Survey Report
Saxton Nuclear Experimental Corporation

Site Areas MA3 and MA4 – Weir Discharge Area

Removal of the SNEC WEIR Line Extension to the Raystown Branch of the Juniata River

Prepared by GPU Nuclear, Inc.

July 2005

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Executive Summary

This report summarizes information collected from the MA3 and MA4 Weir Discharge line and out-fall area. Included, in this report is information from several other reports and a remediation effort that addressed this area, and its formally connected piping. This report provides summary results from post remediation scan surveys, volumetric sampling of sediment within the Juniata River at the exit of the Weir Discharge line, and soil samples taken of the soil bed below the Weir Discharge pipe after its excavation. This survey work is an extension of previous monitoring efforts, and meets many of the requirements set forth by the SNEC License Termination Plan (LTP) **(Reference 9.1)**. This work was conducted by GPU Nuclear, Inc. and is a part of the closeout records for the SNEC facility.

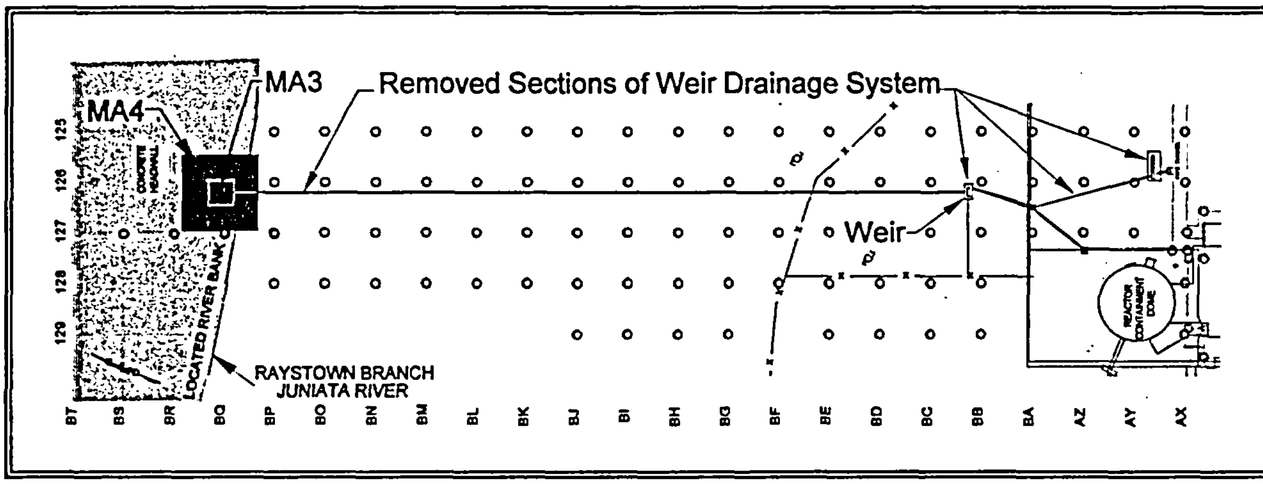


Figure 2, Section of SNEC grid map showing Weir line extension as it empties to the Raystown Branch of the Juniata River

Survey data was collected from the Weir Discharge line area according to data collection requirements specified in survey request SR-0020 **(Appendix A-1)**, SR-0028 **(Appendix A-2)**, SR-0034 **(Appendix A-3)**, and applicable site procedures (e.g., **Reference 9.2**). The following types of measurements were performed on materials found near the Weir Discharge line and out-fall area.

1. NaI scanning measurements were performed of approximately 220 m^2 of soil bed below the Weir Discharge line.
2. Subsurface soil samples were taken approximately 2 to 2.5 meters below the surface along one hundred ten (110) meters of Weir pipe out to the concrete headwall at the Raystown Branch of the Juniata river.

3. Sediment samples were taken in the river at the Weir Discharge line opening, within the pipe itself, and along the shoreline downstream from the exit of the Weir Discharge pipe (see **Appendix A-3**).

4. All samples were analyzed by gamma spectroscopy. Several samples were also sent to off-site laboratories for a more complete analysis that included all radionuclides associated with the SNEC facility decommissioning effort.

Excluding the interior of the Weir Discharge pipe, which was removed all the way to the concrete headwall[1], all soil and sediment samples were below the applicable DCGLw. Therefore, this collection of data demonstrates that these survey units meet the radiological criteria for unrestricted use specified in 10 CFR 20.1402 **(Reference 9.3)**.

Based on the results of these sampling efforts, GPU Nuclear, Inc. concludes that the MA3 and MA4 site areas and the subsurface soil bed below the Weir Discharge pipe meets the NRC requirements for release to unrestricted use.

[1] The Weir Discharge pipe was removed in its entirety all the way to the river bed.

1.0 Purpose and Scope

This report presents the results and conclusions of survey and sampling work performed on the following area/item:

- Weir Discharge Area (MA3) – A Class 2 area at the mouth of the Weir Discharge line which empties to the Raystown Branch of the Juniata River.

- Weir Discharge Area (MA4) – A Class 3 area that is essentially the buffer zone around the mouth of the Weir Discharge line opening.

- Approximately one hundred ten (110) meters of the Class 3 subsurface soil bed that supported the Weir Discharge pipe from SNEC site grid number BF-127 through BQ-127. It ends at the concrete headwall on the bank of the Raystown Branch of the Juniata River.

This survey effort meets the intent of FSS information required by 10 CFR 50.82(a)(11) (**Reference 9.4**) and SNEC's License Termination Plan (LTP) and demonstrates that this area meets the radiological criteria for unrestricted use specified in 10 CFR 20.1402.

2.0 Survey Area Description

The Weir Discharge line originated in the 1.1 acre SNEC facility yard area (OL1 area) at the Weir. The Weir Discharge line was a ten (10) inch corrugated galvanized steel pipe that extended to the river discharge point about one hundred seventy (170) meters north of the SNEC Containment Vessel (CV). The pipe passed below site areas OL1, OL2, OL10 and OL8 on its way to the river before reaching the concrete headwall at the rivers edge. The pipe was buried about one (1) to two and one half (2.5) meters below the surface as it traversed about one hundred fifty (150) meters to the river area, and was excavated in its entirety by September 2001. The MA3 area is a small ~ 25-m^2 area that envelops the former Weir Discharge pipe outlet area. This location is shown on the SNEC site grid map at grid location BP-127 (**Reference 9.5**). The MA3 Class 2 area includes the mouth of the Weir line, and several square meters of area that surround the opening. The pipe outlet extended three to five feet beyond the concrete headwall and was embedded in the river bottom (see **Figure 3** sketch). The MA4 area is an additional ~200-m^2 area that is essentially a Class 3 buffer zone around the MA3 discharge point. MA4 is mostly river area.

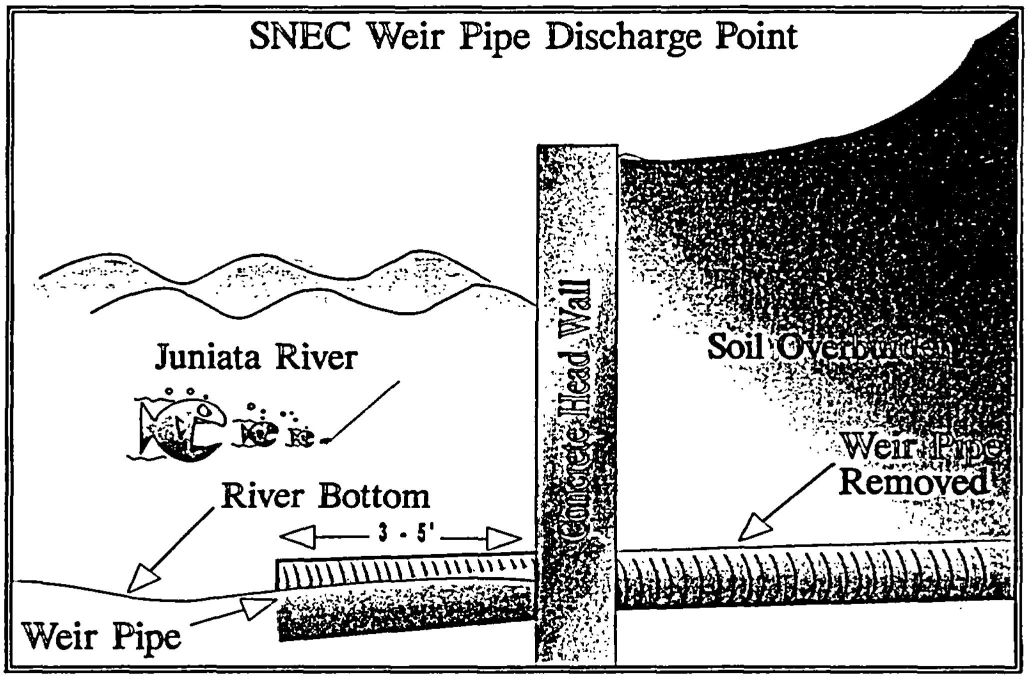


Figure 3, Is a sketch of the Weir discharge pipe exit point.

3.0 Operating History

3.1 Weir Line Use

One of the Radioactive Waste Disposal Facility (RWDF) evaporator water release pathways was via the sewage treatment system in the OL2 area (the CV Yard area), and then on to the river north of the SNEC CV. This pathway involved the SNEC facility Weir and Weir Discharge piping system. In addition, the decontamination shower water from the Control and Auxiliary (C&A) building was directed to this pathway after analysis demonstrated that radioactivity levels were within limits. A respondent to the questionnaire developed for the SNEC Historical Site Assessment **(Reference 9.6)** indicated that the Weir sediment was contaminated during SNEC facility operation. Another respondent indicated that river sediment in the vicinity of the Weir Discharge pipe showed elevated Cs-137 concentrations.

The Weir Discharge area was sampled quarterly and the results were reported annually as location A1-4 in the Radiological Environmental Monitoring Program (REMP) report **(Reference 9.7)**. Scoping and characterization activities at and in the Weir Discharge line also identified Cs-137 concentrations in sediment samples, but no significant levels of other SNEC related radionuclides have been identified.

3.2 Weir Line Remediation Status

Remediation of the Weir and associated piping occurred in stages over a number of years, starting in the OL1 and OL2 site areas. In the final stage, remaining sections of Weir piping extending from just outside the SNEC facility fence line (in grid BF-127) was removed. As part of the Discharge line removal effort a short three (3) to five (5) foot section of pipe that extended beyond the concrete headwall into the river was also removed. All piping systems and yard drains in the Containment Vessel (CV) Yard area were removed previously. Only the concrete headwall exists at the present time.

The Weir piping meets the definition of a Class 1-survey unit (**Reference 9.1, Table 5-5**) since sample analysis results from inside the pipe have shown contamination levels well above the applicable DCGLw. In addition, the pipe and Weir system have been remediated which is indicative of a Class 1 survey area.

3.3 SNEC Facility Operating History

The Saxton Nuclear Experimental Corporation (SNEC) facility featured a pressurized water reactor (PWR), which was licensed to operate at 23.5 megawatts thermal (23.5 MWth). The facility is owned by the Saxton Nuclear Experimental Corporation and is licensed by GPU Nuclear, Inc. The SNEC facility is maintained under a Title 10 Part 50 license and associated Technical Specifications. In 1972, the license was amended to possess but not operate the SNEC reactor.

The facility was built from 1960 to 1962 and operated from 1962 to 1972, primarily as a research and training reactor. After shutdown in 1972, the facility was placed in a condition equivalent to the current SAFSTOR status. Since then, it has been maintained in a monitored storage condition. The fuel was removed in 1972 and shipped to a (now DOE) facility at Savannah River, South Carolina, who is now the owner of the fuel. As a result of this, neither SNEC nor GPU Nuclear, Inc. has any further responsibility for the spent fuel from the SNEC facility.

The reactor, containment vessel and support buildings have all been removed from the site. The building and structures that supported reactor operation were partially decontaminated by 1974. In the late 1980's and through the 1990's, additional decontamination, disassembly and removal of the containment vessel support buildings, large and small components and other miscellaneous support equipment was complete.

By 1992 decontamination and dismantlement of the reactor support structures was complete. Large components such as the pressurizer, steam generator, and reactor vessel were removed in late 1998. The removal of the steel Containment Vessel (CV) (to ~ 4' below grade), and backfill was complete by late 2003. More recently, decontamination, disassembly and demolition of the remaining SNEC facility buildings including remnants of the coal fired Saxton Steam Generating Station (SSGS) has taken place. The SNEC facility is currently in the process of performing the Final Status Survey for unrestricted release leading to license termination.

4.0 Site Release Criteria

The site release criteria as applied to the Weir line and surrounding area, corresponds to the radiological dose criteria for unrestricted use per 10 CFR 20.1402. The dose criteria is met "if the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr, including that from groundwater sources of drinking water; and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."

Levels of residual radioactivity that correspond to the allowable dose and meet site or survey unit release criteria were derived by analyses using either the building occupancy (surface area) or resident farmer (volumetric) scenarios. The dose modeling for these scenarios is explained in Chapter 6 of the SNEC LTP, Revision 3. The derived concentration guideline levels (DCGLs) determined in the LTP form the basis for satisfying the site release criteria.

As described in Chapter 6 of the SNEC LTP **(Reference 9.1)**, a correction to the gross activity DCGLw is made to address de-listed radionuclides and provide a reasonable SNEC established safety factor. The SNEC facility has instituted an administrative limit of 75% for the allowable dose (DCGL) for all measurement results. Thus the de-listed radionuclide dose is accounted for by using the 75% administrative limit.

4.1 Weir Line Area Specific DCGLw Values

The Weir Discharge line was connected to the Weir and other yard drainage systems that interconnected within the OL1 and OL2 site areas, and therefore the radionuclide content for the Weir line should be well represented by a radionuclide mix from this area. Over time, several samples form the Weir line internals were sent to an off-site laboratory for a more complete analysis (see **Table 1**).

Table 1, Weir Discharge Line Samples

SNEC Sample No	LAB No.	Location/Description	pCi/g Co-60	pCi/g Cs-137	Decay Date June 30, 2005 Analysis Date
SX881960174SD	ERL 88237	Sediment - Weir Pipe (~10' out Toward River from Weir), MA3 & 4	[illegible]	29.18	May 7, 1996
SX881960173SD	ERL 88236	Sediment - Weir Pipe (~70' out Toward River from Weir), MA3 & 4	0.15	37.28	May 7, 1996
SX10SL990032	ERL 110643, 111150	*Weir Discharge to River - 30' in from Excavation Beyond Fence MA3 & 4*	[illegible]	3.05	July 19, 1999
SX12SD99285	ERL 111231	Sample #22 Weir Discharge Outfall, MA3 & 4	[illegible]	0.33	December 3, 1999
SX12SD99277	ERL 111223	Sample #21 Weir Discharge Outfall, MA3 & 4	[illegible]	0.36	December 3, 1999
SX11SD01937	BWXT, 0106103-01	Weir Line 135', Above River Outlet, MA3 & 4	[illegible]	56.05	May 24, 2001
SXSD1472	BWXT, 0110089-01	Weir Site # 1, BP-127, Sediment, MA3 & 4	0.01	2.63	October 10, 2001
SXSD4717	Teledyne; L23493-3	A1-4, Weir Discharge, MA3 & 4	[illegible]	0.15	April 15, 2004

NOTE: Samples 174, 173 and 1937 were taken from inside the Weir pipe.

Only Co-60 and Cs-137 were positively identified in these Weir Discharge line samples. Use of the OL1/OL2 area radionuclide listing from the CV Yard is somewhat more restrictive, but just as appropriate since this area is the origin of the effluent that entered the Weir. The applicable DCGLw values for the Weir line are tabulated in **Appendix A-4** and are presented in **Table 2**.

Table 2, Weir Line – DCGLw Values

Gross Activity DCGLw (dpm/100 cm^2)	Volumetric DCGLw (pCi/g) for Cs-137
44,306 (33,229 A.L.)	5.75 (4.31 A.L.)

NOTE: A.L. is the site Administrative Limit or 75% of the effective DCGLw for the area.

5.0 Survey Design/DQO Process

The Weir Discharge line post-remediation survey work was performed in June and September of 2001, with guidance provided by survey request SR-0020 and SR-0028. These SR's required a number of samples from the soil bed below the Weir line after pipe removal between site grid markers BF-127 and BQ-127 as shown on **Figure 4**.

Site Areas MA3 and MA4 – Weir Discharge Area

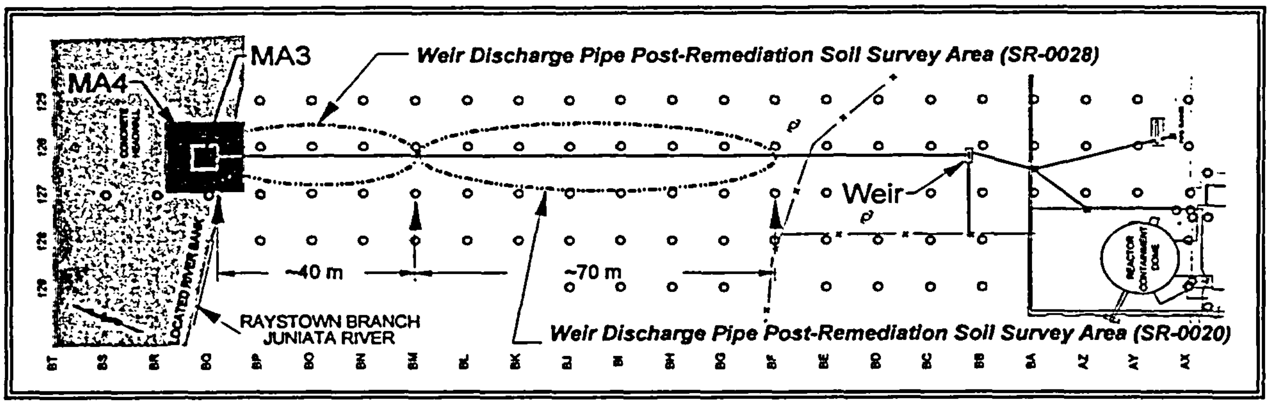


Figure 4, is a diagram of Weir Discharge line area showing the location of post remediation survey work.

