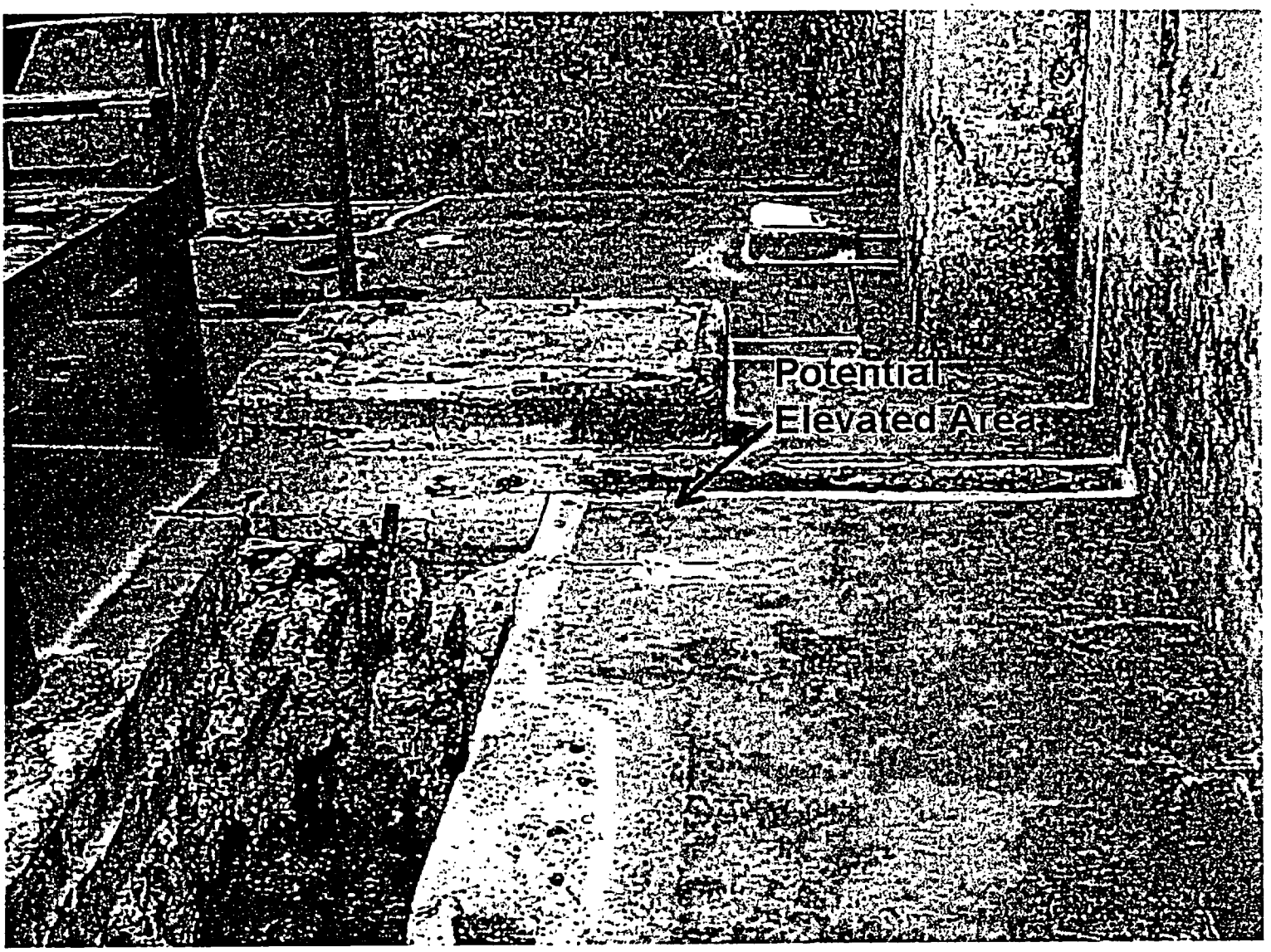
Page 17 L 35
E900-03-029



ATTACHMENT 1 . 6

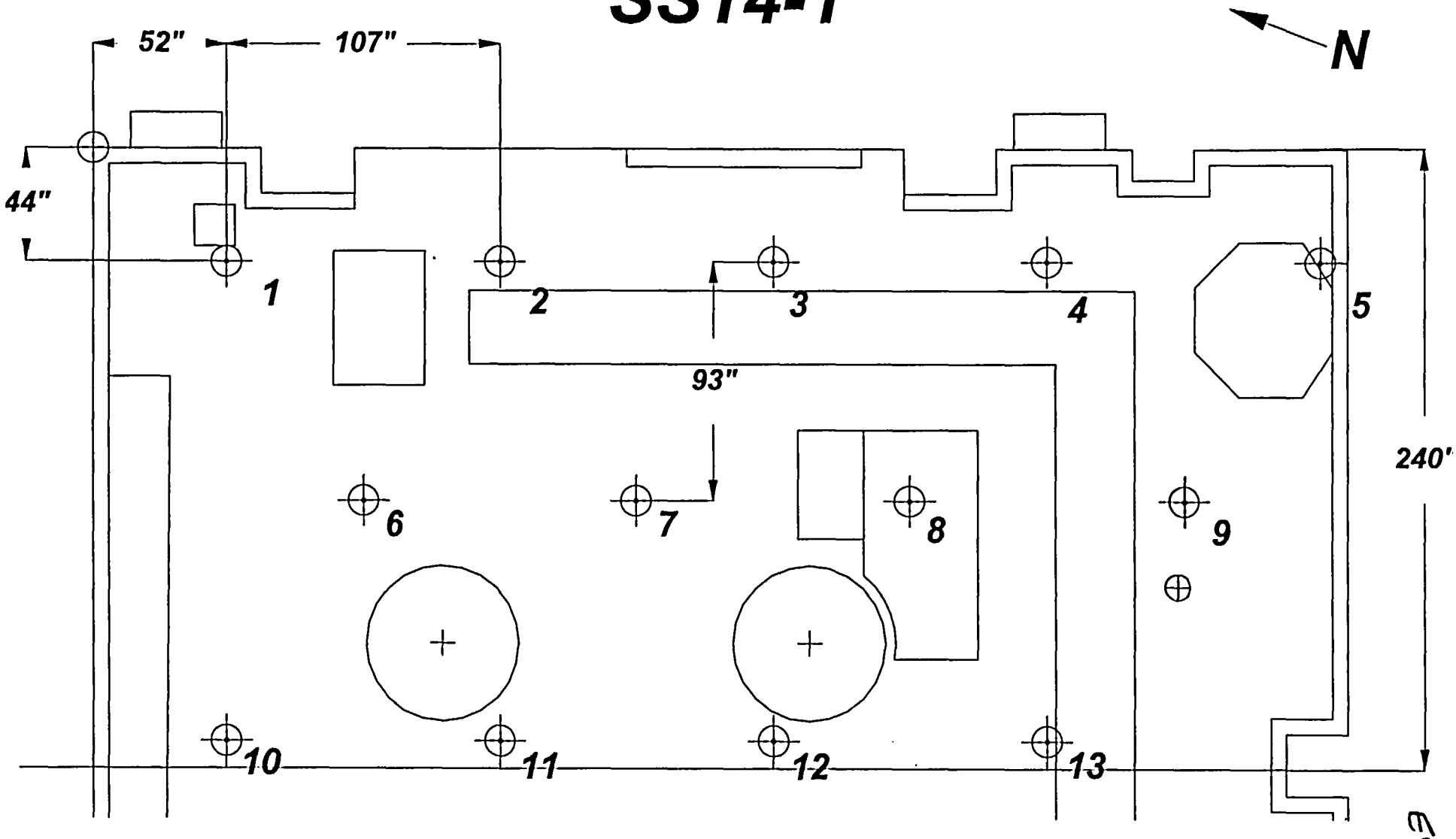


ATTACHMENT 1 - 7



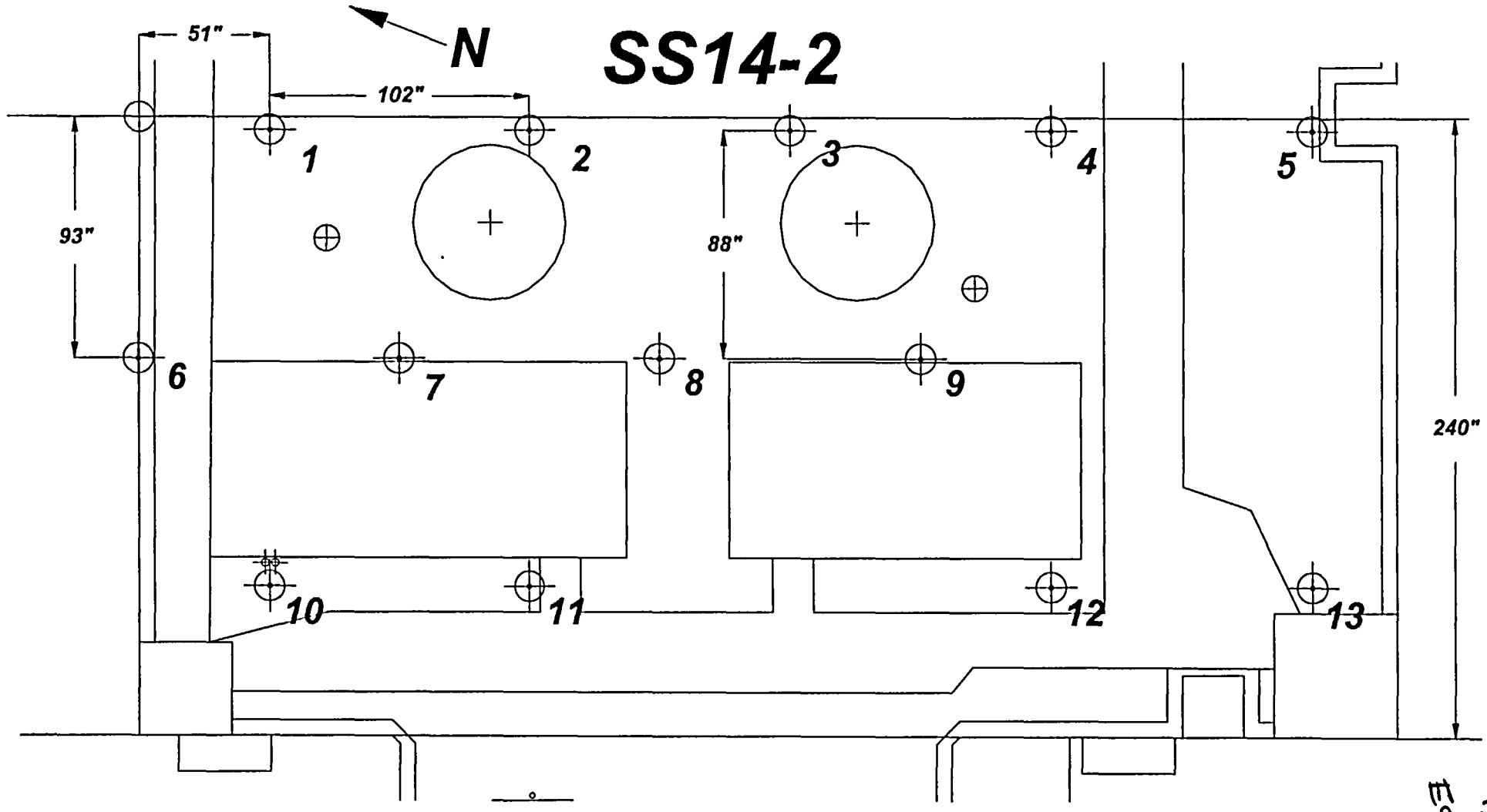
ATTACHMENT 1 . 8

SS14-1



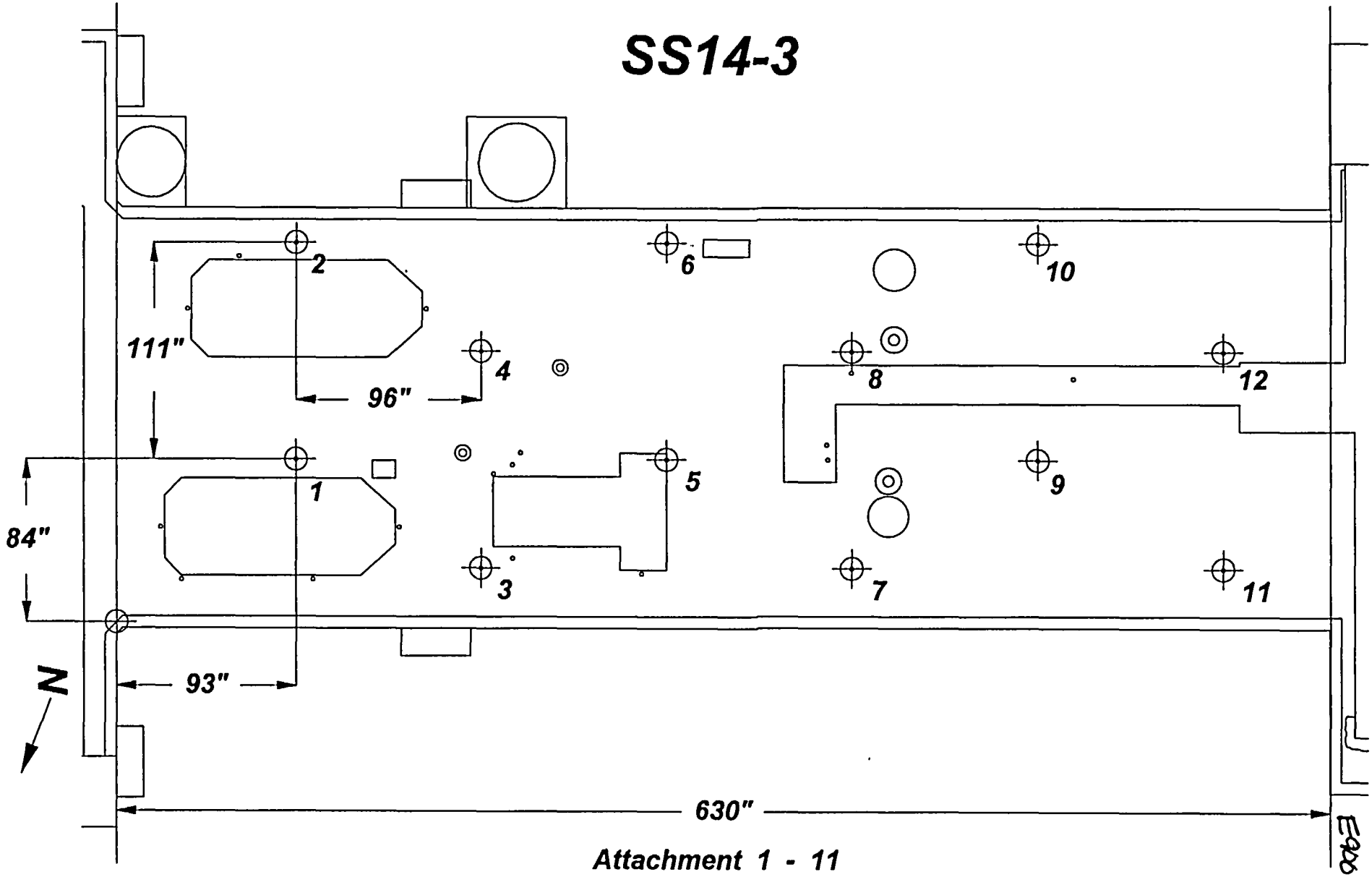
Attachment 1 - 9

Page 20 of 35
E900-03-029



Attachment 1 - 10

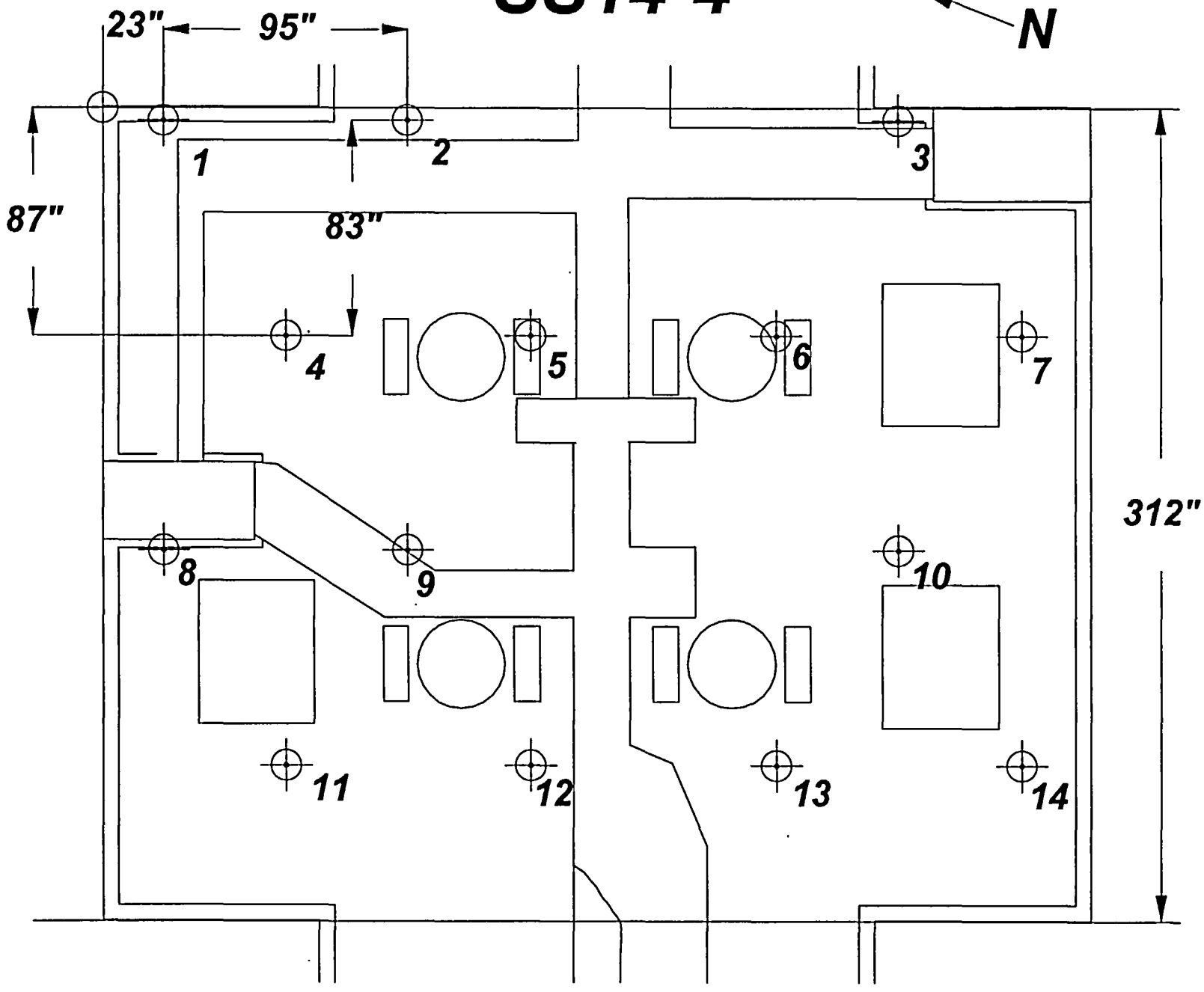
SS14-3



Attachment 1 - 11

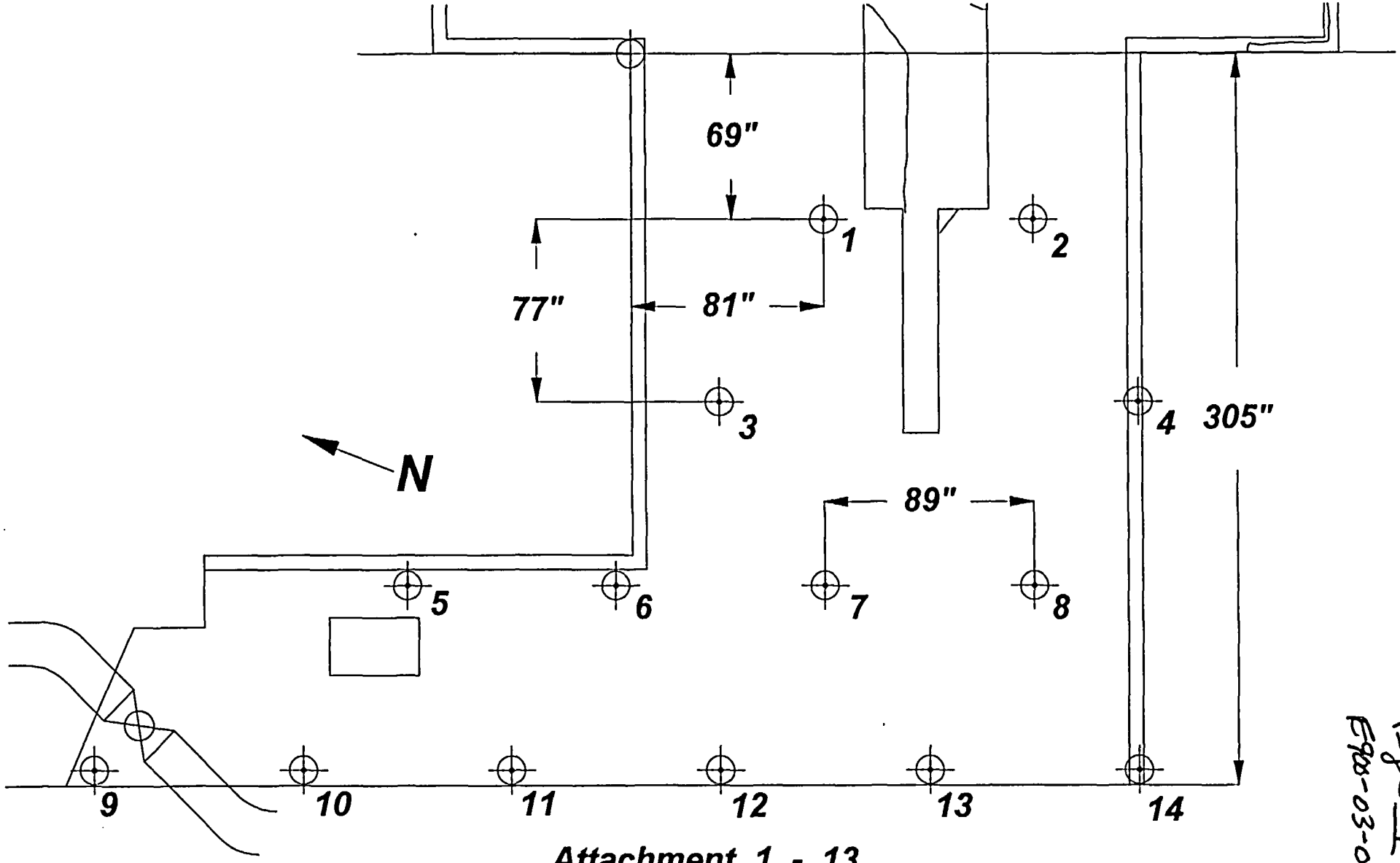
Page 22 of 3
E00-03-029

SS14-4



Attachment 1 - 12

SS14-5



