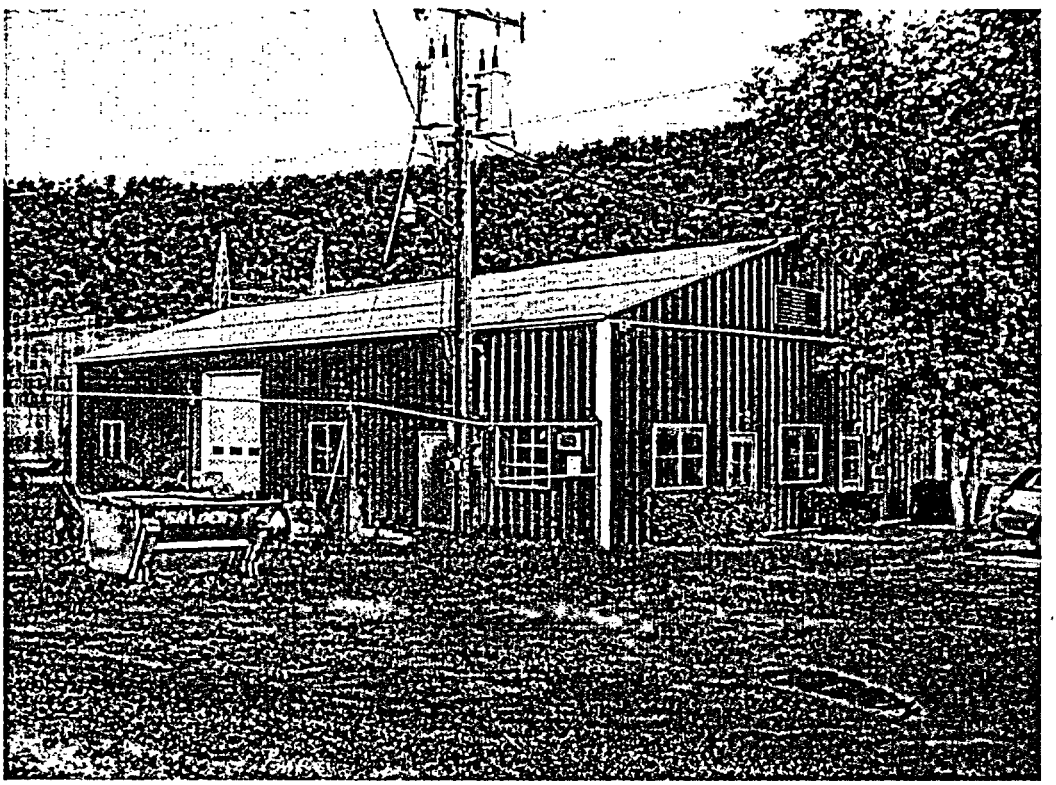
Final Status Survey Report

Saxton Nuclear Experimental Corporation

Penelec Line Shack

Revision 1



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Executive Summary

This report presents the results and conclusions of the Final Status Survey (FSS) conducted by GPU Nuclear, Inc. and Shonka Research Associates (SRA) on the Penelec Line Shack, located next to the Saxton Nuclear Experimental Corporation (SNEC) property. This FSS report provides the summary results of surface measurements taken on the aforementioned building. The FSS performed by SRA was completed in July 2003 while GPU Nuclear, Inc completed the FSS for the attic in July 2004.

The SRA FSS was performed in accordance with the SNEC License Termination Plan (LTP). Excluding the attic the Line Shack was divided into six (6) survey units. Each survey unit was comprised of either building wall, floor, ceiling and/or roof surfaces. Five (5) of the six Line Shack survey units were classified as Class 2, with the exception of the exterior walls, which were classified as Class 3. Survey data was collected from each survey unit according to data collection requirements specified in the FSS design criteria. The following areas represent 1,737 m^2 of total building surface areas. Since these are Class 2 and 3 areas, approximately 10-50% of the total surface area was surveyed. The measured surface areas are listed below with the percentage of total surface area denoted in parenthesis.

1. Scan measurements were performed by SRA on approximately 146.5 m^2 (51% of 290 m^2) of interior floor areas.
2. Scan measurements were performed by SRA on approximately 53.8 m^2 (30% of 177 m^2) of interior walls from the floor up to 2 meters.
3. Scan measurements were performed by SRA on approximately 41.3 m^2 (22% of 191 m^2) of interior upper walls above 2 meters.
4. Scan measurements were performed by SRA on approximately 135.1 m^2 (33% of 412 m^2) of the ceiling.
5. Scan measurements were performed by SRA on approximately 74.7 m^2 (22% of 343 m^2) of exterior walls.
6. Scan measurements were performed by SRA on approximately 169.4 m^2 (52% of 324 m^2) of the roof.

The GPU Nuclear FSS was performed in accordance with the SNEC License Termination Plan (LTP). The Line Shack Attic was divided into four (4) Class 2 survey units. Survey data was collected from each survey unit according to data collection requirements specified in the FSS design criteria. The following areas represent 183 m^2 of the total attic surface areas. Since these are Class 2 areas, approximately 10-50% of the total surface area was surveyed. The measured surface areas are listed below with the percentage of total surface area denoted in parenthesis.

1. Scan measurements were performed on approximately 10 to100% of the exposed attic floor area (i.e. top of wood joists and the top of insulation material). The minimum scanned surface area was approximately 48 m^2.
2. Scan measurements were performed on approximately 12 m^2 (25% of 49 m^2) of the exposed interior steel siding. In addition, the upper horizontal side of easily accessible steel support beams and the louvered vent area on the west wall were also included.
3. Scan measurements were performed on approximately 9 m^2 (25% of 36 m^2) of the exposed interior concrete block wall.
4. Scan measurements were performed on approximately 13 m^2 (25% of 50 m^2) of the interior ceiling. The ceiling was composed of Homasite roofing material and steel supports.

Results of the above measurements were less than the applicable action level or $DCGL_w$ value for each of the respective survey units. The collected FSS data demonstrate that each survey unit meets the radiological criteria for unrestricted use specified in 10 CFR 20.1402. Based on the results of the Penelec Line Shack final status survey, GPU Nuclear, Inc. concludes that this area, as described in this report, meet the NRC requirements for release to unrestricted use.

1.0 Purpose and Scope

This report presents the results and conclusions of the Penelec Line Shack final status surveys performed by Shonka Research Associates, Inc. (SRA) and GPU Nuclear, Inc. (GPUN). The following areas were surveyed:

SRA Surveyed Areas (Excluding Attic)

1. Line Shack floor.
2. Line Shack interior walls from floor up to 2 meters.
3. Line Shack interior upper walls above 2 meters.
4. Line Shack ceiling.
5. Line Shack exterior walls.
6. Line Shack roof.

GPUN Surveyed Areas (i.e. Attic)

1. Line Shack attic floor.
2. Line Shack attic steel siding wall.
3. Line Shack attic concrete block wall.
4. Line Shack attic ceiling.

