YANKEE ATOMIC ELECTRIC COMPANY Telephone (413) 424-5261

49 Yankee Road, Rowe, Massachusetts 01367

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U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-001

References: (a) License No. DPR-3 (Docket No. 50-29)

(b) BYR 2004-133, Submittal of Revision 1 to the Yankee Nuclear Power Station's License Termination Plan

(c) Yankee Nuclear Power Station – Issuance of Amendment 158 Re: License Termination Plan

Subject: Submittal of YNPS-FSS-BRT01-00, the Final Status Survey Report for Survey Areas BRT-01

Dear Madam/Sir:

This letter submits YNPS-FSS-BRT01-00, Final Status Survey Report for BRT-01. This report was written in accordance with Section 5 of the YNPS License Termination Plan, "Final Status Survey Plan," and is consistent with the guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

We trust that this information is satisfactory; however if you should have any questions or require any additional information, please contact Alice Carson at (301) 916-3995 or the undersigned at (413)-424-2261.

Sincerely,

YANKEE ATOMIC ELECTRIC COMPANY

Joseph R. Lynch
Regulatory Affairs Manager

Enclosure: YNPS-FSS-BRT01-00 (2 hard copies plus CDs)

cc (w/o encl):	S. Collins, NRC Region I Administrator Marie Miller, Chief, Decommissioning Branch, NRC Region I J. Kottan, Region I D. Everhart, Region I J. Hickman, NRC Project Manager M. Rosenstein, US Environmental Protection Agency, Region 1 R. Walker, Director, MA DPH W. Perlman, Executive Committee Chair, FRCOG T.W. Hutcheson, Chair, Franklin Regional Planning Board L. Dunlavy, Executive Director, FRCOG P. Sloan, Director of Planning & Development, FRCOG
cc (w/encl on CD)	D. Howland, Regional Engineer, MA DEP M. Whalen, MA DPH D. Katz, CAN Jonathan Block, CAN

Yankee Nuclear Plant Station Final Status Survey Report For BRT-01

Yankee Atomic Electric Company

YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT

REPORT NO.: YNPS-FSS-BRT-01-00

Prepared by: _______________ Date: 8-23-06
Michael D. Rennhack, FSS Radiological Engineer

Reviewed by: _______________ Date: 8-24-06
Christopher C. Messier, FSS Radiological Engineer

Approved by: _______________ Date: 8/24/06
Martin Erickson, FSS Manager

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List of Abbreviations and Acronyms

AL	Action Level
ALARA	As Low As Reasonably Achievable
c/d	Counts per Disintegration
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	DCGL for small areas of elevated activity
$DCGL_{W}$	DCGL for average concentration over a wide area, used with statistical tests
DQO	Data Quality Objectives
EMC	Elevated Measurement Comparison
ETD	Easy-to-Detect
FSS	Final Status Survey
FSSP	Final Status Survey Plan
GPS	Global Positioning System
H_0	Null Hypothesis
HSA	Historical Site Assessment
HTD	Hard-to-Detect
ISOCS	*In-situ* Object Counting System®
LBGR	Lower Bound of the Grey Region
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
PAB	Primary Auxiliary Building
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCA	Radiological Controlled Area
RP	Radiation Protection
RSS	Reactor Support Structure
SFP	Spent Fuel Pool
VC	Vapor Container
VCC	Vertical Concrete Cask
VSP	Visual Sample Plan
YNPS	Yankee Nuclear Power Station

1.0 EXECUTIVE SUMMARY

A Final Status Survey (FSS) was performed of Survey Area BRT-01 in accordance with Yankee Nuclear Power Station's (YNPS) License Termination Plan (LTP). This FSS was conducted as a structure surface FSS with building occupancy Derived Concentration Guideline Levels (DCGLs) even though the BRT-01 structure will be subsurface at license termination. This practice conservatively implements LTP criteria that subsurface structure surfaces be evaluated for the presence of contamination.

1.1 Identification of Survey Area and Units

Survey Area BRT-01 consists of the reinforced concrete structures that comprise the foundations and support pedestals of the sixteen Vapor Container (VC) supports and the eight Reactor Support Structures (RSS) that are expected to remain after demolition of the VC and RSS. BRT-01 is located in the RCA yard area and is within the bounds of survey areas NOL-01 and NOL-06. BRT-01 consists of twelve Survey Units, BRT-01-01, and BRT-01-03 through BRT-01-13. The BRT-01-02 nomenclature was used in conjunction with a survey of material that failed FSS and was shipped off site as radiological waste. It will not be addressed in this report.

1.2 Dates(s) of Survey

Table 1 Date of Surveys

Survey Unit	Survey Start Date	Survey End Date	DQA Date
BRT-01-01	8/9/2005	9/7/2005	11/3/2005
BRT-01-03	8/9/2005	9/13/2005	11/3/2005
BRT-01-04	8/9/2005	9/13/2005	11/3/2005
BRT-01-05	8/9/2005	9/13/2005	11/3/2005
BRT-01-06	8/9/2005	9/13/2005	11/3/2005
BRT-01-07	8/9/2005	9/13/2005	11/3/2005
BRT-01-08	8/25/2005	9/20/2005	11/3/2005
BRT-01-09	8/25/2005	9/22/2005	11/3/2005
BRT-01-10	8/25/2005	9/22/2005	11/3/2005
BRT-01-11	8/25/2005	9/23/2005	11/3/2005
BRT-01-12	8/25/2005	11/23/2006	7/16/2006
BRT-01-13	8/25/2005	12/22/2005	8/8/2006

1.3 Number and Types of Measurements Collected

Final Status Survey Plan (FSSP) was developed for these Survey Units in accordance with YNPS LTP and FSS procedures using the MARSSIM protocol. The planning and design of the survey plan employed the Data Quality Objective (DQO) process, ensuring that the type, quantity and quality of data gathered was appropriate for the decision making process and that the resultant decisions were technically sound and defensible. A total of 274 systematic fixed-point measurements were taken in the 12

Survey Units, providing data for the non-parametric testing of the Survey Area. In addition to the fixed-point samples, ISOCS and hand-held survey instrument scans were performed to provide 100 percent coverage of the Survey Area.

1.4 Summary of Survey Results

Following the survey, the data were reviewed against the survey design to confirm completeness and consistency, to verify that the results were valid, to ensure that the survey plan objectives were met and to verify Survey Unit classification. Fixed point surveys indicated that none of the systematic measurements exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, BRT-01 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mrem/yr, including that from groundwater. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mrem/yr limit will also be met.

2.0 FSS PROGRAM OVERVIEW

2.1 Survey Planning

The YNPS FSS Program employs a strategic planning approach for conducting final status surveys with the ultimate objective to demonstrate compliance with the DCGLs, in accordance with the YNPS LTP. The DQO process is used as a planning technique to ensure that the type, quantity, and quality of data gathered is appropriate for the decision-making process and that the resultant decisions are technically sound and defensible. Other key planning measures are the review of historical data for the Survey Unit and the use of peer review for plan development.

2.2 Survey Design

In designing the FSS, the questions to be answered are: "Does the residual radioactivity, if present in the Survey Unit, exceed the LTP release criteria?" and "Is the potential dose from this radioactivity ALARA?" In order to answer these questions, the radionuclides present in the Survey Units must be identified, and the Survey Units classified. Survey Units are classified with respect to the potential for contamination: the greater the potential for contamination, the more stringent the classification and the more rigorous the survey.

The survey design additionally includes the number, type and locations of fixed measurements/samples (as well as any judgmental assessments required), scanning requirements, and instrumentation selection with the required sensitivities or detection levels. DCGLs are developed relative to the surface/material of the Survey Unit and are used to determine the minimum sensitivity required for the survey. Determining the acceptable decision error rates, the lower bound of the gray region (LBGR), statistical test selection and the calculation of the standard deviation and relative shift allows for the development of a prospective power curve plotting the probability of the Survey Unit passing FSS.

2.3 Survey Implementation

Once the planning and development has been completed, the implementation phase of the FSS program begins. Upon completion of remediation and final characterization activities, a final walk down of the Survey Unit is performed. If the unit is determined to be acceptable (i.e. physical condition of the unit is suitable for FSS), it is turned over to the FSS team, and FSS isolation and control measures are established. After the Survey Unit isolation and controls are in place, grid points are identified for the fixed measurements/samples, using Global Positioning System (GPS) coordinates whenever possible, consistent with the Massachusetts State Plane System, and the area scan grid is identified. Data is collected and any required investigations are performed.

2.4 Survey Data Assessment

The final stage of the FSS program involves assessment of the data collected to ensure the validity of the results, to demonstrate achievement of the survey plan objectives, and to validate Survey Unit classification. During this phase, the DQOs and survey design are reviewed for consistency between DQO output, sampling design and other data collection documents. A preliminary data review is conducted to include: checking for problems or anomalies, calculation of statistical quantities and preparation of graphical representations for data comparison. Statistical tests are performed, if required, and the assumptions for the tests are verified. Conclusions are then drawn from the data, and any deficiencies or recommendations for improvement are documented.

2.5 Quality Assurance and Quality Control Measures

YNPS FSS activities are implemented and performed under approved procedures, and the YNPS Quality Assurance Project Plan (QAPP) assures plans, procedures and instructions have been followed during the course of FSS, as well as providing guidance for implementing quality control measures specified in the YNPS LTP.

3.0 SURVEY AREA INFORMATION

3.1 Survey Area Description

Survey Area Name: Vapor Container & Reactor Support Structures. Survey Area BRT-01 consists of the reinforced concrete structures that comprise the foundations, and support pedestals of the sixteen Vapor Container (VC) supports and the Reactor Support Structure (RSS) that remain (subsurface) after demolition of the VC and RSS. BRT-01 is located in the RCA yard area and is within the bounds of survey areas NOL-01 and NOL-06.

3.2 History of Survey Area

The Vapor Container (VC) was a spherical steel structure that surrounded the RSS. It was located about 23 feet above grade and was supported by 16 steel columns. The steel columns were supported by reinforced concrete pedestals. The VC provided lateral support to the VC Service Elevator Tower and the Primary Vent Stack (PVS). Attachments were limited to minor platform framing, exterior stairs, and lightly loaded supports for pipes and cable trays.

The VC was no longer needed for contamination isolation and was disposed of as radioactive waste.

- The Reactor Support Structure was a reinforced concrete structure which supported the polar crane. The Reactor Support Structure consisted of two concentric concrete cylinders. The cylinders were connected together with reinforced concrete radial walls which formed compartments for the Main Coolant Loops, Pressurizer, and Equipment Hatch. The compartments were covered by a reinforced concrete charging floor. The charging floor was composed of removable concrete slabs which allowed crane access to the compartments. The Reactor Support Structure was supported on eight reinforced concrete steel encased columns which penetrate the VC shell. The VC penetrations were sealed by stainless steel expansion joints. An annular space was provided to permit the VC and internal concrete structure to move independently.

The RSS was demolished and disposed of as radioactive waste.

Upon completion of demolition of these structures, the BRT-01 survey area is comprised of the footing and support pedestals.

3.3 Division of Survey Area into Survey Units

BRT-01 consists of twelve Survey Units, BRT-01-01, and BRT-01-03 through BRT-01-13. Each footing or support pedestal representing its own survey unit. BRT-01-02 nomenclature was used in conjunction with a survey of material that was shipped off site as radiological waste, and will not be addressed in this report.

4.0 SURVEY UNIT INFORMATION

4.1 Summary of Radiological Data Since Historical Site Assessment (HSA)

4.1.1 Chronology and Description of Surveys Since HSA

Isolation and control measures were implemented for the FSS. The condition of BRT-01 Survey Units at the time of FSS was smooth to heavily remediated steel reinforced concrete.

The Table below provides a summary of daily activities performed during the Final Status Survey of Survey Units in BRT-01.

Table 2 FSS Activity Summary for BRT-01 Survey Units

Survey Unit	Date	Activity
BRT-01-01	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	8/25/2005	Performed Sample Quantity Calculations, established DQOs
	8/31/2005	Generated FFS Sample Plans
	9/2/2005 to 9/7/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-03	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	8/26/2006	Performed Sample Quantity Calculations, established DQOs
	9/13/2005	Generated FFS Sample Plans
	9/2/2005 to 9/13/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-04	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/30/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs
	9/6/2005	Generated FFS Sample Plans
	9/7/2005 to 9/13/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-05	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs

Survey Unit	Date	Activity
	9/6/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-06	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/2/2005	Performed Sample Quantity Calculations, established DQOs
	9/6/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-07	9/6/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs
	9/8/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-08	9/14/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/15/2005	Performed Unit Classification
	9/15/2005	Performed Sample Quantity Calculations, established DQOs
	9/15/2005	Generated FFS Sample Plans
	9/19/2005 to 9/20/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-09	9/20/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/20/2005	Performed Unit Classification
	9/20/2005	Performed Sample Quantity Calculations, established DQOs
	9/27/2005	Generated FFS Sample Plans
	9/21/2005 to 9/22/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-10	9/21/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/21/2005	Performed Unit Classification
	9/21/2005	Performed Sample Quantity Calculations, established DQOs
	9/21/2005	Generated FFS Sample Plans
	9/21/2005 to 9/22/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-11	9/22/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls

Survey Unit	Date	Activity
	8/25/2005	Performed Job Hazard Analysis
	9/22/2005	Performed Unit Classification
	9/22/2005	Performed Sample Quantity Calculations, established DQOs
	9/22/2005	Generated FFS Sample Plans
	9/22/2005 to 9/23/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-12	11/22/2005	Performed walk-down of Survey Unit
	11/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	11/17/2005	Performed Unit Classification
	11/17/2005	Performed Sample Quantity Calculations, established DQOs
	11/17/2005	Generated FFS Sample Plans
	11/22/2005 to 11/23/2005	Initiated Scans, and Direct measurements.
	7-16-06	Performed DQA, FSS Complete
BRT-01-13	11/28/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	11/23/2005	Performed Unit Classification
	11/23/2005	Performed Sample Quantity Calculations, established DQOs
	12/21/2005	Generated FFS Sample Plans
	12/12/05 to 12/22/05	Initiated Scans, and Direct measurements.
	08/08/2006	Performed DQA, FSS Complete

4.1.2 Radionuclide Selection and Basis

During the initial DQO process, Co-60 was identified as the radiological nuclide of concern due to its more restrictive DCGL value when compared to Cs-137 (sampling of soil adjacent to the concrete indicated a relationship of approximately 80% Co-60 to 20% Cs-137). Adjacent soil characterization and survey data indicate no other LTP-specified radionuclides warrant consideration in the BRT-01 Survey Units.

4.1.3 Scoping & Characterization

The operational RP turnover survey of the concrete surface of the ring foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm2. The mean detectable radioactivity from fixed-point measurements was 883 ± 727dpm/100cm3, which is significantly lower than the DCGLw for Co-60 (6.3E3 dpm/100cm2).