An open window 2" by 2" NaI detector was used to scan the soil bed below the pipe. The bottom of the open trench area was scanned at 100% coverage. The open trench was approximately two (2) meters wide and one hundred ten (110) meters long (considering both SR-0020 and SR-0028). Then the total area scanned was at least two hundred twenty (220) square meters of subsurface soil.

The MA3/MA4 area has been monitored on a routine basis over several years as part of the SNEC facilities Radiological Environmental Monitoring Program (REMP). The Weir location was designated indicator station A1-4 in the REMP reports. The results from these monitoring efforts for the years 1999 through 2004 are provided in **Table 5**.

Sampling at or near the Weir Discharge point was also performed as a separate function by ENERCON Services, Inc. as part of the GPU Nuclear sediment sampling program for the Raystown Branch of the Juniata River (**Reference 9.8**). This work was previously provided to the US NRC on January 11, 2002 (**Reference 9.9**), and reported in **Reference 9.1**. The results of this work are summarized in **Table 4**. The ENERCON sampling effort proved that the river area adjacent to the SNEC site property is largely non-impacted (**Reference 9.1**), with the exception of the Discharge Tunnel and Weir Discharge line areas (MA2, MA3 and MA4). ENERCON services performed the river sampling program in accordance with applicable site procedures and guides developed specifically by ENERCON for this type of study (see **Reference 9.8**). All samples were collected under SNEC facility survey request SR-0034 and applicable site procedures. The sampling plan was developed for GPU in accordance with applicable sections of the SNEC License Termination Plan (LTP). All SR's are reviewed and approved by the SNEC RSO (or his representative) before implementation. Data Quality Objectives (DQO's) for the Weir area are presented in the following table.

Table 3, DQO/Design Parameters/Results

Survey Unit	Weir Area MA3	Weir Area MA4	Below Weir Line in Subsurface Soil
SNEC Survey Request No.	SR-0034 & REMP	SR-0034	SR-0020 & SR-0028
Survey Area Classification	2	3	Non classified subsurface area below MA4, OL1, OL2, OL8 & OL10
Total Area Size (m^2)	~25	~200 in river area, <10 for headwall	~220 (assumes a ~2 meter wide trench area by ~110 meters long)
Scanning Goal (m^2)*	N/A - under water	Under water except for headwall which was 100%	~220 (100%)
Applicable Statistical Test	N/A (non-random)	N/A (non-random)	N/A (non-random)
Effective Soil DCGLw (Cs-137 pCi/g)	4.31 (A.L.)	4.31 (A.L.)	4.31 (A.L.)
Surface Gross Activity DCGLw (dpm/100 cm^2)	33,229 (A.L.)	33,229 (A.L.)	33,229 (A.L.)
Applicable Number of Soil or Sediment Samples Taken in Accessible Areas*	4 by ENERCON & 1/Qtr for REMP	8 by ENERCON downstream of Weir out-fall	40 (SR-0020 & SR-0028)
Estimated Surface Scan MDC (dpm/100 cm^2)	N/A - under water	N/A - under water	~13,407 for concrete headwall
Estimated Scan MDC for Sediment (Cs-137 pCi/g)	N/A - under water	N/A - under water	~6.9
Scan Speed for Soil-Like Materials (cm/sec)	N/A - under water	N/A - under water	50
NaI Alarm point During Scanning (FSS)	N/A - under water	N/A - under water	> 13,000 gcpm
Number of Alarm Points During Scanning Process	N/A	N/A - under water, none for headwall area	At least 3 biased samples taken @ > 13,000 gcpm
Typical NaI Background Level (cpm)	N/A	N/A	~13,000
Typical GM Background Level (cpm)	N/A	N/A	~40
Scan Survey Instrument	N/A - under water	N/A - under water section	Eberline ASP& SPA-3, 2" by 2" NaI probe for soil, HP-210 GM or equivalent for pipe sections
Instrument Conversion Efficiency (NaI - cpm/mR/h)	N/A	N/A	~ 900,000
Instrument Conversion Efficiency (GM - cpm/dpm)	N/A	N/A	0.1 for Cs-137 GM type detection efficiency

*When scanning is not possible, such as in water-covered areas, out-falls etc., a sufficient number of randomly selected samples are collected (as appropriate). However, much of the immediate river bottom area in MA3/MA4 is solid rock with little or no collectible materials. Thus sediment samples were collected at points where sediment was available.

NaI open window detector used for soil scanning (full spectrum energy region)

N/A = Not Applicable

5.1 Description of Survey Unit

Figure 2 shows that the MA3/MA4 area as approximately 225 square meters that includes river and river bank area (concrete headwall), but is largely river bottom that is underwater except in very dry years. About forty (40) square meters of subsurface soil area was also surveyed during the final remediation stage of the Weir Discharge line. Native soil, river silt, cinders, and coal ash make up the vast majority of material types in the Weir line area.

5.2 Survey Design for the MA3/MA4 Area

One of the sampling efforts in the MA3/MA4 area was provided to the US NRC (**Reference 9.9**). From this report, a total of four (4) samples were selected from the Weir Discharge line exit point in the MA3 river area (see **Reference 9.8**). An additional eight (8) samples were collected within or near the MA4 area downstream from the Weir Discharge point. The results of this sampling effort are provided in **Table 4**. Samples were either sediment that was scooped from the river bottom, or was materials vacuumed from rocky surfaces from the river area at select locations.

The A1-4 REMP sampling area is located directly in front of the concrete bulkhead where the Weir pipe was secured at the rivers edge. These results were routinely collected on a quarterly basis every year the SNEC Decommissioning effort was underway. These results are reported in **Table 5**.

During the final phase remediation effort for the final forty (40) meters of Weir line, samples and NaI scanning was performed in the vicinity of the Weir pipe as it was removed from the soil bed. In addition, a Geiger Mueller (GM) pancake probe was used to surface scan pipe sections and the concrete bulkhead at the rivers edge. The location of sample points were identified on a survey map of the Weir line area. The soil scan MDC was determined to be 6.9 pCi/g for Cs-137 (see **Appendix A-5**). The scan MDC for the GM probe was determined to be 8,024 dpm/100 $cm^2_{Cs\text{-}137}$/0.5985 (Cs-137 fraction in mix) = gross activity scan MDC ***13,407 dpm/100 cm²*** (see **Appendix A-4** and **A-6**).

6.0 Sampling and Survey Results

6.1 Summary of Survey Results from ENERCON River Study

From **Reference 9.8**, six (6) locations were identified for sampling in the vicinity of the Weir Discharge exit pipe. From these six locations, four (4) samples were taken at the base of the concrete headwall (MA3) (locations 1 and 2), and eight (8) additional samples were taken downstream from the Weir line in the MA4 area or beyond (locations 3 through 6). All samples were collected either by scooping up material or by vacuuming up river fines. Samples could not be located randomly and were instead collected using a biased (as available) sampling approach. A complete discussion of the results of this study is provided in **Reference 9.8**. Actual sample results for this area are provided in **Table 4.**

Table 4, ENERCON Weir Area Sample Results (MA3/MA4 – SR-0034)

ENERON Site ID*	SNEC Sample ID	Sample Date	Sampling Method	Cs-137 (pCi/g)	Co-60 (pCi/g)
Weir 1 (MA3)	SXSD1472	10/10/01	Scoop	2.55	< 0.08
Weir 1 (MA3)	SXSD1473	10/10/01	Scoop	1.07	< 0.06
Weir 2 (MA4)	SXSD1474	10/10/01	Scoop	< 0.07	< 0.07
Weir 2 (MA4)	SXSD1475	10/10/01	Scoop	0.05	< 0.055
Weir 3 (MA4)	SXSD1476	10/10/01	Scoop	< 0.039	< 0.05
Weir 3 (MA4)	SXSD1477	10/10/01	Scoop	< 0.06	< 0.05
Weir 4 (MA4)	SXSD1478	10/10/01	Scoop	< 0.06	< 0.05
Weir 4 (MA4)	SXSD1479	10/10/01	Scoop	< 0.05	< 0.04
Weir 5 (MA4)	SXSD1480	10/10/01	Suction	0.15	< 0.04
Weir 5 (MA4)	SXSD1481	10/10/01	Suction	0.08	< 0.04
Weir 6 (MA4)	SXSD1545	10/18/01	Suction	1.8	< 0.05
Weir 6 (MA4)	SXSD1546	10/18/01	Suction	1.2	< 0.07

Data from ENERCON report (Reference 9.8). Note that Weir 3 through 6 may be out of the MA4 200 m^2 area.

All results from the ENERCON study for the Weir area are below the applicable DCGLw for Cs-137 (as the surrogate).

6.2 REMP Sample Results 1999 to 2004

The A1-4 sample location is at the base of the concrete headwall of the Weir pipe river outlet. Samples from this area are reported annually via the Radiological Environmental Monitoring Program (REMP) process. The SNEC facility maintains a fully approved procedure (E900-ADM-4500.22) for performing this type of environmental monitoring **(Reference 9.10)**. The results of REMP sampling at the Weir area are provide in **Table 5.**

Table 5, REMP Data from Location A1-4 (Weir Out-fall)

SNEC REMP Data @ A1-4 Location				
1999	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	N/S	0.087	0.094	0.13
Co-60	N/S	< 0.02	< 0.02	< 0.01
2000	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	0.034	0.03	0.25	0.43
Co-60	< 0.03	< 0.015	< 0.04	< 0.03
2001	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	0.216	< 0.02	0.5	0.17
Co-60	< 0.013	< 0.02	< 0.06	< 0.065
2002	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	0.23	0.33	0.09	0.08
Co-60	< 0.06	< 0.06	< 0.05	< 0.06
2003	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	0.04	< 0.09	0.08	N/S
Co-60	< 0.05	< 0.1	< 0.04	N/S
2004	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cs-137	N/S	0.17	< 0.04	< 0.11
Co-60	N/S	< 0.04	< 0.04	< 0.09

N/S = No sample taken.

6.3 Remediation Support Surveys (SR-0020 and SR-0028)

As previously discussed, the one hundred fifty (150) meter long Weir line was remediated over time, with the last forty (40) meters extricated in about September of 2001. Since this work was in support of the remediation effort at the SNEC facility, no survey design was developed for this work. However, a survey request was written that contained some definable Data Quality Objectives (DQO's). DQO values are summarized in **Table 3**, along with calculated scan MDC values for the 2" by 2" NaI open window detector, and the Geiger Mueller (pancake) probe. The DCGLw calculation logic for the Weir line is provided as **Appendix A-6**. Scan MDC calculations have been included with this report as **Appendix A-5** and **A-6**. Other DQO values are provided in **Table 3** (as applicable).

Samples were also taken from below the Weir Discharge line in the soil bed within the last one hundred ten (110) meters of the line to the rivers edge (see **Appendix A-1** and **A-2**). These sample results are provided in **Table 6**.

Site Areas MA3 and MA4 – Weir Discharge Area

Post remediation survey and sampling results indicate that no significant contamination of the surrounding soils had occurred. No sample result from the soil bed indicated the presence of contaminated soil above the applicable DCGLw. The results of this survey effort are reported in **Appendix A-1**, and in **Table 6**.

Table 6, Soil Bed Sample Results Below Weir Discharge Line (SR-0020, June-2001)

Grid No.	SNEC Sample ID	Sampling Location	Cs-137 (pCi/g)	Co-60 (pCi/g)
BM-127	SXSL1013	0' Removal Start Point	0.19	< 0.05
BL-127	SXSL1014	12' South of Start Point	< 0.05	< 0.05
BL-127	SXSL1015	24' South of Start Point	< 0.07	< 0.07
BK-127	SXSL1016	36' South of Start Point	< 0.06	< 0.06
BK-127	SXSL1017	48' South of Start Point	< 0.06	< 0.06
BK-127	SXSL1018	60' South of Start Point	< 0.07	< 0.07
BJ-127	SXSL1019	72' South of Start Point	< 0.06	< 0.06
BJ-127	SXSL1020	84' South of Start Point	< 0.05	< 0.04
BK-127	SXSL1021	62' South of Start Point	< 0.07	< 0.07
BJ-127	SXSL1022	80' South of Start Point	< 0.07	< 0.08
BJ-127	SXSL1037	96' South of Start Point	< 0.07	< 0.08
BI-127	SXSL1038	108' South of Start Point	< 0.06	< 0.06
BI-120	SXSL1039	120' South of Start Point	0.05	< 0.06
BH-127	SXSL1040	132' South of Start Point	< 0.07	< 0.06
BH-127	SXSL1041	144' South of Start Point	0.08	< 0.07
BH-127	SXSL1049	156' South of Start Point	0.98	< 0.06
BG-127	SXSL1050	168' South of Start Point	0.06	< 0.05
BG-127	SXSL1051	180' South of Start Point	< 0.05	< 0.05
BF-127	SXSL1052	192' South of Start Point	< 0.07	< 0.06
BG-127	SXSL1053	190' QC South of Start Point	< 0.07	< 0.07
BF-127	SXSL1080	204' South of Start Point	0.02	< 0.05
BF-127	SXSL1081	216' South of Start Point	< 0.05	< 0.05
BE-127	SXSL1082	228' South of Start Point	< 0.07	< 0.06
BE-127	SXSL1083	240' South of Start Point	0.19	< 0.08
BF-127	SXSL1084	206' South of Start Point	< 0.06	< 0.07

Note: Soil around the Weir Discharge line should be considered a Class 3 soil volume.

Soil bed sample results were all below the applicable DCGLw. The highest concentration found inside the Weir pipe remnants in this area was 63.2 pCi/g Cs-137 in grid BH-127. Additional pipe internal sample results are provided in **Appendix A-1**.

Table 7, Soil Bed Sample Results Below Weir Discharge Line (SR-0028, Sep-2001)

Grid No.	SNEC Sample ID	Sampling Location	Cs-137 (pCi/g)	Co-60 (pCi/g)
BQ-127	SXSL1406	North End (Headwall)	3.9	< 0.06
BP-127	SXSL1408	10' South. of North End	0.78	< 0.06
BP-127	SXSL1410	20' South. of North End	< 0.08	< 0.07
BP-127	SXSL1412	30' South. of North End	0.11	< 0.08
BO-127	SXSL1414	40' South. of North End	0.06	< 0.05
BO-127	SXSL1415	45' South. of North End	< 0.07	< 0.07
BO-127	SXSL1417	50' South. of North End	< 0.06	< 0.06
BO-127	SXSL1419	60' South. of North End	< 0.06	< 0.07
BN-127	SXSL1421	70' South. of North End	< 0.07	< 0.06
BN-127	SXSL1422	75' South. of North End	< 0.06	< 0.07
BN-127	SXSL1424	80' South. of North End	< 0.05	< 0.05
BN-127	SXSL1426	90' South. of North End	0.06	< 0.06
BM-127	SXSL1429	100' South. of North End	< 0.05	< 0.04
BM-127	SXSL1431	110' South. of North End	< 0.08	< 0.07
BM-127	SXSL1433	120' South. of North End	0.05	< 0.07

Note: Sample SXSL1406 was taken below the open end of the pipe in the river area.

Soil bed sample results were all below the applicable DCGLw. The highest concentration found inside the Weir pipe remnants in this area was 4.9 pCi/g Cs-137 in grid BP-127. Additional pipe internal sample results are provided in **Appendix A-2**.

Scan results[2] of the soil bed below the Weir pipe along the remediated sections did not detect any count rate above 15,000 cpm, while background was determined to be approximately 13,000 cpm. A corresponding sample (SXSL1084) was taken in about the same location as the elevated count rate, and did not yield an above background Cs-137 concentration. The scan MDC for this measurement activity is estimated to be 6.9 pCi/g Cs-137. Supporting documentation for the soil scan MDC calculation is found in **Appendix A-5**.

Scan results of the concrete headwall area using a GM type detector did not show count rates greater than 100 net counts per minute (background was determined to be ~40 cpm). The scan MDC for this measurement activity is estimated to be 8,024 dpm/100 cm^2 for Cs-137, or 8,024 dpm/100 cm^2/0.5985 (see **Appendix A-4**) = gross activity scan MDC of ***13,407 dpm/cm²***. Supporting documentation for scan MDC calculations are found in **Appendix A-5** and **A-6**. All GM scan results of the concrete headwall are below the applicable DCGLw. All previous remediation support survey work is shown in **Appendix A-1** and **A-2**.

[2] Using a 2" by 2" NaI detector equipped with an open window

7.0 Data Assessment

7.1 Assessment Criteria

This survey data has been reviewed to verify authenticity, appropriate documentation, quality, and technical acceptability. The review criteria for data acceptability are:

1) The instruments used to collect the data were capable of detecting the radiation of the radionuclide of interest at or below the investigation levels.