These surveys provide the information required by 10 CFR 50.82(a)(11) and SNEC's License Termination Plan (LTP) to demonstrate that these areas meet the radiological criteria for unrestricted use specified in 10 CFR 20.1402.

The Line Shack (excluding the attic) has sheet metal walls, steel roofing material and a poured concrete interior floor. Other materials including Masonite, cinderblocks, tile and miscellaneous painted surfaces were encountered in the radiological surveys. The FSS surveys were performed with SRA's Surface Contamination Monitor (SCM). The roof and interior ceiling were accessed from a mechanical lift (Genie). For exterior walls, the SCM was rolled on plywood to assure a constant speed and height.

The Line Shack Attic has a floor consisting of wooden beams and fiberglass insulation, walls consisting of steel siding and concrete block, and a ceiling consisting of a Homasite roofing material and associated steel supports. The FSS surveys were performed using a gas flow proportional counter (Ludlum Model 2350-1 w/43-68 probe).

2.0 Final Status Survey Designs

2.1 Description of Survey Units

2.1.1 Line Shack Interior Walls and Floor Excluding Attic

There are four (4) Class 2 survey units specified inside the Line Shack. The four survey units (LS1-1, LS1-2, LS2-1, and LS2-2) cover the floors, interior walls up to 2 meters and interior walls above 2 meters and the ceiling.

The total area for the three survey units is approximately **1070 m^2**. A short description of each survey unit is included below.

1. Survey unit **LS1-1** is composed of portions of the Line Shack floor. This survey unit is approximately **290 m^2** in total area.
2. Survey unit **LS1-2** is composed of portions of the Line Shack's interior walls from the floor up to 2 meters. This survey unit is approximately **177 m^2** in total area.
3. Survey unit **LS2-1** is composed of portions of the Line Shack's upper interior walls above 2 meters. This survey unit is approximately **191 m^2** in total area.
4. Survey unit **LS2-2** is composed of portions of the Line Shack's ceiling. This survey unit is approximately **412 m^2** in total area.

2.1.2 Line Shack Exterior Walls and Roof

There are two (2) survey units specified for outside the Line Shack. The exterior walls survey unit (LS3) is a Class 3 area and the roof survey unit (LS4) is classified as a Class 2 area.

The total area for the two survey units is approximately **667 m^2**. A short description of each survey unit is included below.

1. Survey unit **LS3** is composed of portions of the Line Shack exterior walls. This survey unit is approximately **343 m^2** in total area.
2. Survey unit **LS4** is composed of portions of the Line Shack's roof. This survey unit is approximately **324 m^2** in total area.

2.1.3 Line Shack Attic

There are four (4) Class 2 survey units specified for the attic. The four survey units (LS6-1, LS6-2, LS6-3, and LS6-4) cover the attic floor, interior walls and the ceiling.

The total area for the four survey units is approximately **183 m^2**. A short description of each survey unit is included below.

1. Survey unit **LS6-1** is composed of portions of the attic floor. This survey unit is approximately **48 m^2** in total area.
2. Survey unit **LS6-2** is composed of portions of the attic's interior steel walls. This survey unit is approximately **49 m^2** in total area.
3. Survey unit **LS6-3** is composed of portions of the attic's concrete block wall. This survey unit is approximately **36 m^2** in total area.
4. Survey unit **LS6-4** is composed of portions of the attic's ceiling. This survey unit is approximately **50 m^2** in total area.

2.2 Site Release Criteria

The site release criteria applied to the Line Shack correspond 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 to meet the site or survey unit release criteria were derived by analyses using the building occupancy (surface area) scenario. The dose modeling for this scenario is explained in the SNEC LTP, Chapter 6. The derived concentration guideline levels ($DCGL_w$s) listed in the LTP form the basis for satisfying the site release criteria.

Radioactivity sample results for surfaces inside/outside the Line Shack were compared to calculated gross activity $DCGL_w$s. These gross activity $DCGL_w$s were developed using the methodology described in the SNEC LTP Section 5.2.3.2.4, based on radionuclide specific DCGLs listed in Table 5-1 of the LTP.

As described in Chapter 6 of the SNEC LTP (Reference 6.1) a correction to the gross activity $DCGL_w$ was made to address de-listed radionuclides. The SNEC facility has instituted an administrative limit of 75% for the allowable dose (DCGL) for all measurement results. The de-listed radionuclide dose is accounted for within the 75% administrative limit.

2.3 Survey Designs

The original SRA FSS survey design is provided in Appendix A. This design utilized the NRC surface area default value for Cs-137 for the initial scans. Scan coverage measurements were set at 10-50% for Class 2 areas and approximately 10% for Class 3 areas. The number of static measurement points was to be determined if the SRA survey sensitivity did not meet 10% of the design $DCGL_w$.

After the original FSS survey a new method for determining nuclide mixes was developed and concurred with the NRC. This mix determination method slightly reduced the original surface $DCGL_w$ used in the original survey design. An assessment calculation was written to ensure the scans performed under the first design criteria met the new criteria using the new nuclide mix. This assessment is contained in Appendix B. As a result, the original SRA FSS survey met the criteria specified in Appendix B. Subsequently, the GPUN FSS survey design (Appendix D) for the Line Shack Attic used this same method.

Survey designs use gross activity $DCGL_w$ values developed from results of samples taken in the respective areas. These samples consisted of soil and sediment from environs surrounding the Line Shack. The gross activity surface area $DCGL_w$ was determined from the mean concentration percent of applicable samples. The CV Soil and Boulder radionuclide mix tables were used to determine a representative $DCGL_w$ for the Line Shack. This was based on the assumption that soil/boulder radioactivity became airborne, as a result of site wind erosion, and therefore impacted the Line Shack. The Line Shack surface materials consist of concrete, metal and/or wallboard. Therefore the release limit is based on the surface $DCGL_w$.

From the calculation logic used in Appendix B and D the mean percent of total activity for positively detected nuclides was used to determine the mix. This calculation methodology determines the relative fractions of the total activity contributed by each radionuclide. 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. The mean percent values are averaged using only the positive sample results for each nuclide. Four of the SNEC eleven radionuclides were used to determine mix ratios. These radionuclides are

Co-60 (<1%), Cs-137 (59.5%), H-3 (39.5%), and Sr-90 (<1%). Cs-137 and H-3 accounted for the majority of radionuclides, i.e. greater than 99% of the mix. Using the above calculation logic from Appendix B and D the calculated gross activity $DCGL_w$ is 44,434 dpm/100 cm^2. This value is reduced by 25% as part of SNEC's requirement to apply an administrative limit as discussed in the License Termination Plan (LTP). The administrative gross activity then is therefore 33,325 dpm/100 cm^2.

Table 1 presents data quality objectives (DQOs) and other relevant information, which went into the survey design and assessment calculation (Appendix A, B and D) for the Line Shack.