A sample of concrete was collected from an area of the ring foundation where a cluster of 10 higher-than-the-average measurements was found. Gamma spectroscopy of the surface concrete sample did not identify any LTP-listed gamma-emitting nuclide; only naturally-occurring radioactivity was identified.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known groundwater tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclide.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption. Average radiation level: 883 dpm/100cm2 (from the Operational RP turnover survey). Standard deviation (σ): 727 dpm/100cm2 (from the Operational RP turnover survey).

4.2 Basis for Classification

Based upon the radiological condition of this Survey Area identified in the operating history and as a result of the decommissioning activities performed to date, Survey Area BRT-01 is identified as a Class 1 Area.

4.3 Remedial Actions and Further Investigations

Investigations were performed in BRT-01-01, BRT-01-05, BRT-01-06, BRT-01-07, BRT-01-09, and BRT-01-10.

4.3.1 BRT-01-01 Investigations

Two hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. Both fixed measurement investigations were less than DCGLw.

4.3.2 BRT-01-05 Investigations

Hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. The fixed measurement investigations were less than DCGLw.

4.3.3 BRT-01-06 Investigations

Hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. The fixed measurement investigations were less than DCGLw.

4.3.4 BRT-01-07 Investigations

Hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. The fixed measurement investigations were less than DCGLw.

4.3.5 BRT-01-09 Investigations

Three hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. The three fixed measurement investigations were less than DCGLw.

4.3.6 BRT-01-10 Investigations

Two hand-scan measurements of a vertical wall indicated levels slightly greater than background and were investigated via fixed measurements. Both fixed measurement investigations were less than DCGLw.

4.4 Unique Features of Survey Area

Survey Area BRT-01 exhibited surface characteristics ranging from smooth surfaces to heavily remediated irregular surfaces. Most of the pits and irregularities increased the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces were taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 (Appendix B) provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the irregular surfaces, the vertical walls of the structures are relatively smooth. Table 4.2 of the YA-REPT-00-015-04 (Appendix B) provides instrument efficiency factors (ε_i) for various source-to-detector distances. Detector efficiencies (HP-100C) were applied as follows: smooth surface 0.0603 c/d, irregular surface 0.0373 c/d.

4.5 ALARA Practices and Evaluations

An ALARA evaluation was developed for each Survey Unit in the BRT-01 Survey Area which concluded that additional remediation was not warranted. These evaluations are found in Appendix C.

5.0 SURVEY UNIT FINAL STATUS SURVEY

5.1 Survey Planning

5.1.1 Final Status Survey Plan and Associated DQOs

The FSS for BRT-01 Survey Units was planned and developed in accordance with the LTP using the DQO process. Form DPF-8856.1, found in YNPS Procedure 8856, "*Preparation of Survey Plans*," was used to provide guidance and consistency during development of the FSS Plan. The FSS Plans can be found in Appendix A. The DQO process allows for systematic planning and is specifically designed to address problems that require a decision to be made in a complex survey design and, in turn, provides alternative actions.

The DQO process was used to develop an integrated survey plan providing the Survey Unit identification, sample size, selected analytical techniques, survey instrumentation, and scan coverage. The Sign Test was specified for non-parametric statistical testing for this Survey Unit, if required. The design parameters developed are presented below.

Table 3 Survey Area BRT-01 Design Parameters

Survey Unit	Design Parameter	Value	Basis
BRT-01-01	Survey Unit Area	99 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.6	Class 1, 99 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	6.6m2	Area / Number of Samples (99 m2/15)
	Sample Grid Spacing:	Triangular: 2.8m	Square Root (99 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	99 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137: 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-03	Survey Unit Area	98 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.6	Class 1, 98 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	6.53m2	Area / Number of Samples (98 m2/15)
	Sample Grid Spacing:	Triangular: 2.7m	Square Root (98 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	98 m2	Class 1 Concrete Area:

Survey Unit	Design Parameter	Value	Basis
			100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137: 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-04	Survey Unit Area	75 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.9	Class 1, 75 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	5m2	Area / Number of Samples (75 m2/15)
	Sample Grid Spacing:	Triangular: 2.4m	Square Root (75 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	75 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137: 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-05	Survey Unit Area	69 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.9	Class 1, 69 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	4.6m2	Area / Number of Samples (69 m2/15)
	Sample Grid Spacing:	Triangular: 2.3m	Square Root (69 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	69 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137: 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-06			
	Survey Unit Area	86 m2	Class 1, Concrete, ≤ 100

Survey Unit	Design Parameter	Value	Basis
			m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.9	Class 1, 86 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	5.73m2	Area / Number of Samples (86 m2/15)
	Sample Grid Spacing:	Triangular: 2.6m	Square Root (86 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	86 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137 : 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-07	Survey Unit Area	95 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.6	Class 1, 95 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	6.33m2	Area / Number of Samples (95 m2/15)
	Sample Grid Spacing:	Triangular: 2.7m	Square Root (95 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	95 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137 : 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-08	Survey Unit Area	24.2 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727

Survey Unit	Design Parameter	Value	Basis
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	4.1	Class 1, 24.2 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	1.61m2	Area / Number of Samples (24.2 m2/15)
	Sample Grid Spacing:	Triangular: 1.4m	Square Root (24.2 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	24.2 m2	Class 1 Concrete Area: 100%
	SPA-3 Scan Investigation Level	> Background Audible	Class 1 Area: > DCGLemc
BRT-01-09	Survey Unit Area	62.9 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.9	Class 1, 62.9 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	4.19m2	Area / Number of Samples (62.9 m2/15)
	Sample Grid Spacing:	Triangular: 2.2m	Square Root (62.9 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	62.9 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137 : 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-10	Survey Unit Area	31.1 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846

Survey Unit	Design Parameter	Value	Basis
	Area Factor:	2.4	Class 1, 31.1 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	2.07m2	Area / Number of Samples (31.1 m2/15)
	Sample Grid Spacing:	Triangular: 1.5m	Square Root (31.1 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	31.1 m2	Class 1 Concrete Area: 100%
	SPA-3 Scan Investigation Level	> Background Audible	Class 1 Area: > DCGLemc
BRT-01-11	Survey Unit Area	62.2 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 727
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 4846
	Area Factor:	1.9	Class 1, 62.2 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	4.15m2	Area / Number of Samples (62.2 m2/15)
	Sample Grid Spacing:	Triangular: 2.2m	Square Root (62.2 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	62.2 m2	Class 1 Concrete Area: 100%
	ISCOCS Scan Investigation Level	Co-60: 2.9E3 dpm/100cm^2 Cs-137: 1.1E4 dpm/100cm^2	See Appendix D
BRT-01-12	Survey Unit Area	17.8 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 480
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 5340
	Area Factor:	4.1	Class 1, 17.8 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	1.19m2	Area / Number of Samples (17.8 m2/15)

Survey Unit	Design Parameter	Value	Basis
	Sample Grid Spacing:	Triangular: 1.2m	Square Root (17.8 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	17.8 m2	Class 1 Concrete Area: 100%
	SPA-3 Scan Investigation Level	> Background Audible	Class 1 Area: > DCGLemc
BRT-01-13	Survey Unit Area	19.2 m2	Class 1, Concrete, ≤ 100 m2
	Number of Direct Measurements	15 (calculated)	α (Type I) = 0.05
		+ 0 (added)	β (Type II) = 0.05
		Total: 15	σ: 480
			Relative Shift: 2
			DCGLw: 6300
			LBGR: 5340
	Area Factor:	4.1	Class 1, 19.2 m2
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	1.28m2	Area / Number of Samples (19.2 m2/15)
	Sample Grid Spacing:	Triangular: 1.2m	Square Root (19.2 m2/(0.866*15))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area.
	Scanning Coverage Requirements	19.2 m2	Class 1 Concrete Area: 100%
	SPA-3 Scan Investigation Level	> Background Audible	Class 1 Area: > DCGLemc

5.1.2 Deviations from the FSS Plan as Written in the LTP

Investigation levels for the fixed measurements were set at a greater than three sigma from the mean and $>DCGL_W$ or $>DCGL_{EMC}$. The scan MDCs for the ISOCS measurements were set at the $DCGL_{EMC}$. All MDCs for the surveys of BRT-01 were met in accordance with YNPS LTP. DCGL values and the associated MDC values can be found in Table 3.

Table 4 $DCGL_W$, $DCGL_{EMC}$ and Investigation Level for ISOCS measurements

	DCGLw	$DCGL_{EMC}$ (ISOCS based on source area = $1m^2$)	Investigation Level (ISOCS Based on source area = $1m^2$, 2m 90d collimated)
Nuclide	Bldg Surface (dpm/100 cm^2) at 8.73 mrem/y	Bldg Surface (dpm/100 cm^2)	Bldg Surface (dpm/100 cm^2)
Co-60	6.3E+03	4.6E+04	2.9E+03
Cs-137	2.2E+04	1.7E+05	1.1E+04

The FSSP design was performed to the criteria of the LTP; therefore, no subsequent LTP deviations with potential impact to this Survey Area need to be evaluated.

5.1.3 DCGL Selection and Use

It must be noted that for the final evaluation of the BRT-01 Survey Units and throughout this report, the acceptance criteria of Building Surface LTP-listed DCGL values has been applied. However, given that all of the remaining slab and foundation structure will be at least a few feet subsurface before site grading is complete and will be in such a state at license termination, the LTP, section 5.6.3.1.2, "Exterior Surfaces of Building Foundations," establishes the applicable guidance, as it addresses methods that may be applied to determine if subsurface structure surfaces will be acceptable by meeting LTP-required concrete volumetric DCGLs.

With the established LTP guidance, given that Co-60 and Cs-137 have been found to be the only radionuclides of significance in the area of concern, and conventional hand-held instrument survey criteria techniques being conservatively based on Co-60 beta emissions, performing a Class 1 survey applying Building Surface DCGLs has led to a very conservative approach in determining the final status of the Survey Unit. However, in applying this approach, in addition to evaluating subsurface conditions, there is no unanswered concern should the question of future subsurface structure occupancy arise.

5.1.4 Measurements

Error tolerances and characterization sample population statistics drove the selection of the number of fixed point measurements.

The fixed-point sampling grid was developed as a systematic grid with spacing consisting of a triangular pitch pattern with a random starting point. Sample measurement locations are provided in Attachment A.

A SPA-3 was used for scans of BRT-01-08, BRT-01-10, BRT-01-12, and BRT-01-13. A total of 187 ISOCS scans were performed in the remainder of the Survey Units providing 100 percent coverage of the Survey Area. The ISOCS scan grid used a 2.6-m point-to-point grid with no perimeter points farther than 1.3 m from the survey unit boundary. The ISOCS scan grid did not require a random start. ISOCS scans were performed at a height of 2 m from the surface positioned perpendicular to the scan point using a 90-degree collimator. The adjusted investigation levels, referenced in Table 3, for the ISOCS were derived by multiplying the $DCGL_{EMC}$ ($DCGL_W$ * AF for a 1-m^2 elevated area) by the ratio of MDCs obtained from the 12.6-m^2 field of view relative to the MDC obtained for a 1-m^2 area at the edge of the 12.6-m^2 field of view, as this leads to a conservative model. The values developed for the 1-m^2 elevated area at the edge of the field of view used for the ISOCS scan investigative levels are sensitive enough to detect the elevated comparison values for the 12.6-m^2 area. MDC values for the Portable ISOCS scans were set at the $DCGL_{EMC}$ for the individual radionuclides. The technical basis for the use of the ISOCS is documented in Technical Report YA-REPT-00-018-05, "*Use of In-situ Gamma Spectrum Analysis to Perform Elevated Measurement Comparison in Support of Final Status Surveys.*" (Appendix D).

5.2 Survey Implementation Activities

The Table below provides a summary of daily activities performed during the Final Status Survey of Survey Units in BRT-01.

Table 5 FSS Activity Summary for BRT-01 Survey Units

Survey Unit	Date	Activity
BRT-01-01	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	8/25/2005	Performed Sample Quantity Calculations, established DQOs
	8/31/2005	Generated FFS Sample Plans
	9/2/2005 to 9/7/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-03	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	8/26/2006	Performed Sample Quantity Calculations, established DQOs

Survey Unit	Date	Activity
	9/13/2005	Generated FFS Sample Plans
	9/2/2005 to 9/13/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-04	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/30/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs
	9/6/2005	Generated FFS Sample Plans
	9/7/2005 to 9/13/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-05	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs
	9/6/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-06	8/24/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/2/2005	Performed Sample Quantity Calculations, established DQOs
	9/6/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-07	9/6/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	8/9/2005	Performed Unit Classification
	9/6/2005	Performed Sample Quantity Calculations, established DQOs
	9/8/2005	Generated FFS Sample Plans
	9/8/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-08	9/14/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/15/2005	Performed Unit Classification
	9/15/2005	Performed Sample Quantity Calculations, established DQOs
	9/15/2005	Generated FFS Sample Plans
	9/19/2005 to 9/20/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-09	9/20/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls

Survey Unit	Date	Activity
	8/25/2005	Performed Job Hazard Analysis
	9/20/2005	Performed Unit Classification
	9/20/2005	Performed Sample Quantity Calculations, established DQOs
	9/27/2005	Generated FFS Sample Plans
	9/21/2005 to 9/22/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-10	9/21/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/21/2005	Performed Unit Classification
	9/21/2005	Performed Sample Quantity Calculations, established DQOs
	9/21/2005	Generated FFS Sample Plans
	9/21/2005 to 9/22/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-11	9/22/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	9/22/2005	Performed Unit Classification
	9/22/2005	Performed Sample Quantity Calculations, established DQOs
	9/22/2005	Generated FFS Sample Plans
	9/22/2005 to 9/23/2005	Initiated Scans, and Direct measurements.
	11/3/2005	Performed DQA, FSS Complete
BRT-01-12	11/22/2005	Performed walk-down of Survey Unit
	11/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	11/17/2005	Performed Unit Classification
	11/17/2005	Performed Sample Quantity Calculations, established DQOs
	11/17/2005	Generated FFS Sample Plans
	11/22/2005 to 11/23/2005	Initiated Scans, and Direct measurements.
	7-16-06	Performed DQA, FSS Complete
BRT-01-13	11/28/2005	Performed walk-down of Survey Unit
	8/22/2005	Established Isolation and Controls
	8/25/2005	Performed Job Hazard Analysis
	11/23/2005	Performed Unit Classification
	11/23/2005	Performed Sample Quantity Calculations, established DQOs
	12/21/2005	Generated FFS Sample Plans
	12/12/05 to 12/22/05	Initiated Scans, and Direct measurements.
	08/08/2006	Performed DQA, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area BRT-01, the Survey Units were placed into the program for periodic surveillance surveys on a quarterly basis in accordance with YNPS procedure DP-8860, "*Area Surveillance Following Final Status Survey*." These surveys provide assurance that areas with successful FSS remain unchanged until license termination.

