

Final Status Survey Planning Worksheet

Page 1 of 9

GENERAL SECTION	
Survey Area No.: NOL-05	Survey Unit No.: 01
Survey Unit Name: Northwestern Upper RCA Yard	
FSSP Number: YNPS-FSSP-NOL05-01-01 (supplement investigation survey plan – modifications of the original FSSP Worksheet and new instructions for the investigation survey are indicated by bold font.)	
PREPARATION FOR FSS ACTIVITIES	
Check marks in the boxes below signify affirmative responses and completion of the action.	
1.1 Files have been established for survey unit FSS records.	<input checked="" type="checkbox"/>
1.2 ALARA review has been completed for the survey unit.	<input checked="" type="checkbox"/> Refer to <u>YA-REPT-00-003-05</u>
1.3 The survey unit has been turned over for final status survey.	<input checked="" type="checkbox"/>
1.4 An initial DP-8854 walkdown has been performed and a copy of the completed Survey Unit Walkdown Evaluation is in the survey area file.	<input checked="" type="checkbox"/>
1.5 Activities conducted within area since turnover for FSS have been reviewed.	<input checked="" type="checkbox"/>
Based on reviewed information, subsequent walkdown:	<input checked="" type="checkbox"/> not warranted <input type="checkbox"/> warranted
If warranted, subsequent walkdown has been performed and documented per DP-8854.	<input type="checkbox"/>
OR	
The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown.	<input type="checkbox"/>
1.6 A final classification has been performed.	<input checked="" type="checkbox"/>
Classification: CLASS 1	<input checked="" type="checkbox"/> CLASS 2 <input type="checkbox"/> CLASS 3 <input type="checkbox"/>
DATA QUALITY OBJECTIVES (DQO)	
1.0 State the problem:	
Survey Area NOL-05 consists of the surface area of Southwestern Upper RCA Yard. The open land area is owned by YNPS and is comprised of soil. Survey Unit NOL-05-01 is a sub unit of survey area NOL-05 and is bordered by NOL-06-02 to its north, NOL-05-02 to its east and NOL-04-01 south and OOL-10-01 to its west. It is approximately 1505 square meters of surface area.	
The problem as defined by this survey plan is to demonstrate that the years of plant operation did not result in an accumulation of plant-related radioactivity that exceeds the release criteria.	
The planning team for this effort consists of the FSS Project Manager, FSS Radiological Engineer, FSS Field Supervisor, and FSS Technicians. The FSS Radiological Engineer will make primary decisions with the concurrence of the FSS Project Manager.	
This supplemental plan is designed to investigation the location of soil sample NOL-05-01-259-F-G-I, in which soils samples NOL-05-01-22-F-I and NOL-05-01-23-F-I identified Cs-137 at a concentration (30pCi/g and 20pCi/g respectively) that exceeded the DCGLw (3.0pCi/g). The purpose of this investigation survey is to identify and bound the area where the residual Cs-137 concentration exceeds DGCLw. This investigation consists of collecting 4 additional soil samples from the immediate area surrounding the target location.	

DPF-8856.1

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed the release criteria? Alternative actions may include no action, investigation, resurvey, remediation and reclassification.

3.0 Identify the inputs to the decision:

<i>Sample media:</i>	Soil
<i>Types of measurements:</i>	Soil samples, ISOCS Assays and gamma scans
<i>Radionuclides-of-concern:</i>	Cs-137, Co-60, Ag108m

<i>Applicable DCGL:</i>		The DCGLs applied under this survey plan correspond to annual doses of 8.73 mrem/y (the 10-mrem/y DCGL adjusted for the dose contributions from sub-surface concrete structures and tritium in ground water).			
Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)
Co-60	1.4E+0	Eu-152	3.6E+0	Sr-90	6.0E-1
Nb-94	2.5E+0	Eu-154	3.3E+0	Tc-99	5.0E+0
Ag108m	2.5E+0	Eu-155	1.4E+2	Pu-238	1.2E+1
Sb125	1.1E+1	H-3	1.3E+2	Pu-239/240	1.1E+1
Cs-134	1.7E+0	C-14	1.9E+0	Pu-241	3.4E+2
Cs-137	3.0E+0	Fe-55	1.0E+4	Am-241	1.0E+1
		Ni-63	2.8E+2	Cm-243/244	1.1E+1

Forty (40) samples from the HSA data were used to provide the characterization data for survey unit NOL-05-01. The data is sufficient to support FSS planning of Survey Unit NOL-05-01.

Based on a review of the characterization data, Co-60, Cs-137 and Ag-108m are the only plant-related radionuclides that were identified consistently in the characterization samples analyzed. The results from the characterization data are summarized below:

- Co-60 (11 detects) Co-60 is present in 27.5 % of the characterization samples.
- Cs-137 (16 detects) Cs-137 is present in 40 % of the characterization samples.
- Ag-108m (3 detects) Ag-108m is present in 8 % of the characterization samples.
- Other YNPS ETD There were no other easy to detect nuclides identified >MDA.
- YNPS HTD There were no hard to detect nuclides identified in the four samples analyzed.

The presence of all LTP-listed radionuclides (gamma-emitters, HTD beta-emitters, and TRUs) in the soil will be evaluated under this survey plan. The YNPS Chemistry Dept. will analyze each FSS soil sample for all LTP-listed gamma-emitting nuclides, except Cm-243/244. In addition, 2 FSS soil samples will be sent to an independent laboratory for analyses of gamma-emitters, HTD beta-emitting radionuclides, and alpha-emitting radionuclides, which will include Cm-243/244.

Survey Design / Release Criteria

Classification: Class 1

Average Cs-137 concentration: 0.106 pCi/g

Standard deviation Cs-137 (σ): 0.259 pCi/g

Average Co-60 concentration: 0.041 pCi/g

Standard deviation Co-60 (σ): 0.118 pCi/g

Average Ag-108m concentration: 0.016 pCi/g

Standard deviation Ag-108m (σ): 0.053 pCi/g

Weighted sum (σ): 0.122

Surrogate DCGL: N/A (a surrogate DCGL will not be used)

LBGR Initial = 0.5xDCGL = 0.5 Adjusted = 0.76

Number of Samples Calculated 15+5 additional: total 20

Survey Unit Area 1505 m²

Grid Area (A/N) 75 m²

DCGL_{EMC}: Cs-137 8.671 pCi/g (based on AF = 2.9)

DCGL_{EMC}: Co-60 1.968 pCi/g (based on AF = 1.4)

DCGL_{EMC}: Ag-108m 3.046 pCi/g (based on AF = 1.2)

Investigation Level for soil samples:

- >DCGL_{EMC} for either Cs-137, Co-60 or Ag-108m -or-
- A sum of DCGL_{EMC} fractions > 1.0 -or-
- >DCGL for Cs-137, Co-60 or Ag-108m and a statistical outlier as defined in the LTP.

Note: The same criteria will be applied to any other LTP-listed nuclide if identified in the soil samples.

ISOCS Assay Coverage: 100% of the surface area, ensured by overlapping field-of-views using ISOCS in the 1m-detector height with 180° open collimation configuration.

Investigation Level for ISOCS measurements:

- 0.18 pCi/g Co-60
- 0.70 pCi/g Cs-137
- 0.25 pCi/g Ag-108m
- -or- a sum of their fractions >1.0

Note: The investigation levels for the ISOCS assays were derived by multiplying the DCGL_{EMC} associated with a 1m² area by the ratio of the MDC for the full field of view (38.5m²) to the MDC for a 1m² area at the edge of the full field of view. Additional details regarding the investigation levels for ISOCS assays can be found in YA-REPT-00-018-05. The investigation levels developed in this manner are sensitive enough to detect the DCGL_{EMC} values based on the grid area.

MDC's for ISOCS measurements:

Nuclide	MDC (pCi/g)	Nuclide	MDC (pCi/g)	Nuclide	MDC (pCi/g)
Co-60	.18	Sb-125	1.0	Eu-152	.41
Nb-94	.26	Cs-134	.30	Eu-154	.38
Ag-108m	.25	Cs-137	.70	Eu-155	11.0

Note: The MDCs listed in the above table are equal to the investigation level for ISOCS measurements. Contact the FSSE if the MDC values in the above table cannot be achieved in a reasonable count time.

SPA-3 Gamma Scan Coverage:

SPA-3 scans will be performed for surface soil within the field-of-view of an ISOCS assay or surrounding a FSS sample location that exceeds the investigation criteria. The SPA-3 scan will cover 100% of the ISOCS assay total field-of-view area (38.5m²) or a 1-m radius around the FSS sample location (3.14m²).

Investigation Level for SPA-3 Scans:

Reproducible indication above background using SPA-3 and audible discrimination. The expected background range for SPA-3 scans is between 7,000 cpm and 15,000 cpm.

Radionuclides for analysis:

All LTP nuclides with the focus on Cs-137, Co-60 and Ag-108m

MDCs for gamma analysis of soil samples:

<u>Nuclide</u>	<u>10% - 50% of DCGL (pCi/g)</u>
Co-60	1.4E-01 - 7.0E-01
Nb-94	2.5E-01 - 1.3E+00
Ag-108m	2.5E-01 - 1.3E+00
Sb-125	1.1E+00 - 5.6E+00
Cs-134	1.7E-01 - 8.7E-01
Cs-137	3.0E-01 - 1.5E+00
Eu-152	3.6E-01 - 1.8E+00
Eu-154	3.3E-01 - 1.7E+00
Eu-155	1.4E+01 - 6.9E+01

The desired MDCs in the laboratory analyses of FSS soil samples will be the 10% DCGL values. If it is impractical to achieve those, the 50% DCGL values must be achieved in the laboratory analyses of the FSS soil samples.