Table 1

DQO/Design Parameter	LS1-1, LS1-2, LS2-1, LS2-2, LS4	LS3	LS6-1, LS6-2, LS6-3, LS6-4
SNEC Design Calc. No.	E900-03-014 E900-04-010	E900-03-014 E900-04-010	E900-04-011
MARSSIM Classification	2	3	2
Area Size (m^2)	1394	343	183
Statistical Test	N/A	N/A	WRS
Type I Decision Error (α)	0.05	0.05	0.05
Type II Decision Error (β)	0.10	0.10	0.10
Gross $DCGL_w$ (dpm/100 cm^2)	33,325	33,325	33,325
Cs-137 $DCGL_w$ (dpm/100 cm^2)	19,834	19,834	19,834
Sample #(s) used for nuclide mix	See Appendix A & B	See Appendix A & B	See Appendix D
SNEC Survey Request No.	81	81	141
Survey Instrument Model	SCM	SCM	Ludlum 2350-1 w/43-68
Instrument Total Efficiency	23-37%	23-37%	24-28%
Measurement Type	Scan	Scan	Scan/Static

3.0 Final Status Survey Results

The following sections provide the survey summary results for the Line Shack survey units as required by the respective design. Summary data was taken from Reference 6.7 and 6.8.

3.1 Line Shack Interior Walls and Floor Excluding Attic

3.1.1 Survey Unit Results

Four (4) survey units were developed. These survey units are designated as LS1-1, LS1-2, LS2-1 and LS2-2, which cover the floors, interior walls up to 2 meters, interior walls above 2 meters and the ceiling. These survey units are described in section 2.1.1 of this report. The FSS design and assessment calculation for these survey units are provided in Appendix A and B. DQOs are listed in Table 1. Surveys were performed in accordance with Reference 6.6 (i.e. SR-81). Surface scan measurements were performed using SRA's surface contamination monitor (SCM). The SCM utilizes large-area position sensitive proportional counters (PSPCs) in either rolling (scanning) or static modes.

Per Appendix B the gross $DCGL_w$ for all areas was calculated to be 44,434 dpm/100 cm^2. The 75% administrative gross activity is therefore 33,325 dpm/100 cm^2. Since Cs-137 represented 59.5% of the total mix the $DCGL_w$ was calculated to be 19,834 dpm/100 cm^2. These Class 2 areas were given a scan coverage that ranged from 10-50% of the total survey unit size.

No WRS statistical analysis and/or static measurements are necessary for these survey units since all measurements are less than 10% of the assigned $DCGL_w$. The following tables provide the summary results from the Shonka survey. The file SCS# represents the areas surveyed and are indexed on maps in Appendix C.

Survey Unit:	LS1-1 (floors) Class 2				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Survey Coverage (m^2)	% of Total Area
7016Z	-189	4550	0.2336	125.28	43%
7039Z	32	1600	0.3695	21.24	7%
			Total	146.52	51%

Survey Unit:	LS1-2 (interior walls < 2 meters) Class 2				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Coverage (m^2)	% of Total Area
7010Z	67	1388	0.3664	2.73	2%
7011Z	36	1213	0.3664	7.63	4%
7014Z	98	1424	0.3664	6.02	3%
7040L	-32	1319	0.3695	5.76	3%
7040M	322	2032	0.3695	2.88	2%
7040N	-21	1425	0.3695	1.44	1%
7040O	244	1927	0.3695	2.88	2%
7040P	-113	1230	0.3695	3.42	2%
7040Z	-35	1319	0.3695	5.4	3%
7042L	-117	1244	0.3695	5.22	3%
7042M	-112	1289	0.3695	1.98	1%
7042Z	-72	1271	0.3695	1.62	1%
7044Z	-47	1476	0.3695	3.96	2%
7007Z	-243	2811	0.2521	5.53	3%
7008Z	164	3974	0.2521	7.32	4%
			Total	63.79	36%

Survey Unit:	LS2-1 (interior walls > 2 meters) Class 2				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Coverage (m^2)	% of Total Area
7012Z	3	1316	0.3664	7.63	4%
7013Z	9	1359	0.3664	9.45	5%
7043Z	-102	1720	0.3695	13.1	7%
7045Z	27	1643	0.3695	1.65	1%
7009Z	-422	3465	0.2521	9.49	5%
			Total	41.32	22%

Survey Unit:	LS2-2 (ceiling) Class 2				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Coverage (m^2)	% of Total Area
7017X	36	1590	0.3695	48.87	12%
7017Z	-12	1507	0.3695	66.78	16%
7041Z	201	1880	0.3695	19.44	5%
			Total	135.09	33%

3.2 Line Shack Exterior Walls and Roof

3.2.1 Survey Unit Results

Two (2) survey units were developed. These survey units are designated as LS3 and LS4, which cover the exterior walls and the roof of the Line Shack. These survey units are described in section 2.1.2 of this report. The FSS design and assessment calculation for these survey units are in Appendix A and B. DQOs are listed in Table 1. Surveys were performed in accordance with Reference 6.6 (i.e. SR-81). Surface scan measurements were performed using SRA's surface contamination monitor (SCM). The SCM utilizes large-area position sensitive proportional counters (PSPCs) in either rolling (scanning) or static modes.

Per Appendix B the gross $DCGL_w$ for all areas was calculated to be 44,434 dpm/100 cm^2. The 75% administrative gross activity is therefore 33,325 dpm/100 cm^2. Since Cs-137 represented 59.5% of the total mix the its $DCGL_w$ was calculated to be 19,834 dpm/100 cm^2. Scan coverage ranged approximately 10% for LS3 (Class 3) and 10-50% for LS4 (Class 2) of the respective total survey unit size.

No WRS statistical analysis is necessary for these survey units since the measurements are well below the assigned $DCGL_w$. The following tables provide the summary results from the Shonka survey. The file SCS# represents the areas surveyed and are indexed on maps in Appendix C.

Survey Unit:	LS3 (exterior walls) Class 3				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Coverage (m^2)	% of Total Area
7015R	126	3794	0.2336	19.89	6%
7015S	-7	3579	0.2336	22.68	7%
7015Z	-50	3507	0.2336	32.13	9%
			Total	74.7	22%

Survey Unit:	LS4 (roof) Class 2				
File SCS#	Survey Average (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)	Total Efficiency	Coverage (m^2)	% of Total Area
7006Z	4154	10346	0.2336	169.38	52%

The highest residual radioactivity was identified on the Line Shack roof. The contamination appeared to be uniformly distributed across all the surveyed area with the exception of the new section of roofing on the west end of the south side of the roof (which contained no residual contamination). However, no area of the roof was found to be above the applicable $DCGL_w$.