5.3.2 Resurveys

No resurveys were performed.

5.3.3 Investigations

No additional investigations were required for this Survey Unit due to surveillance surveys.

5.4 Survey Results

Direct measurement surveys indicated that no Survey Units had systematic measurements that exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Units exceeds the release criteria) is rejected.

Table 6 Direct Measurement Summary

Survey Unit	Systematic Samples	Average	Standard Deviation	Maximum	Samples Above DCGLw	Samples Above DCGLemc
BRT-01-01	19	1,546	1,583	5,244	0	0
BRT-01-03	20	9	1,147	1,872	0	0
BRT-01-04	15	3,046	577	3,843	0	0
BRT-01-05	18	1,448	1,231	6,185	0	0
BRT-01-06	17	2,120	971	4,420	0	0
BRT-01-07	15	2,470	854	4,906	0	0
BRT-01-08	29	2,646	1,063	4,323	0	0
BRT-01-09	19	1,100	870	2,548	0	0
BRT-01-10	22	1,782	484	2,815	0	0
BRT-01-11	32	2,231	680	3,600	0	0
BRT-01-12	21	1,649	574	3,401	0	0
BRT-01-13	46	1084	490	2676	0	0

Table 7 Direct Measurement Activity Data

Sample Title	Activity	Sample Title	Activity	Sample Title	Activity
BRT-01-01-001-F-FM	1,196	BRT-01-07-003-F-FM	2,359	BRT-01-11-009-F-FM	3,600
BRT-01-01-002-F-FM	1,383	BRT-01-07-004-F-FM	2,895	BRT-01-11-010-F-FM	2,018
BRT-01-01-003-F-FM	2,349	BRT-01-07-005-F-FM	1,555	BRT-01-11-011-F-FM	2,849
BRT-01-01-004-F-FM	2,670	BRT-01-07-006-F-FM	3,512	BRT-01-11-012-F-FM	1,643
BRT-01-01-005-F-FM	1,517	BRT-01-07-007-F-FM	1,930	BRT-01-11-013-F-FM	2,984
BRT-01-01-006-F-FM	-1,298	BRT-01-07-008-F-FM	2,038	BRT-01-11-014-F-FM	1,858
BRT-01-01-007-F-FM	2,483	BRT-01-07-009-F-FM	4,906	BRT-01-11-015-F-FM	2,876
BRT-01-01-008-F-FM	97	BRT-01-07-010-F-FM	2,172	BRT-01-11-016-F-FM	1,589
BRT-01-01-009-F-FM	-440	BRT-01-07-011-F-FM	1,796	BRT-01-11-017-F-FM	2,742
BRT-01-01-010-F-FM	901	BRT-01-07-012-F-FM	2,359	BRT-01-11-018-F-FM	1,375
BRT-01-01-011-F-FM	740	BRT-01-07-013-F-FM	2,440	BRT-01-11-019-F-FM	3,252
BRT-01-01-012-F-FM	1,866	BRT-01-07-014-F-FM	1,448	BRT-01-11-020-F-FM	1,858
BRT-01-01-013-F-FM	311	BRT-01-07-015-F-FM	2,547	BRT-01-11-021-F-FM	3,037
BRT-01-01-014-F-FM	5,244	BRT-01-08-001-F-FM	-932	BRT-01-11-022-F-FM	1,831
BRT-01-01-015-F-FM	740	BRT-01-08-002-F-FM	409	BRT-01-11-023-F-FM	1,831
BRT-01-01-016-F-FM	4,601	BRT-01-08-003-F-FM	1,293	BRT-01-11-024-F-FM	1,187
BRT-01-01-017-F-FM	2,697	BRT-01-08-004-F-FM	2,553	BRT-01-11-025-F-FM	1,455
BRT-01-01-018-F-FM	1,330	BRT-01-08-005-F-FM	2,741	BRT-01-11-026-F-FM	1,509
BRT-01-01-019-F-FM	981	BRT-01-08-006-F-FM	1,347	BRT-01-11-027-F-FM	2,206
BRT-01-03-001-F-FM	129	BRT-01-08-007-F-FM	2,714	BRT-01-11-028-F-FM	2,474
BRT-01-03-002-F-FM	183	BRT-01-08-008-F-FM	3,089	BRT-01-11-029-F-FM	2,635
BRT-01-03-003-F-FM	-1,614	BRT-01-08-009-F-FM	3,840	BRT-01-11-030-F-FM	2,340
BRT-01-03-004-F-FM	-1,909	BRT-01-08-010-F-FM	2,553	BRT-01-11-031-F-FM	1,858
BRT-01-03-005-F-FM	-1,077	BRT-01-08-011-F-FM	2,098	BRT-01-11-032-F-FM	1,858
BRT-01-03-006-F-FM	-1,051	BRT-01-08-012-F-FM	2,446	BRT-01-12-001-F-FM	1,059
BRT-01-03-007-F-FM	-1,640	BRT-01-08-013-F-FM	2,929	BRT-01-12-002-F-FM	1,092
BRT-01-03-008-F-FM	-997	BRT-01-08-014-F-FM	1,937	BRT-01-12-003-F-FM	976
BRT-01-03-009-F-FM	-702	BRT-01-08-015-F-FM	3,384	BRT-01-12-004-F-FM	1,076
BRT-01-03-010-F-FM	49	BRT-01-08-016-F-FM	3,518	BRT-01-12-005-F-FM	1,357
BRT-01-03-011-F-FM	-622	BRT-01-08-017-F-FM	3,224	BRT-01-12-006-F-FM	1,673
BRT-01-03-012-F-FM	-273	BRT-01-08-018-F-FM	2,312	BRT-01-12-007-F-FM	2,784
BRT-01-03-013-F-FM	772	BRT-01-08-019-F-FM	3,116	BRT-01-12-008-F-FM	3,401
BRT-01-03-014-F-FM	1,309	BRT-01-08-020-F-FM	4,323	BRT-01-12-009-F-FM	2,007
BRT-01-03-015-F-FM	49	BRT-01-08-021-F-FM	3,331	BRT-01-12-010-F-FM	1,656
BRT-01-03-016-F-FM	451	BRT-01-08-022-F-FM	2,446	BRT-01-12-011-F-FM	1,656
BRT-01-03-018-F-FM	1,255	BRT-01-08-023-F-FM	3,331	BRT-01-12-012-F-FM	1,838
BRT-01-03-019-F-FM	1,603	BRT-01-08-024-F-FM	2,795	BRT-01-12-013-F-FM	1,457
BRT-01-03-020-F-FM	1,389	BRT-01-08-025-F-FM	3,599	BRT-01-12-014-F-FM	1,291
BRT-01-03-022-F-FM	1,014	BRT-01-08-026-F-FM	3,036	BRT-01-12-015-F-FM	1,407
BRT-01-03-021-F-FM	1,872	BRT-01-08-027-F-FM	2,741	BRT-01-12-016-F-FM	1,391
BRT-01-04-001-F-FM	3,200	BRT-01-08-028-F-FM	3,063	BRT-01-12-017-F-FM	1,507
BRT-01-04-002-F-FM	1,940	BRT-01-08-029-F-FM	3,492	BRT-01-12-018-F-FM	1,424
BRT-01-04-003-F-FM	2,342	BRT-01-09-001-F-FM	2,548	BRT-01-12-019-F-FM	1,789
BRT-01-04-004-F-FM	2,958	BRT-01-09-002-F-FM	1,422	BRT-01-12-020-F-FM	2,037
BRT-01-04-005-F-FM	2,556	BRT-01-09-003-F-FM	1,583	BRT-01-12-021-F-FM	1,756
BRT-01-04-006-F-FM	2,637	BRT-01-09-004-F-FM	484	BRT-01-13-001-F-FM	986

Sample Title	Activity	Sample Title	Activity	Sample Title	Activity
BRT-01-04-007-F-FM	2,798	BRT-01-09-005-F-FM	1,717	BRT-01-13-002-F-FM	173
BRT-01-04-008-F-FM	3,843	BRT-01-09-006-F-FM	1,020	BRT-01-13-003-F-FM	289
BRT-01-04-009-F-FM	2,878	BRT-01-09-007-F-FM	859	BRT-01-13-004-F-FM	588
BRT-01-04-010-F-FM	3,173	BRT-01-09-008-F-FM	1,208	BRT-01-13-005-F-FM	637
BRT-01-04-011-F-FM	3,763	BRT-01-09-009-F-FM	1,261	BRT-01-13-006-F-FM	903
BRT-01-04-012-F-FM	3,361	BRT-01-09-010-F-FM	2,039	BRT-01-13-007-F-FM	670
BRT-01-04-013-F-FM	3,682	BRT-01-09-011-F-FM	1,261	BRT-01-13-008-F-FM	704
BRT-01-04-014-F-FM	2,717	BRT-01-09-012-F-FM	1,771	BRT-01-13-009-F-FM	961
BRT-01-04-015-F-FM	3,843	BRT-01-09-013-F-FM	1,020	BRT-01-13-010-F-FM	1,375
BRT-01-05-001-F-FM	2,003	BRT-01-09-014-F-FM	28	BRT-01-13-011-F-FM	1,077
BRT-01-05-002-F-FM	797	BRT-01-09-015-F-FM	2,548	BRT-01-13-012-F-FM	745
BRT-01-05-003-F-FM	904	BRT-01-09-016-F-FM	940	BRT-01-13-013-F-FM	795
BRT-01-05-004-F-FM	636	BRT-01-09-017-F-FM	-26	BRT-01-13-014-F-FM	765
BRT-01-05-005-F-FM	1,386	BRT-01-09-018-F-FM	-374	BRT-01-13-015-F-FM	1,080
BRT-01-05-006-F-FM	6,185	BRT-01-09-019-F-FM	-401	BRT-01-13-016-F-FM	1,350
BRT-01-05-007-F-FM	1,118	BRT-01-10-001-F-FM	2,386	BRT-01-13-017-F-FM	1,185
BRT-01-05-008-F-FM	1,386	BRT-01-10-002-F-FM	1,957	BRT-01-13-018-F-FM	1,118
BRT-01-05-009-F-FM	877	BRT-01-10-003-F-FM	2,279	BRT-01-13-019-F-FM	986
BRT-01-05-010-F-FM	636	BRT-01-10-004-F-FM	1,314	BRT-01-13-020-F-FM	1,035
BRT-01-05-011-F-FM	1,145	BRT-01-10-005-F-FM	1,850	BRT-01-13-021-F-FM	1,068
BRT-01-05-012-F-FM	1,306	BRT-01-10-006-F-FM	1,394	BRT-01-13-022-F-FM	1,085
BRT-01-05-013-F-FM	1,440	BRT-01-10-007-F-FM	1,448	BRT-01-13-023-F-FM	1,168
BRT-01-05-014-F-FM	1,145	BRT-01-10-008-F-FM	2,815	BRT-01-13-024-F-FM	1,566
BRT-01-05-015-F-FM	1,333	BRT-01-10-009-F-FM	1,769	BRT-01-13-025-F-FM	1,085
BRT-01-05-016-F-FM	1,467	BRT-01-10-010-F-FM	1,126	BRT-01-13-026-F-FM	1,085
BRT-01-05-017-F-FM	877	BRT-01-10-011-F-FM	1,314	BRT-01-13-027-F-FM	1,317
BRT-01-05-018-F-FM	1,413	BRT-01-10-012-F-FM	1,850	BRT-01-13-028-F-FM	1,400
BRT-01-06-001-F-FM	1,283	BRT-01-10-013-F-FM	2,225	BRT-01-13-029-F-FM	687
BRT-01-06-002-F-FM	2,516	BRT-01-10-014-F-FM	2,064	BRT-01-13-030-F-FM	1,616
BRT-01-06-003-F-FM	1,658	BRT-01-10-015-F-FM	1,635	BRT-01-13-031-F-FM	704
BRT-01-06-004-F-FM	1,632	BRT-01-10-016-F-FM	1,206	BRT-01-13-032-F-FM	2,005
BRT-01-06-005-F-FM	827	BRT-01-10-017-F-FM	1,421	BRT-01-13-033-F-FM	906
BRT-01-06-006-F-FM	2,141	BRT-01-1`0-018-F-FM	2,172	BRT-01-13-034-F-FM	1,845
BRT-01-06-007-F-FM	1,149	BRT-01-10-019-F-FM	2,198	BRT-01-13-035-F-FM	1,952
BRT-01-06-008-F-FM	2,838	BRT-01-10-020-F-FM	2,279	BRT-01-13-036-F-FM	1,550
BRT-01-06-009-F-FM	2,999	BRT-01-10-021-F-FM	1,528	BRT-01-13-037-F-FM	1,469
BRT-01-06-010-F-FM	1,471	BRT-01-10-022-F-FM	965	BRT-01-13-038-F-FM	1,576
BRT-01-06-011-F-FM	4,420	BRT-01-11-001-F-FM	1,884	BRT-01-13-039-F-FM	1,630
BRT-01-06-012-F-FM	2,221	BRT-01-11-002-F-FM	973	BRT-01-13-040-F-FM	2,676
BRT-01-06-013-F-FM	3,052	BRT-01-11-003-F-FM	1,992	BRT-01-13-041-F-FM	483
BRT-01-06-014-F-FM	1,176	BRT-01-11-004-F-FM	2,769	BRT-01-13-042-F-FM	417
BRT-01-06-015-F-FM	3,294	BRT-01-11-005-F-FM	1,965	BRT-01-13-043-F-FM	384
BRT-01-06-016-F-FM	1,122	BRT-01-11-006-F-FM	2,447	BRT-01-13-044-F-FM	845
BRT-01-06-017-F-FM	2,248	BRT-01-11-007-F-FM	3,359	BRT-01-13-045-F-FM	1,027
BRT-01-07-001-F-FM	2,708	BRT-01-11-008-F-FM	3,144	BRT-01-13-046-F-FM	894
BRT-01-07-002-F-FM	2,386				

A SPA-3 was used for scans of BRT-01-08, BRT-01-10, BRT-01-12, and BRT-01-13. ISOCS was used to scan the remainder of the Survey Units. The ISOCS scan data is summarized below. Scans of BRT-01-01, BRT-01-05, BRT-01-06, BRT-01-07, BRT-01-09, and BRT-01-10 resulted in investigations, as denoted in section 4.3.