Attachment 1 - 13

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	
17498	dpm/100 cm^2	13124	dpm/100 cm^2

25.0 mrem/y TEDE Limit

SAMPLE NO(s)⇒ SSGS Footprint

Cs-137 Limit		Cs-137 Administrative Limit	
17461	dpm/100 cm^2	13095	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	4.27E-01	0.027%	27	4.81	4.45	N/A	4.81	Am-241
2	C-14		0.000%	3,700,000	0.00	0.00	0.00	N/A	C-14
3	Co-60	2.27E+00	0.146%	7,100	25.57	0.09	25.57	N/A	Co-60
4	Cs-137	1.55E+03	99.784%	28,000	17460.65	15.59	17460.6	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		0.000%	1,800,000	0.00	0.00	Not Detectable	N/A	Ni-63
8	Pu-238	2.65E-01	0.017%	30	2.99	2.49	N/A	2.99	Pu-238
9	Pu-239	2.36E-01	0.015%	28	2.66	2.37	N/A	2.66	Pu-239
10	Pu-241		0.000%	880	0.00	0.00	Not Detectable	N/A	Pu-241
11	Sr-90	1.52E-01	0.010%	8,700	1.71	0.00	1.71	N/A	Sr-90
			100.000%		17498	25.0	17488	10	
					Maximum Permissible dpm/100 cm^2				

ATTACHMENT 3.1

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