A sodium iodide study was conducted to determine the reason for the residual radioactivity on the old portion of the Line Shack roof. This study is documented in Appendix B. The conclusion of the study is the contaminant concentration identified by SRA is obviously a beta or alpha emitting radionuclide. The origin of the count rate is most likely natural occurring Ra-226 daughters in the roof materials. Ra-226 is naturally present in coal dust materials found on-site. The key Ra-226 daughters that emit alpha and beta radiations are most likely Po-210 and Bi-214. Over the years coal dust fallout on the Line Shack roof has combined with rain to cause an oxidation reaction on the roof surface. This reaction is believed to be one possible reason for the thin layer of corrosion (patina), which is likely the significant cause for the residual activity.

3.3 Shonka Survey Methodology

3.3.1 Surface Contamination Monitor (SCM) Description

All Line Shack surveys (excluding the attic) were performed with SRA's Surface Contamination Monitor (SCM). The SCM utilized large-area position-sensitive proportional counters (PSPCs) in the rolling (scanning) modes. The PSPCs used with the SCM were typically either 90 cm or 180 cm in active length.

In rolling mode, the SCM logs information in 25 cm^2 bins by logging data for each 5 cm width of the PSPC and for every 5 cm of forward travel. A precision wheel encoder measures the distance the SCM travels. Corner mode data is recorded in a similar manner, except the wheel encoder is replaced with a computer-based timer and a "speed" parameter is set so that the desired count time corresponds to a "distance" of 5 cm. In either mode, data are recorded in 25 cm^2 pixels over the entire surface surveyed, meaning the SCM records 400 measurements for every square meter it covered. When SCM data is analyzed, the software algorithm considers each 25 cm^2 measurement as $\frac{1}{4}^{th}$ of four separate 100 cm^2 areas. This technique ensures that the highest-activity 100-cm^2 area is

identified because it is not sensitive to registration of the detector as may occur using systems that employ multiple, non-overlapping detectors. The fact the SCM records 400 measurements for every square meter it covers allows data to be evaluated via statistical methods that consider the distribution of activity on a surface in addition to its average concentration.

The PSPCs were calibrated using a traceable, wide-area reference standard provided by GPU. This calibration source used was a Cs-137 source with serial number GO536. The efficiency applied to 100 cm^2 data is calculated as:

Total 100cm^2 Efficiency= $\varepsilon T_{100} = \varepsilon_i * \varepsilon_s$

Where	εT_{100},	Total Efficiency
	ε_i,	Instrument Efficiency
	ε_s,	Source Efficiency

The Source Efficiency was chosen per ISO 7503 Part 1 Sec 4.2.3.2 to be 50%. The Instrument Efficiency is the net count rate the SCM reports for a 100 cm^2 area divided by the decay corrected emission rate per 100 cm^2 of the calibration source.

SCM detectors are available in two cross-sectional shapes and various lengths. Model numbers have a prefix that is either "TF or T", (trapezoidal cross section with a flange, optimized for rolling surveys), or "C" (corner detector with a rectangular cross section optimized for static surveys). For example the detector types and related efficiencies, which were used in the Line Shack survey, are as follows: T70 (0.2521), T180 (0.2336), C70 (0.3664) and C180 (0.3695). The suffix is the active length of the detector in centimeters.

The differences observed in efficiencies between different detector types generally can be contributed to the configuration and mode in which the detector is used. This is similar to an analytical lab having different efficiencies for different geometries. The large difference observed between trapezoidal and corner detectors results from their different modes of operation. Corner detectors are used and therefore calibrated in a static mode. A calibration source (Cs-137) is placed on the detector using a jig. As a result the source is resident under the detector for the entire count cycle.

In contrast trapezoidal detectors are used in a rolling mode. The Cs-137 source is placed in a jig to secure the source to a surface. The calibration data is collected by surveying the source with the same detector configuration and geometry that will be used during the survey. When the cart is moving relative to the source, the source will not be fully resident under the detector for the entire count cycle. This results in fewer counts available to the detector and therefore a lower efficiency.

Detector carriers can also contribute to changes in efficiency. Detectors may be used with different styles of detector carriers and mounts. This can result in differences in stand off height between the source and detector. For instance a survey may require a rugged carrier in an area in which a particular length of detector is used, while you may be able to use a less rugged carrier that gets the detector closer to the source for other detector lengths.

Finally, differences in efficiency can be observed as detector length changes. The SCM electronics are optimized for the range of detector lengths generally deployed on surveys. However, longer anode wires in longer detectors present larger distributed resistance and

capacitance to the preamplifier inputs. Thus, differences are observed between C180 and C090 detectors.

3.3.2 Explanation of Shonka Radiological Survey Reports

Appendix E Radiological Survey Reports (RSR) all follow the same format, beginning with general information about the survey area, the detectors used, their respective efficiencies and backgrounds, and the applicable investigation levels. Following this information are the survey results, which include a two-dimensional (2-D) color map image, a cumulative frequency distribution (CFD) plot, and a "meter grid summary table." For floor areas, and areas such as the roof and paved outdoor areas, the 2-D image is always oriented so that the top is north. For walls, the image is oriented as if the reader was facing the wall. Surveys of areas such as ceilings are oriented as if the reader was looking down through the roof.

Each RSR shares the same format. A data header block at the top of every report provides a general description of the survey including the:

- Survey Unit Name – This is the name assigned by GPU to areas within a given SR.
- Survey Filename – This is the name of the record assigned by the SCM that the data was recorded under. One or more surveys may have been recorded to complete the survey of the Survey Unit.
- Survey Date – The date and time that the file was recorded.
- Survey Location Code – This is a code used by the survey information management system (SIMS) database to track survey data.
- Survey Equipment – SCM serial number.
- Calibration Due Date – The calibration date of the SCM.
- Detector(s) – Model name of detector(s) used for this survey.
- Surveyors Name(s) – The surveyors who operated the SCM.
- SIMS Version – This is the version of the software used to post-process the data and generate the RSR.
- SCM Version – This is the version of the software used to record the data on the SCM.
- Background – This is the background count rate for the material surveyed for the given detector used to perform the survey. The detector model and background cpm is shown.
- Efficiency (100 cm^2) - This is the efficiency for the given detector used to perform the survey. The detector model and efficiency is shown.
- m^2 Correction Factor - This is the correction factor used to determine the square meter efficiency for the given detector used to perform the survey. The detector model and efficiency is shown.
- Any 100 cm^2 Measurement – This is the limit that triggers an investigation on small sources. Since the SCM records data in 25 cm^2 samples, SIMS performs 400 tests in any given square meter.
- Average Over Any 1 m^2 – This is limit that triggers an investigation on large sources. The square meter grid that is laid over the imaged data is investigated at the level shown.
- Maximum 100 cm^2 – This value is filled in by the SIMS report generator. The investigation levels shown in the "Any 100 cm^2 Measurement" header blocks are used to compare against the recorded data.
- Maximum m^2 Average - This value is filled in by the SIMS report generator. The investigation levels shown in the "Average Over Any 1 m^{2n} header blocks are used to compare against the recorded data.

- Average of Survey Area – This is the average concentration for the data recorded under the filename shown in the "Survey Filename" header block.
- MDC - This is the minimum detectable concentration for the data recorded under the filename shown in the "Survey Filename" header block.