MDC's for HTD nuclide:

<u>Nuclide</u>	<u>10% - 50% DCGL (pCi/g)</u>
H-3	1.3E+01 - 6.4E+01
C-14	1.9E-01 - 9.7E-01
Fe-55	1.0E+03 - 5.1E+03
Ni-63	2.8E+01 - 1.4E+02
Sr-90	6.0E-02 - 3.0E-01
Tc-99	5.0E-01 - 2.5E+00
Pu-238	1.2E+00 - 5.8E+00
Pu-239	1.1E+00 - 5.3E+00
Pu-241	3.4E+01 - 1.7E+02
Am-241	1.0E+00 - 5.1E+00
Cm-243	1.1E+00 - 5.6E+00

The MDC values for difficult to detect nuclides will be conveyed to the outside laboratory via the sample chain-of-custody form DPF-8823.1 which will accompany the soil samples.

MDCR for SPA-3:

The accompanying table in Attachment 1 provides MDCR values by various background levels.

MDC (fDCGL_{surveyor-emc}) for SPA-3 scans:

The accompanying table in Attachment 1 provides MDC values by various background levels.

QC checks and measurements:

- QC checks for ISOCS will be in accordance with DP-8869 and DP-8871.
- QC checks for the Leica GPS will be performed in accordance with DP-8859.
- QC checks for the SPA-3 will be performed in accordance with DP-8504.
- Two QC split samples will be collected (note: this is in accordance with and exceeds DP-8852 requirements.)
- One QC recount for soil samples will be performed by the YNPS Chemistry Lab (note: this is in accordance with DP-8852 requirements.)

4.0 Define the boundaries of the survey:

- Boundaries of Survey Unit NOL-05-01 are as shown on the attached map. This area is bordered by NOL-06-02 to its north, NOL-05-02 to its east and NOL-04-01 south and OOL-10-01 to its west.
- The survey will be performed under appropriate weather conditions (as defined by instrumentation limitations and human tolerance). Surveys may be performed on any shift of work.

5.0 Develop a decision rule:

Upon review of the FSS data collected under this survey plan:

- (a) If all the sample data show that the soil concentrations of plant related nuclides are below the 8.73 mrem/year DCGLs and the sum of fractions of nuclides are below unity, then reject the null hypothesis (i.e., Survey Unit NOL-05-01 meets the release criteria).
- (b) If the investigation levels are exceeded, then perform an investigation survey.
 - If the sample data show that the area of elevated Cs-137 concentration has been successfully bounded, then terminate the investigation and proceed with the evaluation of the FSS data for NOL-05-01 in accordance with the FSS program requirements.
 - If the sample data show that the area where the investigated level for Cs-137 has not been successfully bounded, then confer with the FSS Project Manager regarding the value of pursuing further investigative actions versus requesting additional remediation action.
- (c) If the average concentration of any LTP-listed nuclide exceeds its respective DCGL_w or the average sum of fractions for any LTP-listed nuclide exceeds one, then accept the null hypothesis (i.e., Survey Unit NOL-05-01 fails to meet the release criteria).

Note: Alternate actions beyond investigations are not expected to be necessary within this survey unit.

Specify tolerable limits on decision errors:

Null hypothesis:	Residual plant-related radioactivity in Survey Unit NOL-05-01 exceeds the release criteria.
Probability of type I error:	0.05
Probability of type II error:	0.05

<i>LBGR:</i>	The applicable soil (8.73-mrem/y) DCGL ÷ 2 LBGR = 0.5 (Unity Rule)
--------------	---

6.0 Optimize Design:

Type of statistical test: WRS Test Sign Test (background will not be subtracted)

Number and Location of Samples: Twenty (20) soil samples will be collected at locations based on a random start, systematic triangular grid (refer to accompanying DPF-8853.2).

GENERAL INSTRUCTIONS

1. Where possible, measurement locations will be identified using GPS in accordance with DP-8859. Each location will be marked to assist in identifying the location. Any locations that are not suitable for soil sampling will be relocated to the nearest suitable location and documented in the field log in accordance with DP-8856.
2. Soil samples will be collected in accordance with DP-8120.
3. Chain of Custody form will be used in accordance with DP-8123 for all soil samples sent to an off-site laboratory.
4. All soil samples will be received and prepared in accordance with DP-8813. Note: Split samples to be sent to an off-site lab will not be dried prior to counting on site or shipping.
5. Collect ISOCS measurements in accordance with DP-8871 to provide 100% scan coverage of the survey unit.
6. Survey instrument: Operation of the E-600 w/SPA-3 will be in accordance with DP-8535 with QC checks performed in accordance with DP-8504. The instrument response checks shall be performed before issue and after use.
7. All SPA-3 scans will be performed with the audible feature activated. FSS Technicians will listen for upscale readings to which they will respond by slowing down or stopping the probe to distinguish between random fluctuations in the background and greater than background readings.
8. The job hazards associated with the Survey described in this package are addressed in the accompanying Job Hazard Assessment (JHA) for NOL-05-01.
9. All personnel participating in this survey shall be trained in accordance with DP-8868.
10. Ensure that ground water is pumped from the excavated area to permit sampling around the target location.
11. Collect 4 biased 1-liter FSS soil samples in accordance with DP-8120, using sampling equipment as stated in DP-8120. Collect each sample approximately 50cm from the target location at the following compass directions (relative to the target location): N, S, E and W.

SPECIFIC INSTRUCTIONS

1. All designated measurement locations will be identified by GPS per DP-8859 or by use of reference points and tape measure as necessary. If a designated sample location is obstructed for any reason, the FSS Radiological Engineer or the FSS Field Supervisor will select an alternate location in accordance with DP-8856. A detailed description of the alternate location will be recorded on form DPF-8856.2, the survey unit map will be annotated appropriately, and the alternate location will be conspicuously marked to facilitate re-visiting to identify and record the coordinates with GPS in accordance with DP-8859 or by measurement from a known reference point when GPS is not available.

DPF-8856.1

2. Sample Requirements:

- Collect twenty (20) random 1-liter soil samples in accordance with DP-8120. Two (2) of the twenty (20) random soil samples will be analyzed as QC split samples to fulfill the QC requirement of DP-8852. The same QC split samples will also be analyzed for Hard-to-Detect nuclides in accordance with section 5.6.3.2.1 of the LTP and DP-8856.

3. Soil Sample Designation:

FSS soil samples:	NOL-05-01-001-F through NOL-05-01-020-F corresponding to FSS sample locations 001 through 020.
QC split samples:	NOL-05-01-010-F-S and NOL-05-01-013-F-S are to be designated as QC split samples. These samples will be sent to the off-site laboratory as collected from the field (i.e., without drying). YNPS Chemistry will count these samples in the “wet” condition prior to shipment to the offsite laboratory.
Recount samples:	NOL-05-01-005-F-RC is to be counted twice on site. The results will be compared in accordance with DP-8864.

4. Sample Analysis:

- Gamma analysis will be performed on all soil samples. If any of the gamma analyses show that an investigation level has been exceeded an investigation survey will be conducted at that sample location as directed in specific instruction # 6.
- YNPS Chemistry will analyze NOL-05-01-001-F through NOL-05-01-020-F for gamma-emitting nuclides.
- YNPS Chemistry will analyze NOL-05-01-005-F as a sample recount. The recounted sample will possess the naming convention NOL-05-01-005-F-RC.
- YNPS Chemistry will analyze NOL-05-01-010-F-S and NOL-05-01-013-F-S for gamma-emitting nuclides prior to being sent to the off-site laboratory. These samples will be analyzed for gamma-emitting nuclides and HTD at the off-site laboratory.
- On-site gamma analysis of the FSS samples shall achieve the MDC values stated in the DQO section of this plan. The MDC’s will be communicated to the laboratory using an attachment to the Chain-of- Custody form.

5. ISOCS Assays.

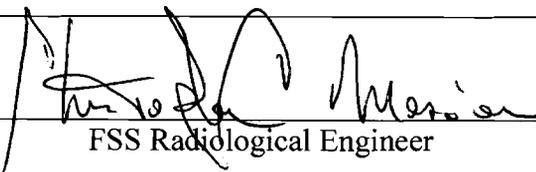
- Collect the appropriate number of ISOCS measurements in accordance with DP-8871 to provide 100% scan coverage of the survey unit.
- ISOCS assays are designated as NOL-05-01-xxx -F-G where “xxx” continues sequentially from the last number assigned to an FSS measurement.
- QC checks shall be performed at least once per shift in accordance with DP-8869 and DP-8871. Resolve flags encountered prior to survey.
- ISOCS assays to be performed with 180° collimator at 1m unless otherwise directed by the FSS Engineer. Make note on the daily survey journal (DPF-8856.2) if other geometries are used.
- For ISOCS assay locations shown on map “ISOCS Scans”, position the detector downward facing keeping the detector perpendicular to the ground.