2) The calibration of the instruments used to collect the data was current and radioactive sources used for calibration were traceable to recognized standards or calibration organizations.

3) Instrument response was checked before, and when required, after instrument use each day data was collected.

4) Survey team personnel were properly trained in the applicable survey techniques and training was documented.

5) MDC values and the assumptions used to develop them were appropriate for the instruments and the survey methods used to collect the data.

6) The survey methods used to collect the data were appropriate for the media and types of radiation being measured.

7) Special instrument methods used to collect data were applied as warranted by survey conditions, and were documented in accordance with an approved site Survey Request procedure.

8) The custody of samples that were sent for off-site analysis was tracked from the point of collection until final results were provided.

9) Final status survey data consists of qualified measurement results representative of current facility status and were collected in accordance with the applicable survey request.

If a discrepancy existed where one or more criteria were not met, the discrepancy was reviewed and corrective action taken (as appropriate) in accordance with site procedures.

7.2 Survey Variations (Design, Survey Request, LTP)

7.2.1 The remediation support survey work (SR-0020 and SR-0028) was performed in accordance with an approved survey request, but lacked a reviewed survey design associated with a final status survey. Samples collected under these survey requests were biased in that they were taken from the soil bed below the Weir pipe in the area where leaks would be expected. This is a reasonable subsurface sampling approach. In addition, sampling and analysis when performed under an approved survey request is a fully qualified activity that adheres to applicable site procedures such as **Reference 9.2.**

7.2.2 The entire Weir line remediation effort was not covered by a similar remediation support survey process, and therefore these sections of the Weir line must be considered as representative of the entire Weir pipe length. This is not an unreasonable assumption, and while the Weir Discharge line is a Class 1 survey object, the soil volume around the pipe is not.

7.2.3 Samples taken form the river in the MA3/MA4 areas were not located using a random selection methodology, since that would have been less effective in determining if elevated Cs-137 concentrations were present in the area. Except for the immediate Weir Discharge line opening, additional samples were taken downstream form the river in deposits of sediment, and at locations where changes in the rivers direction would have deposited sediment. These natural deposition points retain higher probabilities of maintaining positive sample results than solid rock bottom surfaces which are constantly swept clean by aggressive water motion.

7.2.4 Scanning results of soils and the Weir out-let concrete headwall do not have a 5% QC re-scan documented in the survey record in accordance with the SNEC LTP.

7.2.5 No static GM measurements were taken on the concrete headwall. However, remediation support scan survey work was performed over the entire exposed headwall surface. The results yielded < 100 net counts per minute in all accessible areas. The estimated scan MDC is provided in **Appendix A-6**.

7.2.6 A sample of concrete from the top of the headwall structure yielded a concentration of 4.7 pCi/g for Cs-137. This relatively small location is slightly above the applicable volumetric administrative limit DCGLw of 4.3 pCi/g. However, this value is well below the maximum 5.75 pCi/g Cs-137 DCGLw listed in **Table 2**. Another sample of the same concrete structure yielded a much lower concentration. It is not clear why one small location on the concrete headwall was at this elevated concentration.

7.3 Quality Control Measurements

Quality Control (QC) samples are reported for each of the applicable **Appendices (A-1, A-2** and **A-3**). All QC samples were taken in accordance with the requirements of **Reference 9.1**, and applicable site procedures which require that at least 5% of all samples be re-taken. However, some QC samples may have been collected at errant locations. Additionally, repeat scan surveys should have been performed in accordance **Reference 9.2**, but the documentation does not provide this information. Additional QC related issues are provided in the **Appendix A-1** and **A-2**.

7.4 Assessment Summary

<u>Statistical testing of the data does not need to be performed for this survey work since the data clearly show that these survey units meets the site release criteria.</u> This survey unit clearly meets the criterion because of the following:

1. ☒ All measurements in the survey units are less than or equal to the $DCGL_W$, or

2. ☐ A background reference area was used, and the difference between the maximum survey unit measurement and the lowest background reference area measurement are less than or equal to the DCGL.

8.0 <u>Final Status Survey Conclusions</u>

In general, the Weir Discharge line area (MA3/MA4) survey and sampling work was performed in accordance with Revision 3 of the SNEC LTP and site implementing procedures. Survey and sampling data were reviewed to determine if the data meet the quantity and quality specified for this survey unit as prescribed by the applicable survey design. The survey data for each survey unit met the following conditions:

1. The average residual radioactivity within the (MA3/MA4) area is less than the assigned DCGLw.

2. Since all measurements were less than the DCGLw, no $DCGL_{EMC}$ criteria need be applied.

3. No remediation of the MA3/MA4 areas were performed to reduce levels of residual radioactivity below concentrations necessary to meet DCGLw values.

These conditions satisfy the release criteria established in the SNEC LTP and the radiological criteria for unrestricted use given in 10 CFR 20.1402. Therefore, it is concluded that the SNEC Weir Line Area (MA3/MA4) as described in this report is suitable for unrestricted release.

9.0 References

9.1 SNEC License Termination Plan

9.2 SNEC Procedure E900-IMP-4520.04, "Survey Methodology to Support SNEC License Termination"

9.3 Code of Federal Regulations, 10 CFR 20.1402.

9.4 Code of Federal Regulations, 10 CFR 50.82(a)(11).

9.5 SNEC Facility Site Area Grid Map - Drawing Number SNECRM-020.

9.6 SNEC Facility Historical Site Assessment Report, March 2000.

9.7 SNEC Facility Radiological Environmental Monitoring Report, 1999 to 2004.

9.8 Final Report, Sediment Sampling Raystown Branch of the Juniata River for GPU Nuclear, Inc., Prepared By: ENERCON Services, Inc., November 1, 2001.

9.9 GPU Nuclear Correspondence to U.S. NRC, E910-02-002, January 11, 2002, "Phase 2 and 3 Characterization Data".

9.10 SNEC Procedure E900-ADM-4500.22, "Environmental Monitoring".

9.11 NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions".

9.12 SNEC Procedure E900-ADM-4500.60 "Final Status Survey Report".

APPENDIX A-1

SR-0020

SURVEY REQUEST CONTINUATION SHEET			
SR NUMBER	0020	AREA/LOCATION	WEIR Piping
SPECIFIC SAMPLING/SURVEY INSTRUCTIONS OR COMMENTS			

RESULTS SUMMARY FOR SR-0020

SR-0020 was issued to obtain radiological survey and sampling data to ensure adequate and correct classification of soil and materials surrounding the Weir piping. The survey unit covered under this SR is WEIR Piping (grids are listed in the SR). The SR required the following radiological measurements.

- Surface scan measurements using a NaI detector (SPA-3 or equivalent). Survey techniques will be IAW the SR.
- A minimum of 21 non-biased soil samples were required to be taken for analysis. A systematic approach to taking the samples was required to be used to ensure entire length of the trench is sampled.
- Surface Soil Samples: Using appropriate tools obtain samples as directed in the SR. Obtain a sample to a depth of 15 centimeters (6 in.)
- QC Repeat Measurements: A minimum of 5% of all surface scan measurements and sampling were required to be re-performed using identical methodology. Surface Soil sampling was performed by taking a second sample from the same drill hole or sample point.
- QC Repeat Analysis (Replicate):
- Additional sampling/surveys were not performed.

1. Summary of Results

A. Surface Scan Measurements (NaI Detector)

A 100% surface scan was required of all accessible areas of the Weir pipe trench, IAW the SR. A total of 100% of this area was surveyed.

Results: The calculated ABCR for the trench was 13,000 cpm. The maximum reading seen in the trench was 15,000 cpm.

B. Surface Static Measurements

No static measurements were obtained.

Results: Not Applicable.

SURVEY REQUEST CONTINUATION SHEET			
SR NUMBER	0020	AREA/LOCATION	WEIR Piping
SPECIFIC SAMPLING/SURVEY INSTRUCTIONS OR COMMENTS			

C. Surface Soil and Sediment Sampling

Thirty (30) Surface Soil samples were obtained. Five (5) Sediment samples were taken. These samples were randomly taken and spread over the length of the weir pipe trench except for 2 samples that were taken at locations of increased activity.

Results: Eighteen (18) Surface Soil and Sediment samples taken for this SR were less than MDA. MDA activity range is from 0.05 pCi/g to 0.07 pCi/g (for the surrogate isotope, Cs-137). For the seventeen (17) samples, not including QC samples, that did contain Cs-137 activity greater than the sample MDA, activities ranged from 0.02 pCi/g to 63.2 pCi/g. Co-60 was identified in the highest activity Cs-137 sample at 0.41 pCi/g and in three (3) other samples at lower concentrations..

2. Quality Control (QC) Measurements and Comparisons

- **Repeat Scan measurements and Soil/Sediment samples** were required to be performed to meet the applicable acceptance criteria established in Section 4.6 of E900-IMP-4520.04. QC scan measurements were repeated for an unknown percentage of the area scanned. Surface Soil and Sediment sample QC measurements were repeated for 0.00% of Surface Soil and Sediment samples. **(See Section #4)**

3. Quality Control Sample Recounts

- **Repeat QC replicate recount** –Monthly, approximately five per cent (5%) of all samples counted on the gamma spectroscopy system or Tri-Carb system, IAW SNEC Procedure E900-QAP-4220.02, are required to be counted for replicate analysis. (e.g. FSS soil samples). **(See Section #4)**

4. Exceptions and Discrepancies

- Cs-134 was required by the SR to meet an MDA of 0.15 pCi/g. Cs-134 is not on the data base printout. Unable to determine if this SR requirement was met.
- Field Sample Collection Sheets show that there were four (4) QC Samples taken for the Soil/Sediment. The problem is that none of these "QC" samples was taken in the same location as a sample for which it was to be the QC. These can not be counted as QC samples as the closest you get to another sample point is 2 feet, unless another type of sample is taken; i.e. SL and SD at same location, both labeled QC
- Unable to tell by the survey form how much of the trench was QC surveyed, if any at all. There is no second person and/or no second instrument number on the survey form in the package.
- There was no replicate/QC done for the smears/dose rates on the weir piping boxes.

SURVEY REQUEST CONTINUATION SHEET			
SR NUMBER	0020	AREA/LOCATION	WEIR Piping
SPECIFIC SAMPLING/SURVEY INSTRUCTIONS OR COMMENTS			

5. Special Note(s)

- As far as the need for replicates goes, the procedure refers you to E900-QAP-4220.02 – SNEC Count Room Quality Assurance Program

Chris A. Marthaller [signature] 7-26-05

Print/Signature Date

APPENDIX A-2

SR-0028

SURVEY REQUEST CONTINUATION SHEET			
SR NUMBER	0028	AREA/LOCATION	Weir Piping
SPECIFIC SAMPLING/SURVEY INSTRUCTIONS OR COMMENTS			

RESULTS SUMMARY FOR SR-0028

The purpose of SR-0028 is to survey and sample below grade materials surrounding the remaining section of Weir piping on U.S. Army Corp of Engineers (Raystown Lake) property. This SR also includes surveying and sampling of the Weir concrete headwall at the bank of the Juniata river.

- Surface scan measurements were performed using an E-140N w/ HP-210/260 or equivalent, an ASP-1 and a Micro Rem meter. Survey techniques will be IAW the SR and E900-IMP-4520.04 Rev 1 Survey Methodology.
- Obtain at least one (1) non-biased soil sample for approximately every 10 feet of trench length. Samples shall be representative of material that surrounded the Weir piping.
- At least two (2) non-biased concrete samples of the Weir headwall and additional samples of areas demonstrating elevated activity. Sample volume should be at least 100 cc.
- Surface Soil Samples are to be obtained at a depth of less than 15 cm (6 inches).
- Obtain representative non-biased soil samples throughout the remaining section of the Weir piping.
- Obtain additional samples of areas demonstrating elevated activity as applicable.
- QC measurements will be performed by randomly re-sampling and re-surveying at least 5% of all sampling and survey points using identical methodology contained in this SR.
- Replicate sample analysis will be performed in accordance with Reference 6.13.

1. Summary of Results

A. Surface Scan Measurements

A 100% surface scan was required of all accessible areas of the Weir piping, the headwall and the trench (where permissible). See 4.1.

Results: Direct frisk readings on the Weir piping and headwall showed <100 ncpm (40cpm bkg). No readings with the ASP-1 or the Micro Rem exceeded action levels.

B. Surface Static Measurements

No static measurements were obtained.

Results: Not Applicable.

C. Surface Soil Samples (SSS)

Thirty eight (38) SSS plus one (1) QC sample were taken. (See 4.2). These samples were spaced based on the SR requirement to sample approximately every 10' of the trench.

Results: Thirteen (13) SSS taken for this SR were less than MDA. MDA activity range is from <0.05 pCi/gm to <0.08 pCi/gm for the surrogate isotope Cs-137. For the twenty five (25) samples (not including the QC sample) that did contain Cs-137 activity greater than MDA activities ranged from 0.046 pCi/gm to 4.90 pCi/gm. No other licensed isotopes were identified for this SR.

2. Quality Control (QC) Measurements and Comparisons

- **Repeat Scan measurements and SSS samples**
- For QC scan measurements see 4.3.
- One (1) SSS sample was taken for 2.6% of SSS samples. See 4.2

3. Quality Control Sample Recounts

- **Repeat QC replicate recount –** See 4.4

4. Exceptions and Discrepancies

- 4.1 E900-IMP-4520.04 Rev 1 4.3.2 states that all survey instruments will have an established ABCR (4.3.2-3) prior to scanning. No written documentation could be found to establish that this step had been performed for this SR.

- 4.2 Although four (4) QC samples were listed on the field collection data sheet only one (1) qualified as a QC sample. The other three (3) QC samples were obtained from unique locations and therefore must be considered a sample and not a QC.

- 4.3 E900-IMP-4520.04 Rev 1 states that at least 5% of all scanned areas shall have a repeat QC scan. No written documentation could be found to establish that this step had been performed for this SR.

- 4.4 E900-IMP-4520.04 Rev 1 requires that at least 5% of all samples taken have a replicate count performed. No written documentation could be found to establish that step had been performed for this SR.

SURVEY REQUEST CONTINUATION SHEET

SR NUMBER	0028	AREA/LOCATION	Weir Piping
SPECIFIC SAMPLING/SURVEY INSTRUCTIONS OR COMMENTS			

5. Special Note(s)

N/A

- N/A

Bill Horton *Bill Horton* 07-13-05

Print/Signature Date

APPENDIX A-3

SR-0034

ORIGINAL

SURVEY REQUEST FORM

SR NUMBER	SR-0034	DATE OF REQUEST	10/04/01
TYPE OF SR	☐ FSS ☒ CHARACTERIZATION ☐ OTHER:		
AREA/LOCATION	Raystown Branch of the Juniata River - Sediment Sampling		
PURPOSE	The purpose of this SR is to obtain sediment samples from the Juniata River bottom in accordance with the attached ENERCON Services work procedure. See attached map for sampling locations.		
SURVEY UNIT #	N/A	GRID #	N/A
SURVEY UNIT #	N/A	GRID #	N/A
SURVEY UNIT #	N/A	GRID #	N/A

SAMPLE TYPE

☐ SURFACE SOIL SAMPLE:

☐ SUB-SURFACE SOIL SAMPLE:

☒ SEDIMENT SAMPLE: See specific sampling instructions on page 2 of this SR.

☐ CORE SAMPLE:

☐ WATER SAMPLE:

☐ OTHER:

SURVEY TYPE

SURFACE SCAN	☐ BETA ☐ GAMMA ☐ ALPHA	INST. TYPE		SCAN RATE & DETECTOR DISTANCE FROM SURFACE	
		PROBE TYPE			
SURFACE SCAN	☐ BETA ☐ GAMMA ☐ ALPHA	INST. TYPE		SCAN RATE & DETECTOR DISTANCE FROM SURFACE	
		PROBE TYPE			
STATIC MEASUREMENT	☐ BETA ☐ GAMMA ☐ ALPHA	INST. TYPE		COUNT TIME & DETECTOR DISTANCE FROM SURFACE	
		PROBE TYPE			
STATIC MEASUREMENT	☐ BETA ☐ GAMMA ☐ ALPHA	INST. TYPE		COUNT TIME & DETECTOR DISTANCE FROM SURFACE	
		PROBE TYPE			
OTHER SURVEY TYPES OR COMMENTS					

ORIGINAL

SR NUMBER	SR-0034	DATE OF REQUEST	10/0401

SPECIFIC SAMPLING / SURVEY INSTRUCTIONS

General Requirements

1. All personnel working under this Survey Request (SR) (including support personnel) shall comply with the ENERCON Services Health and Safety Plan titled "Sediment Sampling Raystown Branch of the Juniata River".
2. If possible, obtain photographs of the sampling areas. Photographs should be attached to this SR as part of the record data.

Sediment Samples

1. Obtain samples in accordance with the applicable procedural steps stated in section 4.2.4 of SNEC procedure E900-IMP-4520.04, "Survey Methodology to Support SNEC License Termination" and attached ENERCON Services procedure.
2. Ensure that each sample container is labeled with the following information:
   A. SR Number
   B. Sample Number
   C. Sample Date and Time
   D. Sample Location
   E. Sampler's Initials
3. Record the sampling location of all samples on an approved map or drawing.
4. Document all discrepancies or deviations from this SR on a SR Continuation Sheet or Field Sample Collection Sheet (Sediment Sampling Data Form).
5. Consult the SNEC Project Manager for Juniata River Sampling and responsible GRCS before processing any sample. Samples may be composited, processed as a whole, processed in sections, or other method as determined by SNEC Project Manager and GRCS.
6. Sample processing methodology shall be performed in accordance with SNEC Procedure E900-IMP-4520.02, "Preparation of Sample Materials for Analysis".