Page 2 of the RSR shows two images: a 2-dimensional plot of the surveyed data and a CFD of 100 cm^2 areas. The 2-dimensional plot has x and y-axis numbered in meters. Each pixel in the image is a 100 cm^2 area. The color bar on the right side of the image shows the reference for the pixels in the image. The image titled "CFD of 100 cm^2 areas" has the x-axis in units of dpm per 100 cm^2 and the y-axis in percent. The crossing of the 50% probability with the plotted data is the median value of the data.

The 2-D images in each SCM report are scaled so that the DCGLw corresponds to white on the color scale and zero is black. However, in the case of final surveys, since there is little if any residual radioactivity in most of the areas, the images do not provide a lot of information. They are primarily black, indicating net activity in the area is close to zero.

For each SCM survey, a one-meter by one-meter grid is superimposed on the data field, oriented with its origin corresponding to the bottom left corner. Page(s) 3 (and beyond) of the report shows the square meter statistics for the area surveyed in a table entitled "Meter Grid Summary Table." The "Meter Grid Summary Table" provides information for each grid, which is denoted by its X and Y coordinates. The X and Y columns reference the grids of Figure 1 of the RSR. Meters with no recorded data are not displayed. In the table, the column labeled "mean" gives the square meter average for each grid. The mean is the average of all measurements in the grid. The next three columns give the maximum, minimum, and the standard deviation of all the individual 100 cm^2 measurements in each grid. The standard deviation is calculated from pixels that contain data. The last column specifies how many 100 cm^2 measurements the results are based on for each grid. When "100" is indicated in the "Areas" column, the grid is a full square meter. Note that not all grids will have one-hundred individual 100 cm^2 measurements, since the survey may not have covered the entire area due to an obstruction, or the grid itself may not be a full square meter. Note that the result in the "minimum" field for each grid will almost always be negative for a final survey, since it is most unlikely that all of the 100 cm^2 measurements in a given grid area were greater than background. Conversely, a minimum result that is non-zero, or even close to zero, usually indicates the presence of residual activity. An excessive number of negative results in the "mean" column indicate areas where the background value used was higher than the nominal background for the material covered. In such cases, the data were evaluated vis-à-vis the investigation criteria to ensure that significant under-estimations did not occur.

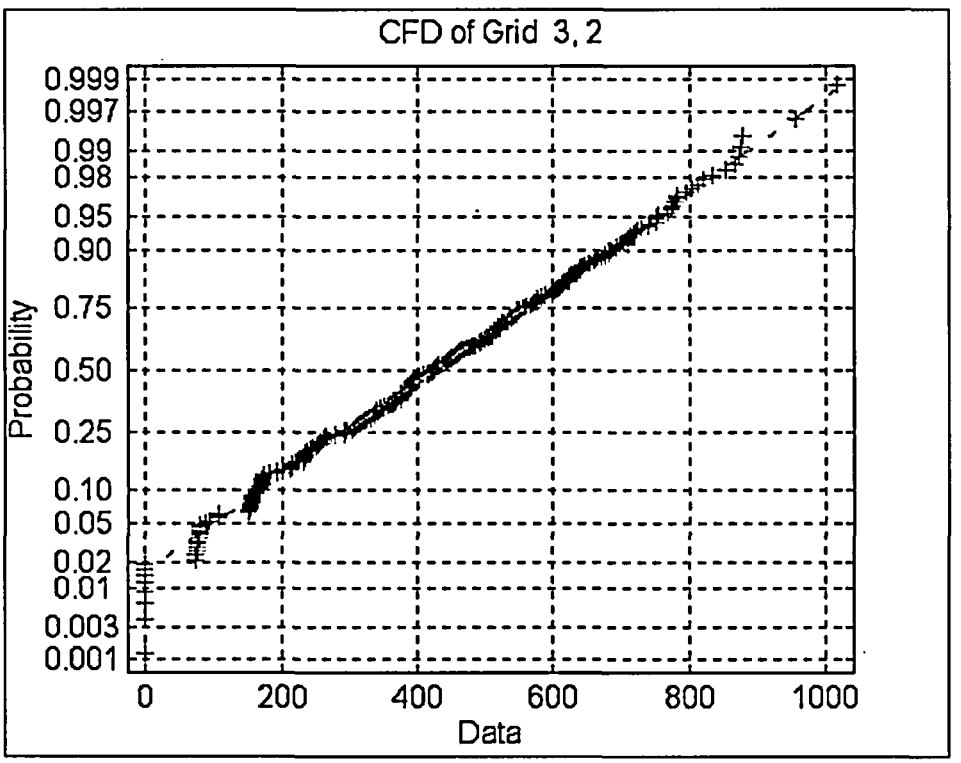
A feature of the "meter grid summary table" is the data are bolded for any areas (grids) for which either the 100 cm^2 or the square meter investigation levels were exceeded. If this occurs, i.e., if an investigation level is exceeded, the SCM report will conclude with a second image that shows the location of the area(s) that exceed the level. This second image uses the same grid system as the 2-D color map image included in every SCM report.

3.3.3 Statistical Analysis of Background

The survey data was reviewed to find square meter regions within them that appeared to be "clean", i.e., free from any residual radioactivity. Cumulative Frequency Distributions (CFDs) were then developed for the data in these "clean" regions and examined to determine if each region was indeed free from any plant-related radioactive material. The basis for this judgment was to evaluate the shape of the CFD plot and determine if the data represented a single, normal distribution. Regions that suggested bi-modal distributions (or greater) or that did not appear to be normally-distributed (meaning the distribution did not fall on a straight line on the CFD) were rejected. If the data met the criteria of being a single, normal distribution, then the mean (50% probability) of the distribution was selected as the background. This process was conducted in an iterative fashion throughout the review of the final survey data to arrive at a set of background values that were conservative (i.e., bounding), but not excessively so, in order to minimize unnecessary investigations.

An example of a CFD plot used to establish a background value is shown in Figure 1. The plot shows the distribution of the values (in cpm per 100 cm^2) from an arbitrary square meter of area. The data is clearly linear and unimodal, having no extreme values or other characteristics that would suggest any plant-related radioactive material was present. The mean (50% probability) of this distribution (400 cpm per 100 cm^2) was typical for this material and thus selected as its background.

Figure 1 - Example of CFD



The background values used in the evaluation of most of the final release survey data are summarized in Table 2. These values were selected based on a thorough review of the final survey data and are representative of the nominal backgrounds observed for a given

material or mixture of materials. Backgrounds established for mixtures of materials (for example, miscellaneous interior/exterior walls or structural steel/overhead areas) reflect bounding values for the lowest-background material noted during review of the survey data.