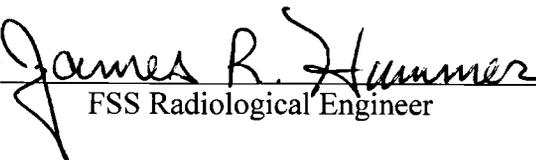
- Designate additional assay locations in continuing sequence from the last number assigned to an FSS measurement. Record detailed information about additional assay locations on the daily survey journal.
 - If the results on any ISOCS assay exceed an investigation level, investigate the area within the field of view (7m diameter – 38.5m² area for 180°-1m) for that assay as directed in Specific Instruction # 7.
 - Remove standing water prior to performance of ISOCS assays. Contact the FSS Engineer for directions if conditions are such that standing water cannot be removed.
6. If the results of any FSS sample (statistical and/or biased points) analysis exceed an investigation level, perform a first level investigation as follows:
- Note: Detailed descriptions of investigation actions shall be recorded in the daily survey journal (DPF-8856.2).
- Review ISOCS data for assays in which the sample requiring investigation may have been in the field of view.
 - Scan a 1m radius footprint around the sample location with a SPA-3 in rate-meter mode moving the detector at a speed of 0.25m or less per second, keeping the probe at a distance of approximately 3” from the surface and following a serpentine path that includes at least 3 passes across each square meter. The area of scan should be increased as necessary to bound any areas of elevated activity identified.
 - Mark the boundaries around any detected elevated areas in the soil and identify the boundaries on a survey map. Measure the total area of each outlined area in square centimeters.
 - Mark the location of the highest identified activity for each of the elevated areas in the soil and on the survey map.
 - At each of the highest identified activity area
 - Perform and record a 1-minute scaler mode SPA-3 measurement. Designate the reading as “NOL-05-01-xxx-F-SC-I” where “xxx” continues sequentially from the last number assigned to an FSS measurement.
 - Obtain a soil sample at the location. Designate the sample as “NOL-05-01-xxx-F-I” where “xxx” continues sequentially from the last number assigned to an FSS measurement.
 - Perform and record a post sample 1-minute SPA-3 measurement. Designate the reading as described above.
7. If the results of an ISOCS assay exceed an investigation level, perform a first level investigation as follows:
- Note: Detailed descriptions of investigation actions shall be recorded in the daily survey journal (DPF-8856.2).
- Scan the ISOCS footprint with a SPA-3 in rate-meter mode moving the detector at a speed of 0.25m or less per second, keeping the probe at a distance of approximately 3” from the surface and following a serpentine path that includes at least 3 passes across each square meter.

- Mark the boundaries around any detected elevated areas in the soil and identify the boundaries on a survey map. Measure the total area of each outlined area in square centimeters.
- Mark the location of the highest identified activity for each of the elevated areas in the soil and on the survey map.
- At each of the highest identified activity area
 - Perform and record a 1-minute scaler mode SPA-3 measurement. Designate the reading as "NOL-05-01-xxx-F-SC-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.
 - Obtain a soil sample at the location. Designate the sample as "NOL-05-01-xxx-F-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.
 - Perform and record a post sample 1-minute SPA-3 measurement. Designate the reading as described above.
- Re-perform the ISOCS assay. Designate the assay as "NOL-05-01-xxx-F-G-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.

8. Soil Investigations:

- **Designate additional soil sample locations in continuing sequence from the last number assigned to an FSS measurement. Record detailed information about additional assay locations on the daily survey journal.**
- **YNPS Chemistry will analyze for gamma-emitting nuclides (wet) a correction factor of 40% will be applied to the results to make a determination as to successfully bounding the extents of the elevated area of radioactivity.**
- **Confer with the FSS Radiological Engineer to determine if additional samples need to be collected.**
- **YNPS Chemistry will analyze for gamma-emitting nuclides (dry) to confirm the results following FSS soil counting protocol.**

Prepared by  Date 6-8-06
 FSS Radiological Engineer

Reviewed by  Date 6-8-06
 FSS Radiological Engineer

Approved by  Date 6/8/06
 FSS Project Manager

Final Status Survey Planning Worksheet

GENERAL SECTION	
Survey Area #: NOL-05	Survey Unit #: 02
Survey Unit Name: Northwestern Upper RCA Yard Survey Unit 2 – Soil Locations	
FSSP Number: YNSP-FSSP-NOL-05-02-00	
PREPARATION FOR FSS ACTIVITIES	
Check marks in the boxes below signify affirmative responses and completion of the action.	
1.1 Files have been established for survey unit FSS records. <input checked="" type="checkbox"/>	
1.2 ALARA review has been completed for the survey unit (ref Att.1). <input checked="" type="checkbox"/> See YA-REPT-00-003-05	
1.3 The survey unit has been turned over for final status survey. <input checked="" type="checkbox"/>	
1.4 An initial DP-8854 walkdown has been performed and a copy of the completed Survey Unit Walkdown Evaluation is in the survey area file. <input checked="" type="checkbox"/>	
1.5 Activities conducted within area since turnover for FSS have been reviewed. <input checked="" type="checkbox"/>	
Based on reviewed information, subsequent walkdown: <input checked="" type="checkbox"/> not warranted <input type="checkbox"/> warranted	
If warranted, subsequent walkdown has been performed and documented per DP-8854. <input type="checkbox"/>	
OR	
The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. <input type="checkbox"/>	
1.6 A final classification has been performed. <input checked="" type="checkbox"/>	
Classification: CLASS 1 <input checked="" type="checkbox"/> CLASS 2 <input type="checkbox"/> CLASS 3 <input type="checkbox"/>	

DATA QUALITY OBJECTIVES (DQO)

1.0 State the problem:

Survey Area NOL-05 consists of land area within the RCA. The surface of NOL-05 is the exposed land area remaining from the demolition of the WST concrete pad (WST-2 (RCA Warehouse), WST-3 (Waste Disposal Building), and WST-4 (Radioactive Waste Compactor Building)) and the remaining remnants from demolition of the PCA-1 bathtub foundation. The remaining footprint includes miscellaneous excavations which expose underlying soil and/or concrete remnants, and the exposed soil grade.

Events and conditions during operations and decommissioning have introduced radioactive materials into the survey area. Examples include the following.

- AOR 61-15, Radioactive Spill chemistry sample container breakage
- PIR 75-07, Yard Area Contamination
- PIR 84-16, Drain Pipe Failure
- Leaks from welded seam defects in the Old Safety Injection Tank.
- Radioactive contaminated soil from various excavations stored in the area, contaminating the adjacent concrete pads as well as exposed soil in cratered areas. This includes the SFP excavation and the sweeper truck residues.

Final Status Survey Planning Worksheet

The original HSA, Table 2-2 of the YNPS LTP and surveys prompted a LTP MARSSIM Classification of 1.

NOL-05-02 is a soil (open land) survey unit of 1,544 m². It consists of non-contiguous craters which expose a large contiguous soil area.

The problem is to determine if the residual plant related activity remaining in the soil meets the release criterion.

The planning team for this effort consists of the FSS Project Manager, FSS Radiological Engineer, FSS Field Supervisor, and FSS Technicians. The FSS Radiological Engineer will make primary decisions with the concurrence of the FSS Project Manager.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed the LTP release criteria?

Alternative actions that may be employed are investigation, remediation and re-survey.

3.0 Identify the inputs to the decision:

Inputs to the decision include various information that will be required in the decision making process:

Sample media: Soil

Types of measurements: ISOCS gamma scans, direct measurements obtained via soil sampling.

Radionuclides-of-concern: All LTP-listed radionuclides are of concern, with the primary focus on Co-60 and Cs-137.

DCGL_w: Table 1 below indicates the DCGL_w for Co-60 and Cs-137.

DCGL_{SURR}: After evaluating previous offsite laboratory soil sample analysis results from previously completed FSS survey units for both ETD as well as HTD nuclides, the data suggests that developing surrogate DCGLs is not necessary, because significant HTD nuclides have not been identified at sufficient magnitudes which would significantly impact investigation levels.

DCGL_{EMC}: Based on a contaminated source area of 1 m² (see Table 1) for use during ISOCS scans. If necessary, the DCGL_{EMC} will be recalculated if an actual area of elevated concentration is discovered with a source area greater than 1 m².

Final Status Survey Planning Worksheet

Table 1. MDC, DCGL_w, DCGL_{EMC} Investigation Level: gamma analysis of soil and ISOCS measurements

Nuclide	DCGL _w Soil (pCi/g) at 8.73 mrem/y	DCGL _{EMC} Soil (pCi/g) at 8.73 mrem/y with AF based on LTP App.6Q	Range of Soil Sample MDC (pCi/g) from desired (10% DCGL) to required (50% DCGL)	DCGL _{EMC} ISOCS (based on source area = 1m ²)	Investigation Level ISOCS (based on source area = 1m ² , 1m, 180d open collimation w/4 meter grid spacing)
				Soil (pCi/g)	Soil (pCi/g)
Co-60	1.4E+00	2.0E+00	1.4E-01 to 7.0E-01	1.5E+01	0.28
Nb-94	2.5E+00		2.5E-01 to 1.2E+00	2.3E+01	
Ag-108m	2.5E+00		2.5E-01 to 1.2E+00	2.3E+01	
Sb-125	1.1E+01		1.1E+00 to 5.5E+00	1.0E+02	
Cs-134	1.7E+00		1.7E-01 to 8.0E-01	2.8E+01	
Cs-137	3.0E+00	8.7E+00	3.0E-01 to 1.4E+00	6.6E+01	1.20
Eu-152	3.6E+00		3.6E-01 to 1.7E+00	3.4E+01	
Eu-154	3.3E+00		3.3E-01 to 1.6E+00	3.2E+01	
Eu-155	1.4E+02		1.4E+01 to 6.9E+01	1.1E+03	

Investigation Level ISOCS: The investigation level for ISOCS scans is calculated from the DCGL_{EMC} as shown by Table 1 above (ref YA-REPT-00-018-05; see Attachment 4 for the calculations). It is derived by multiplying the DCGL_{EMC} associated with a 1 m² area by the ratio of the MDCs for the full field of view (i.e. 38.5 m² for a 1m height above the surface) to the 1 m² area at the centerline (offset) between the scan grids using an assumed grid spacing of 4 meters. Thus for example the calculated 0.28 pCi/g investigation level for Co-60 is sensitive enough to detect the DCGL_{EMC} of 15.4 pCi/g.