APPROVAL SIGNATURES

SR COORDINATOR	William Stoner / [signature]	DATE	10/04/01
RTR	A. Paynter / [signature]	DATE	04Oct01
ISR	N/A	DATE	
CONCURRENCE	N/A	DATE	
RSO APPROVAL	A. Paynter / [signature]	DATE	04Oct01

SR CLOSE-OUT

GRCS		DATE	
QAO		DATE	
SR COORDINATOR		DATE	
RSO		DATE	

COMMENTS

ORIGINAL

SURVEY REQUEST - SAMPLE ANALYSIS SHEET

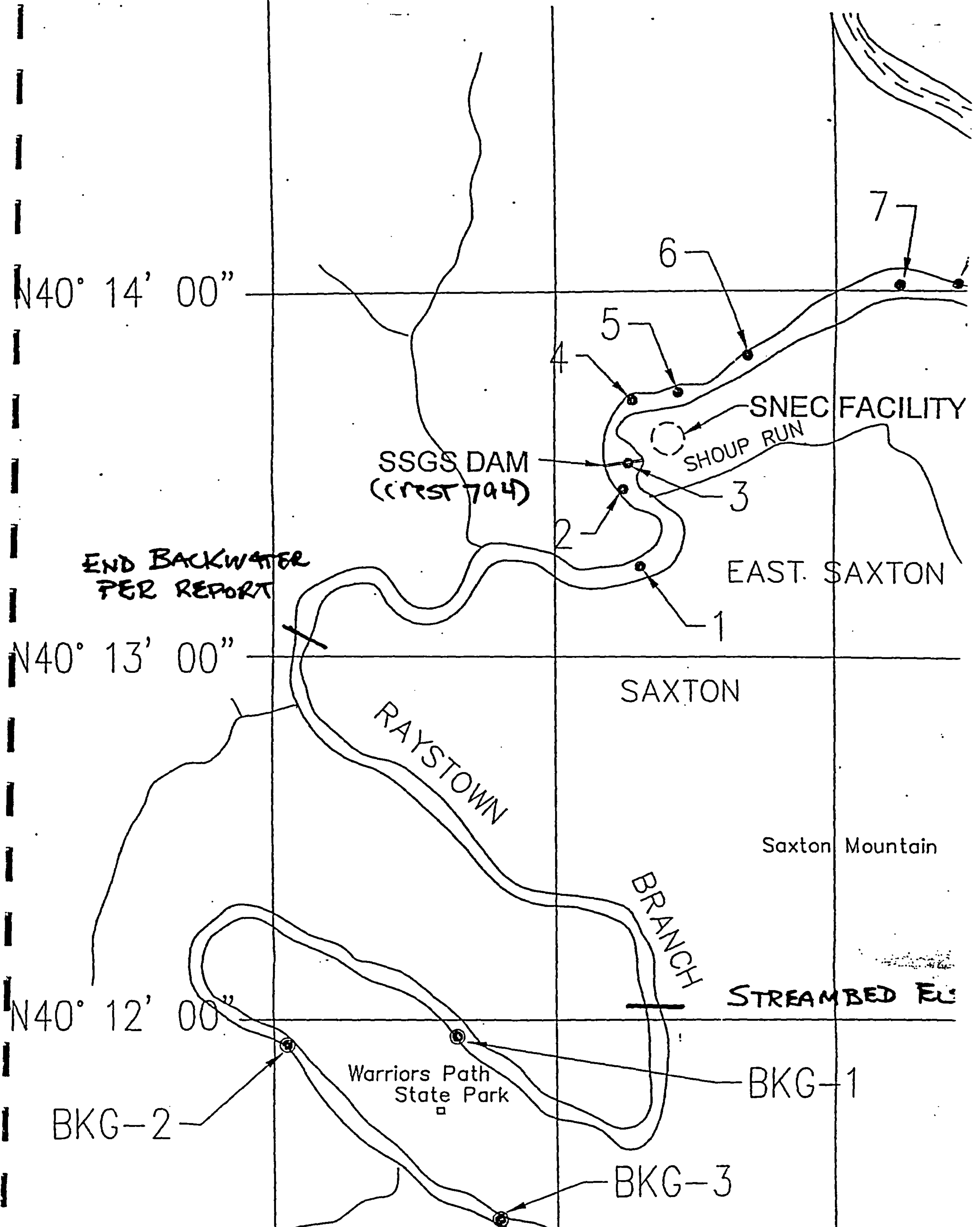
SR NUMBER	SR-0034	DATE OF REQUEST	10/04/01

REQUESTED SAMPLE ANALYSIS

SAMPLE TYPE	RADIONUCLIDE	TYPE OF ANALYSIS REQUESTED	REQUIRED COUNTING SYSTEM MDA	COMMENTS
Sediment and Scrape Samples	Cs-137	Gamma Scan	0.18 pCi/g	Other analysis (i.e., TRU, HTD, etc.) may be performed as requested by the SNEC Project Manager for Juniata River Sampling, RSO, or SR Coordinator.
	Co-60	Gamma Scan	0.15 pCi/g	

SIGNATURES

SR COORDINATOR	William Stoner / [signature]	DATE	10/04/01
RSO APPROVAL	A. Paynter / [signature]	DATE	04Oct01


7
6
N40° 14' 00"
5
4
SNEC FACILITY
SHOUP RUN
SSGS DAM
(crest 794)
3
2
END BACKWATER
PER REPORT
EAST SAXTON
1
N40° 13' 00"
SAXTON
RAYSTOWN
BRANCH
Saxton Mountain
STREAMBED EL
N40° 12' 00"
Warriors Path
State Park
BKG-1
BKG-2
BKG-3

Work Procedure

Sediment Sampling
Raystown Branch of the Juniata River
for
GPU Nuclear, Inc.
Saxton Nuclear Experimental Corporation Facility
Saxton, Pennsylvania

Prepared For:

GPU Nuclear, Inc.
300 Madison Avenue
Post Office Box 1911
Morristown, NJ 07962-1911

Prepared By:

ENERCON Services, Inc.
4115 William Penn Highway
Suite 202
Murrysville, PA 15668

October 2, 2001

Work Procedure
Sediment Sampling
Raystown Branch of the Juniata River
for
GPU Nuclear, Inc.
Saxton Nuclear Experimental Corporation Facility
Saxton, Pennsylvania

1.0 Purpose

This plan has been prepared by ENERCON Services, Inc. (ENERCON) and Marion Hill Associates, Inc. (Marion Hill) at the request of GPU Nuclear, Inc. (GPU) to assure that sediment sampling activities on the Raystown Branch of the Juniata River are conducted in a safe manner.

2.0 Applicability/Scope

This procedure applies to all sediment sampling activities performed on the Raystown Branch of the Juniata River. The goal of this Work Procedure is to describe proper general procedures for sediment sampling and the use of sediment sampling equipment. Sound sediment sampling techniques that are followed for all sampling efforts on this project will improve the quality of data received from sediment surveys. Effective and proper use and cleaning of sampling equipment is important to the safety of field staff and quality assurance and control of samples Study goals may require that additional or alternate equipment or procedures be used than are discussed here. Any procedure changes will be based on sound scientific and practical reasons and should ultimately help further the goals of the study, without the loss of quality assurance and control.

3.0 Definitions

R.S.O.: GPU Radiation Safety Officer

4.0 Equipment

- Global Positioning System (GPS) unit
- Recording fathometer
- Personal protective clothing
- Sampling Vessels
  - Modified sediment sampling vessel (14 feet)
  - 13 x 16 feet sediment sampling barge (if needed)

- 12 or 14 feet tender boat (if needed)
- Back up safety boat to be located near Guard Station

4.1 USCG Safety Equipment on Each Vessel

- Personal Flotation Devices for each individual
- Throwable device
- Fire extinguisher (if flammable fuel on board)
- Oars and/or paddles
- Signaling device capable of being heard for one-half mile
- VHF-FM marine radio
- Outboard engine (optional)
- Anchoring device (optional)
- Registration

4.2 Coring Equipment

- Two and three inch OD steel tubes – two and four foot lengths
- Plastic liners (if practicable), nose cones and catchers (if needed)
- Slide hammer
- Hoisting boom or tripod
- Winch
- Lines and/or cables
- Pulleys
- Liner holders (if needed)
- Containers to composite samples
- Spoons

4.3 Alternative Devices - General

- Split spoons two and three inch outside diameter

- Ponar grab samples
- Containers to composite samples
- Spoons

4.4 Alternative Device – Suction (NOTE: Due to the lack of suitable depositional areas, an alternative suction method may be used.)

- Two-inch trash pump with adequate lengths of intake and discharge hose
- Modified nose cone to collect finer particles and to keep out the very coarse material that would clog the pump
- Holding containers to permit small particles to drop out of solution (50 gallon plastic containers that can be stacked for ease of transport)
- Draining device and/or submersible pump to remove excess water from holding containers
- Container to composite sediment samples
- Spoons

4.5 Decontamination Gear

- Processing table to provide a clean surface for equipment
- Wash and rinse containers for solvent (Ivory liquid soap and water) and wash water ~~(river water)~~ uL 10/8/01
- Containers for used solvent and concentrated rinse water with lids
- Submersible pump or buckets
- Brushes
- Aluminum foil and/or plastic bags
- Solid waste containers (e.g. garbage bags) for trash

5.0 Procedure

5.1 Limits and Precautions

See ENERCON Health and Safety Plan.

5.2 Site Reconnaissance

5.2.1 The survey team will perform site reconnaissance activities prior to sampling to verify that selected site locations are in viable sediment deposition areas. A deposition area will be considered viable for core sampling if a significant accumulation of fine-grained sediments exists at that location

5.2.2 Record the findings of reconnaissance activities in a field notebook including, date, time, water depth, substrate characteristics, flow conditions, site location, conclusions regarding site viability, and proposed sampling approach.

5.3 Preparation for Sampling

5.3.1 Field Staff - All field staff working at a site will understand the basic goals of the study, use of the samples, and the basic methods to be used to assure that quality samples are collected.

5.3.2 Safety - All field staff will be aware of and fully understand the possible safety hazards posed by the site Precautions will be taken to prevent exposure to contaminated sediments (See Site Specific Health and Safety Plan.).

5.3.3 Cleaning Equipment - All equipment will be cleaned before going into the field and between sites to prevent contaminating sediment samples. Equipment will be washed with clean scrub brushes using Ivory liquid and river water. To properly clean equipment, wash apparatus thoroughly with detergent, then rinse 5-6 times with ~~river~~ water. Rinse the apparatus with site water before taking the first sediment sample. AL 10/8/01

5.4 General Procedures in the Field

5.4.1 Make sure all equipment is clean and ready to use.

5.4.2 When working from a boat, two or three anchors or spuds driven into the sediment in shallow water will help stabilize boat in breezy, open water conditions (if needed).

5.4.3 Each grab or core attempt should be taken from undisturbed sediment at the site. Avoid disturbing sediments with a boat motor or by walking on the site. Approach sites from downstream to avoid suspending sediment into the water column over the site.

5.4.4 Have container ready to accept entire sample quickly upon retrieval.

5.4.5 Label every sample container with a permanent marker on labeling tape on the side of the jar or wherever the label will not come off accidentally. Information on the label will be that required for SNEC facility samples.

5.4.6 Record all site information in a field notebook or on field sheets (Exhibit 1 attached) before leaving site. Information usually includes: field measurements, time and date, persons collecting samples, number and types of samples taken including field blanks, etc., labels assigned to each sample, and any general observations. Keep records of all samples, how they were labeled and any blanks or duplicates that are submitted for analysis.

5.5 Collecting Composite Samples (if necessary).

5.5.1 Composite samples may required to generate sufficient sample volume for all analyses. Multiple grabs or cores for a composite sample should be taken from a relatively homogeneous sediment deposit (i.e., all grabs should be of similar sand/silt content). It is best to know the rough boundaries of the sediment deposit or "site" before sampling.

5.5.2 Place each grab or core into a single mixing bowl, remove any large objects such as sticks, leaves or stones, etc. and stir thoroughly with a spoon to homogenize. A single grab or core should be mixed at least two minutes. Multiple grab or core samples should be mixed five minutes or longer if necessary.

5.5.3 Fill sample jars with the sediment mixture by placing one spoonful sequentially into each jar until the jars are full (see section on sample containers). This subsampling system assures that each sample container contains a sample as similar as possible to the other containers.

5.6 Quality Control Measurements

5.6.1 Quality control measurements will be performed by randomly re-sampling 5% of all sampling points using identical methodology.

5.6.2 The locations of quality control samples will be determined by the R.S.O.

5.7 Collecting Replicate Samples

5.7.1 Replicate samples will be collected at each sampling site.

5.7.2 Each replicate sample will be taken from an undisturbed area of sediment.

5.7.3 Equipment will rinsed with site water between replicate samples.

5.8 Core Sampling

5.8.1 To prepare for collecting a sample, the survey team will begin by measuring water depth. The corer will then be assembled and lowered to the river bottom.

5.8.2 The survey team will utilize a slide hammer to drive 2 or 3 inch outside diameter stainless steel sampling tubes with plastic liners (is appropriate) connectable in 2 or 4 foot lengths into river substratum and bottom sediments.

5.8.3 The slide hammer will be used to drive the sampling tube into the river bottom. Once the desired depth of drive or refusal is achieved, the sampler will be removed from the river bottom by using a winch system (if appropriate) and brought to the surface for removal and processing.

5.8.4 More than one core sample may be required at each sampling location to achieve the required volume.

5.8.5 The survey team will conduct this sediment sampling effort using an aluminum workboat modified for the collection of sediments and/or a mobile workbarge capable of being assembled on site. Shallow areas may be sampled using waders or hip boots.

5.8.6 Heavy-duty anchors with long lines may be used to hold position on sampling locations. The workboat may also be anchored to land bound anchor points (e.g. trees, rocks) where appropriate.

5.8.7 The survey team will have available stainless steel Ponar samplers, 2 or 3 inch outside diameter sampling tubes, split spoon samplers and all the necessary sediment sampling equipment to collect the sediments from the river. The survey team will also provide the solvents and/or wash water used for decontamination of the equipment. These spent fluids will be containerized and their disposal will be the responsibility of the client.

5.8.8 The survey team will identify the sample location using Global Position System (GPS), transport samples to the processing station, containerize the sediments, decontaminate sampling equipment, maintain chain-of-custody, and handle delivery of the samples.

5.9 Grab Samplers (Ponar).

5.9.1 Scope

Based on the river morphology of the area, cobble, gravel and sand are likely to be encountered. Therefore, recovery of soft sediments in the core sampler may be difficult to achieve. Cobble and gravel size of greater than 1.5 inches may impede any recovery by the corer. Therefore, it may be difficult to recover the required sample volume. In these cases use a Ponar grab sampler may be used if (if practicable).

5.9.2 Collection Procedure

5.9.2.1 Set closing mechanism and lower grab slowly to substrate, being careful to avoid a shock wave caused by too rapid of a descent near the sediment.

5.9.2.2 Initiate closure mechanism of grab. This is usually a sharp pull on the rope.

5.9.2.3 When it feels like the grab has closed and contains sediment, raise grab at a steady rate and immediately position over large bucket.

5.9.2.4 Empty entire contents of grab into mixing bowl if sample needs to be mixed.

5.9.2.5 Place appropriate volume of sediment into sample container.

5.10 Suction Devices.

5.10.1 Scope: In areas where a sample should/must be taken (e.g. weir and discharge areas) and suitable areas of deposition does not exist, a suction method may be attempted.

5.10.2 Collection Procedure.

5.10.2.1 The trash pump will be started and permitted to warm-up and generate an adequate flow rate and suction.

5.10.2.2 River water being pumped during this start up phase will be recirculated back into the river.

5.10.2.3 For sediment sampling, the modified suction head will be placed in contact with the river bottom and forced among the larger cobbles and boulders.

5.10.2.4 Once sediment starts flowing through the hoses, this slurry will be directed into the 50-gallon settling containers. It may take several 50 gallon containers to collect enough sediment for one sample.

5.10.2.5 Once enough water sediment slurry has been collected, this would be permitted to settle. The excess water would be decanted off and the remaining sediment would be placed in the sample container.

6.0 Responsibilities

Responsibilities are as stated in Section 4.0.