Table 8 ISOCS Scan Summary

Sample Title	Unity	Sample Title	Unity	Sample Title	Unity
BRT-01-01-020-F-G	0.00	BRT-01-03-052-F-G	0.00	BRT-01-06-023-F-G	0.00
BRT-01-01-021-F-G	0.00	BRT-01-03-053-F-G	0.00	BRT-01-06-024-F-G	0.00
BRT-01-01-022-F-G	0.00	BRT-01-03-054-F-G	0.00	BRT-01-06-025-F-G	0.00
BRT-01-01-023-F-G	0.00	BRT-01-03-055-F-G	0.00	BRT-01-06-026-F-G	0.00
BRT-01-01-024-F-G	0.00	BRT-01-03-056-F-G	0.00	BRT-01-06-027-F-G	0.00
BRT-01-01-025-F-G	0.00	BRT-01-03-057-F-G	0.00	BRT-01-06-028-F-G	0.10
BRT-01-01-026-F-G	0.00	BRT-01-04-019-F-G	0.00	BRT-01-06-029-F-G	0.00
BRT-01-01-027-F-G	0.00	BRT-01-04-020-F-G	0.00	BRT-01-06-030-F-G	0.12
BRT-01-01-028-F-G	0.00	BRT-01-04-021-F-G	0.00	BRT-01-06-031-F-G	0.13
BRT-01-01-029-F-G	0.00	BRT-01-04-022-F-G	0.00	BRT-01-06-032-F-G	0.00
BRT-01-01-030-F-G	0.00	BRT-01-04-023-F-G	0.00	BRT-01-06-033-F-G	0.16
BRT-01-01-031-F-G	0.00	BRT-01-04-024-F-G	0.00	BRT-01-06-034-F-G	0.00
BRT-01-01-032-F-G	0.00	BRT-01-04-025-F-G	0.00	BRT-01-06-035-F-G	0.00
BRT-01-01-033-F-G	0.00	BRT-01-04-026-F-G	0.00	BRT-01-06-036-F-G	0.11
BRT-01-01-034-F-G	0.00	BRT-01-04-027-F-G	0.00	BRT-01-06-037-F-G	0.00
BRT-01-01-035-F-G	0.00	BRT-01-04-028-F-G	0.00	BRT-01-06-038-F-G	0.00
BRT-01-01-036-F-G	0.00	BRT-01-04-029-F-G	0.00	BRT-01-06-039-F-G	0.00
BRT-01-01-037-F-G	0.00	BRT-01-04-030-F-G	0.00	BRT-01-06-040-F-G	0.10
BRT-01-01-038-F-G	0.00	BRT-01-04-031-F-G	0.00	BRT-01-07-016-F-G	0.26
BRT-01-01-039-F-G	0.79	BRT-01-04-032-F-G	0.00	BRT-01-07-017-F-G	0.00
BRT-01-01-040-F-G	0.00	BRT-01-04-033-F-G	0.00	BRT-01-07-018-F-G	0.16
BRT-01-01-041-F-G	0.00	BRT-01-04-034-F-G	0.00	BRT-01-07-019-F-G	0.00
BRT-01-01-042-F-G	0.00	BRT-01-04-035-F-G	0.00	BRT-01-07-020-F-G	0.00
BRT-01-01-043-F-G	0.10	BRT-01-04-036-F-G	0.00	BRT-01-07-021-F-G	0.00
BRT-01-01-044-F-G	0.00	BRT-01-04-037-F-G	0.00	BRT-01-07-022-F-G	0.00
BRT-01-01-045-F-G	0.00	BRT-01-04-038-F-G	0.00	BRT-01-07-023-F-G	0.00
BRT-01-01-046-F-G	0.00	BRT-01-04-039-F-G	0.00	BRT-01-07-024-F-G	0.13
BRT-01-01-047-F-G	0.00	BRT-01-04-040-F-G	0.00	BRT-01-07-025-F-G	0.00
BRT-01-01-048-F-G	0.00	BRT-01-04-041-F-G	0.00	BRT-01-07-026-F-G	0.00
BRT-01-01-049-F-G	0.00	BRT-01-04-042-F-G	0.00	BRT-01-07-027-F-G	0.63
BRT-01-01-050-F-G	0.00	BRT-01-04-043-F-G	0.00	BRT-01-07-028-F-G	0.45
BRT-01-01-051-F-G	0.00	BRT-01-04-044-F-G	0.00	BRT-01-07-029-F-G	0.31
BRT-01-01-052-F-G	0.00	BRT-01-04-045-F-G	0.00	BRT-01-09-026-F-G	0.00
BRT-01-01-053-F-G	0.00	BRT-01-04-046-F-G	0.00	BRT-01-09-027-F-G	0.00
BRT-01-03-023-F-G	0.00	BRT-01-04-047-F-G	0.00	BRT-01-09-028-F-G	0.00
BRT-01-03-024-F-G	0.00	BRT-01-04-048-F-G	0.00	BRT-01-09-029-F-G	0.00
BRT-01-03-025-F-G	0.00	BRT-01-04-049-F-G	0.00	BRT-01-09-030-F-G	0.00
BRT-01-03-026-F-G	0.00	BRT-01-04-050-F-G	0.00	BRT-01-09-031-F-G	0.00
BRT-01-03-027-F-G	0.00	BRT-01-04-051-F-G	0.00	BRT-01-09-032-F-G	0.00
BRT-01-03-028-F-G	0.00	BRT-01-04-052-F-G	0.00	BRT-01-09-033-F-G	0.00

Sample Title	Unity	Sample Title	Unity	Sample Title	Unity
BRT-01-03-029-F-G	0.00	BRT-01-05-019-F-G	0.00	BRT-01-09-034-F-G	0.00
BRT-01-03-030-F-G	0.00	BRT-01-05-020-F-G	0.00	BRT-01-09-035-F-G	0.00
BRT-01-03-031-F-G	0.00	BRT-01-05-021-F-G	0.00	BRT-01-09-036-F-G	0.00
BRT-01-03-032-F-G	0.00	BRT-01-05-022-F-G	0.33	BRT-01-09-037-F-G	0.00
BRT-01-03-033-F-G	0.00	BRT-01-05-023-F-G	0.00	BRT-01-09-038-F-G	0.00
BRT-01-03-034-F-G	0.00	BRT-01-05-024-F-G	0.11	BRT-01-09-039-F-G	0.00
BRT-01-03-035-F-G	0.00	BRT-01-05-025-F-G	0.10	BRT-01-09-040-F-G	0.00
BRT-01-03-036-F-G	0.00	BRT-01-05-026-F-G	0.00	BRT-01-09-041-F-G	0.00
BRT-01-03-037-F-G	0.00	BRT-01-05-027-F-G	0.00	BRT-01-09-042-F-G	0.00
BRT-01-03-038-F-G	0.00	BRT-01-05-028-F-G	0.08	BRT-01-09-043-F-G	0.00
BRT-01-03-039-F-G	0.00	BRT-01-05-029-F-G	0.14	BRT-01-09-044-F-G	0.00
BRT-01-03-040-F-G	0.00	BRT-01-05-030-F-G	0.16	BRT-01-09-045-F-G	0.00
BRT-01-03-041-F-G	0.00	BRT-01-05-031-F-G	0.12	BRT-01-09-046-F-G	0.00
BRT-01-03-042-F-G	0.00	BRT-01-05-032-F-G	0.25	BRT-01-09-047-F-G	0.00
BRT-01-03-043-F-G	0.00	BRT-01-05-033-F-G	0.13	BRT-01-11-033-F-G	0.00
BRT-01-03-044-F-G	0.00	BRT-01-05-034-F-G	0.79	BRT-01-11-034-F-G	0.00
BRT-01-03-045-F-G	0.00	BRT-01-05-035-F-G	0.70	BRT-01-11-035-F-G	0.00
BRT-01-03-046-F-G	0.00	BRT-01-05-036-F-G	0.22	BRT-01-11-036-F-G	0.00
BRT-01-03-047-F-G	0.00	BRT-01-05-037-F-G	0.33	BRT-01-11-037-F-G	0.25
BRT-01-03-048-F-G	0.00	BRT-01-06-020-F-G	0.06	BRT-01-11-038-F-G	0.00
BRT-01-03-049-F-G	0.00	BRT-01-06-021-F-G	0.00	BRT-01-11-039-F-G	0.00
BRT-01-03-050-F-G	0.00	BRT-01-06-022-F-G	0.00	BRT-01-11-040-F-G	0.27
BRT-01-03-051-F-G	0.00				

5.5 Data Quality Assessment

The Data Quality Assessment phase is the part of the FSS where survey design and data are reviewed for completeness and consistency, ensuring the validity of the results, verifying that the survey plan objectives were met, and validating the classification of the Survey Unit.

The sample design and the data acquired were reviewed and found to be in accordance with applicable YNPS procedures DP-8861, "*Data Quality Assessment*"; DP-8856, "*Preparation of Survey Plans*"; DP-8853, "*Determination of the Number and Locations of FSS Samples and Measurements*"; DP-8857, "*Statistical Tests*"; DP-8865, "*Computer Determination of the Number of FSS Samples and Measurements*" and DP-8852, "*Final Status Survey Quality Assurance Project Plan*".

A preliminary data review was performed and statistical quantities were calculated. The post-FSS standard deviations in eight of the Units were greater than the standard deviations used for the planning process, however after reviewing the retrospective power curves, all of the Survey Units possessed sufficient power to pass the FSS. The data range for all but BRT-01-05, BRT-01-12 and BRT-01-13 were within three standard deviations. The above mentioned units (BRT-01-05, BRT-01-12 and BRT-01-13) had one data point each that was high (i.e. greater than three standard deviations but less than DCGLw) Frequency plots for all the units were reviewed and all displayed a normal distribution with the above Units skewed slightly high due to the slightly elevated data points. The scatter plots generated exhibit a normal dispersion about the respective mean. The data posting plots do not clearly reveal any systematic spatial trends. Review of the quantile plots indicates some asymmetry in the lower quartiles. The data sets verify the assumptions of the statistical test.

The Data Quality Assessment power curves, scatter, quantile and frequency plots are found in Attachment B. Posting Plots are found in Attachment A.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Instrument QC Checks

Operation of the E-600 w/SPA-3 was in accordance with DP-8535,"*Setup and Operation of the Eberline E-600 Digital Survey Instrument,*" with QC checks preformed in accordance with DP-8540, "*Operation and Source Checks of Portable Friskers.*" Instrument response checks were performed prior to and after use for the E-600 w/SPA-3. All instrumentation involved with the FSS of BRT-01 satisfied the above criteria for the survey. QC records are found in Attachment C.

6.2 Split Samples and Recounts

DP-8864,"*Split Sample Assessment for Final Status Survey*" deals strictly with soil samples and provides no criteria for fixed-point measurements therefore no measurement comparison were made.

6.3 Self-Assessments

No self-assessments were performed during the FSS of BRT-01.

7.0 CONCLUSION

The FSS of BRT-01 has been performed in accordance with YNPS LTP and applicable FSS procedures. Evaluation of the fixed-point data has shown none of the systematic fixed-point measurements exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_0) is rejected.

BRT-01 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, BRT-01 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mrem/yr, including that from groundwater. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mrem/yr limit will also be met.

List of Appendices

List of Attachments

(In the electronic version, every Table of Contents, Figures, Appendices and Attachments, as well as every mention of an Appendix or Attachment is a hyperlink to the actual location or document.)

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 01
Survey Unit Name: RSS Footprint – RSS Ring Foundation (Southeast)	
FSSP Number: YNPS-FSSP-BRT01-01-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Unit BRT01-01 consists of the southeast quadrant of the RSS ring foundation, which is a subsurface concrete structure located within the RSS footprint. The surface of the RSS ring foundation was exposed by remediation of radiological-contaminated and PCB-contaminated soil. The boundaries of the unit are formed by soil of Survey Area NOL-01 on the east and west sides of the unit, and by units BRT01-07 and BRT01-03 at the north and south, respectively. Survey Unit BRT01-01 includes the remnants of 2 RSS support columns and a pipe chase. The footprint area of the unit is approximately 1,061 ft^2 (99 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surfaces of Survey Unit BRT01-01 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Survey media: concrete

Types of measurements: Fixed-point measurements, beta scans, gamma scans, and ISOCS measurements.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the ring foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean detectable radioactivity from fixed-point measurements was 883 ± 727dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). A sample of concrete was collected from an area of the ring foundation where a cluster of 10 higher-than-the-average measurements was found. Gamma spectroscopy of that surface concrete sample did not identify any LTP-listed gamma-emitting nuclide; only naturally-occurring radioactivity was identified.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from the Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from the Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the ring foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the ring foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the ring foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.6 = 1.0E4 dpm/100cm^2

- for smooth concrete surface: 1.0E4 dpm/100cm^2 * 0.0603 c/d = 6.1E2 cpm/100cm^2
- for pitted/irregular surface: 1.0E4 dpm/100cm2 * 0.0373 c/d = 3.7E2 cpm/100cm^2.

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >6.1E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >3.7E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)

2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.0E3	Sb-125	5.6E3	Eu-152	2.1E3
Nb-94	1.5E3	Cs-134	1.6E3	Eu-154	1.9E3
Ag-108m	1.4E3	Cs-137	3.5E3	Eu-155	3.6E4

<u>Note</u>: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 8m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete.

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the unit, including the 2 concrete support columns.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected ambient background for the HP-100 range is 200 - 400 cpm.

Note: If the ambient background for the HP-100 exceeds 1000 cpm, notify the FSS Radiological Engineer before proceeding with the survey.

MDC(f$DCGL_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

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

<u>Define the boundaries of the survey</u>:

Boundaries of BRT01-01 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 is the survey unit footprint with an overlay of the random-start systematic grid. Grid points that fall outside the footprint are measurement locations on the vertical walls. Map 3 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. Also shown in Map 3 are the codes assigned to the ISOCS assays. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

4.0 <u>Develop a decision rule</u>:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

5.0 <u>Specify tolerable limits on decision errors</u>:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-01 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

6.0 *LBGR*: 6.3E3 dpm/100 $cm^2 \div 2$ = 3.2E3 dpm/100 cm^2

7.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the measurement points at the locations shown in the attached map.

   (a) If a measurement location is obstructed such that a measurement cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the north end, center, and south end of the survey unit.

   (b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Collect 19 fixed-point (1-min) measurements in accordance with DP-8534.

   (a) Designate the fixed-point measurements as BRT-01-01-001-F-FM through BRT-01-01-019-F-FM, corresponding to the grid locations 001 through 019 on Map 2.

   (b) Use the distances (from edge of survey unit footprint) shown on Map 2 to locate the fixed-point measurements on the vertical walls.

   (c) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect 34 ISOCS measurements (18 overhead assays and 16 assays of the side of the columns) in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

   (a) For the overhead assays: position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 3. The designations of the overhead measurements are of the top surfaces are BRT-01-01-020-F-G through BRT-01-01-037-F-G.

   (b) For the side assays: position the ISOCS at 1m from the face of each of the original sides of the support columns, angling the detector as necessary to keep it perpendicular to the area being surveyed. Move the ISOCS around the column, ensuring that the assays of all 8 sides are collected in sequence. Designate the 8 side assays from the north column as BRT-01-01-038-F-G through BRT-01-01-045-F-G, and designate the 8 side assays from the south column as BRT-01-01-046-F-G through BRT-01-01-053-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance.