The SPA-3 non-surrogated DCGL_{EMC} calculated below of 2.0 pCi/g (Co-60) and 8.7 pCi/g (Cs-137) yields a gross activity SPA-3 DCGL_{EMC} of 2.3 pCi/g. The ISOCS Investigation Level is conservatively calculated for a 1 m² area at a two meter offset, using 4 meter grid spacing. Thus its detection capability is comparable to the SPA-3 DCGL_{EMC}.

If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria.

Investigation Level SPA-3 Scans: The investigation level for SPA-3 scans is a reproducible indication above background using the audible feature with headphones. To achieve the required MDCR, the scan speed shall not exceed 3"/sec.

Investigation Level Soil Sample Direct Measurements: The investigation level for soil sample direct measurements is equivalent to the DCGL_{EMC} (see above) or when any reading is above the DCGL_w (see above) and is a statistical outlier.

Radionuclides for analysis: All LTP nuclides with the focus on Co-60 and Cs-137. After evaluating FSS SFP soil sample results for both ETD as well as HTD nuclides, it was concluded that no significant HTD nuclides are present in sufficient quantities to justify use of as surrogate DCGL.

ISOCS Nuclide Library: Library will include all gamma emitters listed in Table 1 above.

Final Status Survey Planning Worksheet

MDCs for ETD nuclides in soil samples and ISOCS: The desired MDCs for laboratory analysis of FSS soil samples should be 10% of the $DCGL_w$. If it is impractical to achieve those, the 50% DCGL values must be achieved. The required MDC for ISOCS is the $DCGL_{EMC}$. Refer to Table 1 above.

MDCs for HTD nuclides in soil samples: In addition to the MDC values listed in Table 1, the MDC values in Table 2 will also be transmitted to the outside laboratory via the chain-of-custody form accompanying the FSS soil samples. See Attachment 3 for the MDC calculations.

Soil Sample $DCGL_{EMC}$: As noted in Table 1 above, the soil sample $DCGL_{EMC}$ has been calculated based on the geometry of the sampling grid, utilizing LTP Appendix 6Q to determine the Area Factor. The Co-60 and Cs-137 $DCGL_{EMC}$ have been used to determine the Gross Activity $DCGL_{EMC}$ of 2.3 pCi/g.

Table 2. MDCs for Hard-To-Detect Nuclides in Soil Samples

	DCGL _w	
Nuclide	Soil (pCi/g) at 8.73 mrem/y	Range of MDC (pCi/g) from desired (10% DCGL) to required (50% DCGL)
H-3	1.3E+02	1.3E+01 to 6.4E+01
C-14	1.9E+00	1.9E-01 to 9.0E-01
Fe-55	1.0E+04	1.0E+03 to 5.0E+03
Ni-63	2.8E+02	2.8E+01 to 1.4E+02
Sr-90	6.0E-01	6.0E-02 to 3.0E-01
Tc-99	5.0E+00	5.0E-01 to 2.4E+00
Pu-238	1.2E+01	1.2E+00 to 5.8E+00
Pu-239	1.1E+01	1.1E+00 to 5.2E+00
Pu-241	3.4E+02	3.4E+01 to 1.7E+02
Am-241	1.0E+01	1.0E+00 to 5.0E+00
Cm-243	1.1E+01	1.1E+00 to 5.5E+00

SPA-3 Scan MDCR and MDC($DCGL_{EMC}$): Refer to Attachment 2 for SPA-3 scan MDC values given a range of background values.

SPA-3 $DCGL_{EMC}$: Refer to Attachment 2 for the following, which calculates:

- The SPA-3 scan Area Factors for Co-60 and Cs-137 at the LTP App. 6Q Area of Source of 75 m² (next highest relative to 51.5 m² calculated source area) for this survey unit.
- The SPA-3 $DCGL_{EMC}$ of 2.0 pCi/g (Co-60) and 8.7 pCi/g (Cs-137).
- Finally yielding a gross activity SPA-3 $DCGL_{EMC}$ of 2.3 pCi/g.

Scan Survey coverage: ISOCS scans will overlap so as to provide a 100% coverage of the survey area.

QC checks and measurements: QC checks for survey instruments will be performed in accordance with DP-8534. QC checks for the ISOCS will be in accordance with DP-8869 and DP-8871.

4.0 Define the boundaries of the survey:

NOL-05-02 is a discontinuous array of open land areas representing:

Final Status Survey Planning Worksheet

- Craters within and around the PCA-1, WST-2, WST-3, and WST-4 pad footprints and vaults.
- Excavations after the removal of the concrete pad.

The Survey Unit NOL-05-02 is bounded by survey areas NOL-05-01 to the west, survey area AUX-01 and AUX-02 to the north, NOL-02 and NOL-03 to the east and NOL-04 to the south. The survey of NOL-05-02 will be performed during weather conditions that will not adversely affect data acquisition.

The soil sample locations will be defined by a random-start systematic grid. The ISOCS scans are 100% of the survey unit.

5.0 Develop a decision rule:

- a. If all of the sample data show that the soil concentrations of all plant-related nuclides are below the DCGLs and the sum of fractions for these nuclides are less than unity, reject the null hypothesis (i.e. the Survey Unit meets the release criteria).
- b. If the investigation levels are exceeded, perform an investigation survey. This may include the use of a statistical test.
- c. If the average of the direct measurements is below the $DCGL_w$, but some individual measurements exceed the $DCGL_w$, then apply a statistical test as the basis for accepting or rejecting the null hypothesis.
- d. If the average concentration exceeds the $DCGL_w$ or the SOF exceeds unity, then accept the null hypothesis (i.e. the Survey Area does not meet the release).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: The null hypothesis (H_0), as required by MARSSIM, is stated and tested in the negative form: "Residual licensed radioactive materials in the Survey Unit exceeds the release criterion.

Probability of type I (α) error: 0.05

Probability of type II (β) error: 0.05

LBGR: 0.70 pCi/g

7.0 Optimize Design:

Type of statistical test: WRS Test Sign Test

Background to be applied: media-specific ambient none

If WRS test is specified, record background reference area location: _____

Basis including background reference location (if WRS test is specified): N/A

Number of direct measurements: Thirty (30) direct measurement soil samples will be taken, with the triangular grid laid out from a random start point.

Final Status Survey Planning Worksheet

INSTRUCTIONS

1. The FSS Field Supervisor is responsible to notify QA of date and time of the pre-survey briefing, commencement of direct measurements and any other activities subject to QA notification.
2. The FSS Field Supervisor is responsible to brief on the Job Hazards Assessment.
 - 2.1. The job hazards associated with the FSS in Survey Area NOL-05 are addressed in the accompanying JHA.
3. Locate and mark the measurement points at the locations shown on the attached map(s).
 - 3.1. If a measurement location is obstructed such that the measurement can not be collected, select an alternate location in accordance with DP-8856.
4. Designation of survey points including investigations are as follows.
 - 4.1. ISOCS
 - 4.1.1. Start with NOL-05-02-100-F-G and increment as needed.
 - 4.1.2. For investigations, append terms as follows.
 - 4.1.2.1. For example, if ISOCS point NOL-05-02-123-F-G is to be investigated:
 - 4.1.2.1.1. Use NOL-05-02-123-F-I-G-001 for the first ISOCS investigation survey of ISOCS point number 123.
 - 4.1.2.1.2. Use NOL-05-02-123-F-I-SC-001 for the first SPA-3 investigation scan of ISOCS point number 123.
 - 4.1.2.1.3. Use NOL-05-02-123-F-I-SS-001 for the first investigation soil sample of ISOCS point number 123.
 - 4.2. Soil Samples
 - 4.2.1. Start with NOL-05-02-001-F and increment the soil sample number as needed.
 - 4.2.2. For soil sample recounts, append “-RC” as follows.
 - 4.2.2.1. If fixed point measurement NOL-05-02-016-F is to be recounted, use NOL-05-02-016-F-RC.
 - 4.2.3. For soil sample splits, append “-S” as follows.
 - 4.2.3.1. If soil sample NOL-05-02-014-F is to be split, use NOL-05-02-014-F-S.
 - 4.2.4. For investigations, append terms as follows.
 - 4.2.4.1. For example, if soil sample NOL-05-02-014-F is to be investigated and NOL-05-02-001-F through NOL-05-02-024-F have been taken or are planned:
 - 4.2.4.1.1. Use NOL-05-02-014-F-I-G-001 for the first ISOCS investigation survey of soil sample number 014.
 - 4.2.4.1.2. Use NOL-05-02-014-F-I-SC-001 for the first SPA-3 investigation scan of soil sample number 014.
 - 4.2.4.1.3. Use NOL-05-02-025-F-I for the first investigation soil sample of soil sample number 014.
NOTE that this is an incremented number with the “I” appended.
 - 4.3. Any other measurement designations will be determined by the FSS Engineer.
5. Collect soil sample direct measurements at the 30 locations specified on the map, as well as biased locations if necessary per FSSE direction.
 - 5.1. Soil samples are collected in accordance with DP-8120. Remove extraneous vegetation, debris, rocks, etc prior to placing the soil into the one-liter marinelli beaker.
 - 5.2. Soil samples are to be received and prepared in accordance with DP-8813.