7.0 Exhibits

Exhibit 1 – Sediment Sampling Data Form

EXHIBIT 1

SEDIMENT SAMPLING DATA FORM

DATE/TIME ____________________

SAMPLE NO. ____________________

SAMPLE AREA: ____________________

TITLE OF STUDY ____

LOCATION ____

LONG. ______________ LAT. ______________

SAMPLE SIZE/CONTAINER ____

SAMPLING METHOD (DESCRIPTION) ____

____

VISUAL CHARACTERIZATION ____

____

ANALYZE FOR: ____

____

REMARKS: ____

____

____

PERSONNEL: ____

____

PHOTOGRAPH NOS. ____

SAMPLER'S SIGNATURE: ______________ DATE/TIME: ______________

Table 1
Sediment Sampling Locations

Site Identification	Sample Identification	Latitude	Longitude	Sample Date	Sample Time	Sample Type
Weir 1	SXSD1472	40° 13' 42.539"	78° 14' 33.429"	10/10/01	855	Scoop
Weir 1	SXSD1473	40° 13' 42.539"	78° 14' 33.429"	10/10/01	900	Scoop
Weir 2	SXSD1474	40° 13' 43.417"	78° 14' 30.996"	10/10/01	1205	Scoop
Weir 2	SXSD1475	40° 13' 43.417"	78° 14' 30.996"	10/10/01	1215	Scoop
Weir 3	SXSD1476	40° 13' 43.491"	78° 14' 31.384"	10/10/01	1226	Scoop
Weir 3	SXSD1477	40° 13' 43.491"	78° 14' 31.384"	10/10/01	1232	Scoop
Weir 4	SXSD1478	40° 13' 43.676"	78° 14' 32.104"	10/10/01	1240	Scoop
Weir 4	SXSD1479	40° 13' 43.676"	78° 14' 32.104"	10/10/01	1245	Scoop
Weir 5	SXSD1480	40° 13' 42.832"	78° 14' 32.382"	10/10/01	1415	Suction
Weir 5	SXSD1481	40° 13' 42.832"	78° 14' 32.382"	10/10/01	1420	Suction
Weir 6	SXSD1545	40° 13' 42.597"	78° 14' 33.435"	10/18/01	817	Suction
Weir 6	SXSD1546	40° 13' 42.597"	78° 14' 33.435"	10/18/01	823	Suction
Discharge Tunnel 1	SXSD1482	40° 13' 43.548"	78° 14' 34.806"	10/10/01	1502	Scoop
Discharge Tunnel 1	SXSD1483	40° 13' 43.548"	78° 14' 34.806"	10/10/01	1508	Scoop
Discharge Tunnel 2	SXSD1484	40° 13' 43.561"	78° 14' 35.097"	10/10/01	1525	Scoop
Discharge Tunnel 2	SXSD1485	40° 13' 43.561"	78° 14' 35.097"	10/10/01	1535	Scoop
Discharge Tunnel 3	SXSD1486	40° 13' 42.284"	78° 14' 34.657"	10/10/01	1515	Ponar
Discharge Tunnel 3	SXSD1487	40° 13' 42.284"	78° 14' 34.657"	10/10/01	1530	Ponar
Discharge Tunnel 4	SXSD1488	40° 13' 42.440"	78° 14' 36.302"	10/10/01	1555	Ponar
Discharge Tunnel 4	SXSD1489	40° 13' 42.440"	78° 14' 36.302"	10/10/01	1605	Ponar
Discharge Tunnel 5	SXSD1490	40° 13' 42.116"	78° 14' 36.419"	10/10/01	1612	Scoop
Discharge Tunnel 5	SXSD1491	40° 13' 42.116"	78° 14' 36.419"	10/10/01	1615	Scoop
Spray Pond Lagoon	SXSD1498	40° 13' 27.614"	78° 14' 40.116"	10/11/01	1130	Core
Spray Pond Lagoon	SXSD1499	40° 13' 27.614"	78° 14' 40.116"	10/11/01	1155	Core
Spray Pond Bog	SXSD1500	40° 13' 28.015"	78° 14' 39.220"	10/11/01	1240	Ponar
Spray Pond Bog	SXSD1501	40° 13' 28.015"	78° 14' 39.220"	10/11/01	1242	Ponar
Site 1	SXSD1502	40° 13' 20.197"	78° 14' 35.441"	10/11/01	1310	Scoop
Site 1	SXSD1503	40° 13' 20.197"	78° 14' 35.441"	10/11/01	1313	Scoop
Site 2	SXSD1496	40° 13' 30.559"	78° 14' 43.783"	10/11/01	1018	Scoop
Site 2	SXSD1497	40° 13' 30.559"	78° 14' 43.783"	10/11/01	1022	Scoop
Site 3	SXSD1494	40° 13' 32.130"	78° 14' 45.129"	10/11/01	1007	Ponar
Site 3	SXSX1495	40° 13' 32.130"	78° 14' 45.129"	10/11/01	1010	Ponar
Site 4	SXSD1492	40° 13' 36.644"	78° 14' 46.519"	10/11/01	947	Scoop
Site 4	SXSD1493	40° 13' 36.644"	78° 14' 46.519"	10/11/01	954	Scoop
Site 5	Deleted due to redundancy with discharge tunnel sampling.					
Site 6	SXSD1506	40° 13' 56.499"	78° 13' 53.996"	10/15/01	1415	Core
Site 6	SXSD1507	40° 13' 56.499"	78° 13' 53.996"	10/15/01	1430	Core
Site 7	SXSD1508	40° 13' 59.081"	78° 13' 48.768"	10/15/01	1510	Core
Site 7	SXSD1509	40° 13' 59.081"	78° 13' 48.768"	10/15/01	1532	Core
Site 8	SXSD1535	40° 14' 01.520"	78° 13' 39.818"	10/16/01	946	Core
Site 8	SXSD1536	40° 14' 01.520"	78° 13' 39.818"	10/16/01	1014	Core
Site 9	SXSD1504	40° 13' 57.580"	78° 13' 24.309"	10/16/01	1200	Core
Site 9	SXSD1505	40° 13' 57.580"	78° 13' 24.309"	10/16/01	1216	Core
Site 10	SXSD1470	40° 14' 16.367"	78° 13' 15.900"	10/9/01	1530	Core
Site 10	SXSD1471	40° 14' 16.367"	78° 13' 15.900"	10/9/01	1600	Core
Site 11	SXSD1547	40° 14' 54.757"	78° 13' 49.096"	10/18/01	1116	Core
Site 11	SXSD1548	40° 14' 54.757"	78° 13' 49.096"	10/18/01	1200	Core
BKG - 1	SXSD1537	40° 09' 25.063"	78° 15' 22.185"	10/17/01	940	Core
BKG - 1	SXSD1538	40° 09' 25.063"	78° 15' 22.185"	10/17/01	955	Core
BKG - 2	SXSD1539	40° 12' 12.494"	78° 15' 46.467"	10/17/01	1300	Ponar
BKG - 2	SXSD1540	40° 12' 12.494"	78° 15' 46.467"	10/17/01	1315	Ponar
BKG - 3	SXSD1543	40° 11' 47.708"	78° 15' 04.959"	10/17/01	1355	Ponar
BKG - 3	SXSD1544	40° 11' 47.708"	78° 15' 04.959"	10/17/01	1405	Ponar

Table 2
Juniata River Sediment Gamma Spec Results

SAMPLE ID	HpGe ID #	SAMPLE DATE	TIME	DESCRIPTION/LOCATION	Cs-137 (pCi/g)	Co-60 (pCi/g)
1472	3-9330	10/10/01	855	WEIR SITE #1	2.55	< 0.08
1473	2-9329	10/10/01	900	WEIR SITE #1	1.07	< 0.06
1474	3-9327	10/10/01	1205	WEIR SITE #2	< 0.07	< 0.07
1475	2-9326	10/10/01	1215	WEIR SITE #2	0.05	< 0.055
1476	1-9325	10/10/01	1226	WEIR SITE #3	< 0.039	< 0.05
1477	1-9338	10/10/01	1232	WEIR SITE #3	< 0.06	< 0.05
1478	2-9339	10/10/01	1337	WEIR SITE #4	< 0.06	< 0.05
1479	1-9328	10/10/01	1245	WEIR SITE #4	< 0.05	< 0.04
1480	1-9344	10/10/01	1415	WEIR SITE #5	0.15	< 0.04
1481	1-9345	10/10/01	1420	WEIR SITE #5	0.08	< 0.04
1545	1-9412	10/18/01	817	WEIR SITE #6	1.8	< 0.05
1546	2-9413	10/18/01	823	WEIR SITE #6	1.2	< 0.07
1482	2-9346	10/10/01	1502	DISCHARGE TUNNEL #1	0.07	< 0.06
1483	2-9354	10/10/01	1508	DISCHARGE TUNNEL #1	< 0.07	< 0.07
1484	3-9352	10/10/01	1525	DISCHARGE TUNNEL #2	< 0.09	< 0.07
1485	2-9366	10/10/01	1535	DISCHARGE TUNNEL #2	< 0.04	< 0.07
1486	3-9356	10/10/01	1515	DISCHARGE TUNNEL #3	< 0.05	< 0.06
1487	2-9348	10/10/01	1530	DISCHARGE TUNNEL #3	< 0.045	< 0.06
1488	1-9371	10/10/01	1555	DISCHARGE TUNNEL #4	< 0.05	< 0.04
1489	2-9372	10/10/01	1605	DISCHARGE TUNNEL #4	< 0.06	< 0.06
1490	3-9349	10/10/01	1612	DISCHARGE TUNNEL #5	< 0.06	< 0.06
1491	2-9351	10/10/01	1615	DISCHARGE TUNNEL #5	< 0.06	< 0.06
1498	1-9369	10/11/01	1130	SPRAY POND LAGOON	< 0.06	< 0.05
1499	2-9364	10/11/01	1155	SPRAY POND LAGOON	< 0.06	< 0.07
1500	1-9367	10/11/01	1240	SPRAY POND BOG	< 0.06	< 0.06
1501	1-9363	10/11/01	1242	SPRAY POND BOG	< 0.14	< 0.12
1502	1-9365	10/11/01	1310	RIVER SITE #1	< 0.04	< 0.05
1503	1-9361	10/11/01	1313	RIVER SITE #1	< 0.05	< 0.05
1496	3-9358	10/11/01	1018	RIVER SITE #2	< 0.05	< 0.08
1497	3-9362	10/11/01	1022	RIVER SITE #2	< 0.1	< 0.1
1494	3-9360	10/11/01	1007	RIVER SITE #3	< 0.1	< 0.09
1495	2-9357	10/11/01	1010	RIVER SITE #3	< 0.1	< 0.09
1492	2-9370	10/11/01	947	RIVER SITE #4	< 0.08	< 0.07
1493	1-9347	10/11/01	954	RIVER SITE #4	< 0.047	< 0.057
1506	1-9397	10/15/01	1415	RIVER SITE #6	0.07	< 0.04
1507	2-9399	10/15/01	1430	RIVER SITE #6	< 0.053	< 0.055
1508	1-9390	10/15/01	1510	RIVER SITE #7	< 0.05	< 0.04
1508-B	2-9403	10/15/01	1510	RIVER SITE #7	< 0.06	< 0.05
1509	2-9391	10/15/01	1532	RIVER SITE #7	< 0.06	< 0.06
1509-B	1-9402	10/15/01	1532	RIVER SITE #7	< 0.04	< 0.03
1535	2-9386	10/16/01	946	RIVER SITE #8	0.09	< 0.06
1536	1-9387	10/16/01	1014	RIVER SITE #8	0.11	< 0.05
1504	1-9392	10/15/01	1200	RIVER SITE #9	0.16	< 0.04
1505	2-9393	10/15/01	1216	RIVER SITE #9	< 0.06	< 0.06
1470	1-9333	10/9/01	1530	RIVER SITE #10	0.13	< 0.037
1471	2-9334	10/9/01	1600	RIVER SITE #10	< 0.044	< 0.04
1547	1-9420	10/18/01	1116	RIVER SITE #11	< 0.03	< 0.04
1548	2-9416	10/18/01	1200	RIVER SITE #11	< 0.049	< 0.063
1537	2-9419	10/17/01	940	BKG #1 RIDDLESBURG	0.08	< 0.07
1538	2-9421	10/17/01	955	BKG #1 RIDDLESBURG	< 0.07	< 0.07
1539	2-9423	10/17/01	1300	BKG #2 WARRIORS PATH	0.07	< 0.06
1540	1-9418	10/17/01	1315	BKG #2 WARRIORS PATH	0.09	< 0.05
1543	1-9422	10/17/01	1355	BKG #3 WARRIORS PATH	0.01	< 0.04
1544	1-9414	10/17/01	1405	BKG #3 WARRIORS PATH	< 0.04	< 0.05

Areas with a < symbol are less than MDA.

TRU analyses performed on these samples (Ref. BWXT Report #0110089).

Table 3
Juniata River Sediment TRU HTD Results

Reference BWXT Report # 0110089, November 13, 2001

Results (pCi/g)						
Isotope		Weir #1		River Site #9		Bkg #1 (Riddlesburg)
H-3	<	1.02E+01	<	1.01E+01	<	9.62E+00
C-14	<	4.58E+00	<	4.82E+00	<	4.94E+00
Fe-55	<	1.19E+00	<	3.21E-01	<	1.61E-01
Ni-59	<	5.20E+00	<	1.34E+01	<	5.74E+00
Ni-63	<	7.46E+00	<	6.94E+00	<	7.98E+00
Sr-90	<	1.40E-02	<	1.00E-02	<	1.00E-02
Tc-99	<	5.56E-01	<	2.05E+00	<	1.25E+00
I-129	<	1.35E+00	<	1.46E+00	<	1.27E+00
Np-237	<	3.41E-03	<	5.45E-03	<	1.03E-02
Pu-242	<	3.41E-03	<	4.35E-03	<	3.56E-03
Pu-239/240	<	3.41E-03	<	3.12E-03	<	3.56E-03
Pu-238	<	3.41E-03	<	3.48E-03	<	3.56E-03
Pu-241	<	9.60E-01	<	1.06E+00	<	1.15E+00
Am-243	<	5.13E-03	<	2.83E-03	<	3.50E-03
Am-241	<	4.89E-03	<	2.83E-03	<	3.50E-03
Cm-244	<	3.70E-03	<	3.16E-03	<	3.50E-03
Cm-242	<	5.72E-03	<	3.02E-03	<	3.72E-03
U-234		4.30E-01		5.29E-01		7.70E-01
U-235		2.30E-02		1.24E-02		1.81E-02
U-238		3.11E-01		4.12E-01		4.95E-01
Co-60		2.00E-02	<	2.74E-02	<	1.37E-02
Nb-94	<	1.08E-02	<	2.36E-02	<	1.13E-02
Sb-125	<	3.83E-02	<	5.90E-02	<	3.11E-02
Cs-134	<	1.57E-02	<	3.86E-02	<	2.04E-02
Cs-137		2.87E+00		1.54E-01		6.62E-02
Ce-144	<	8.78E-02	<	1.32E-01	<	8.73E-02
Eu-152	<	6.24E-02	<	1.39E-01	<	6.86E-02
Eu-154	<	4.20E-02	<	9.41E-02	<	4.66E-02
Eu-155	<	4.69E-02	<	6.98E-02	<	3.26E-02

Shaded areas denote positive results.
Areas with a < symbol are less than MDA.

APPENDIX A-4

DCGLw Calculation Logic for CV Yard

DCGL Calculation Logic-CV Yard Soil & Boulders (Decay Update)

I. **Survey Unit:** SNEC Containment Vessel (CV) Yard Soil and Boulders

II. **Description:** The purpose of this calculation is to determine a representative isotopic mix for the CV Yard Soil and associated Boulders from available sample analyses. The effective surface and volumetric $DCGL_w$s are then determined from the mean percent of applicable samples.

III. **Data Selection Logic Tables**: The radionuclide selection logic and subsequent DCGL calculations are provided in seven (7) tables. These tables were developed using Microsoft Excel. Table explanation is as follows.

Table 1: Reduced Listing – This table, which has been extracted from a larger database, provides a list of the most representative sample analyses. Results are from scoping, characterization, and pre/post remediation surveys. The samples consist of soil and soil-like media that was taken in support of the aforementioned surveys. As applicable, a sample number, sample location/description, radionuclide concentration, analysis date are provided for each sample. Positive nuclide concentrations are noted with yellow/shaded background fields while MDA values are noted in the gray shaded fields. Values in red typeface are on-site analysis results.

Table 2: Reduced Listing - Decayed - This table decays the data from Table 1. Half-life values (days) are listed above each respective nuclide column. Samples are decayed from the respective analysis date to December 15, 2004. Positive results are denoted in a yellow background field while MDA values are noted in the gray shaded fields. Values in red typeface are on-site analysis results.

Table 3: Reduced Listing Decayed - MDAs Removed – This table provides the best overall representation of the data. Non-positive nuclide columns have been removed as well as all the MDA values. Therefore, 11 nuclides have been reduced to four (4).

Table 4: Mean Percent of Total for Positive Nuclides – This table provides the calculation methodology for determining the relative fractions of the total activity contributed by each radionuclide. From this information the mean, sigma, and mean % of total are calculated. From this information the mean, sigma, and mean % of total are calculated. The mean % of total values is used to calculate the surface gross activity $DCGL_w$ per MARSSIM equation 4-4. See Table 6. Note that the mean percent values were averaged using only the positive sample results in each column. In some cases only a single nuclide value (e.g. Sr-90) had a positive result. This value is listed as the value in the mean result field, and results in higher "mean percent of total" values for single positive radionuclides in the mix, which is a conservative.

Table 5: Ratio to Cs-137 for Positive Nuclides – This table provides the calculation methodology for determining the surrogate ratio to Cs-137 for each radionuclide. From this information the mean, sigma, and mean % of total are calculated. The mean % of total values is used to calculate the volumetric $DCGL_w$ per MARSSIM equation I-14. See Table 7. Note that the mean percent values were averaged using only the positive sample results in each column. In some cases only a single nuclide value (e.g. Sr-90) had a positive result. This value is listed as the value in the mean result field. This results in higher "mean percent of total" values in the mix, which are conservative.

Note: From Tables 4 and 5, only the "mean % of total" values are used as input to the "Effective DCGL Calculation Spreadsheet" as illustrated in Tables 6 and 7.