9. The job hazards associated with this survey are addressed in the accompanying JHA for BRT-01-01.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans covering 100% of the accessible vertical wall surface:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the above background indication is reproducible and cannot be attributed to a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the highest reading observed during the scan,

(3) The designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-01-054-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) clearly mark the location of any fixed-point measurement collected during this level of investigation. The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Gamma scans on the irregular surfaces of the vertical walls and cracks in the concrete:

(a) Perform SPA-3 scans on the irregular surfaces and over cracks by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning with the survey instrument in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as describe in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing QA signature: ____________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________

(3) Date/time of commencement of SPA-3 measurement QA signature: ____________

(4) Date/time of commencement of ISOCS measurements QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) n Specify: ____________

Prepared by J. Buzzn Date 8-31-05
FSS Radiological Engineer

Reviewed by G. Hummer Date 8-31-05
FSS Radiological Engineer

Approved by D. C. Smith Date 9/1/05
FSS Project Manager

MDCR/MDC Table for Survey Unit BRT01-01

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.6
1000	2	239	0.9

detector = HP-100 (1-in efficiency factor)

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 03
Survey Unit Name: RSS Footprint – RSS Ring Foundation (Southwest)	
FSSP Number: YNPS-FSSP-BRT01-03-01 **(Rev 1 changes appear in 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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

During the implementation of revision 0 of this plan, it was observed that a portion of the top surface adjacent to the east column was not captured by ISOCS assay BRT-01-03-034-F-G. A decision was made in the field by the FSS Radiological Engineer to add an extra ISOCS assay location that ensured that the excluded surface area was assayed. FSS Field Technicians confirmed (through use of a tape measure) that the excluded area was captured within the field-of-view of the added ISOCS assay. Two other pre-marked ISOCS locations (BRT-01-03-028-F-G and BRT-01-03-030-F-G) would also have resulted in incomplete coverage of the top surface (the top surface near the inner ring wall was not within the field-of-view for the ISOCS assays). These locations were moved approximately 2 feet closer to the inner ring wall. FSS Field Technicians used a tape measure to confirm that new locations for those 2 ISOCS assays provided the desired coverage (100%) of the top surface area. The added location was designated as BRT-01-03-057-F-G. The designations for the 2 relocated ISOCS assays were not changed because the assays had not yet been collected.

Survey Unit BRT01-03 consists of the southeast quadrant of the RSS ring foundation, which is a subsurface concrete structure located within the RSS footprint. The surface of the RSS ring foundation was exposed by remediation of radiological-contaminated and PCB-contaminated soil. The soil in Survey Area NOL-06 forms the east and west boundaries of the unit, and Survey Units BRT01-04 and BRT01-01 form the north and south boundaries, respectively. Survey Unit includes the remnants of 2 RSS support columns. The surface area of Survey Unit BRT01-03 is approximately 1,050 ft^2 (98 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-03 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Survey media: concrete

Types of measurements: Fixed-point measurements, beta scans, gamma scans, and ISOCS measurements.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure) The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the ring foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean detectable radioactivity from fixed-point measurements was 883 ± 727dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). A sample of concrete was collected from an area of the ring foundation where a cluster of 10 higher-than-the-average measurements was found. Gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from the Operational RP turnover survey)

Standard deviation (σ) : 727 dpm/100cm^2 (from the Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the ring foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the ring foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the ring foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.6 = 1.0E4 dpm/100cm^2

- for smooth concrete surface: 1.0E4 dpm/100cm^2 * 0.0603 c/d = 6.1E2 cpm/100cm^2
- for pitted/irregular surface: 1.0E4 dpm/100cm2 * 0.0373 c/d = 3.7E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >6.1E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >3.7E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)
2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.0E3	Sb-125	5.6E3	Eu-152	2.1E3
Nb-94	1.5E3	Cs-134	1.6E3	Eu-154	1.9E3
Ag-108m	1.4E3	Cs-137	3.5E3	Eu-155	3.6E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 8m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete.

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the foundation and the top and sides of the 2 concrete support columns.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected ambient background for the HP-100 range is 100 - 400 cpm.

Note: If the ambient background for the HP-100 exceeds 1000 cpm, notify the FSS Radiological Engineer before proceeding with the survey.

MDC(f$DCGL_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8504. Pre- and post-use instrument QC checks will be performed. QC checks for the ISOCS will be in accordance with DP-8869 and DP-8871.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-03 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 is the survey unit footprint with an overlay of the random-start systematic grid. Grid points that fall outside the footprint are measurement locations on the vertical walls. Map 3 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.

(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-03 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None.

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the sampling points at the locations shown in the attached map.

   (a) If a measurement location is obstructed such that a sample cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the east end, center, and west end of the survey unit.

   (b) Record the background data on the attached Form 1(even if the measurements were logged).

4. Collect 22 fixed-point (1-min) measurements in accordance with DP-8534.

   (a) Designate the fixed-point measurements as BRT-01-03-001-F-FM through BRT-01-03-022-F-FM, corresponding to the grid location 001 through 022 on Map 2.

   (b) Use the distances (from edge of survey unit footprint) shown on Map 2 to locate the fixed-point measurements on the vertical walls.

   (c) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect 35 ISOCS measurements (19 overhead assays and 16 assays of the side of the columns) in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

   (a) For the overhead assays: position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 3. The designations of the overhead measurements are of the top surfaces are BRT-01-03-023-F-G through BRT-01-03-040-F-G**, and BRT-01-03-057-F-G**.

   (b) For the side assays: position the ISOCS at 1m from the face of each of the original sides of the support columns, angling the detector as necessary to keep it perpendicular to the area being surveyed. Move the ISOCS around the column, ensuring that the assays of all 8 sides are collected in sequence. Designate the 8 side assays from the east column as BRT-01-03-041-F-G through BRT-01-03-048-F-G, and designate the 8 side assays from the west column as BRT-01-03-049-F-G through BRT-01-03-056-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance.

9. The job hazards associated with this survey are addressed in the JHA for BRT-01-01.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans covering 100% of the accessible vertical wall surface:
   - (a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.
   - (b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.
   - (c) If the HP-100 scan investigation level is exceeded:
     - (1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,
     - (2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,
     - (3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-03-058-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurements were logged).
     - (4) clearly mark the location of any fixed-point measurement collected during this level of investigation. The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.
   - (d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Gamma scans on the irregular surfaces of the vertical walls and cracks in the concrete:
   - (a) Perform SPA-3 scans on the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.
   - (b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.
   - (c) If a SPA-3 reading exceeds the investigation level:
     - (1) confirm that the greater-than-investigation level reading is reproducible and cannot be attributed to a nearby source,
     - (2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record each investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.
   - (d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS

QA notification* point(s) (y/n) __y

(1) Date/time of initial pre-survey briefing ______ QA signature: ____________________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________________

(3) Date/time of commencement of SPA-3 measurement QA signature: ____________________

(4) Date/time of commencement of ISOCS measurements QA signature: ____________________

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) __n_____ Specify: ____________________

Prepared by J. Buxom Date 9-13-05
FSS Radiological Engineer

Reviewed by J. Hummer Date 9-13-05
FSS Radiological Engineer

Approved by DC Smith / [signature] Date 9/13/05
FSS Project Manager

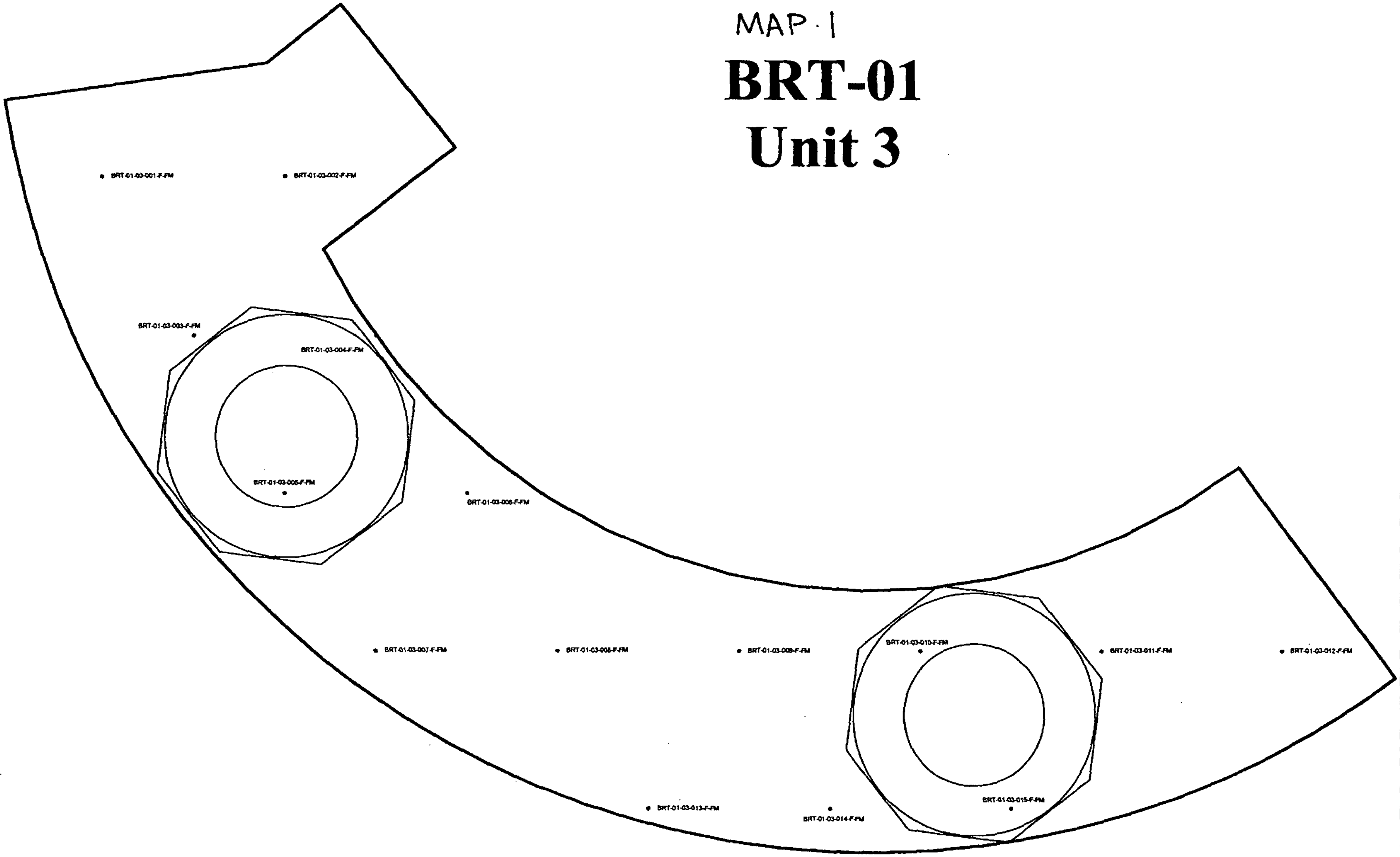
MDCR/MDC Table for Survey Unit BRT01-03

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.6
1000	2	239	0.9

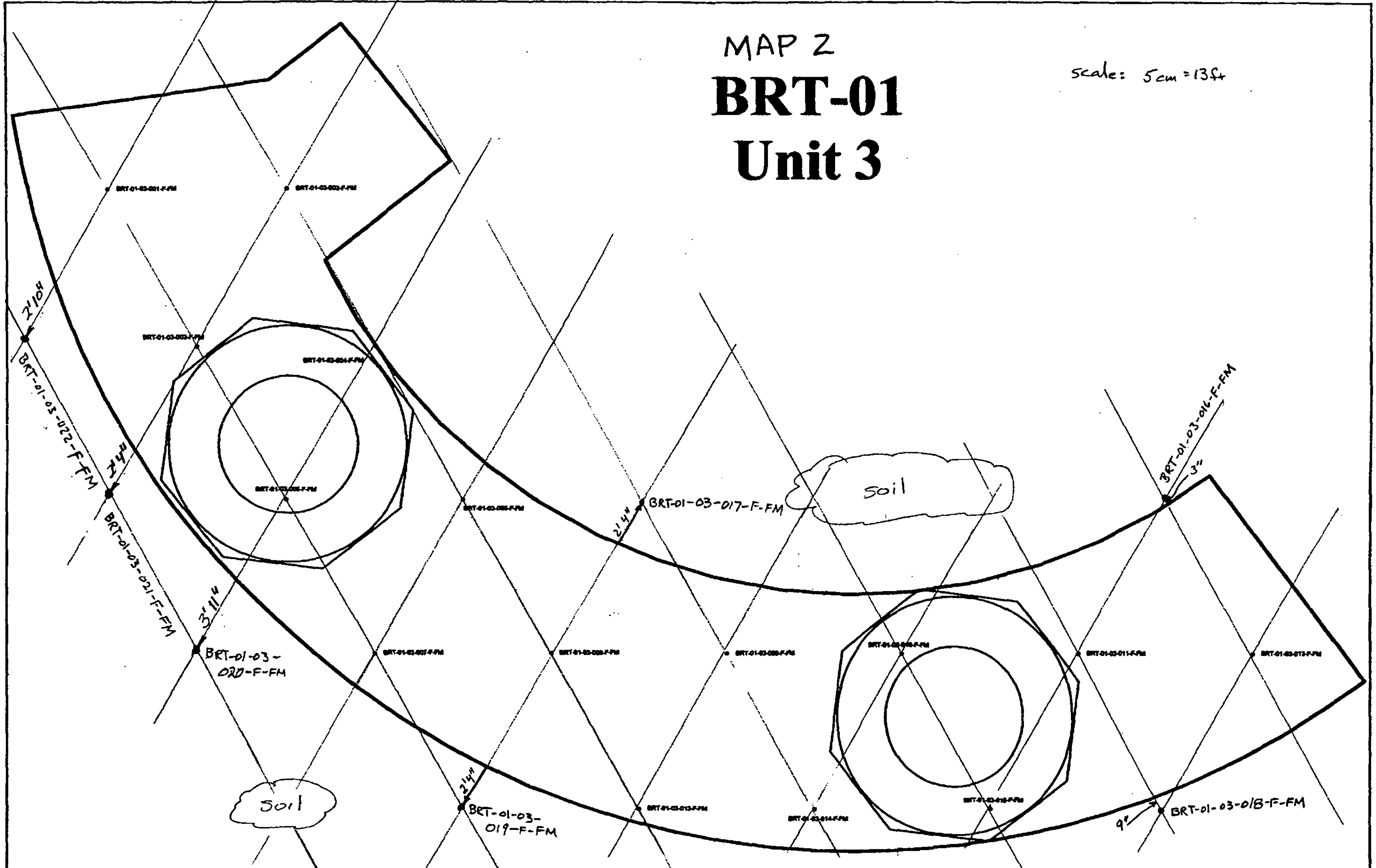
detector = HP-100 (1-in efficiency factor)