Final Status Survey Planning Worksheet

- 5.2.1. Soil samples are to be analyzed onsite for easy-to-detect nuclides and associated MDCs as listed in Table 1 above.
- 5.3. Two soil samples (NOL-05-02-026-F and NOL-05-02-023-F) will be counted twice and the results evaluated in accordance with DP-8864.
- 5.4. Two soil samples (NOL-05-02-006-F and NOL-05-02-022-F) will be split:
 - 5.4.1. The results will be evaluated in accordance with DP-8864.
 - 5.4.2. The Chain-of-Custody will be maintained in accordance with DP-8123.
- 5.5. Send the following soils to the offsite lab for analysis of hard-to-detect nuclides and associated MDCs as listed in Table 2 above.
 - 5.5.1. The split soil samples specified above. Do not dry split samples sent off-site for analysis.
- 5.6. The direct measurement locations may be identified using GPS.
 - 5.6.1. If the location cannot be determined directly using GPS, an offset will be used to describe the distance and bearing from a known GPS location.
 - 5.6.2. Each location will be marked either prior to or at the time of the sampling.
 - 5.6.3. The FSS Radiological Engineer or FSS Field Supervisor will guide the FSS Technician to the sample locations as necessary.
6. Scan 100% of the soil area using ISOCS at a 1m height with 180° open collimation at the locations specified on the ISOCS map.
 - 6.1. Operation of the Portable ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Resolve flags encountered prior to survey.
 - 6.2. Lay out the grid by placing parallel rows of markers forming a square pattern at a maximum distance of 4.0 m apart and a maximum of 2.0 m from the edge of each surface area.
 - 6.2.1. As a prerequisite for scan grid point count acquisition, ensure all standing water, ice, and/or snow has been removed from the scan field of view. Incidental amounts of moisture occurring during the acquisition such as rain or snow are acceptable, since the short duration of a count (600 seconds) should not accumulate significant absorber interference.
 - 6.2.2. Angle the detector as necessary perpendicular to the scan surface and perform an analysis in accordance with DP-8871 using a preset count time sufficient to meet the MDAs referenced in the survey plan.
 - 6.2.3. Using the 180-degree open collimation configuration, position the ISOCS detector directly above (perpendicular to the reference plane) each marker 1m from the surface to be scanned.
 - 6.2.4. Add additional scan points closer than 4.0 m apart as necessary to achieve 100% unit survey coverage, however, a fully documented GPS survey coordinate survey is required for any additional ISOCS scan points.
 - 6.2.5. In deep holes, ISOCS may be used to survey vertical or sloping surfaces. As with horizontal surfaces, the ISOCS should be positioned perpendicularly 1m from the surface.
 - 6.2.6. For areas where concrete walls or berms exist in the field of view, estimate the percentage of concrete in the field of view and record on the log sheet.
 - 6.2.7. For areas with saturated soil, such as low points of mud holes, estimate the percentage of saturated soil in the field of view and record on the log sheet. Note: Investigation levels will be reduced on these locations by 20% per guidance in YA-REPT-00-018-05 Rev 0 to account for matrix moisture attenuation effects.
 - 6.3. Review the report ensuring that the MDAs have been met.
 - 6.4. Review the report for identified nuclides and compare values against the $DCGL_{EMC}$.

Final Status Survey Planning Worksheet

7. Operation of the E-600 will be in accordance with DP-8535
 - 7.1. QC checks will be performed in accordance with DP-8540.
 - 7.2. Resolve flags encountered prior to survey.
8. All personnel participating in this survey shall be trained in accordance with DP-8868.
9. If an ISOCS measurement needs to be investigated, obtain additional radiological data as follows.
 - 9.1. Scan the ISOCS footprint with a SPA-3 at approximately 3" or less per second in rate-meter mode with audible on.
 - 9.2. If the SPA-3 background exceeds 20,000 cpm contact the FSS Engineer.
 - 9.3. Mark the boundaries around any detected elevated areas in the soil.
 - 9.4. Identify the boundaries on the survey map.
 - 9.5. Measure the total area of each outlined area in square centimeters.
 - 9.6. Indicate on the map and the actual location the highest identified activity among all of the elevated areas.
 - 9.7. Indicate the highest reading on the map for each elevated area.
 - 9.8. At the highest reading in each elevated area:
 - 9.8.1. First, perform and record a SPA-3 reading.
 - 9.8.2. Second, obtain a soil sample at that location.
 - 9.8.3. Third, obtain a second SPA-3 reading in the same location and manner as the first.
 - 9.9. Re-perform the ISOCS measurement.
10. If a direct measurement needs to be investigated, obtain additional radiological data as follows.
 - 10.1. Review ISOCS data which may or may not confirm that the soil sample direct measurement was in fact above the investigation level. Because direct measurement locations are usually not coincidentally directly below an ISOCS shot, one or more ISOCS shots may indicate the need to investigate a single or multiple direct measurement locations.
 - 10.2. Scan a 2-meter radius footprint around the direct measurement location using a SPA-3 at approximately 3" or less per second in rate-meter mode with audible on.
 - 10.3. If the background exceeds 20,000 cpm contact the FSS Engineer.
 - 10.4. Mark the boundaries around any detected elevated areas in the soil.
 - 10.5. Identify the boundaries on the survey map.
 - 10.6. Measure the total area of each outlined area in square centimeters.
 - 10.7. Indicate on the map and the actual location the highest identified activity among all of the elevated areas.
 - 10.8. Indicate the highest reading on the map for each elevated area.
 - 10.9. At the highest reading in each elevated area:
 - 10.9.1. First, perform and record a SPA-3 reading.
 - 10.9.2. Second, obtain a soil sample at that location.
 - 10.9.3. Third, obtain a second SPA-3 reading in the same location and manner as the first.
 - 10.10. Obtain a second soil sample around and below the hole from where the first soil sample was obtained.
 - 10.11. Re-perform the ISOCS measurement.
11. Document investigative actions on DPF-8856.2.

Final Status Survey Planning Worksheet

12. Upon completion of the survey:

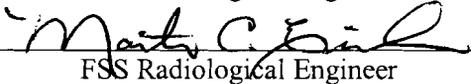
12.1. Verify that MDAs have been met.

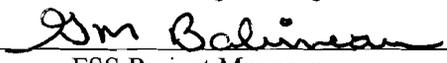
12.2. Assess nuclides listed in the LTP through the use of the unity rule.

12.3. Perform an investigation as indicated by the results of the actions listed above.

NOTIFICATION POINTS	
QA notification* point(s) (y/n) YES	
(1)Date/time of initial pre-survey briefing _____ / _____	QA Signature/Date: (1) _____
(2)Date/time of daily pre-shift briefing _____ / _____	QA Signature/Date: (2) _____
(3)Date/time of commencement of soil samples _____ / _____	QA Signature/Date: (3) _____
(4)Date/time of first ISOCS measurement _____ / _____	QA Signature/Date: (4) _____
FSI point(s) (y/n) NO	
(1) _____ / _____	
(2) _____ / _____	
*Voice mail or email notification to Trudeau@yankeerowe.com and copy to Marchi@cyapco.com .	