SNEC AL	75%	Total Activity Limit DCGLw		Administrative Limit	
		6.58	pCi/g	4.94	pCi/g

SAMPLE NUMBER(s)⇒ SSGS Footprint

Cs-137 Limit		Cs-137 Administrative Limit	
6.57	pCi/g	4.93	pCi/g

23596.16%	25.0	mrem/y TEDE Limit
565.72%	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	0.427	0.027%	9.9	2.3	0.00	0.08	0.00	1.08	0.74	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	2.270	0.146%	3.5	67.0	0.01	0.40	0.01	16.21	0.14	Co-60
4	Cs-137	1550.00	99.784%	6.6	397	6.57	273.99	6.57	5871.21	15.62	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		0.000%	747	19000	0.00	0.00	0.00	0.00	0.00	Ni-63
8	Pu-238	0.265	0.017%	1.8	0.41	0.00	0.05	0.00	3.68	2.59	Pu-238
9	Pu-239	0.236	0.015%	1.6	0.37	0.00	0.04	0.00	3.69	2.55	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	0.152	0.010%	1.2	0.61	0.00	0.03	0.00	3.17	1.00	Sr-90
		1.55E+03	100.000%			6.58	274.58	6.58	5899.039	22.629	
						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 3 . 2

Page 27 of 35
EQD-03-029

Duratek

CALIBRATION CERTIFICATE

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

ORIGINAL

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

CUSTOMER INFORMATION		INSTRUMENT INFORMATION	
Customer Name: Duratek Inc. - Instrument Services Facility		Manufacturer: Ludlum	
Address: 628 Gallaher Road, Kingston, TN 37763		Model: 2350-1	Serial Number: 126182
Contact Name: Thomas Scott		Probe: N/A	Serial Number: N/A
Customer Purchase Order Number: N/A	Work Order Number: 2003-00753	Calibration Method: Electronic and Source	