MAP·1

BRT-01
Unit 3



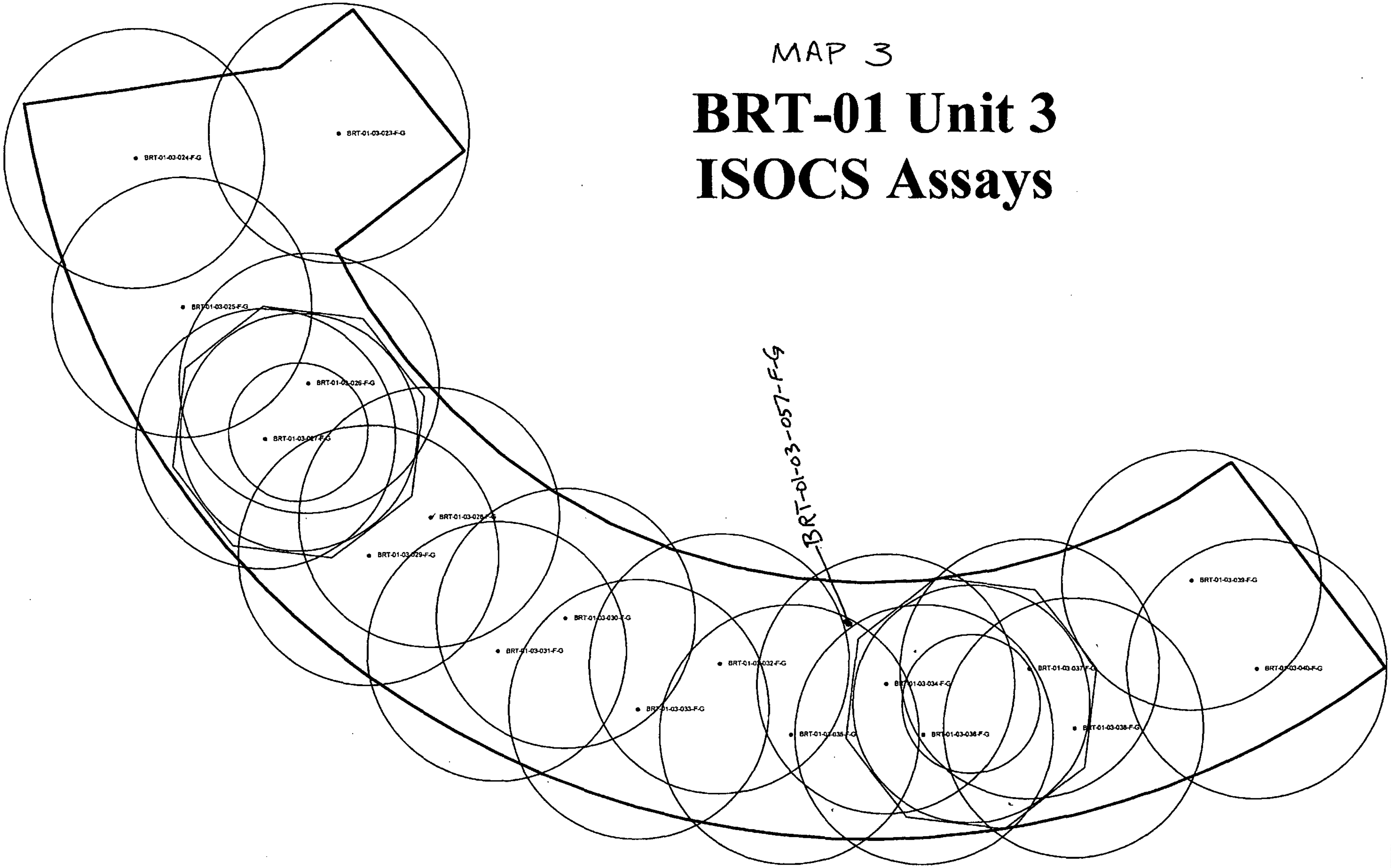
N Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 22, 2005	Survey Area & Unit: BRT-01-03 Grid Pattern: __ Square ✓ Triangular __N/A No. of Samples: Area size: 1,050 ft2 (98 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 8-29-05



Legend	Map current as of	Survey Area & Unit: BRT-01-03	Yankee Atomic Power Company	Reviewed by: JWB
~ = Survey Unit Boundary	August 22, 2005	Grid Pattern: __ Square __ Triangular __N/A	Sample Location Map	Date: 8-29-05
DPF-8865.1		No. of Samples:		
		Area size: 1,050 ft2 (98 m2)		

MAP 3

BRT-01 Unit 3 ISOCS Assays



Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 31, 2005	Survey Area & Unit: BRT-01-03 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 1,050 ft2 (98 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 8-31-05

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 04
Survey Unit Name: RSS Footprint –RSS Ring Foundation (Northwest)	
FSSP Number: YNPS-FSSP-BRT01-04-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Unit BRT01-04 consists of the southeast quadrant of the RSS ring foundation, which is a subsurface concrete structure located within the RSS footprint. The surface of the RSS ring foundation was exposed by remediation of radiological-contaminated and PCB-contaminated soil. Survey Areas NOL-01 and NOL-06 form the north and south boundaries with the unit, and units BRT01-03 and BRT01-07 form the west and east boundaries, respectively. Survey Unit includes the remnants of 2 RSS support columns. The surface area of Survey Unit BRT01-04 is approximately 813 ft^2 (75 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-04 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Survey media: concrete

Types of measurements: Fixed-point measurements, ISOCS assays, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the ring foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean net detectable radioactivity from the fixed-point measurements was 883 ± 727dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). A sample of concrete was collected from an area of the ring foundation where a cluster of 10 higher-than-the-average measurements was found. Gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the ring foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the ring foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the ring foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.9 = 1.2E4 dpm/100cm^2

- for smooth concrete surface: 1.2E4 dpm/100cm^2 * 0.0603 c/d = 7.2E2 cpm/100cm^2
- for pitted/irregular surface: 1.2E4 dpm/100cm2 * 0.0373 c/d = 4.5E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >7.2E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >4.5E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)
2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.2E3	Sb-125	6.6E3	Eu-152	2.5E3
Nb-94	1.7E3	Cs-134	1.9E3	Eu-154	2.3E3
Ag-108m	1.7E3	Cs-137	4.2E3	Eu-155	4.3E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 6m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete.

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the foundation and the top and sides of the 2 concrete support columns.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected ambient background for the HP-100 range is 100 - 400 cpm.

Note: If the ambient background for the HP-100 exceeds 1000cpm, notify the FSS Radiological Engineer before proceeding with the survey.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

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

4.0 Define the boundaries of the survey:

Boundaries of BRT01-04 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 is the survey unit footprint with an overlay of the random-start systematic grid. Grid points that fall outside the footprint are measurement locations on the vertical walls. Map 3 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-04 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None.

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2.Locate and mark the sampling points at the locations shown in the attached map.

(a) If a measurement location is obstructed such that a sample cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the east end, center, and west end of the survey unit.

(b) Record the background data on the attached Form 1 (even if the measurement was logged).

4. Collect 18 fixed-point (1-min) measurements in accordance with DP-8534.

(a) Designate the fixed-point measurements as BRT-01-04-001-F-FM through BRT-01-04-018-F-FM, corresponding to the grid locations 001 through 018 on Map 2.

(b) Use the distances (from edge of survey unit footprint) shown on Map 2 to locate the fixed-point measurements on the vertical walls.

(c) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect 34 ISOCS measurements (18 overhead assays and 16 assays of the side of the columns) in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

(a) For the overhead assays: position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 3. The designations of the overhead measurements are of the top surfaces are BRT-01-04-019-F-G through BRT-01-04-036-F-G.

(b) For the side assays: position the ISOCS at 1m from the face of each of the original sides of the support columns, angling the detector as necessary to keep it perpendicular to the area being surveyed. Move the ISOCS around the column, ensuring that the assays of all 8 sides are collected in sequence. Designate the 8 side assays from the east column as BRT-01-04-037-F-G through BRT-01-04-044-F-G, and designate the 8 side assays from the west column as BRT-01-04-045-F-G through BRT-01-04-052-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance

9. The job hazards associated with this survey are addressed in the JHA for BRT-01 concrete survey units.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans covering 100% of the accessible vertical wall surface:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) The designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-04-058-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged),

(4) clearly mark the location of any fixed-point measurement collected during this level of investigation. The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans around the perimeter of the support column remnants:

(a) Perform SPA-3 around the outer perimeter of the support column remnants by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing QA signature: ____________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________

(3) Date/time of commencement of SPA-3 measurement QA signature: ____________

(4) Date/time of commencement of ISOCS measurements QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankeerowe.com with a copy to Calsyn@yankeerowe.com satisfies this step.

FSI point(s) (y/n) n Specify: ____________

Prepared by J. Brown Date 9-6-05
FSS Radiological Engineer

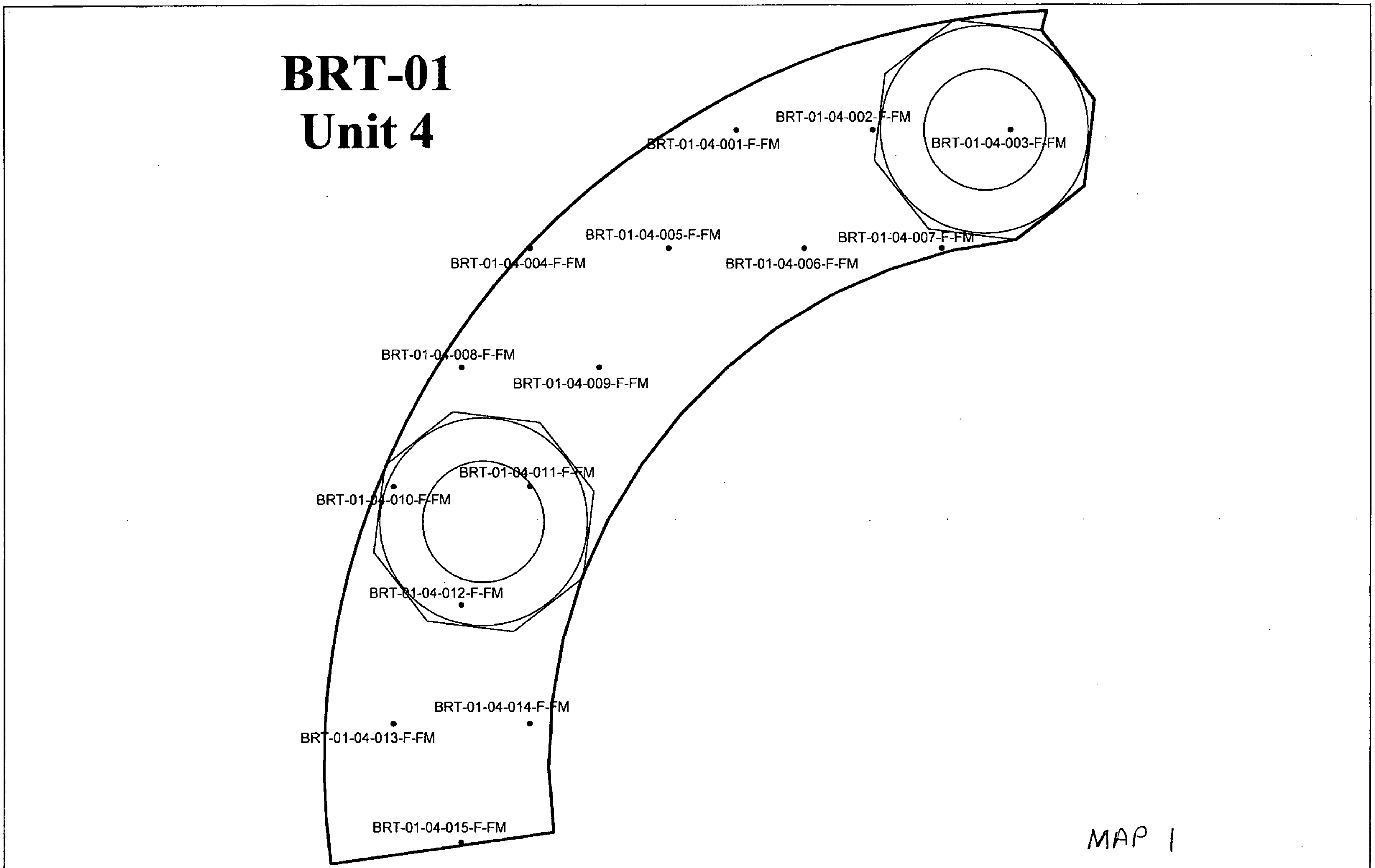
Reviewed by G. Hummer Date 9-6-05
FSS Radiological Engineer

Approved by D C Smith / D Smith Date 9/6/05
FSS Project Manager

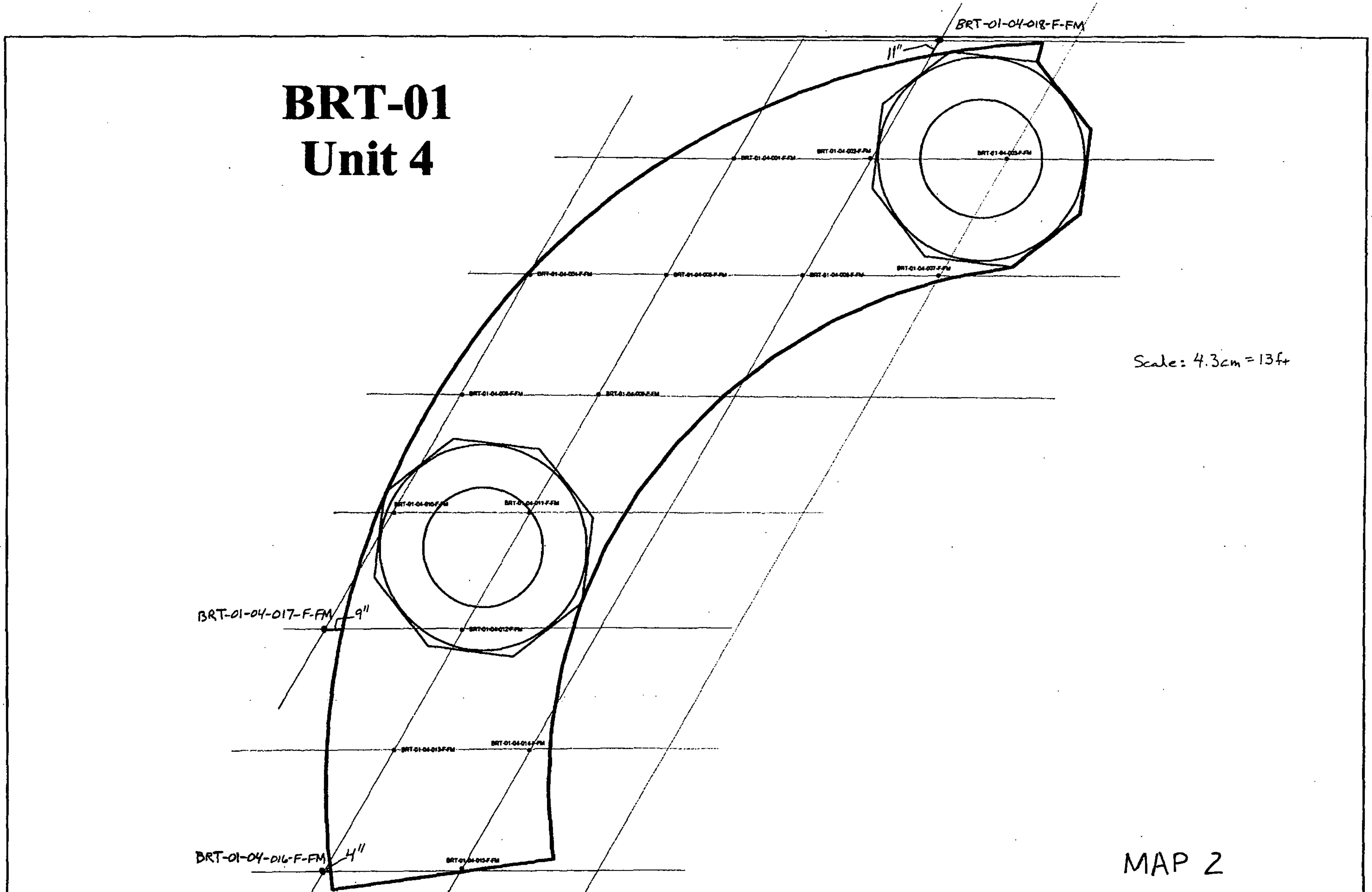
MDCR/MDC Table for Survey Unit BRT01-04

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

detector = HP-100 (1-in efficiency factor)