Prepared by  Date 12/2/05
 FSS Radiological Engineer

Reviewed by  Date 12/2/05
 FSS Radiological Engineer

Approved by  Date 12/5/05
 FSS Project Manager

Final Status Survey Planning Worksheet
Attachment 1

Yankee Nuclear Power Station (Rowe)
SURVEY AREA:
Gel Analysis Request

Radiological Engineer: Gordon Madison

Date: 12/1/05

Phone: 413-424-2432

GEL Contact: Cheryl Jones

Phone: 843-556-8171 X 4243

# Sample ID	Media	Analysis Requested			
		Nuclide	MDC	Nuclide	MDC
1 NOL-05-02-006-F-S	Soil			See below	
2 NOL-05-02-022-F-S	Soil			See below	

Analysis Requested

Gamma Analysis	
Nuclide	MDC (pCi/g)
Co-60	0.14
Nb-94	0.25
Ag-108m	0.25
Sb-125	1.1
Cs-134	0.17
Cs-137	0.3
Eu-152	0.35
Eu-154	0.33
Eu-155	14
HTD Analysis	
Nuclide	MDC (pCi/g)
H-3	13
C-14	1.9
Fe-55	1000
Ni-63	28
Sr-90	0.06
Tc-99	0.48
Pu-238	1.1
Pu-239	1
Pu-241	34
Am-241	1
Cm-243	1.1
TCU	total chemical uranium
U-235	0.5 chem seperation
U-238	0.5 chem seperation

Final Status Survey Planning Worksheet
Attachment 2

SOIL SAMPLES CALCULATION

Inputs: $MDCR = 1.38 \cdot \sqrt{b} / \sqrt{p} \cdot t$

Where:

b = background counts in time t

p = 0.5 surveyor efficiency

Scan speed: 0.08 m/s

Localized contam dia: 56 cm

t(sec) det above local activity 7 dia / scan speed

0.117 time (min)

$$MDC(fDCGL_{EMC}) = MDCR \sum (f^i / E_i AF^i DCGL^i)$$

(DP-8853)

AF = Area Factor

E_i = Scanning instrument efficiency (YA-REPT-00-015-04)

f = radionuclide fraction

Cs-137

Co-60

E_i = 188 379

DCGL 2.99 1.41

f = 0.16 0.84

AF = 2.9 1.4 LTP App 6Q

BKG (cpm)	BKG/t	MDCR (cpm)	MDC (fDCGL _{emc})
7000	816.7	478	5.84E-01
8000	933.3	511	6.24E-01
9000	1050.0	542	6.62E-01
10000	1166.7	571	6.98E-01
13400	1563.3	661	8.08E-01
11000	1283.3	599	7.32E-01
12000	1400.0	626	7.64E-01
13000	1516.7	651	7.95E-01
14000	1633.3	676	8.25E-01
15000	1750.0	700	8.54E-01
16000	1866.7	723	8.82E-01
17000	1983.3	745	9.10E-01
18000	2100.0	767	9.36E-01
19000	2216.7	788	9.62E-01
20000	2333.3	808	9.87E-01
21000	2450.0	828	1.01E+00
22000	2566.7	847	1.03E+00
23000	2683.3	867	1.06E+00
24000	2800.0	885	1.08E+00
25000	2916.7	903	1.10E+00

Final Status Survey Planning Worksheet
Attachment 3

Nuclide	DCF	LTP App.6E Soil DCGL (25 mrem/y)	DCGL (8.73 mrem/y)	Range of MDC (pCi/g)
	(mrem/y per pCi/g)	(pCi/g)	(pCi/g)	from Desired (10% DCGL) to Required (50% DCGL)
H-3	0.0679	368.1885125	128.5714	1.3E+01 to 6.4E+01
C-14	4.52	5.530973451	1.931416	1.9E-01 to 9.0E-01
Fe-55	0.000857	29171.52859	10186.7	1.0E+03 to 5.0E+03
Co-60	6.21	4.025764895	1.405797	1.4E-01 to 7.0E-01
Ni-63	0.0307	814.3322476	284.3648	2.8E+01 to 1.4E+02
Sr-90	14.5	1.724137931	0.602069	6.0E-02 to 3.0E-01
Nb-94	3.46	7.225433526	2.523121	2.5E-01 to 1.2E+00
Tc-99	1.76	14.20454545	4.960227	5.0E-01 to 2.4E+00
Ag-108m	3.44	7.26744186	2.537791	2.5E-01 to 1.2E+00
Sb-125	0.782	31.96930946	11.16368	1.1E+00 to 5.5E+00
Cs-134	5.02	4.980079681	1.739044	1.7E-01 to 8.0E-01
Cs-137	2.92	8.561643836	2.989726	3.0E-01 to 1.4E+00
Eu-152	2.43	10.28806584	3.592593	3.6E-01 to 1.7E+00
Eu-154	2.63	9.505703422	3.319392	3.3E-01 to 1.6E+00
Eu-155	0.0629	397.4562798	138.7917	1.4E+01 to 6.9E+01
Pu-238	0.748	33.42245989	11.67112	1.2E+00 to 5.8E+00
Pu-239	0.83	30.12048193	10.51807	1.1E+00 to 5.2E+00
Pu-241	0.0254	984.2519685	343.7008	3.4E+01 to 1.7E+02
Am-241	0.859	29.10360885	10.16298	1.0E+00 to 5.0E+00
Cm-243	0.785	31.84713376	11.12102	1.1E+00 to 5.5E+00

Final Status Survey Planning Worksheet
Attachment 4

ISOCS Soil Investigation Levels Using the 180-Degree Open Collimation
Configuration at Height of 1 Meter above the Reference Plane

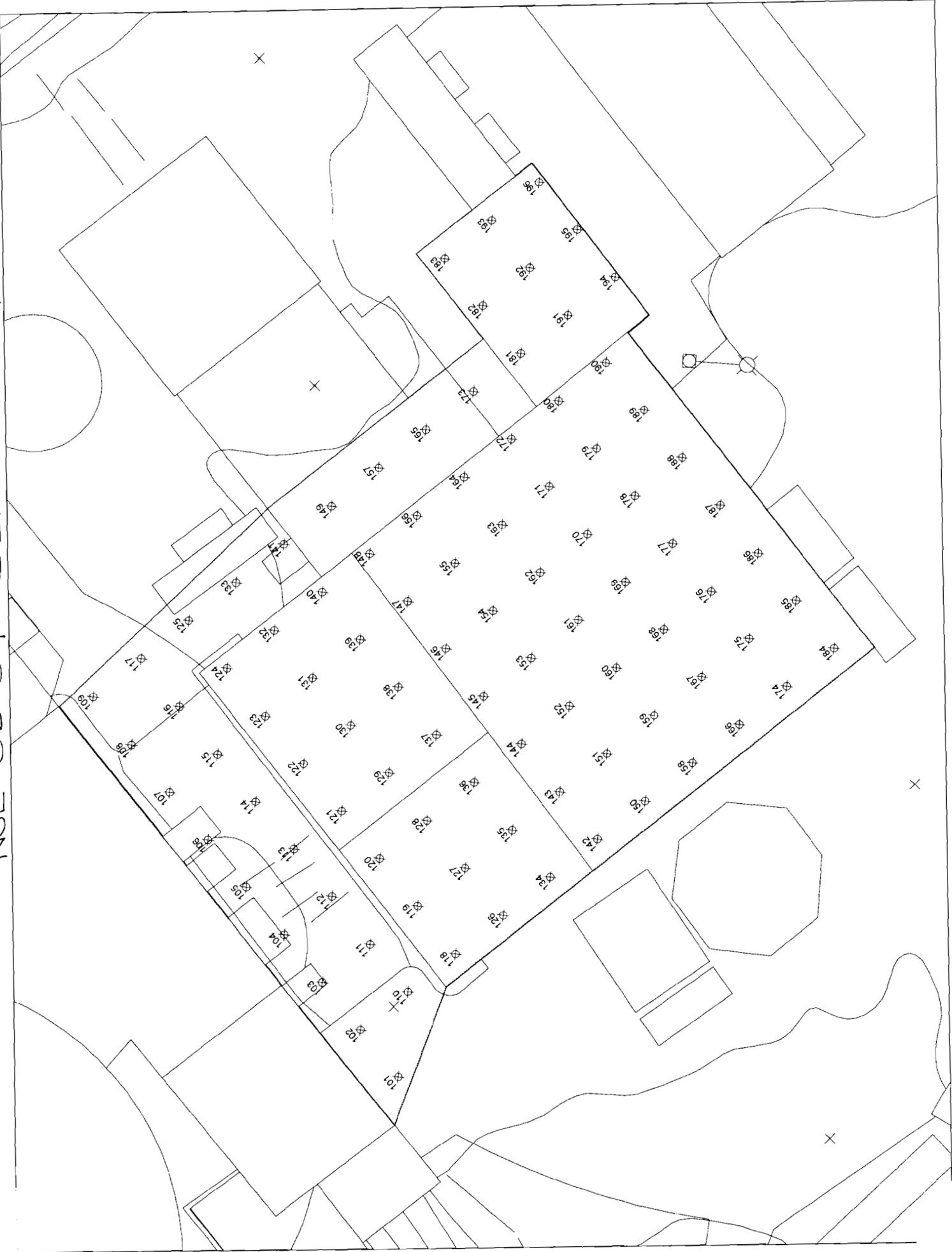
Nuclide	pCi/g
Co-60	0.28
Ag-108m	0.42
Cs-134	0.50
Cs-137	1.20

- Notes: 1. These investigation levels are not surrogated
2. These levels assume proper survey design scan grid pattern spacing of 4 meters.
3. Investigation levels calculated/derived IAW YA-REPT-00-018-05 Rev 0

NOL-05-04 SOIL SAMPLE LOCATIONS



NOL-05-04 SCAN LOCATIONS



Attachment 4 ISOCS Investigation Levels for 1 Meter 180 Degree Soil for FSS Scans for Class 1 Survey Unit NOL-05-02

Field MDAs for 38.5 m2 FOV for 600 sec count on Red rover (6264)-1 meter det height-180 degree open collimation configuration

Nuclide	MDA-pCi/g
Co-60	8.49E-02
Ag-108m	1.31E-01
Cs-134	1.32E-01
Cs-137	1.25E-01

Field MDAs for 1.0 m2 FOV for 600 sec count on Red Rover (6264) @ 2.0 meter offset-1m det height-180 degree open collimation

Nuclide	MDA-pCi/g	1m180d adjustment factors	1m180d adjustment factor
Co-60	4.48E+00	Co-60	1.90E-02
Ag-108m	7.32E+00	Ag-108m	1.79E-02
Cs-134	7.40E+00	Cs-134	1.78E-02
Cs-137	7.01E+00	Cs-137	1.78E-02

Adjusted Class 1 Investigation levels based on DCGL_{emc}*MDA@38.5 m2/MDA @1m2 offset

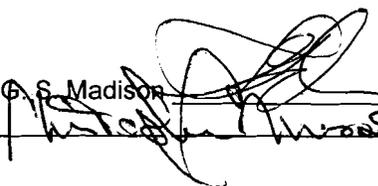
Nuclide	pCi/g	
Co-60	0.28	(NS)
Ag-108m	0.42	(NS)
Cs-134	0.50	(NS)
Cs-137	1.20	(NS)

Note: (NS) Not Surrogated

Spectrum used for evaluation-OOL-05-04-003-F-G obtained 10/13/2005 @ 2:46:36 PM

Investigation levels calculated/derived IAW YA-REPT-00-018-05 Rev 0

Note: These levels assume proper survey design scan grid pattern spacing of 4 meters.