All survey data were reviewed to screen for cases where the background values used may not have been sufficiently conservative or representative for the materials covered. This was done by reviewing each square meter average in each survey report for large regions of excessively negative values. While it is not unusual to have negative values for square meter averages (an area with no residual radioactivity will theoretically show an equal number of positive and negative results, or more specifically, an average of zero if the background used was accurate), areas that show nothing but negative values for the square meter average may indicate the background used was too high for that particular surface. If this occurs, usually it is a local effect due to small regions of lower-background material in an area that consists primarily of a higher-background material. Examples of this include concrete slab floors with occasional steel plates, concrete block walls that include coverage of personnel doors, and cases such as short walls or pedestals where a portion of the detector extends beyond the surface into free air. However, in some cases an inappropriate initial background value can affect a large region of a survey or the survey as a whole, and requires reconsideration. All of the final release survey data were subjected to this iterative process of choosing an initial background from the set of general values given in Table 2. Every SCM survey report shows the background value used for each detector.

When mixtures of materials were encountered that resulted in local areas of lower-background material in an area that was primarily a higher-background material, the general approach was to use the background that was appropriate for the principal material (i.e., that which made up the largest fraction of the total area). If this resulted in small regions of negative values (where a lower-background material was surveyed), these data were evaluated vis-à-vis the investigation criteria to ensure that significant under-estimations did not occur. This approach (i.e., using the background appropriate for the principal material) was used to avoid an excessive number of investigations. However, there were cases where the background for the lowest-background material in the mix was used despite this resulting in a high bias for the majority of the survey results. The latter approach was used in areas where a lower-background material occurred in several regions of the area surveyed, and where the potential for residual radioactivity was small.

Table 2 - Approximate background values used to evaluate final release survey data.

Material Description	Background Value (cpm)	Standard Deviation (cpm)	Square Meters
Concrete	757	93	1,389
Cinder Block	618	56	278
Painted Concrete*	706	27	93
Linoleum*	552	23	93
Masonite Ceiling	486	12	185
Misc Painted Material	456	64	278
Corrugated Metal Roof*	686	26	93
Inside Metal Siding	526	15	648
Outside Metal Siding	445	4	185

Material Descriptions with an asterisk used only one SCM survey.

Multiple SCM surveys were used to determine the background values. The Square Meters column shows the number of square meters used in the calculation of the background value. The Standard Deviation is the variance between multiple SCM surveys records used to compose the background values.

3.4 Line Shack Attic

3.4.1 Survey Unit Results

Four (4) survey units were developed. These survey units are designated as LS6-1, LS6-2, LS6-3 and LS6-4, which cover the attic floor, interior walls and the ceiling. These survey units are described in section 2.1.3 of this report. The FSS design calculation for these survey units are provided in Appendix D. DQOs are listed in Table 1. Surveys were performed in accordance with Reference 6.8 (i.e. SR-141). Surface scan measurements were performed using a gas flow proportional counter (GFPC). The GFPC (Ludlum Model 2350-1 w/43-68 probe) was used in both the scanning and static modes.

Per Appendix D the gross $DCGL_w$ for all areas was calculated to be 44,434 dpm/100 cm^2. The 75% administrative gross activity is therefore 33,325 dpm/100 cm^2. Since Cs-137 represented 59.5% of the total mix the $DCGL_w$ was calculated to be 19,834 dpm/100 cm^2. These Class 2 areas were given a scan coverage that ranged from 10-50% of the total survey unit size.

No WRS statistical analysis is necessary for these survey units since all resulting static measurements are less than the assigned $DCGL_w$ (i.e. 4,619 ncpm or 33,325 dpm/100 cm^2).

3.4.3.1 Surface Scan Measurements (GFPC Detector)

Surface scan measurements were conducted on all required areas. Action level for scanning was set at 2000 gross cpm. All areas measured were below the action level.

3.4.3.2 Static Measurements (GFPC Detector)

Forty-four (44) static measurements were performed. All measurements were below the DCGL limit (i.e. 4,619 net cpm or 33,325 dpm/100 cm^2. Static measurement results are listed in the following table.

Static Location Number	LS6-1 (gross cpm)	LS6-2 (gross cpm)	LS6-3 (gross cpm)	LS6-4 (gross cpm)
1	321	369	234	294
2	512	311	239	299
3	487	272	232	295
4	491	337	231	243
5	444	320	258	271
6	461	327	246	270
7	416	298	230	267
8	488	298	236	263
9	430	316	244	278
10	465	293	214	300
11	445	305	239	286
MEAN	451	313	237	279
2 ST. DEV.	104	51.2	22.1	35.8
MAX	512	369	258	300
MIN	321	272	214	243
MEDIAN	461	311	236	278

4.0 Data Assessment

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

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

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, where required, after instrument use each day data was collected.

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

5. The MDCs 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 measurement 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 laboratory analysis, were tracked from the point of collection until the final results were obtained, and

9. The final status survey data consists of qualified measurement results representative of current facility status, and were collected in accordance with the applicable survey design package.

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

The statistical test does not need to be performed for this final status survey since the data clearly show that the survey unit meets the site release criteria. The survey units clearly meet the criterion since all measurements in the survey units are less than or equal to the $DCGL_W$.

5.0 Final Survey Conclusions

The FSS for the Line Shack was performed in accordance with the SNEC LTP and site implementing procedures. Final status survey data was collected to meet and/or exceed the quantity and quality specified for each 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 inside and outside the respective Line Shack area was less than the assigned $DCGL_w$.

2. Since all measurements were less than the $DCGL_w$, no $DCGL_{EMC}$ criteria needed to be applied.

3. Except for the Line Shack roof, where natural residual radioactivity is present, all scan measurements were less than 10% of the $DCGL_w$. Therefore, no static measurements were required per section 5.4.3 of the SNEC LTP.

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 Line Shack as described in this report, is suitable for unrestricted release.

6.0 References

6.1 SNEC License Termination Plan, Revision 3, February 2004.

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

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

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

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

6.6 SNEC Survey Request (SR) # 081 – Line Shack– Shonka SCM Measurements.

6.7 Shonka Report, "Final Report for SCM Survey of Saxton Nuclear Experimental Corporation," October 17, 2003.

6.8 SNEC Survey Request (SR) #0141 - Results Summary for SR 141

7.0 Appendices

Appendix A - SNEC Calculation #E900-03-014, "Shonka Line Shack & Warehouse/Garage Pads FSS Survey Design," July 21 2003.

Appendix B – SNEC Calculation #E900-04-010, Rev 0, "Assessment of E900-03-014, Rev 0, "Shonka Line Shack & Warehouse/Garage Pads FSS Survey Design," June 2004.

Appendix C – Penelec Line Shack Diagrams

Appendix D - SNEC Calculation #E900-04-011, "Penelec Line Shack Attic Survey Design," July 22 2004.

Appendix E - SR 81 – Shonka Radiological Survey Reports.