Table 6: Effective DCGL Calculator for Cs-137 (in dpm/100 cm^2) – This table provides the surface gross activity $DCGL_w$ calculation results from data derived from Table 4.

Table 7: Effective DCGL Calculator for Cs-137 (in pCi/g) – This table provides the surrogate volumetric modified Cs-137 $DCGL_w$ calculation results from data derived from Table 5.

IV. **Summary** – Since the CV Yard and Boulders are volumes of soil or rock material, existing in place or in a pile, the release limit is primarily based on the volumetric $DCGL_w$. Using the above data selection logic tables the calculated Cs-137 volumetric $DCGL_w$ is 5.75 pCi/g (previous value was 5.73 pCi/g due to earlier decay date of January 15, 2004). The updated value will be reduced by 25% as part of SNEC's requirement to apply an administrative limit as discussed in the License Termination Plan (LTP).

Using the above data selection logic tables the calculated gross activity $DCGL_w$ for surface area is 44,306-dpm/100 cm^2 (previous value of 44,434-dpm/100 cm^2 due to earlier decay date of January 15, 2004). The updated value will be reduced by 25% as part of SNEC's requirement to apply an administrative limit as discussed in the License Termination Plan (LTP).

TABLE 1 - REDUCED LISTING

	SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Am-241	Pu-238	Pu-239	Pu-241	C-14	Ni-63	Eu-152	Decay Date Analysis Date
1	CV Tunnel	BWXT, 0102059-01	CV Tunnel Sediment Composite, OL1	9.4	9.67	1.26	1250	0.18	0.55	0.22	44.69	9.34	4.02	0.13	February 14, 2001
2	SX9SL99219	111074	Subsuface Sample #29 (0-5'), AY-128, OL1			0.07	0.59								November 17, 1999
3	SXSL1063	Teledyne-80018; L19184-1	North CV Yard Soil BA-127, 812' El, Sample # 5, OL2	4.58	0.0531	0.0192	0.886	0.0961	0.0468	0.0327	3.77	0.21	10.9	0.0525	June 27, 2002
4	SXSL1089	Teledyne-80019; L19184-2	North CV Yard Soil AY-127, 810' El, Sample # 3, OL1	3.03	0.0695	0.0332	1.29	0.0993	0.128	0.05	4.97	0.21	7.54	0.0828	June 28, 2002
5	SXSL1115	Teledyne-80020; L19184-3	North CV Yard Soil AY-128, 804' El, Sample # 2, OL1	4.88	0.0536	0.0243	1.8	0.24	0.138	0.0407	4.21	0.21	7.6	0.0571	June 29, 2002
6	SXSL1122	Teledyne-80021; L19184-4	North CV Yard Soil AY-129, 798' El, Sample # 2, OL1	3.44	0.0529	0.0279	4.77	0.183	0.0894	0.04	3.68	0.206	8.75	0.0862	June 29, 2002
7	SXSL1130	Teledyne-80022; L19184-5	North CV Yard Soil AX-129, 803' El, Sample # 4, OL1	4.99	0.0648	0.0298	22.6	0.149	0.0656	0.0121	3.55	0.231	13.4	0.0989	July 3, 2002
8	SXSL1132	Teledyne-80023; L19184-6	North CV Yard Soil AZ-130, Sample # 5, OL1	2.98	0.0715	0.035	2.59	0.164	0.0746	0.0646	5.27	0.215	12.6	0.0734	July 3, 2002
9	SXSL1270	BWXT, 0108055-02	AX-129, 3-3, Soil, CV SE Side 5' From CV, 800' El., OL1	11.31	0.02	0.01	23.1	0.037	0.007	0.007	2.104	3.93	8.68	0.07	July 26, 2001
10	SXSL1281	BWXT, 0108055-01	AX-128, 3-1, Soil, CV Tunnel East 5' From CV, 800' El, OL1	11.52	0.03	0.01	4.38	0.031	0.016	0.007	1.908	4	7.78	0.04	July 26, 2001
11	SXSL2649	Teledyne-73220; L18077-2	Anulus Well, A-2, 5 to 10' Depth, OL1	2	0.0314	0.1	0.6	0.00978	0.0133	0.011	1.87	0.183	1.75		February 13, 2002
13	SXSL2871	Teledyne-71949; L17838-11	CV Area - East Yard Dirt Pile - Middle, 1/2 Way Up, OL1		0.03	0.07	0.56								March 6, 2002
14	SXSL2872	Teledyne-71949; L17838-10	CV Area - East Yard Dirt Pile - Bottom (also top center), OL1		0.03	0.06	0.1								March 6, 2002
15	SXSL3140	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 6' on West Side (6" Depth), OL1	1.892	0.012	0.014	0.825	0.007	0.005	0.005	0.369	0.086	3.406	0.03	August 30, 2002
16	SXSL3142	Teledyne; L20326-3	Soil Pile, CV Yard, Three Feet on East Side, SR-37, OL1		0.0295	0.07	0.6								August 13, 2002
17	SXSL3145	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 3' on East Side (6" Depth), OL1	1.897	0.017	0.013	1.26	0.004	0.005	0.005	0.376	0.083	3.69	0.038	August 30, 2002
18	SXSL3149	Teledyne; L20326-4	Soil Pile, CV Yard, Six Feet on East Side, SR-37, OL1		0.0297	0.08	0.3								August 13, 2002
19	SXSL3153	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ Top (6" Depth), OL1	1.937	0.043	0.023	0.3	0.003	0.005	0.005	0.343	0.087	4.177	0.051	August 30, 2002
21	SXSL4142	Teledyne; L22187-2	CV Yard Soil - West Side, AP1-7, OL1	2.22	0.0325	0.05	0.9	0.0176	0.0671	0.0202					October 2, 2003
22	SXSL4143	Teledyne; L22187-3	CV Yard Soil - West Side, AP1-7, OL1	2.23	0.0316	0.05	0.5	0.0221	0.0631	0.0364					October 2, 2003
23	SXSL4149	Teledyne; L22187-4	CV Yard Soil - West Side, AP1-7, OL1	2.24	0.0277	0.07	3.9	0.0277	0.043	0.0304					October 2, 2003

TABLE 2 - REDUCED LISTING - DECAYED

				T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	T 1/2	Decay Date	
				4485.27	10446.15	1925.233	11019.59	157861.1	32050.69	8813848	5259.6	2092883	36561.53	4967.4	December 15, 2004	
	SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Am-241	Pu-238	Pu-239	Pu-241	C-14	Ni-63	Eu-152	Analysis Date	ET (d)
1	CV Tunnel	BWXT, 0102059-01	CV Tunnel Sediment Composite, OL1	7.57E+00	8.81E+00	7.61E-01	1.14E+03	1.79E-01	5.34E-01	2.20E-01	3.72E+01	9.34E+00	3.91E+00	1.07E-01	February 14, 2001	1400
2	SX9SL99219	111074	Subsuface Sample #29 (0-5'), AY-128, OL1			3.59E-02	5.25E-01								November 17, 1999	1855
3	SXSL1063	Teledyne-80018; L19184-1	North CV Yard Soil BA-127, 812' El, Sample # 5, OL2	3.98E+00	5.00E-02	1.39E-02	8.37E-01	9.57E-02	4.59E-02	3.27E-02	3.35E+00	2.10E-01	1.07E+01	4.63E-02	June 27, 2002	902
4	SXSL1089	Teledyne-80019; L19184-2	North CV Yard Soil AY-127, 810' El, Sample # 3, OL1	2.64E+00	6.55E-02	2.40E-02	1.22E+00	9.89E-02	1.26E-01	5.00E-02	4.41E+00	2.10E-01	7.41E+00	7.30E-02	June 28, 2002	901
5	SXSL1115	Teledyne-80020; L19184-3	North CV Yard Soil AY-128, 804' El, Sample # 2, OL1	4.25E+00	5.05E-02	1.76E-02	1.70E+00	2.39E-01	1.35E-01	4.07E-02	3.74E+00	2.10E-01	7.47E+00	5.04E-02	June 29, 2002	900
6	SXSL1122	Teledyne-80021; L19184-4	North CV Yard Soil AY-129, 798' El, Sample # 2, OL1	2.99E+00	4.98E-02	2.02E-02	4.51E+00	1.82E-01	8.77E-02	4.00E-02	3.27E+00	2.06E-01	8.60E+00	7.60E-02	June 29, 2002	900
7	SXSL1130	Teledyne-80022; L19184-5	North CV Yard Soil AX-129, 803' El, Sample # 4, OL1	4.34E+00	6.11E-02	2.16E-02	2.14E+01	1.48E-01	8.40E-02	1.21E-02	3.15E+00	2.31E-01	1.32E+01	8.73E-02	July 3, 2002	896
8	SXSL1132	Teledyne-80023; L19184-6	North CV Yard Soil AZ-130, Sample # 5, OL1	2.59E+00	6.74E-02	2.54E-02	2.45E+00	1.63E-01	7.32E-02	6.46E-02	4.68E+00	2.15E-01	1.24E+01	6.48E-02	July 3, 2002	896
9	SXSL1270	BWXT, 0108055-02	AX-129, 3-3, Soil, CV SE Side 5' From CV, 800' El., OL1	9.34E+00	1.84E-02	6.40E-03	2.14E+01	3.68E-02	6.82E-03	7.00E-03	1.79E+00	3.93E+00	8.48E+00	5.89E-02	July 26, 2001	1238
10	SXSL1281	BWXT, 0108055-01	AX-128, 3-1, Soil, CV Tunnel East 5' From CV, 800' El, OL1	9.51E+00	2.76E-02	6.40E-03	4.05E+00	3.08E-02	1.56E-02	7.00E-03	1.62E+00	4.00E+00	7.60E+00	3.37E-02	July 26, 2001	1238
11	SXSL2649	Teledyne-73220; L18077-2	Anulus Well, A-2, 5 to 10' Depth, OL1	1.70E+00	2.93E-02	6.89E-02	5.62E-01	9.74E-03	1.30E-02	1.10E-02	1.63E+00	1.83E-01	1.72E+00	0.00E+00	February 13, 2002	1036
13	SXSL2871	Teledyne-71949; L17838-11	CV Area - East Yard Dirt Pile - Middle, 1/2 Way Up, OL1		2.80E-02	4.86E-02	5.25E-01								March 6, 2002	1015
14	SXSL2872	Teledyne-71949; L17838-10	CV Area - East Yard Dirt Pile - Bottom (also top center), OL1		2.80E-02	4.16E-02	9.38E-02								March 6, 2002	1015
15	SXSL3140	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 6' on West Side (6" Depth), OL1	1.66E+00	1.14E-02	1.04E-02	7.83E-01	6.97E-03	4.91E-03	5.00E-03	3.30E-01	8.60E-02	3.35E+00	2.67E-02	August 30, 2002	838
16	SXSL3142	Teledyne; L20326-3	Soil Pile, CV Yard, Three Feet on East Side, SR-37, OL1		2.79E-02	5.15E-02	5.69E-01								August 13, 2002	855
17	SXSL3145	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 3' on East Side (6" Depth), OL1	1.67E+00	1.61E-02	9.61E-03	1.20E+00	3.99E-03	4.91E-03	5.00E-03	3.37E-01	8.30E-02	3.63E+00	3.38E-02	August 30, 2002	838
18	SXSL3149	Teledyne; L20326-4	Soil Pile, CV Yard, Six Feet on East Side, SR-37, OL1		2.81E-02	5.88E-02	2.84E-01								August 13, 2002	855
19	SXSL3153	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ Top (6" Depth), OL1	1.70E+00	4.07E-02	1.70E-02	2.85E-01	2.99E-03	4.91E-03	5.00E-03	3.07E-01	8.70E-02	4.11E+00	4.54E-02	August 30, 2002	838
21	SXSL4142	Teledyne; L22187-2	CV Yard Soil - West Side, AP1-7, OL1	2.07E+00	3.16E-02	4.27E-02	8.75E-01	1.76E-02	6.65E-02	2.02E-02					October 2, 2003	440
22	SXSL4143	Teledyne; L22187-3	CV Yard Soil - West Side, AP1-7, OL1	2.08E+00	3.07E-02	4.27E-02	4.86E-01	2.21E-02	6.25E-02	3.64E-02					October 2, 2003	440
23	SXSL4149	Teledyne; L22187-4	CV Yard Soil - West Side, AP1-7, OL1	2.09E+00	2.69E-02	5.97E-02	3.79E+00	2.76E-02	4.26E-02	3.04E-02					October 2, 2003	440

KEY	
	Yellow Background = Positive Result
	Gray Shaded Background = MDA
XXXX	Red Values = On-Site Analysis

C01

TABLE 3 - REDUCED LISTING DECAYED - MDA's REMOVED

	SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Total pCi/g
1	CV Tunnel	**BWXT, 0102059-01**	CV Tunnel Sediment Composite, OL1		8.81E+00	7.61E-01	1.14E+03	1154.23
2	SX9SL99219	111074	Subsuface Sample #29 (0-5'), AY-128, OL1				5.25E-01	0.53
3	SXSL1063	**Teledyne-80018; L19184-1**	North CV Yard Soil BA-127, 812' El, Sample # 5, OL2	3.98E+00			8.37E-01	4.82
4	SXSL1089	**Teledyne-80019; L19184-2**	North CV Yard Soil AY-127, 810' El, Sample # 3, OL1	2.64E+00			1.22E+00	3.86
5	SXSL1115	**Teledyne-80020; L19184-3**	North CV Yard Soil AY-128, 804' El, Sample # 2, OL1	4.25E+00			1.70E+00	5.95
6	SXSL1122	**Teledyne-80021; L19184-4**	North CV Yard Soil AY-129, 798' El, Sample # 2, OL1	2.99E+00			4.51E+00	7.50
7	SXSL1130	**Teledyne-80022; L19184-5**	North CV Yard Soil AX-129, 803' El, Sample # 4, OL1	4.34E+00		2.16E-02	2.14E+01	25.73
8	SXSL1132	**Teledyne-80023; L19184-6**	North CV Yard Soil AZ-130, Sample # 5, OL1	2.59E+00			2.45E+00	5.04
9	SXSL1270	**BWXT, 0108055-02**	AX-129, 3-3, Soil, CV SE Side 5' From CV, 800' El., OL1				2.14E+01	21.37
10	SXSL1281	**BWXT, 0108055-01**	AX-128, 3-1, Soil, CV Tunnel East 5' From CV, 800' El, OL1				4.05E+00	4.05
11	SXSL2649	**Teledyne-73220; L18077-2**	Anulus Well, A-2, 5 to 10' Depth, OL1				5.62E-01	0.56
13	SXSL2871	**Teledyne-71949; L17838-11**	CV Area - East Yard Dirt Pile - Middle, 1/2 Way Up, OL1				5.25E-01	0.53
14	SXSL2872	**Teledyne-71948; L17838-10**	CV Area - East Yard Dirt Pile - Bottom (also top center), OL1				9.38E-02	0.09
15	SXSL3140	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ 6' on West Side (6" Depth), OL1				7.83E-01	0.78
16	SXSL3142	**Teledyne; L20326-3**	Soil Pile, CV Yard, Three Feet on East Side, SR-37, OL1				5.69E-01	0.57
17	SXSL3145	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ 3' on East Side (6" Depth), OL1				1.20E+00	1.20
18	SXSL3149	**Teledyne; L20326-4**	Soil Pile, CV Yard, Six Feet on East Side, SR-37, OL1				2.84E-01	0.28
19	SXSL3153	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ Top (6" Depth), OL1				2.85E-01	0.28
21	SXSL4142	**Teledyne; L22187-2**	CV Yard Soil - West Side, AP1-7, OL1				8.75E-01	0.88
22	SXSL4143	**Teledyne; L22187-3**	CV Yard Soil - West Side, AP1-7, OL1				4.86E-01	0.49
23	SXSL4149	**Teledyne; L22187-4**	CV Yard Soil - West Side, AP1-7, OL1			5.97E-02	3.79E+00	3.85