Calculated by: G. S. Madison  Date: 11/30/05
 Reviewed by: [Signature] Date: 12-13-05

Geometry Composer Report

Date: Wednesday, November 09, 2005
 Description: 1m180d_soileMC
 Comment: 1m180d_soileMC
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\test.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: RED-6264
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2^(4) CRPN= 2^(4)

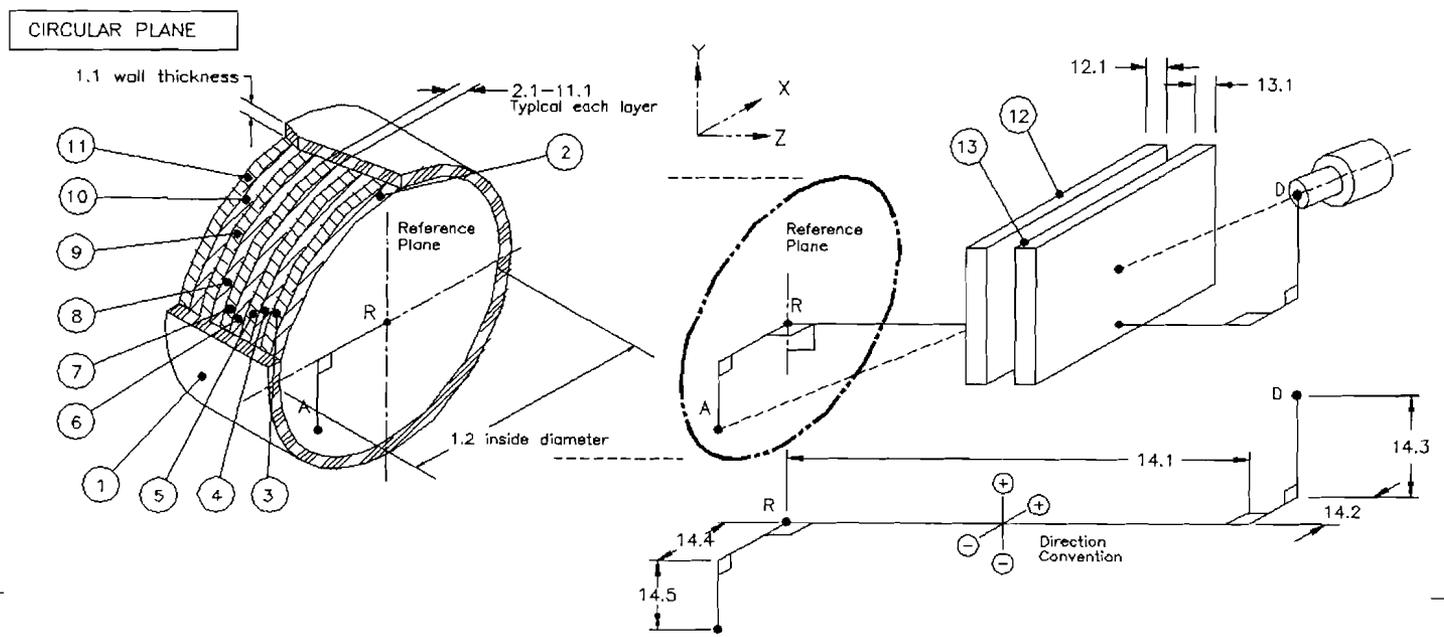
Dimensions (cm):

# Geometry Compon.	d1	d2	d3	d4	d5	d6	Material	D(g/cm3)	R.Conc.
1 Side Walls		113.00					none		
2 Layer 1	15.00						dirt4	1.70	1.00
3 Layer 2							none		
4 Layer 3							none		
5 Layer 4							none		
6 Layer 5							none		
7 Layer 6							none		
8 Layer 7							none		
9 Layer 8							none		
10 Layer 9							none		
11 Layer 10							none		
12 Absorber1							none		
13 Absorber2							none		
14 Source-Detector	100.00	200.00		200.00					

Collimator: 50mm-180d_new
 newISOCS_50mm_side_180deg_collimation_[no_collimator]

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



YANKEE ATOMIC ELECTRIC COMPANY

RADIATION PROTECTION SURVEY FORM

Remediation

DATE 12-5-05 TIME 14:45

SURVEYOR (Red)

INSTRUMENT/# CAL DUE

ISOCs 6264 NA

NA NA

KEY
RADIATION GENERAL AREA

RADIATION CONTACT

SMEAR LOCATION

BARRIER MASSLINN

() DIRECT RADIATION READINGS IN MR/HR EXCEPT AS NOTED.

() CONTAMINATION

() LESS THAN 1000 dpm/100cm² BETA-GAMMA UNLESS NOTED

() LESS THAN 50 dpm/100cm² ALPHA UNLESS NOTED.

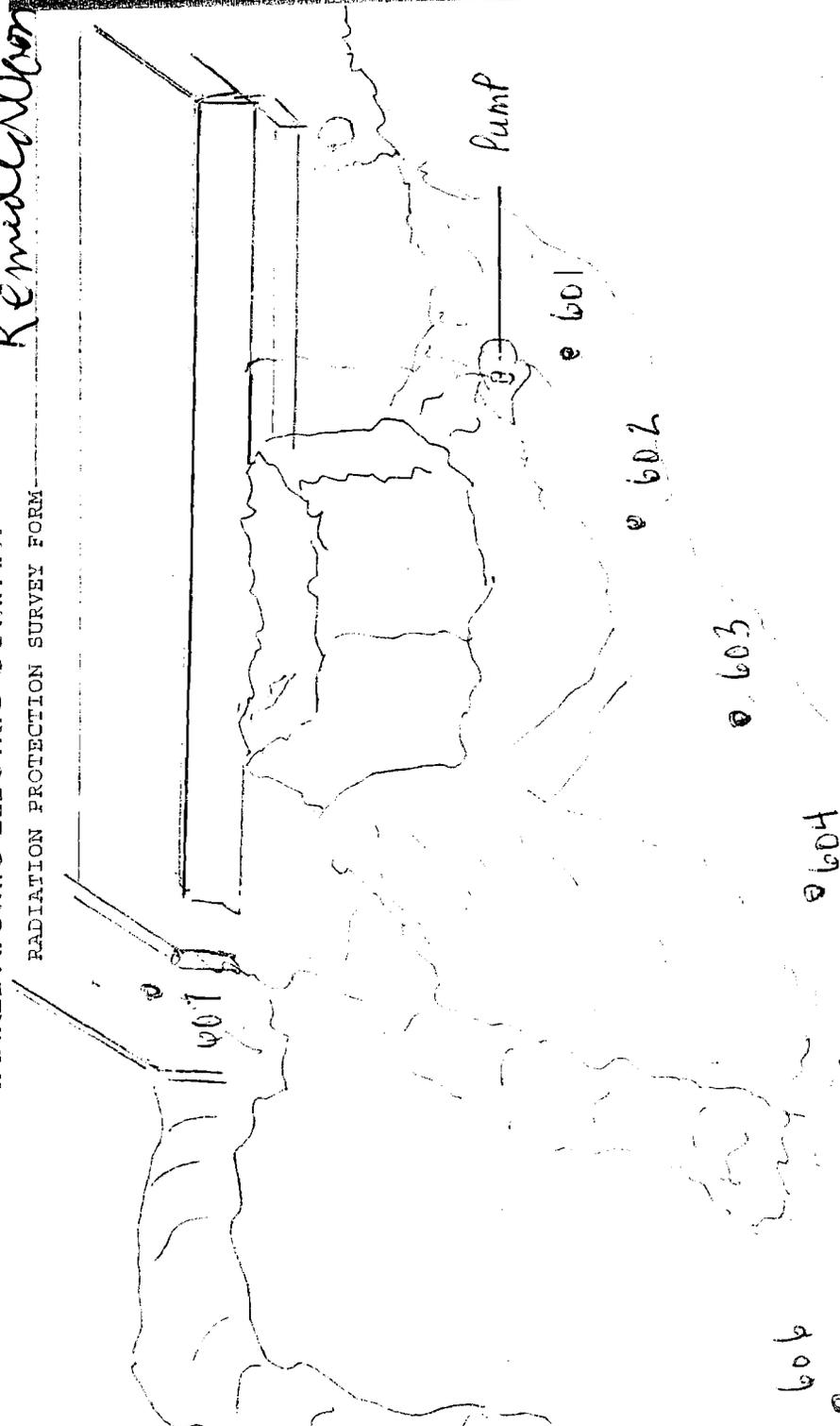
() HOT PARTICLE SURVEY

NO HOT PARTICLES FOUND UNLESS NOTED.