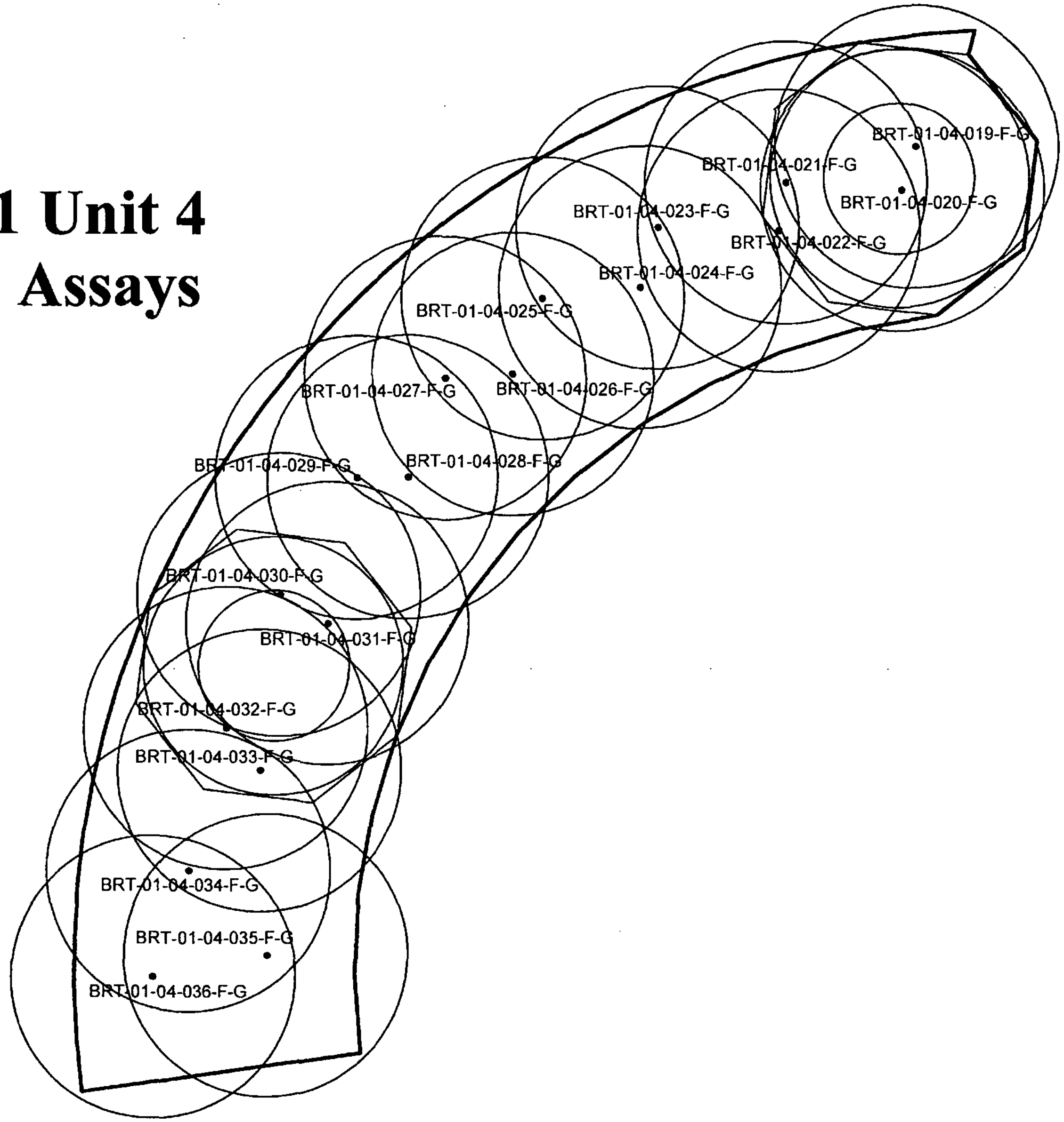
Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 22, 2005	Survey Area & Unit: BRT-01-04 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 814 ft2 (75 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-6-05



Legend	Map current as of	Survey Area & Unit: BRT-01-04	Yankee Atomic Power Company	Reviewed by: JWB
~ = Survey Unit Boundary	August 22, 2005	Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 814 ft2 (75 m2)	Sample Location Map	Date: 8-29-05
DPF-8865.1				

MAP 3

BRT-01 Unit 4
ISOCS Assays



Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 31, 2005	Survey Area & Unit: BRT-01-04 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 814 ft2 (75 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-6-05

BRT-01-04-GPS

1	272343.5877	3093568.5983
2	272351.5018	3093568.5983
3	272359.4160	3093568.5983
4	272331.7164	3093561.7444
5	272339.6306	3093561.7444
6	272347.5448	3093561.7444
7	272355.4589	3093561.7444
8	272327.7594	3093554.8905
9	272335.6735	3093554.8905
10	272323.8023	3093548.0367
11	272331.7164	3093548.0367
12	272327.7594	3093541.1828
13	272323.8023	3093534.3289
14	272331.7164	3093534.3289
15	272327.7594	3093527.4751
19	272358.7151	3093570.0645
20	272358.0702	3093568.0666
21	272352.6915	3093568.3944
22	272352.3636	3093566.1654
23	272346.7225	3093566.2965
24	272345.9354	3093563.5429
25	272341.4094	3093563.0184
26	272340.0099	3093559.5156
27	272336.8614	3093559.3190
28	272335.1559	3093554.7297
29	272332.7946	3093554.7297
30	272329.2525	3093549.2881
31	272331.4827	3093547.9768
32	272326.8159	3093543.0980
33	272328.3901	3093541.1312
34	272325.1104	3093536.4763
35	272328.7181	3093532.5426
36	272323.4706	3093531.5592

Form 1
Background Data

Survey Unit BRT01-04
Instrument No.: ___________

Location	Measurement No.	Measurement (cpm)
East end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
Center of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
West end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-04
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)
BRT-01-04-001-F-FM	
BRT-01-04-002-F-FM	
BRT-01-04-003-F-FM	
BRT-01-04-004-F-FM	
BRT-01-04-005-F-FM	
BRT-01-04-006-F-FM	
BRT-01-04-007-F-FM	
BRT-01-04-008-F-FM	
BRT-01-04-009-F-FM	
BRT-01-04-010-F-FM	
BRT-01-04-011-F-FM	
BRT-01-04-012-F-FM	
BRT-01-04-013-F-FM	
BRT-01-04-014-F-FM	
BRT-01-04-015-F-FM	
BRT-01-04-016-F-FM	
BRT-01-04-017-F-FM	
BRT-01-04-018-F-FM	

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 05
Survey Unit Name: RSS Footprint – RSS Mat Foundation (East Side)	
FSSP Number: YNPS-FSSP-BRT01-05-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Unit BRT01-05 consists of the east side of the RSS mat foundation, a concrete structure located at the center of the VC footprint. It is encompassed by the RSS ring foundation. The survey unit includes the remnant of a RSS support column. The west boundary is formed with unit BRT01-06, and by unit BRT01-05 to the northeast. The soil that is directly adjacent to the unit is part of Survey Area NOL-01. The surface area of Survey Unit BRT01-05 is approximately 745 ft^2 (69 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-05 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, gamma scans, and ISOCS measurements.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the mat foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements was 516±298 dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). FSS planning for the mat foundation used survey data from the ring foundation (883 ± 727 dpm/100cm2) because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test. The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ) : 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the mat foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.9 = 1.2E4 dpm/100cm^2

- for smooth concrete surface: 1.2E4 dpm/100cm^2 * 0.0603 c/d = 7.2E2 cpm/100cm^2
- for pitted/irregular surface: 1.2E4 dpm/100cm2 * 0.0373 c/d = 4.5E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >7.2E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >4.5E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)
2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.2E3	Sb-125	6.6E3	Eu-152	2.5E3
Nb-94	1.7E3	Cs-134	1.9E3	Eu-154	2.3E3
Ag-108m	1.7E3	Cs-137	4.2E3	Eu-155	4.3E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 6m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete.

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the foundation and the top and sides of the concrete support column.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC($fDCGL_{EMC}$) values by various background levels.

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

4.0 Define the boundaries of the survey:

Boundaries of BRT01-05 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 is the survey unit footprint with an overlay of the random-start systematic grid. Grid points that fall outside the footprint are measurement locations on the vertical walls. Map 3 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-05 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None.

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the sampling points at the locations shown in the attached map.

   (a) If a measurement location is obstructed such that a sample cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the north end, center, and south end of the survey unit.

   (b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Collect 18 systematic fixed-point measurements in accordance with DP-8534.

   (a) Designate the fixed-point measurement as BRT-01-05-001-F-FM through BRT-01-05-018-F-FM, corresponding to the grid location 001 through 018.

   (b) Use the distances (from edge of survey unit footprint) shown on Map 2 to locate the fixed-point measurements on the vertical walls.

   (c) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect 19 ISOCS measurements (11 overhead assays and 8 assays of the side of the columns) in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

   (a) For the overhead assays: position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 3. The designations of the overhead measurements are of the top surfaces are BRT-01-05-019-F-G through BRT-01-05-029-F-G.

   (b) For the side assays: position the ISOCS at 1m from the face of each of the original sides of the support column, angling the detector as necessary to keep it perpendicular to the area being surveyed. Move the ISOCS around the column, ensuring that the assays of all 8 sides are collected in sequence. Designate the 8 side assays from the column as BRT-01-05-030-F-G through BRT-01-05-037-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance

9. The job hazards associated with this survey are addressed in the JHA for BRT-01 concrete survey units.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans of the smooth concrete areas of the vertical walls:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) The designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-05-038-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged),

(4) clearly mark the location of any fixed-point measurement collected during this level of investigation. The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. SPA-3 scans around the perimeter of the support column remnants and over cracks in the concrete:

(a) Perform SPA-3 by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS

QA notification* point(s) (y/n) __y__

(1) Date/time of initial pre-survey briefing QA signature: ____________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________

(3) Date/time of commencement of SPA-3 measurement QA signature: ____________

(4) Date/time of commencement of ISOCS measurements QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankeerowe.com with a copy to Calsyn@yankeerowe.com satisfies this step.

FSI point(s) (y/n) __n__ Specify: ____________

Prepared by J. Buzzn Date 9-6-05
FSS Radiological Engineer

Reviewed by S. Hummer Date 9-6-05
FSS Radiological Engineer

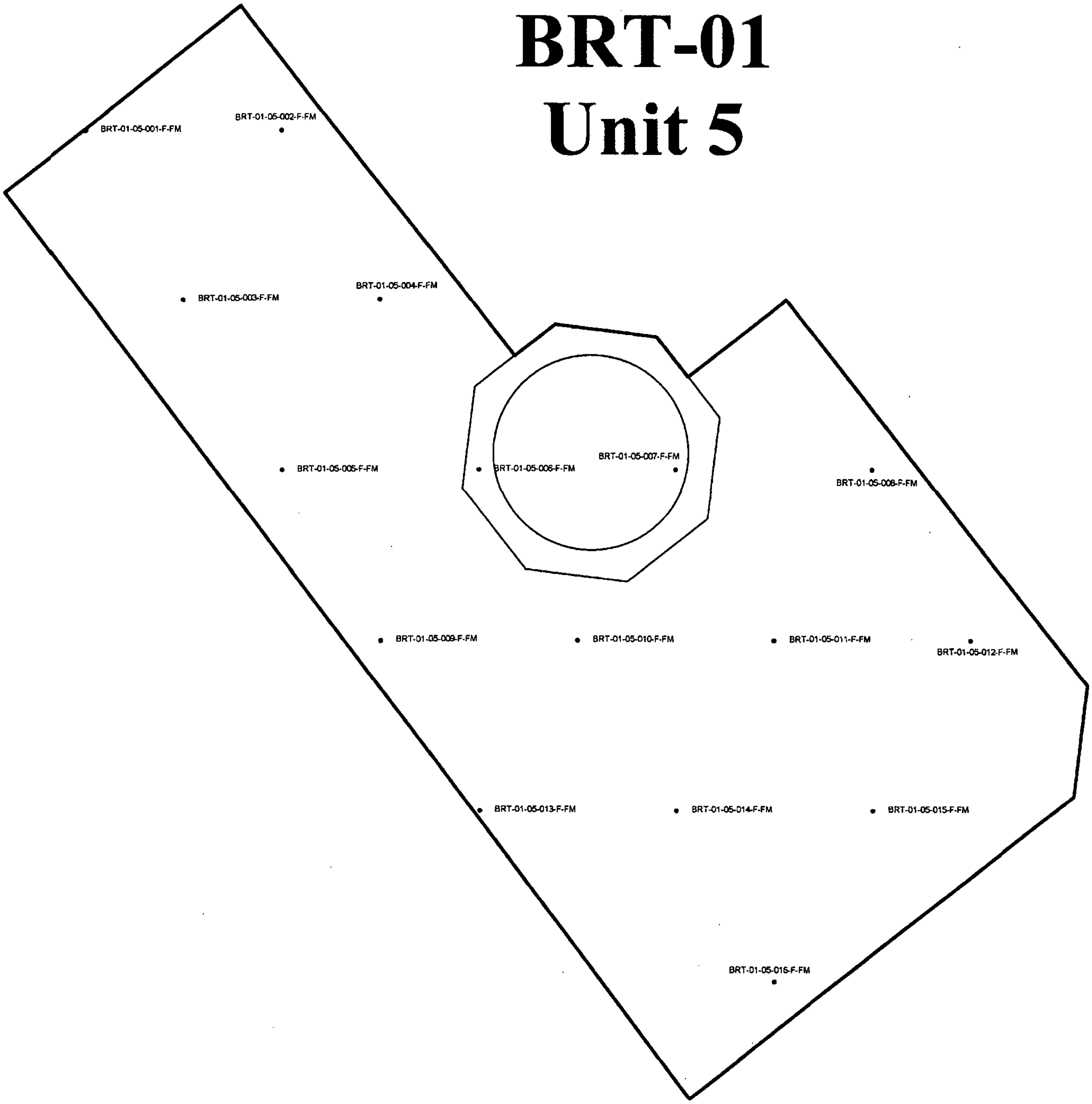
Approved by D.C. Smith Date 9/6/05
FSS Project Manager