TABLE 4 - MEAN PERCENT OF TOTAL FOR POSITIVE NUCLIDES

	SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Total
1	CV Tunnel	**BWXT, 0102059-01**	CV Tunnel Sediment Composite, OL1		0.76%	0.07%	99.17%	100.0%
2	SX9SL99219	111074	Subsuface Sample #29 (0-5'), AY-128, OL1				100.00%	100.0%
3	SXSL1063	**Teledyne-80018; L19184-1**	North CV Yard Soil BA-127, 812' El, Sample # 5, OL2	82.64%			17.36%	100.0%
4	SXSL1089	**Teledyne-80019; L19184-2**	North CV Yard Soil AY-127, 810' El, Sample # 3, OL1	68.38%			31.62%	100.0%
5	SXSL1115	**Teledyne-80020; L19184-3**	North CV Yard Soil AY-128, 804' El, Sample # 2, OL1	71.40%			28.60%	100.0%
6	SXSL1122	**Teledyne-80021; L19184-4**	North CV Yard Soil AY-129, 798' El, Sample # 2, OL1	39.91%			60.09%	100.0%
7	SXSL1130	**Teledyne-80022; L19184-5**	North CV Yard Soil AX-129, 803' El, Sample # 4, OL1	16.89%		0.08%	83.03%	100.0%
8	SXSL1132	**Teledyne-80023; L19184-6**	North CV Yard Soil AZ-130, Sample # 5, OL1	51.45%			48.55%	100.0%
9	SXSL1270	**BWXT, 0108055-02**	AX-129, 3-3, Soil, CV SE Side 5' From CV, 800' El., OL1				100.00%	100.0%
10	SXSL1281	**BWXT, 0108055-01**	AX-128, 3-1, Soil, CV Tunnel East 5' From CV, 800' El, OL1				100.00%	100.0%
11	SXSL2649	**Teledyne-73220; L18077-2**	Anulus Well, A-2, 5 to 10' Depth, OL1				100.00%	100.0%
13	SXSL2871	**Teledyne-71949; L17838-11**	CV Area - East Yard Dirt Pile - Middle, 1/2 Way Up, OL1				100.00%	100.0%
14	SXSL2872	**Teledyne-71948; L17838-10**	CV Area - East Yard Dirt Pile - Bottom (also top center), OL1				100.00%	100.0%
15	SXSL3140	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ 6' on West Side (6" Depth), OL1				100.00%	100.0%
16	SXSL3142	**Teledyne; L20326-3**	Soil Pile, CV Yard, Three Feet on East Side, SR-37, OL1				100.00%	100.0%
17	SXSL3145	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ 3' on East Side (6" Depth), OL1				100.00%	100.0%
18	SXSL3149	**Teledyne; L20326-4**	Soil Pile, CV Yard, Six Feet on East Side, SR-37, OL1				100.00%	100.0%
19	SXSL3153	**BWXT,1030-003-10-01**	East CV Yard, Soil Pile @ Top (6" Depth), OL1				100.00%	100.0%
21	SXSL4142	**Teledyne; L22187-2**	CV Yard Soil - West Side, AP1-7, OL1				100.00%	100.0%
22	SXSL4143	**Teledyne; L22187-3**	CV Yard Soil - West Side, AP1-7, OL1				100.00%	100.0%
23	SXSL4149	**Teledyne; L22187-4**	CV Yard Soil - West Side, AP1-7, OL1			1.55%	98.45%	100.0%
			Mean⇒	0.551113	0.007635	0.005668	0.841366	1.41
			Sigma⇒	0.241		0.009	0.282	
			Mean % of Total⇒	39.20%	0.54%	0.40%	59.85%	100.00%
			2 Sigma + Mean⇒	1.03E+00	7.63E-03	2.27E-02	1.40E+00	2.47
			% of Total⇒	41.86%	0.31%	0.92%	56.91%	100.00%

C02

TABLE 5 - RATIO TO Cs-137 FOR POSITIVE NUCLIDES

	SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Total
1	CV Tunnel	BWXT, 0102059-01	CV Tunnel Sediment Composite, OL1		7.70E-03	6.65E-04	1.00E+00	1.01
2	SX9SL99219	111074	Subsuface Sample #29 (0-5'), AY-128, OL1				1.00E+00	1.00
3	SXSL1063	Teledyne-80018; L19184-1	North CV Yard Soil BA-127, 812' El, Sample # 5, OL2	4.76E+00			1.00E+00	5.76
4	SXSL1089	Teledyne-80019; L19184-2	North CV Yard Soil AY-127, 810' El, Sample # 3, OL1	2.16E+00			1.00E+00	3.16
5	SXSL1115	Teledyne-80020; L19184-3	North CV Yard Soil AY-128, 804' El, Sample # 2, OL1	2.50E+00			1.00E+00	3.50
6	SXSL1122	Teledyne-80021; L19184-4	North CV Yard Soil AY-129, 798' El, Sample # 2, OL1	6.64E-01			1.00E+00	1.66
7	SXSL1130	Teledyne-80022; L19184-5	North CV Yard Soil AX-129, 803' El, Sample # 4, OL1	2.03E-01		1.01E-03	1.00E+00	1.20
8	SXSL1132	Teledyne-80023; L19184-6	North CV Yard Soil AZ-130, Sample # 5, OL1	1.06E+00			1.00E+00	2.06
9	SXSL1270	BWXT, 0108055-02	AX-129, 3-3, Soil, CV SE Side 5' From CV, 800' El., OL1				1.00E+00	1.00
10	SXSL1281	BWXT, 0108055-01	AX-128, 3-1, Soil, CV Tunnel East 5' From CV, 800' El, OL1				1.00E+00	1.00
11	SXSL2649	Teledyne-73220; L18077-2	Anulus Well, A-2, 5 to 10' Depth, OL1				1.00E+00	1.00
13	SXSL2871	Teledyne-71949; L17838-11	CV Area - East Yard Dirt Pile - Middle, 1/2 Way Up, OL1				1.00E+00	1.00
14	SXSL2872	Teledyne-71948; L17838-10	CV Area - East Yard Dirt Pile - Bottom (also top center), OL1				1.00E+00	1.00
15	SXSL3140	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 6' on West Side (6" Depth), OL1				1.00E+00	1.00
16	SXSL3142	Teledyne; L20326-3	Soil Pile, CV Yard, Three Feet on East Side, SR-37, OL1				1.00E+00	1.00
17	SXSL3145	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ 3' on East Side (6" Depth), OL1				1.00E+00	1.00
18	SXSL3149	Teledyne; L20326-4	Soil Pile, CV Yard, Six Feet on East Side, SR-37, OL1				1.00E+00	1.00
19	SXSL3153	BWXT,1030-003-10-01	East CV Yard, Soil Pile @ Top (6" Depth), OL1				1.00E+00	1.00
21	SXSL4142	Teledyne; L22187-2	CV Yard Soil - West Side, AP1-7, OL1				1.00E+00	1.00
22	SXSL4143	Teledyne; L22187-3	CV Yard Soil - West Side, AP1-7, OL1				1.00E+00	1.00
23	SXSL4149	Teledyne; L22187-4	CV Yard Soil - West Side, AP1-7, OL1			1.57E-02	1.00E+00	1.02
			Mean⇒	1.890991	0.007699	0.005808	1	2.90
			Sigma⇒	1.656		0.009	0.000	
			Mean % of Total⇒	65.11%	0.27%	0.20%	34.43%	100.00%
			2 Sigma + Mean⇒	5.20E+00	7.70E-03	2.30E-02	1.00E+00	6.23
			% of Total⇒	83.47%	0.12%	0.37%	16.04%	100.00%

Table 6

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

Gross Activity DCGLw		Gross Activity Administrative Limit	
44306	dpm/100 cm^2	33229	dpm/100 cm^2
Cs-137 Limit		Cs-137 Administrative Limit	
26517	dpm/100 cm^2	19888	dpm/100 cm^2
SNEC AL	75%		

25.0 mrem/y TEDE Limit

SAMPLE NO(s)→ CV Yard Soil & Boulder Samples - Deacy 12-15-04

	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		0.000%	27	0.00	0.00	N/A	0.00	Am-241
2	C-14		0.000%	3,700,000	0.00	0.00	0.00	N/A	C-14
3	Co-60	5.67E-03	0.403%	7,100	178.64	0.63	178.64	N/A	Co-60
4	Cs-137	8.41E-01	59.850%	28,000	26517.03	23.68	26517.0	N/A	Cs-137
5	Eu-152		0.000%	13,000	0.00	0.00	0.00	N/A	Eu-152
6	H-3	5.51E-01	39.203%	120,000,000	17369.23	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		0.000%	30	0.00	0.00	N/A	0.00	Pu-238
9	Pu-239		0.000%	28	0.00	0.00	N/A	0.00	Pu-239
10	Pu-241		0.000%	880	0.00	0.00	Not Detectable	N/A	Pu-241
11	Sr-90	7.64E-03	0.543%	8,700	240.63	0.69	240.63	N/A	Sr-90
			100.000%		44306	25.0	26936	0	
					Maximum Permissible dpm/100 cm^2				

Table 7

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

SNEC AL	75%	Total Activity Limit DCGLw		Administrative Limit	
		16.70	pCi/g	12.53	pCi/g
		Cs-137 Limit		Cs-137 Administrative Limit	
		5.75	pCi/g	4.31	pCi/g

SAMPLE NUMBER(s)→ CV YARD SOIL & BOULDER SAMPLES - Decayed to 12-15-04

17.39%	25.0	mrem/y TEDE Limit
7.60%	4.0	mrem/y Drinking Water (DW) Limit

☑ Check for 25 mrem/y

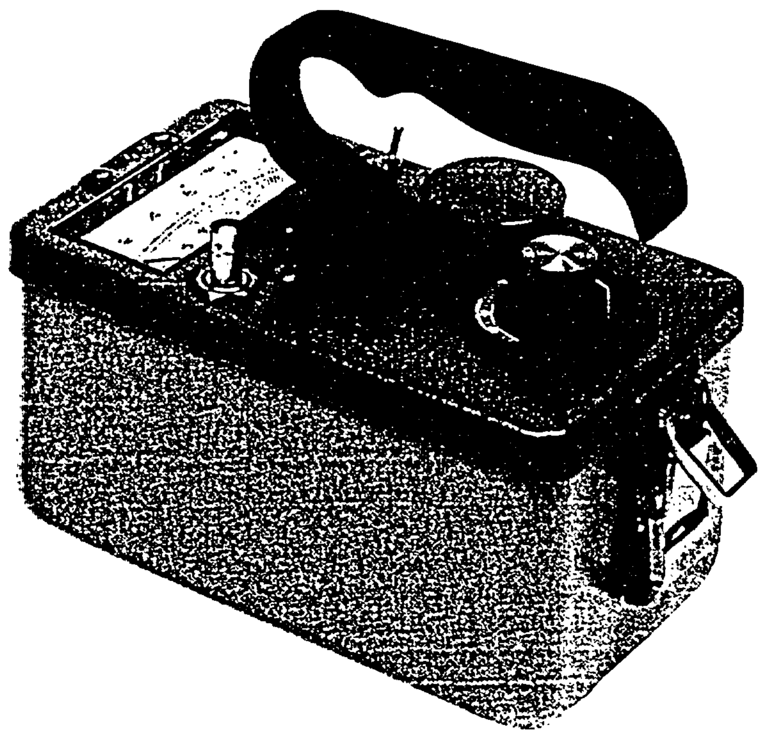
	Isotope	Sample Input (pCi/g, uCi, etc.)	% of Total	25 mrem/y TEDE Limits (pCi/g)	4 mrem/y DW Limits (pCi/g)	A - Allowed pCi/g for 25 mrem/y TEDE	B - Allowed pCi/g for 4 mrem/y DW	Value Checked from Column A or B	This Sample mrem/y TEDE	This Sample mrem/y DW	
1	Am-241		0.000%	9.9	23	0.00	0.00	0.00	0.00	0.00	Am-241
2	C-14		0.000%	2.0	5.40	0.00	0.00	0.00	0.00	0.00	C-14
3	Co-60	0.006	0.200%	3.5	67.0	0.03	0.08	0.03	0.04	0.00	Co-60
4	Cs-137	1.00	34.429%	6.6	397	5.75	13.15	5.75	3.79	0.01	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	1.89	65.106%	132	3111	10.87	24.87	10.87	0.36	0.24	H-3
7	Ni-63		0.000%	747	9000	0.00	0.00	0.00	0.00	0.00	Ni-63
8	Pu-238		0.000%	1.8	0.41	0.00	0.00	0.00	0.00	0.00	Pu-238
9	Pu-239		0.000%	1.6	0.37	0.00	0.00	0.00	0.00	0.00	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	0.008	0.265%	1.2	0.61	0.04	0.10	0.04	0.16	0.05	Sr-90
		2.90E+00	100.000%			16.70	38.20	16.70	4.348	0.304	
						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		

APPENDIX A-5

Scan MDC for NaI Measurement of Soils

Analog Smart Portable

Model ASP-1



- OPERATES WITH EBERLINE DETECTOR PROBES TO MEASURE ALPHA, BETA, GAMMA, X-RAY AND NEUTRON RADIATION
- OFFERS EXTENDED RANGE WITH AUTOMATIC DEAD-TIME CORRECTION
- RADIATION UNITS EASILY SELECTED BY THE USER
- FUNCTIONS AS A RATE METER AND INTEGRATOR
- BATTERY-SAVING CMOS MICROCOMPUTER
- OPTIONAL SINGLE-CHANNEL PULSE-HEIGHT ANALYZER (PHA) AND INTERNAL G-M DETECTOR AVAILABLE

Eberline A DIVISION OF Thermo Electron CORPORATION

Model ASP-1, Analog Smart Portable

GENERAL DESCRIPTION

The Eberline Analog Smart Portable (ASP-1) is our most versatile, metered survey instrument. Designed for use with G-M, scintillation and proportional detectors, it is capable of measuring alpha, beta, gamma, x-ray and neutron radiation.

The ASP-1 functions as a rate meter and an integrator, and displays the present radiation rate or the integrated total radiation received.

Microcomputer-based, the ASP-1 corrects for coincidence loss so that the upper limit of the range of each detector is increased by a factor of ten or more. When the useful range is exceeded, an overrange alarm is given. The ASP-1 has built-in speaker and a head-set is provided for use in noisy areas.

When the ASP-1 is used as a rate meter, the CMOS microcomputer selects the appropriate response time based on the count rate from the detector and the range switch position. Normal response time ranges from one to ten seconds with a standard deviation (SD) no greater than five percent over the top three decades of the useful range. Longer response times, and better precision, can be selected.

Inventory savings can be significant by using the ASP-1. This instrument will perform the functions of many other radiation survey instruments when coupled with detector probes available as accessories. One detector probe can be used to measure gamma exposure rate, another to measure beta-gamma contamination, another to measure alpha contamination, and another to measure neutron dose equivalent. With appropriate detectors, the ASP-1 performs all functions of Eberline's E-120, E-130A, E-140, E-520, E-530, PNR-4, PRM-6 and PRM-7, combined.

SPECIFICATIONS

Meter (lighted):

Upper scale: 0 to 1.0, 50 divisions (range determined by detector used)
Lower scale: 0 to 2500 V, 50 divisions
Scale lengths: 7.6 cm (3 in.)

High Voltage Output: From 300 to 2500 V with no load and up to 1600 V with a 100 MΩ load.

Input Sensitivity: Adjustable from 1 to 50 mV, negative pulse.

Detector Dead-Time Compensation: Up to 255 μs.

External Control

A nine-position rotary switch turns the ASP-1 on, checks the batteries, displays the high voltage and selects the range of operation. Three toggle switches control the speaker, the meter light, the reset function, the response time and the operating mode (rate or integrate).

Operating Modes

The ASP-1 continually computes the detector pulse rate and the total integrated count from the detector. When the response switch is set at SLOW or FAST, the meter displays the count rate in the calibrated units (mR/h, rem/min, cpm, etc.). When INTEGRATE is selected, the meter displays the total radiation received (in the same units of calibration, mR, rem, counts, etc.) since integration was last reset.

Battery

Six C-cell size batteries are used. The life of six carbon-zinc batteries is variable from about 150 to 250 hours, depending on the high voltage power required, the speaker usage and the light usage. Alkaline batteries will last more than twice as long under the same operating conditions. The BAT position of the range switch checks the battery condition.

OTHER SPECIFICATIONS

Dimensions: 4.2 in. wide x 7.9 in. long x 6.2 in. high (10.7 cm x 20 cm x 15.7 cm)

Temperature Range: −40°F to +122°F (−40°C to +50°C). Use alkaline or nickel cadmium batteries below 0°F (−18°C)

Weight:2.8 lbs. (1.3 kg)

Connector:MHV for detector input

DETECTOR PROBES RECOMMENDED FOR USE WITH ASP-1*

Model No.	Type Measurement	Useful Range with ASP-1
HP-270	Exposure or Exposure Rate	Bkg to 3000 mR/h
HP-290	Exposure or Exposure Rate	0.0005 to 40 R/h
HP-210L HP-260	Beta-Gamma Contamination	Bkg to 20,000 counts/s
AC-3	Alpha Contamination	Bkg to 40,000 counts/s
NRD	Neutron Dose Equivalent or Dose Equivalent Rate	0.001 to 50 rem/h
LEG-1	Low Energy Gamma or X-Ray	Bkg to 40,000 counts/s
SPA-3	High Sensitivity Gamma	Bkg to 35,000 counts/s

*When ordering the ASP-1 with a detector, please specify the preferred radiation rate units. When ordering the ASP-1 without a detector, or with more than one detector, please specify the first detector to be used and the preferred radiation units so that Eberline can set up the ASP-1 accordingly. If no detector is specified, the ASP-1 will be configured for use with a Model HP-270 detector; calibrated in mR/h.