Appendix A

SNEC Calculation #E900-03-014, "Shonka Line Shack & Warehouse/Garage Pads FSS Survey Design," July 21 2003

Appendix B

SNEC Calculation #E900-04-010, Rev 0, "Assessment of E900-03-014, Rev 0, "Shonka Line Shack & Warehouse/Garage Pads FSS Survey Design," June 2004

Appendix C

Penelec Line Shack Diagrams

Name of CAD Map	Survey Request	SCM File Name(s)	Description of Surveyed Area
Penelec Lineshack	SR-0081	SRS7007Z	Inside North Wall Below 2 m
		SCS7010Z	Inside North Wall Below 2 m
		SCS7011Z	Inside South Wall Below 2 m
		SCS7012Z	Inside North Wall Above 2 m
		SCS7013Z	Inside South Wall Above 2 m
		SCS7014Z	Inside South Wall Below 2 m
		SCS7016z	Main Floor
		SCS7039Z	Office Floor
		SCS7040N	South Office South Wall Below 2 m
		SCS7042Z	Bathroom East Wall
		SCS7043Z	East Wall Above 2 m
		SCS7044Z	West Wall Below 2 m
		SCS7045Z	West Wall Above 2 m
Radiation Survey Map Penelec Lineshack	SR-0081	SRS7008Z	Inside East Wall Below 2 m
		SRS7009Z	Inside East Wall Above 2 m
		SRS7017Z	Main Room Ceiling
		SRS7017X	Main Room Ceiling
		SCS7040Z	North Office North Wall Below 2 m
		SCS7040L	North Office South Wall Below 2 m
		SCS7040M	North Office West Wall Below 2 m
		SCS7040O	South Office West Wall Below 2 m
		SCS7040P	South Office North Wall Below 2 m
		SCS7041Z	Office Ceiling
		SCS7042L	Bathroom South Wall
		SCS7042M	Bathroom West Wall
Radiation Survey Map Penelec Lineshack	SR-0081	SRS7006X	Roof
		SRS7015Z	Outside North Wall
		SRS7015R	Outside West Wall
		SRS7015S	Outside South Wall