SMEAR LOCATION & NET dpm/100 cm²

1	11	21
2	12	22
3	13	23
4	14	24
5	15	25
6	16	26
7	17	27
8	18	28
9	19	29
10	20	30

COMMENTS:



Survey points 4-5 mtes
 Apart
 ISOCs positioned 1 mte
 Soil 180° Collimation

Survey Completed After Ice Removal
 And clean off of exit Area

Copy

WST

Co60 pCi/g
Mean 2.14E-01
SD 3.26E-01
Min 1.59E-02
Max 1.34E+00

Mean
SD
Min
Max

Cs137 pCi/g
8.68E-02
8.10E-02
-1.26E-03
2.88E-01

$$\sigma = \sqrt{\left(\frac{0.081}{3.0}\right)^2 + \left(\frac{0.326}{1.4}\right)^2}$$

885 3.2
Sample #

8' x 5' H x 6'

Attachment 2 SPA-3 Scan
YNPS-FSSP-NOL-05-02-00

SOIL SAMPLES CALCULATION

Inputs: $MDCR = 1.38 * \sqrt{b} / \sqrt{p} * t$

Where:

b = background counts in time t

p = 0.5 surveyor efficiency

Scan speed: 0.0508 m/s

Localized contam dia: 56 cm

t(sec) det above local activity 11.024 dia / scan speed

0.1837 time (min)

$$MDC(fDCGL_{EMC}) = MDCR \sum (f^i / E_i AF^i DCGL^i)$$

(DP-8853)

AF= Area Factor

E_i = Scanning instrument efficiency (YA-REPT-00-015-04)

f = radionuclide fraction

Cs-137

Co-60

E_i = 188 379

DCGL 2.99 1.41

f = 0.16 0.84

AF = 2.9 1.4 LTP App 6Q

		MDC	
BKG (cpm)	BKG/t	MDCR (cpm)	(fDCGL _{emc})
7000	1286.1	381	4.65E-01
8000	1469.8	407	4.97E-01
9000	1653.5	432	5.27E-01
10000	1837.3	455	5.56E-01
13400	2461.9	527	6.44E-01
11000	2021.0	478	5.83E-01
12000	2204.7	499	6.09E-01
13000	2388.5	519	6.34E-01
14000	2572.2	539	6.58E-01
15000	2755.9	558	6.81E-01
16000	2939.6	576	7.03E-01
17000	3123.4	594	7.25E-01
18000	3307.1	611	7.46E-01
19000	3490.8	628	7.66E-01
20000	3674.5	644	7.86E-01
21000	3858.3	660	8.06E-01
22000	4042.0	675	8.25E-01
23000	4225.7	691	8.43E-01
24000	4409.4	705	8.61E-01
25000	4593.2	720	8.79E-01

Attachment 2 SPA-3 Scan
YNPS-FSSP-NOL-05-02-00

SOIL SAMPLES CALCULATION

Inputs: $MDCR = 1.38 * \sqrt{b} / \sqrt{p} * t$

Where:

b = background counts in time t
 p = 0.5 surveyor efficiency
 Scan speed: 0.08 m/s
 Localized contam dia: 56 cm
 t(sec) det above local activity 7 dia / scan speed
 0.1167 time (min)

$$MDC(fDCGL_{EMC}) = MDCR \sum (f^i / E_i AF^i DCGL^i)$$

(DP-8853)

AF= Area Factor

E_i = Scanning instrument efficiency (YA-REPT-00-015-04)

f = radionuclide fraction

	Cs-137	Co-60
E _i =	188	379
DCGL	2.99	1.41
f =	0.16	0.84
AF =	2.9	1.4 LTP App 6Q

BKG (cpm)	BKG/t	MDCR (cpm)	MDC (fDCGL _{emc})
7000	816.7	478	5.84E-01
8000	933.3	511	6.24E-01
9000	1050.0	542	6.62E-01
10000	1166.7	571	6.98E-01
13400	1563.3	661	8.08E-01
11000	1283.3	599	7.32E-01
12000	1400.0	626	7.64E-01
13000	1516.7	651	7.95E-01
14000	1633.3	676	8.25E-01
15000	1750.0	700	8.54E-01
16000	1866.7	723	8.82E-01
17000	1983.3	745	9.10E-01
18000	2100.0	767	9.36E-01
19000	2216.7	788	9.62E-01
20000	2333.3	808	9.87E-01
21000	2450.0	828	1.01E+00
22000	2566.7	847	1.03E+00
23000	2683.3	867	1.06E+00
24000	2800.0	885	1.08E+00
25000	2916.7	903	1.10E+00

Attachment 3
 Derivation of MDCs for ISOCS and Soil Samples
 YNPS-FSSP-NOL-05-02-00

	DCF	LTP App.6E Soil DCGL (25 mrem/y)	DCGL (8.73 mrem/y)	Range of MDC (pCi/g)
Nuclide	(mrem/y per pCi/g)	(pCi/g)	(pCi/g)	from Desired (10% DCGL) to Required (50% DCGL)
H-3	0.0679	368.1885125	128.5714	1.3E+01 to 6.4E+01
C-14	4.52	5.530973451	1.931416	1.9E-01 to 9.0E-01
Fe-55	0.000857	29171.52859	10186.7	1.0E+03 to 5.0E+03
Co-60	6.21	4.025764895	1.405797	1.4E-01 to 7.0E-01
Ni-63	0.0307	814.3322476	284.3648	2.8E+01 to 1.4E+02
Sr-90	14.5	1.724137931	0.602069	6.0E-02 to 3.0E-01
Nb-94	3.46	7.225433526	2.523121	2.5E-01 to 1.2E+00
Tc-99	1.76	14.20454545	4.960227	5.0E-01 to 2.4E+00
Ag-108m	3.44	7.26744186	2.537791	2.5E-01 to 1.2E+00
Sb-125	0.782	31.96930946	11.16368	1.1E+00 to 5.5E+00
Cs-134	5.02	4.980079681	1.739044	1.7E-01 to 8.0E-01
Cs-137	2.92	8.561643836	2.989726	3.0E-01 to 1.4E+00
Eu-152	2.43	10.28806584	3.592593	3.6E-01 to 1.7E+00
Eu-154	2.63	9.505703422	3.319392	3.3E-01 to 1.6E+00
Eu-155	0.0629	397.4562798	138.7917	1.4E+01 to 6.9E+01
Pu-238	0.748	33.42245989	11.67112	1.2E+00 to 5.8E+00
Pu-239	0.83	30.12048193	10.51807	1.1E+00 to 5.2E+00
Pu-241	0.0254	984.2519685	343.7008	3.4E+01 to 1.7E+02
Am-241	0.859	29.10360885	10.16298	1.0E+00 to 5.0E+00
Cm-243	0.785	31.84713376	11.12102	1.1E+00 to 5.5E+00

Attachment 6
 Calculation of DCGLemc, N, L for Soil
 YNPS-FSSP-NOL-05-02-00

CALCULATION OF DCGLemc FOR SOIL			LTP App 6Q - soil		
	Cs-137	Co-60	Area of Source (m2)	Co-60 Area Factor	Cs-137 Area Factor
DCGLw	2.99	1.41 pCi/g - Table 1			
nuclide f	0.16	0.84 From NOL-05-02 Char Data			
L		7.7 m			
Area of triangle * L2		0.433 m2	1	1.1E+01	2.2E+01
Area of diamond * L2		0.866 m2	2	6.5E+00	1.3E+01
Calc Area of Source		51.46667 m2	4	4.1E+00	8.5E+00
Area of Source		75 m2 - LTP App.6Q	6	3.2E+00	6.6E+00
Area Factor	2.9	1.4	8	2.7E+00	5.6E+00
DCGLemc	8.7	2.0 pCi/g	10	2.4E+00	4.9E+00
GA DCGLemc	2.3	pCi/g	25	1.8E+00	3.7E+00
			50	1.5E+00	3.1E+00
			75	1.4E+00	2.9E+00
			100	1.4E+00	2.8E+00
			250	1.3E+00	2.4E+00
			500	1.2E+00	2.1E+00
			750	1.2E+00	1.9E+00
			1000	1.1E+00	1.7E+00
			2500	1.1E+00	1.6E+00
			5000	1.1E+00	1.4E+00
			7500	1.0E+00	1.2E+00
			10000	1.0E+00	1.1E+00
			11500	1.0E+00	1.1E+00
			13022	1.0E+00	1.0E+00
CALCULATION OF N AND L					
Survey Unit Area		1544 m2			
Type 1 Error		0.05			
Type 2 Error		0.05			
Stdev - Char		0.33 pCi/g - NOL 05-02 Char Data			
DCGLw		1.41 pCi/g			
LBGR		0.705 0.5*DCGLw			
Shift		0.705 DCGLw - LBGR			
Rel Shift		2.1 Shift / stdev			
Adj Rel Shift		N/A DP-8853			
N		15 DP-8853 Att A			
adj N		30 for mapping purposes			
L (triangular grid)		7.7 m			