ACCESSORIES

Audio Headset: Part No. ADHS4

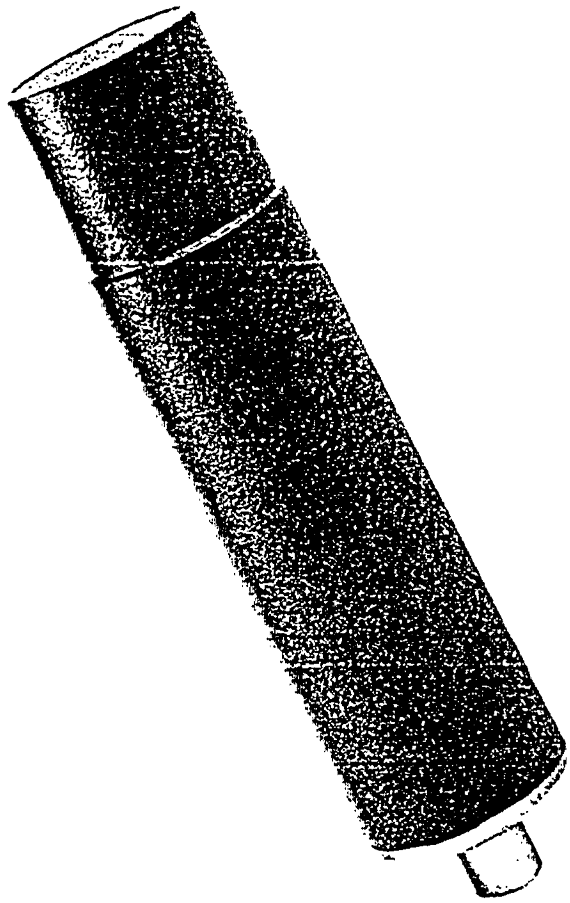
Carrying Strap:ZP10125099

Any of the following Eberline detectors can be used with the ASP-1:

Detector Probe	Cable	Check Sources	Probe Holder/Bracket
AC-3	CA-12-60	CS-1, CS-10, CS-12, CS-15	
HP-190A	CA-16-60	CS-7A	ZP10434029
HP-210AL	CA-16-60	CS-13	
HP-210L	CA-16-60	CS-13	
HP-210T	CA-16-60	CS-13	
HP-220A	CA-16-60	CS-7A	
HP-230A	CA-16-60	CS-13	ZP10434029
HP-260	CA-16-60	CS-13	ZP10434029
HP-270	CA-16-60	CS-7A	ZP10434029
HP-280	CA-15-36		
HP-290	CA-16-60	CS-7A	ZP10434029
LEG-1	CA-12-60		
NRD	CA-15-60		YP11358000
PG-2	CA-12-60		
SPA-3	CA-12-60	CS-7B	
SPA-6	CA-15-36	CS-7B	

Scintillation Probe

Model SPA-3



- HIGH GAMMA SENSITIVITY
- 2-INCH X 2-INCH NaI(Tl) CRYSTAL
- RUGGED CONSTRUCTION

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SPA-3

Model SPA-3, Scintillation Probe

GENERAL DESCRIPTION

The Model SPA-3 scintillation probe is a rugged, waterproof gamma detector designed for high sensitivity of pulse-height applications.

The SPA-3 contains a 2-inch-diameter, 2-inch-long NaI(Tl) crystal, a 2-inch, 10-stage photomultiplier tube, tube socket with a dynode resistor string, and a magnetic shield.

SPECIFICATIONS

Crystal: NaI(Tl), 2-inch-diameter × 2 inches long (5.1 cm × 5.1 cm).

Photomultiplier Tube: ≅2-inch-diameter, 10-dynode, end-window with S-11 photocathode.

Operating Voltage: Variable dependent upon application.

Maximum Voltage: +1600 V

Sensitivity: ≅1200k cpm per mR/h with ^{137}Cs

Current Drain: ≅120 MΩ resistance string yields 10 μA at 1200 V.

Wall Material: Aluminum

Wall Thickness: 1/8-inch (0.32 cm), 1/16-inch (0.16 cm) at crystal

Connector: Mates with Eberline CP-1

Finish: Enameled body with chrome-plated connector

Size: 2 5/8-inch-diameter × 11 1/8 inches long (6.7 cm × 28.3 cm)

Weight: 3.25 pounds (1.5 kg)

AVAILABLE ACCESSORIES

Instruments	Cables
PRM-6	CA-12-60
ESP-1	CA-12-60
RM-20	CA-12-60
RM-21	CA-12-60
MS-2	CA-12-60
MS-3	CA-12-60
SAM-2	CA-12-60

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NUREG 1507 Table 6.4

NaI Scintillation Detector Scan MDCs for Common Radiological Contaminants[a]

The estimates of the scan MDCs provided in this table should be evaluated to determine the appropriateness of using these estimated scan MDCs for implementation in the final status survey.

	1.25" x 1.5" NaI Detector		2" x 2" NaI Detector	
Radionuclide/Radioactive Material	**Scan MDC (pCi/g)**	**Weighted cpm/μR/h**	**Scan MDC (pCi/g)**	**Weighted cpm/μR/h**
Am-241	44.6	5,830	31.5	13,000
Co-60	5.8	160	3.4	430
Cs-137	10.4	350	6.4	900
Th-230	3,000	4,300	2,120	9,580
Ra-226 (In equilibrium with progeny)	4.5	300	2.8	760
Th-232 decay series (Sum of all radionuclides in thorium decay series, in equilibrium)	28.3	340	18.3	830
Th-232 alone[b] (In equilibrium with progeny in decay series)	2.8	340	1.8	830
Depleted Uranium[c] (0.34% U-235)	80.5	1,680	56.0	3,790
Processed Natural Uranium[c]	115	1,770	80.0	3,990
3% Enriched Uranium[c]	137	2,010	95.7	4,520
20% Enriched Uranium[c]	152	2,210	107	4,940
50% Enriched Uranium[c]	168	2,240	118	5,010
75% Enriched Uranium[c]	188	2,250	132	5,030

[a] Refer to text for complete explanation of factors used to calculate scan MDCs. For example, the background level for the 1.25" x 1.5" NaI detector was assumed to be 4,000 cpm and 10,000 cpm for the 2" x 2" NaI detector. The observation interval was 1 second and the level of performance was selected to yield d' of 1.38.

NaI Scan MDC Calculation - Weir Line Soils

$b := 13000$ $p := 0.5$ $HS_d := 56.42$ $SR := 50$ $d := 1.38$

$Conv := 900$ $MS_{output} := 2.612 \cdot 10^{-4}$

$\frac{HS_d}{SR} = 1.128$ *Observation Interval (seconds)*

$O_i := \frac{HS_d}{SR}$ *Observation Interval (seconds)*

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

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

$MDCR_i = 1.147 \cdot 10^3$ *net counts per minute*

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

$MDCR_{surveyor} = 1.623 \cdot 10^3$ *net counts per minute*

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

$MDER = 1.803$ µR/h

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

$MDC_{scan} = 6.902$ pCi/g

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

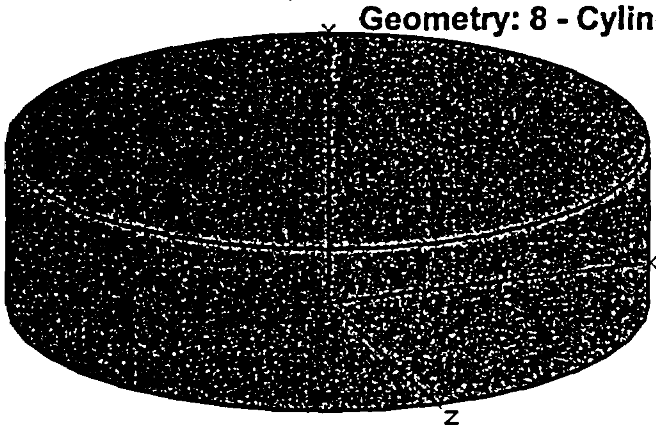
SR = scan rate in centimeters per second

MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page : 1
DOS File : SOIL.MS5
Run Date: July 21, 2005
Run Time: 3:22:53 PM
Duration : 00:00:08

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Soil
Description: Soil Density 1.5 g/cc, 6" Cylinder @ 6 cm from Surface
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.24 cm	6.0 in
Radius	28.21 cm	11.1 in

Dose Points

	X	Y	Z
# 1	0 cm	23.78 cm	0 cm
	0.0 in	9.4 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.81e+04 cm³	Concrete	1.5
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	5.4066e-008	2.0004e+003	1.4190e-006	5.2503e-002
Cs-137	5.7152e-008	2.1146e+003	1.5000e-006	5.5500e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	60
Circumferential	60
Y Direction (axial)	60

Results

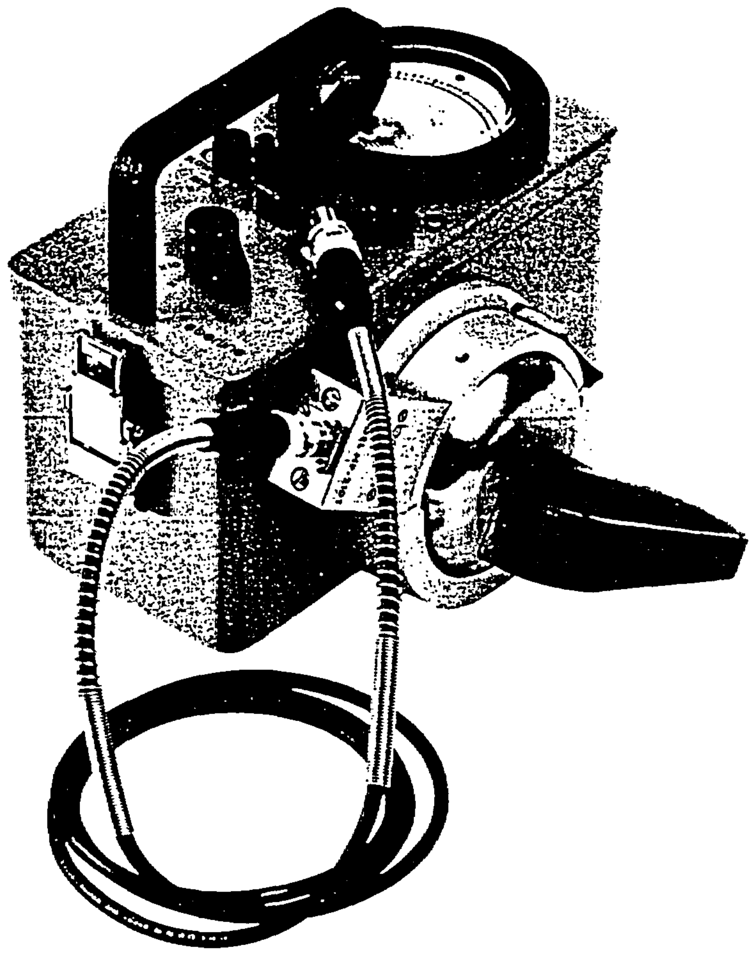
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	4.142e+01	8.226e-06	9.957e-06	6.852e-08	8.294e-08
0.0322	7.641e+01	1.582e-05	1.927e-05	1.273e-07	1.551e-07
0.0364	2.781e+01	8.770e-06	1.146e-05	4.983e-08	6.508e-08
0.6616	1.800e+03	7.609e-02	1.347e-01	1.475e-04	2.612e-04
TOTALS:	1.946e+03	7.613e-02	1.348e-01	1.478e-04	2.615e-04

APPENDIX A-6

Scan MDC for Geiger Mueller Detector

GM Survey Meter

Model E-140N



- BUILT-IN SPEAKER
- 500, 5k, 50k cpm SCALES
- RUGGEDIZED, SPLASHPROOF PACKAGE

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A DIVISION OF Thermo Electron CORPORATION

E-140N

Model E-140N, Geiger-Mueller Survey Meter

GENERAL DESCRIPTION

The Model E-140N Survey Meter combines the proven reliability of Geiger-Mueller (GM) detectors with reliable electronics to provide an instrument with outstanding operational characteristics in a compact, lightweight package.

The ruggedized meter gives exceptional readability and linearity with a variable response time. Calibration stability results from temperature compensation and voltage regulation. High efficiency circuits extend battery life.

A single printed circuit board contains most components, resulting in a minimum of solder joints which enhances reliability. The PC board connects to the cover, which permits an operational unit to be removed from the case for ease of calibration.

The E-140N is equipped with a built-in-speaker and a mounted probe holder which will accommodate the HP-210 type (DT-304/PDR) hand probe.

SPECIFICATIONS

Range: Three linear ranges, covering 0 to 50k cpm.

Display: Ruggedized meter with 0-500 cpm scale.

Response Time: Variable from 2 to 10 seconds for 0-90 percent of final value.

Linearity: Within ±5 percent of full scale when driven with a repetitive signal.

Battery Complement: Two "D" cells.

Battery Life: Nominal 300 hours C-Zn, 500 hours Alkaline. Built-in battery check.

Voltage Coefficient: Reading changes <10 percent from new battery to end point.

Connectors: BNC for detector input. No. 5501 MP for headphones.

Construction: Splashproof, all metal case, enamel finish.

Temperature: Operational from -40 °C to +60 °C (-40 °F to 140 °F).

Dimensions: 5 inches wide, 8½ inches long, 7⅛ inches high (including handle) (12.7 cm x 21.6 cm x 18.1 cm).

Weight: 3.6 pounds (1.64 kg) with C-Zn batteries.

Detectors: The Model E-140N is compatible with all Eberline GM hand probes (+900 V).

AVAILABLE ACCESSORIES

Hand probe assemblies

Model

HP-210T (tungsten)
HP-210Al (aluminum)
HP-210L (lead)

Connecting Cables

(Instrument to Probe)

Model

CA-18-60, 60-inch ruggedized cable (standard)

CA-1-36, 36-inch coaxial

CA-1-60, 60-inch coaxial

Audio Headset Assembly: Model BA201M

Carrying Strap: Model ZP10125099

Radioactive Check Source: CS-7A, gamma source

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7-84

Hand Probe

Model HP-210

HP-210AL

HP-210T

- THIN WINDOW "PANCAKE" GM
- HIGH BETA SENSITIVITY
- WINDOW PROTECTIVE SCREEN

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HP-210

Model HP-210, Hand Probe

GENERAL DESCRIPTION

The Model HP-210 series hand probes provide a sensitive beta detector featuring a "Pancake" GM tube with a thin mica window. The open window, which is protected by a sturdy wire screen, permits useful beta sensitivities down to 40 keV. The detector is alpha sensitive (above 3 MeV).

The HP-210 is designed for contamination surveys on personnel, table tops, floors, equipment, etc.

The HP-210T, with a high density tungsten shield, permits relatively low-level beta monitoring in a gamma background. Also available is the HP-210L with a lead shield which has the same specifications as the tungsten shield. When low-level beta monitoring is required in a low background area, the HP-210AL with an aluminum housing may be used.

SPECIFICATIONS

	HP-210T (DT-304) HP-210L	HP-210AL
Operating Voltage:	900 ±50 V	900 ±50 V
Plateau Length:	100 V minimum	100 V minimum
Plateau Slope:	0.1 percent per V maximum	0.1 percent per V maximum
Dead Time:	50 μs maximum	50 μs maximum
Temperature Range:	−22°F to +167°F (−30°C to +75°C)	−22°F to +167°F (−30°C to +75°C)
Mica Window Thickness:	1.4 to 2.0 mg/cm²	1.4 to 2.0 mg/cm²
Mica Window Size:	1.75 in. diameter (4.45 cm) 2.4 in²	1.75 in. diameter (4.45 cm) 2.4 in²
Series Resistor:	3.3 mΩ (in probe)	3.3mΩ (in probe)
Gamma Sensitivity: (into window)	≅3600 cpm/mR/h (^{137}Cs) ≅ 5000 cpm/mR/h (Co-60)	≅3600 cpm/mR/h (^{137}Cs)
Shielding Ratio: (window: back) Ron Ulbricht Eberline	≅4:1 (^{60}Co) ≅ 100:1 (Cs137) maybe	≅1:1
***Beta Efficiency:**	≅45 percent ^{90}Sr-^{90}Y ≅30 percent ^{99}Tc ≅10 percent ^{14}C	≅45 percent ^{90}Sr-^{90}Y ≅30 percent ^{99}Tc ≅10 percent ^{14}C
Alpha Sensitivity:	3 MeV at window	3 MeV at window
Connector:	BNC series coaxial	BNC series coaxial
Size:	6.5 in. long x 3.5 in. wide x 3.8 in. high (16.2 cm x 8.8 cm x 9.6 cm)	6.5 in. long x 3.5 in. wide x 3.8 in. high (16.2 cm x8.8 cm x 9.6 cm)
Weight:	4.25 lbs. (1.9 kg)	1.5 lbs. (0.7 kg)

*Efficiencies with screen in place. Screen removal will increase efficiency by 45 percent of stated value. Efficiencies listed as percentage of 2π emission rate from a one inch diameter source.

AVAILABLE ACCESSORIES

Instruments	Cables
E-120	CA-1-36
E-140	CA-1-36
E-140N	CA-18-60
E-520	CA-1-36
ESP-1	CA-16-60
RM-14	CA-1-60
RM-20	CA-16-60
RM-21	CA-16-60
MS-3	CA-16-60

Sample Holder: SH-4A

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Beta Scan Measurement MDC Calculation

Weir Concrete Headwall Scan Parameters - HP-210 Probe

$\varepsilon_i := .1$ $\varepsilon_s := 1$ $b := 40$ $p := 0.5$ $W_d := 4.445$ $S_r := 7.62$ $d := 1.38$ $A := 15.6$

$\frac{W_d}{S_r} = 0.583$ *Observation Interval (seconds)* $O_i := \frac{W_d}{S_r}$ *Observation Interval (seconds)*

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

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

$\varepsilon_i = 0.1$

$b_i = 0.4$ *Counts in observation Interval*

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

$C = 90.655$

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

$MDCR_i = 88.5$ *net counts per minute*

$MDCR_i + b = 128.517$ *gross counts per minute*

$\frac{MDCR_i}{O_i} = 151.7$ *net counts per minute in observation interval*

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

$MDC_{scan} = 8.024 \cdot 10^3$ *dpm per 100 cm^2*

Parameters from Post Remediation Surveys
900-01-2477, 900-01-2476, 700-01-1763, 700-01-1764, 305-01-1751, 305-01-1752

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)