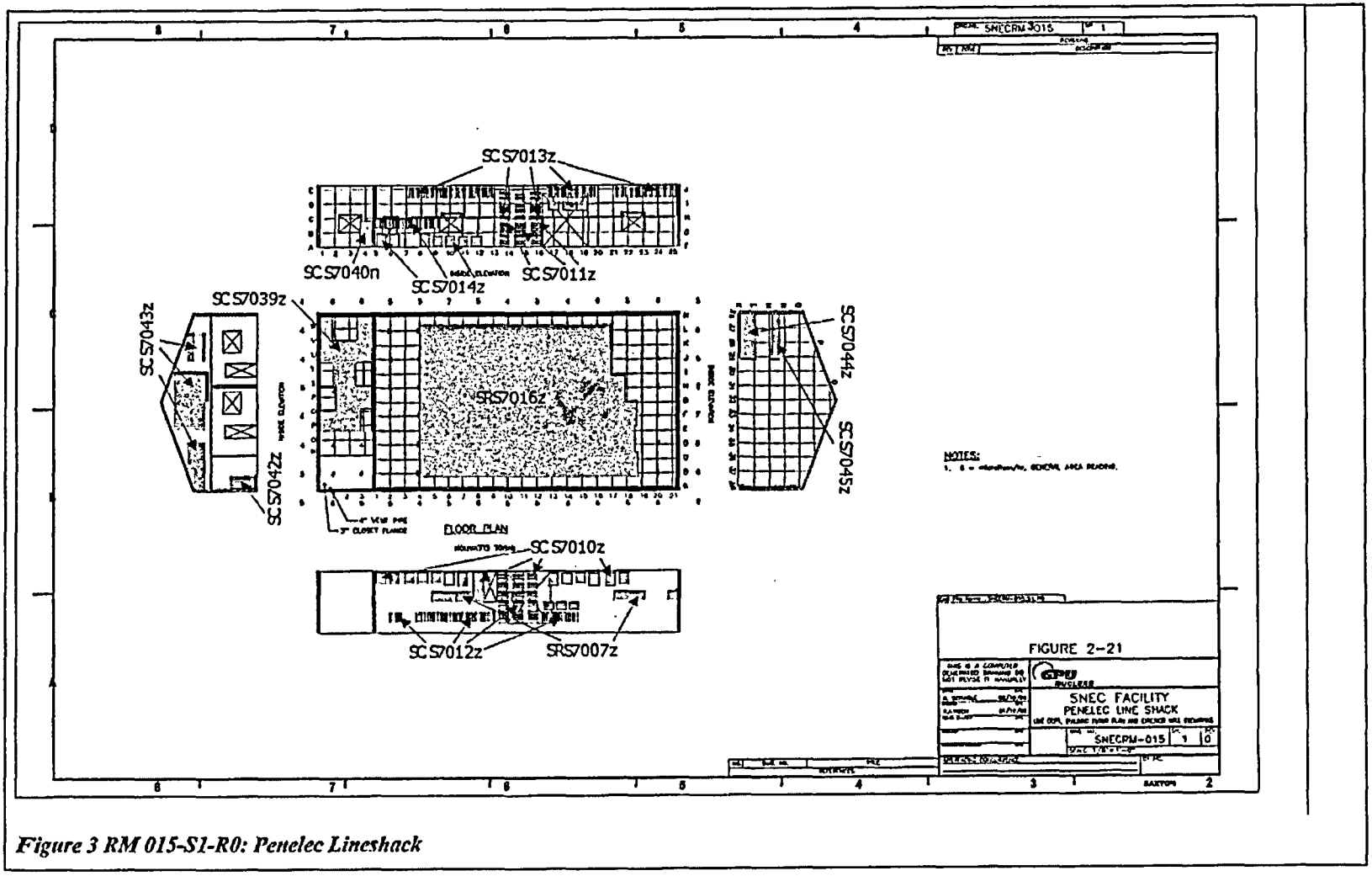


Figure 3 RM 015-S1-R0: Penelec Lineshack

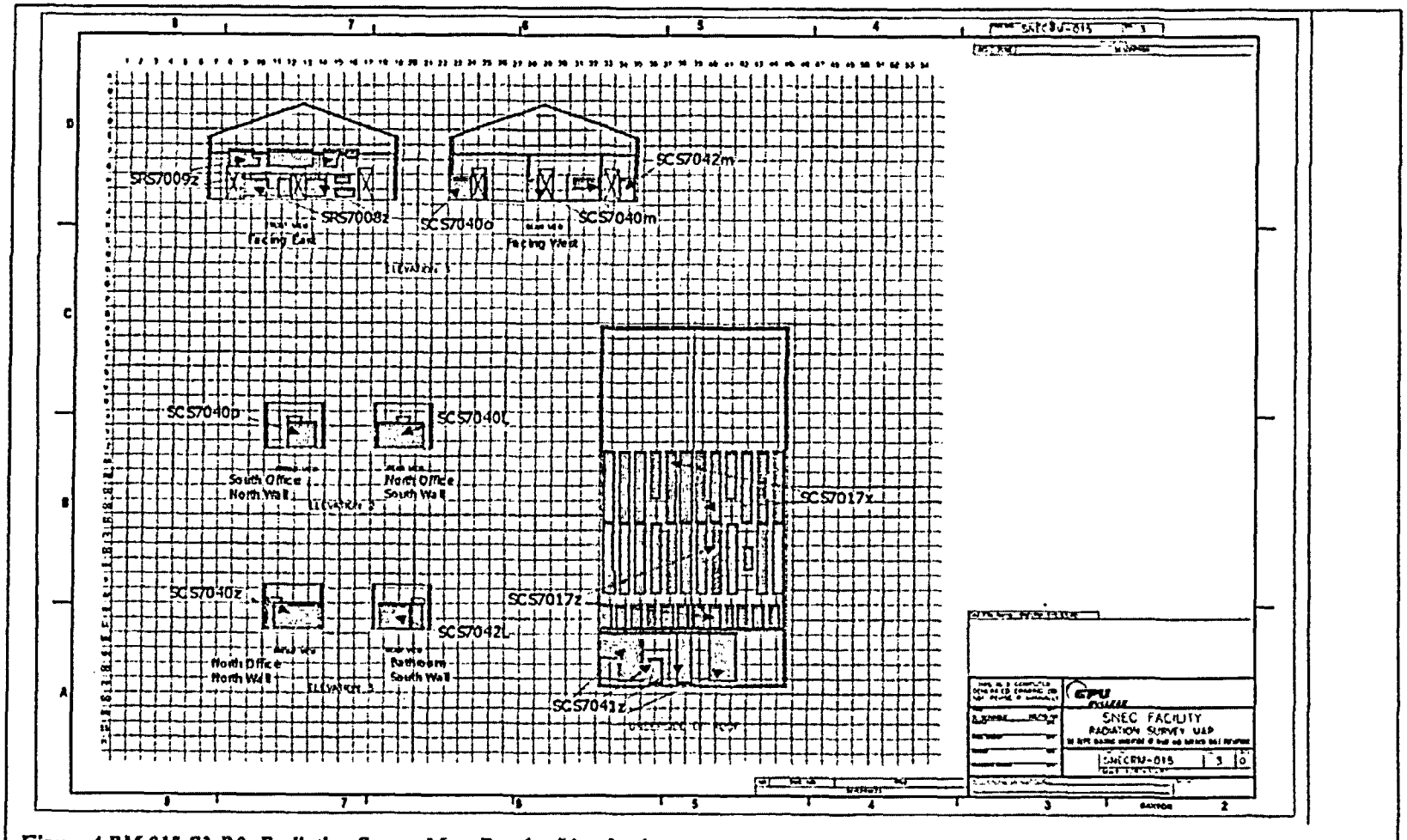


Figure 4 RM 015-S3-R0: Radiation Survey Map, Penelec Lineshack

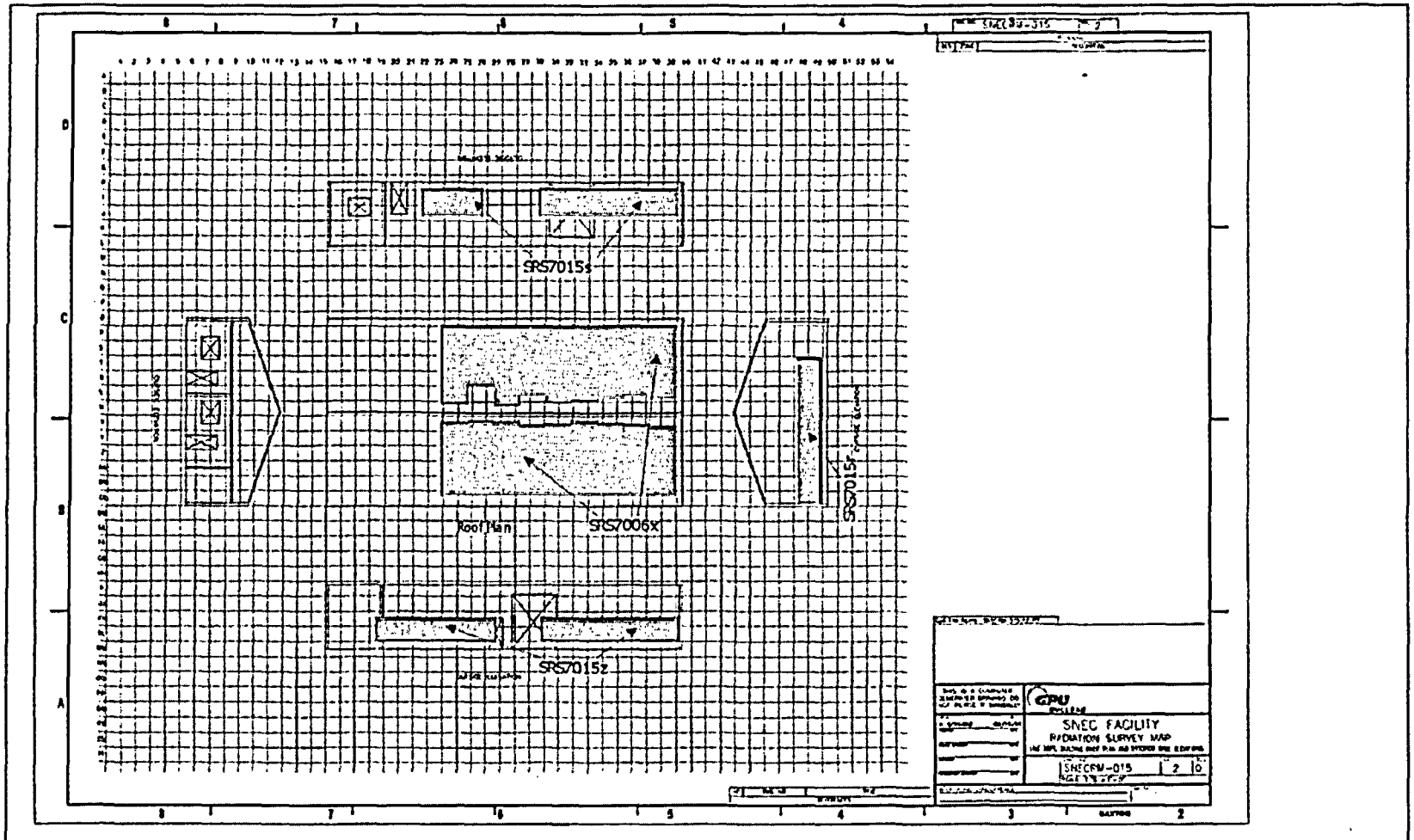


Figure 5 RM 015-S2-R0: Radiation Survey Map, Penelec Lineshack

Appendix D

SNEC Calculation #E900-04-011, "Penelec Line Shack Attic Survey Design,"
July 22 2004

Appendix E

SR 81 – Shonka Radiological Survey Reports