INSTRUMENT CALIBRATION INFORMATION

Instrument Range (CPM)	Calibration Standard Value (CPM)	Instrument Response		Comments
		Before Calibration	After Calibration	Calibrated in accordance with RP-INS-I-245 Rev 0
400K	400,000	402,437	403,468	Pulser: 120935 Cal Due: 03/28/04
40K	40,000	40,248	40,302	D-814: 2551 Cal Due: 10/07/03
4K	4,000	4,026	4,030	Psychron: 5546 Cal Due: 02/10/04
400	400	405	405	EPPROM Version: 37122N21
HV Cal Values (M2350 HV Entry)	Desired HV (Voltmeter) (VDC)	As Found (VDC)	As Left (VDC)	
600	600	602	602	Temp: 20.7°C
1,200	1,200	1202	1202	Pressure: 741mmHg
1,800	1,800	1798	1798	Humidity: 56%
Parameter	Tolerance (±10%)	As Found	As Left	
Low End Threshold	10 ± (9 to 11) mVDC	N/A	10.6	Geotropism: SAT ACK/Scroll: SAT
Midpoint Threshold	50 ± (45 to 55) mVDC	N/A	48.8	BAT>4.5: SAT Volume: SAT
High End Threshold	100 ± (90 to 110) mVDC	N/A	97	Count: SAT Audio Divide: SAT
Window Width	10 ± (9 to 11) mVDC	N/A	10	Alarms: SAT Lamp: SAT
Display-to-mV ratio:	100 to 10 mV			Overload Test: SAT

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected 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 instrument).

Instrument Calibrated By:	Reviewed By:	Date: 7-30-03
Calibration Date: 07/30/03	Calibration Due: 01/30/04	

ATTACHMENT 4 - 1

Duratek

Inst.# ~~126218~~ 8/12/03 RM
126182

ORIGINAL

CALIBRATION CERTIFICATE

Page 29 of 35
E900-03-029

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: 196021
Customer Purchase Order Number: N/A	Work Order Number: 2003-00722	Evaluation Method: Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION			
1) Source Nuclide: Cs^{137}	Serial Number: 019454	Activity: 5μCi	Certification Date: N/A (Used for Plateau Only)
2) Source Nuclide: Cs^{137}	Serial Number: 049711	Activity: Variable	Certification Due Date: 04/09/03

Scaler Information		Precision Test	mR/Hr (Source #2)
2350-1	#117566	Count 1	1.99
Due Date	01/22/04	Count 2	2.00
Threshold	T=100 (10mV)	Count 3	2.01
Cable Length	5ft.	Average	2.00
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 = 74,731	High Sample Activity (2mR/hr) Using Source #2 = 268,512	Dead Time (DT): 1.57194E-05	Calibration Constant (CC): 6.213047E+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	.417	.402
Voltage Plateau:	YES ✓	NO	1	0.90-1.10	.942	.937
High Voltage: 1050V			2	1.8-2.2	2.07	2.00

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:	I certify that the above information is correct: Reviewed By:	Date: 7-22-03
Certification Date: 07/22/03		Certification Due: 01/22/04

ATTACHMENT 4.2

ORIGINAL

LUDLUM MODEL 44-10 HIGH VOLTAGE PLATEAU DATA SHEET Page 30 of 43
(Detector peaked using Cs137 #019454 5uCi button) E900-03-029

Serial Number: 196021 .

HIGH VOLTAGE	SOURCE (10 second count)
700	37,380
701	39,576
702	40,089
703	41,493
704	42,325
705	42,859
706	42,756
707	41,336
708	40,700
709	N/A
710	N/A
711	N/A

Detector Parameters for Peaking

Parameter	Setting	Comments
Threshold (10mV/100)	612	Peaked for Cs^{137} at 662keV
Window (On)	100	
High Voltage	705	
CPM/mR/Hr	221,028	

FWHM values performed with Threshold = 642 and Window = 40

FWHM = $\frac{685-605}{662} \times 100\%$	12.1%

Detector peaked for Cs^{137} using Ludlum peaking procedure and threshold setting of 612 and window setting of 100 as requested by John Duskin. 2350-1 #117566 calibration due 01/22/04 used for peaking 44-10 detector.

Performed By: [signature] Date: 7/22/03 .

Reviewed By: [signature] Date: 9-18-03 .

2350-1 # 126182
44-10 # 196021

ATTACHMENT 4.3

ORIGINAL

Radiological Survey Form - SNEC Facility

Survey Information	Instrument Data			Air Sample	File Code Number: SDG-03-1434
Location NON-IMPACTED Concrete Intake structure "West"	Contamination Survey		Radiation Survey	Sample ID No(s): NA	Smearable Contamination
Reason Concrete BKG. Study	Inst NA	Inst NA	Inst 2350/NAI Ana. Inst NA		Smear # NA
Date 10-23-03 Time 1515	S/N	S/N	S/N 176182/196621 S/N		βγ
Tech [illegible]	Cal Due	Cal. Due	Cal. Due 1-30-04/1-30-04 Cal. Due	Contamination Results:	α
Tech. NA	Eff	Eff	B.C.F. NA B.C.F.	1 = dpm / 100 cm 2	Ratio
	Bkg	Bkg	Notes: Radiation in u R/hr / MR/hr (circle one) Dose rates are general area unless otherwise noted	2 = dpm / Gross Wipe	Units
	Mdc	Mdc		3 = Mrad/hr / 100 cm2	Comments
	☐ = Smear Location		○ = Contact Reading	4 = Other (Explain in remarks)	
GRCS Review JAUSKIN/JKU Date. 10/24/03				Beta Survey Exempt Per GRCS ☑ Yes ☐ No	

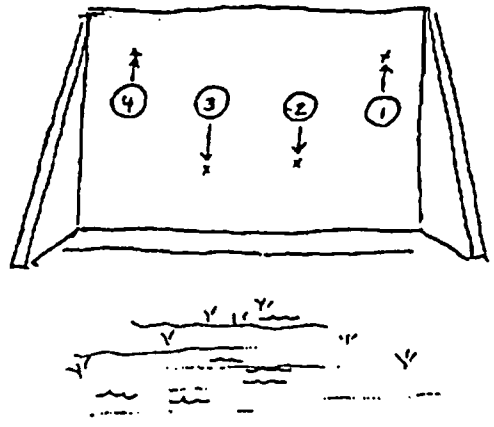
Background readings taken on concrete face of Intake structure "side facing river" At 2" "surface to probe" 300 sec. count time. ← N

① = 421

② = 405

③ = 403

④ = 411



Remarks.

* This Inst. set up with Cs137 window.

ATTACHMENT 5.1

Page 31 of 35
E900-03-029

NaI Static Measurement MDC Calculation [redacted]

Use when Background Count Time ≠ Sample Count Time

$B := 421$ $T_{SB} := 5$ $T_B := 5$ $MSO := 7.888 \cdot 10^{-5}$ $CF := 221028$

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

$K := CF \cdot \frac{MSO}{\left(Ci \cdot 2.22 \cdot 10^{12}\right)}$ $K = 1.803 \cdot 10^{-3}$ $Mass := 4355.3$

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

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

$L_C = 47.8$ *Critical level*

$L_C + B = 468.8$ *Any count above this value should be regarded at being greater than background (page 6-37 of MARSSIM).*

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

$L_D = 98.41$ *Detection limit*

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

$\frac{MDC}{2.22} = 4.92 \cdot 10^{3}$ *Results in pCi* $\frac{\left(\frac{MDC}{2.22}\right)}{Mass} = 1.13$ $\frac{pCi}{g}$

ATTACHMENT 5.2

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)

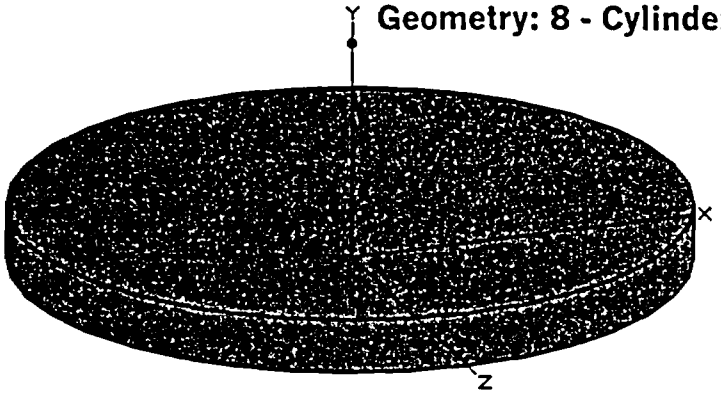
Page 37 & 35
E900-03-029

MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page : 1
DOS File : STATIC.MS5
Run Date : October 29, 2003
Run Time : 1:26:52 PM
Duration : 00:00:01

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: SSGS Static Points
Description: 1 pCi/g Concrete - Cs-137; 2" Air Gap
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	2.54 cm	1.0 in
Radius	15.24 cm	6.0 in

Dose Points

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

ATTACHMENT 5-4

DOS File : STATIC.MS5
Run Date : October 29, 2003
Run Time : 1:26:52 PM
Duration : 00:00:01

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
0.0364	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