MDCR/MDC Table for Survey Unit BRT01-05

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

detector = HP-100 (1-in efficiency factor)

BRT-01
Unit 5

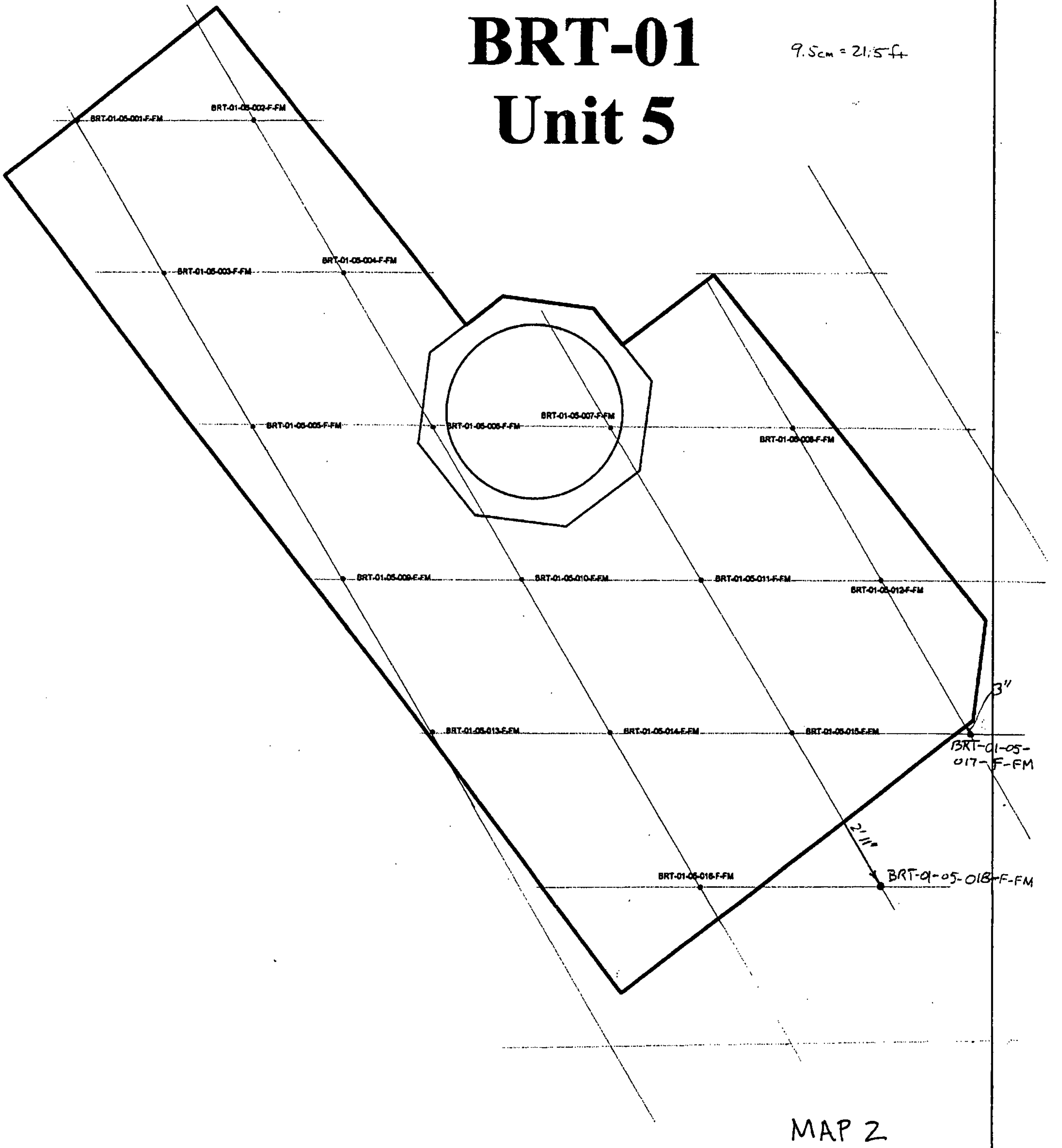


MAP 1

Legend ~ = Survey Unit Boundary DPF-8865.1	Map current as of August 22, 2005	Survey Area & Unit: BRT-01-05 Grid Pattern: __ Square ✓ Triangular __N/A No. of Samples: Area size: 745 ft2 (69 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 8-29-05

BRT-01 Unit 5

9.5cm = 21.5ft

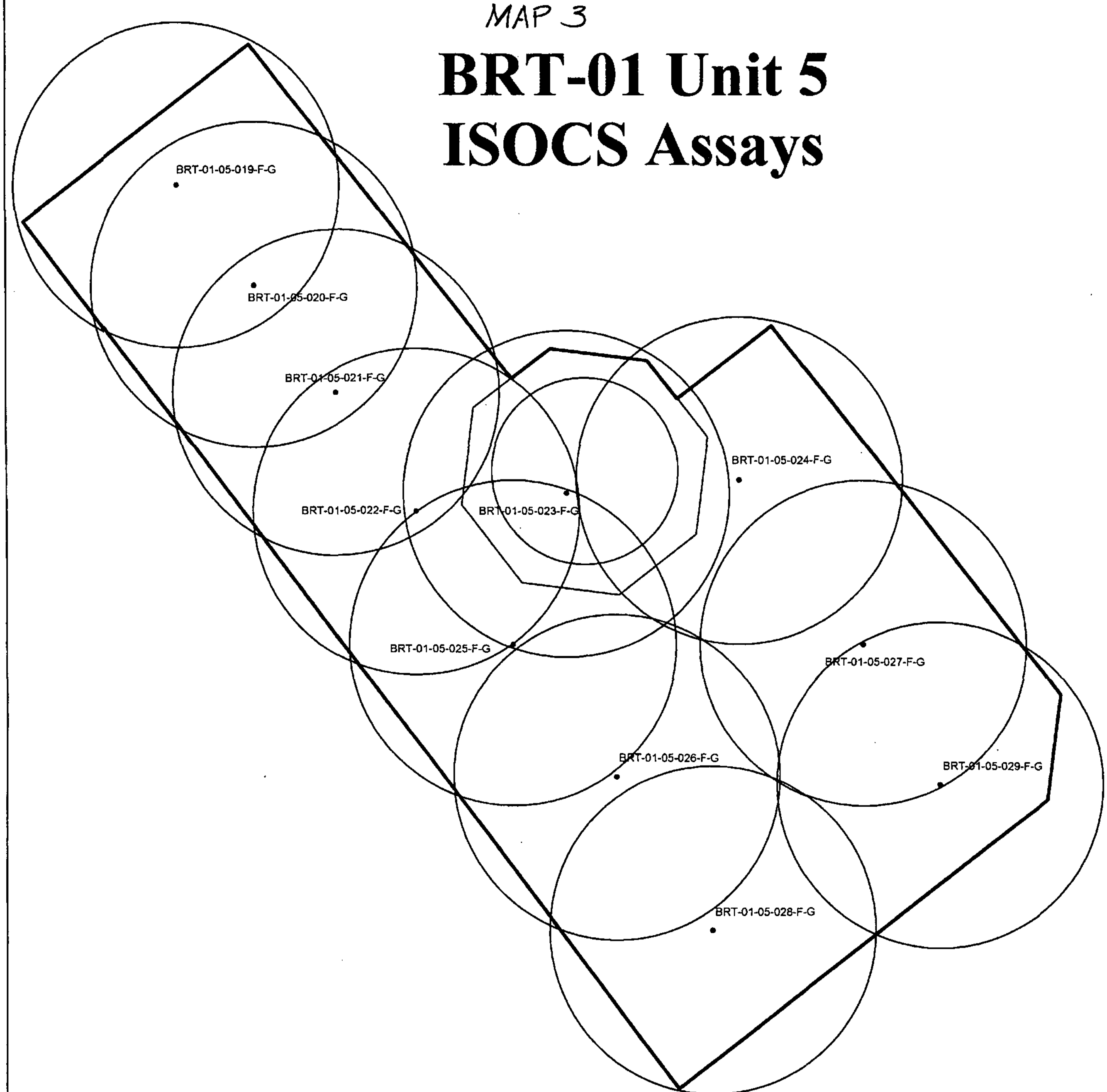


MAP 2

Legend	Map current as of	Survey Area & Unit: BRT-01-05	Yankee Atomic Power Company	Reviewed by: JWB
= Survey Unit Boundary		Grid Pattern: __ Square __ Triangular __N/A		
DPF-8865.1	August 22, 2005	No. of Samples:	Sample Location Map	Date: 8-29-05
		Area size: 745 ft2 (69 m2)		

MAP 3

BRT-01 Unit 5 ISOCS Assays



Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 31, 2005	Survey Area & Unit: BRT-01-05 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 745 ft2 (69 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-1-05

1	272353.0141	3093552.0402
2	272360.5848	3093552.0402
3	272356.7994	3093545.4838
4	272364.3701	3093545.4838
5	272360.5848	3093538.9274
6	272368.1555	3093538.9274
7	272375.7262	3093538.9274
8	272383.2969	3093538.9274
9	272364.3701	3093532.3710
10	272371.9408	3093532.3710
11	272379.5115	3093532.3710
12	272387.0822	3093532.3710
13	272368.1555	3093525.8145
14	272375.7262	3093525.8145
15	272383.2969	3093525.8145
16	272379.5115	3093519.2581
19	272356.0910	3093551.1221
20	272359.1934	3093547.0863
21	272362.4846	3093542.7507
22	272365.6891	3093537.9619
23	272371.7277	3093538.6825
24	272378.6782	3093539.2271
25	272369.5757	3093532.6369
26	272373.7216	3093527.2770
27	272383.6536	3093532.6348
28	272377.5771	3093521.1196
29	272386.7219	3093526.9757

Form 1
Background Data

Survey Unit BRT01-05
Instrument No.: ___________

Location	Measurement No.	Measurement (cpm)
North end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
Center of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
South end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-05
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)
BRT-01-05-001-F-FM	
BRT-01-05-002-F-FM	
BRT-01-05-003-F-FM	
BRT-01-05-004-F-FM	
BRT-01-05-005-F-FM	
BRT-01-05-006-F-FM	
BRT-01-05-007-F-FM	
BRT-01-05-008-F-FM	
BRT-01-05-009-F-FM	
BRT-01-05-010-F-FM	
BRT-01-05-011-F-FM	
BRT-01-05-012-F-FM	
BRT-01-05-013-F-FM	
BRT-01-05-014-F-FM	
BRT-01-05-015-F-FM	
BRT-01-05-016-F-FM	
BRT-01-05-017-F-FM	
BRT-01-05-018-F-FM	

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 06
Survey Unit Name: RSS Footprint – RSS Mat Foundation (West Side)	
FSSP Number: YNPS-FSSP-BRT01-06-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Unit BRT01-06 consists of the west side of the RSS mat foundation, a concrete structure located at the center of the VC footprint. It is encompassed by the RSS ring foundation. The east boundary is formed with unit BRT01-05, and the soil areas that are directly adjacent to the unit to the north, west, and south are part of Survey Area NOL-06. The surface area of Survey Unit BRT01-06 is approximately 930 ft^2 (86 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-06 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, gamma scans, and ISOCS measurements.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the mat foundation consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements was 516±298 dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). FSS planning for the mat foundation used survey data from the ring foundation (883 ± 727 dpm/100cm2) because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test. The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the mat foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.9 = 1.2E4 dpm/100cm^2

- for smooth concrete surface: 1.2E4 dpm/100cm^2 * 0.0603 c/d = 7.2E2 cpm/100cm^2
- for pitted/irregular surface: 1.2E4 dpm/100cm2 * 0.0373 c/d = 4.5E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >7.2E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >4.5E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)

2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.2E3	Sb-125	6.6E3	Eu-152	2.5E3
Nb-94	1.7E3	Cs-134	1.9E3	Eu-154	2.3E3
Ag-108m	1.7E3	Cs-137	4.2E3	Eu-155	4.3E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 6m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete.

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the foundation and the top and sides of the concrete support column.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

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

4.0 Define the boundaries of the survey:

Boundaries of BRT01-06 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 is the survey unit footprint with an overlay of the random-start systematic grid. Grid points that fall outside the footprint are measurement locations on the vertical walls. Map 3 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-06 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None.

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the sampling points at the locations shown in the attached maps.

   (a) If a measurement location is obstructed such that a sample cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the north end, center, and south end of the survey unit.

   (b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Collect 19 fixed-point (1-min) measurements in accordance with DP-8534.

   (a) Designate the fixed-point measurement as BRT-01-06-001-F-FM through BRT-01-06-019-F-FM, corresponding to the grid location 001 through 019.

   (b) Use the distances (from edge of survey unit footprint) shown on Map 2 to locate the fixed-point measurements on the vertical walls.

   (c) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect ~~19~~ 21 GWB 9/8/05 ISOCS measurements (1~~1~~ 3 GWB 9/8/05 overhead assays and 8 assays of the side of the column) in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

   (a) For the overhead assays: position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 3. The designations of the overhead measurements are of the top surfaces are BRT-01-06-020-F-G through BRT-01-06-032-F-G.

   (b) For the side assays: position the ISOCS at 1m from the face of each of the original sides of the support column, angling the detector as necessary to keep it perpendicular to the area being surveyed. Move the ISOCS around the column, ensuring that the assays of all 8 sides are collected in sequence. Designate the 8 side assays from the column as BRT-01-06-033-F-G through BRT-01-06-040-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance

9. The job hazards associated with this survey are addressed in the JHA for BRT-01 concrete survey units.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans covering 100% of the accessible vertical wall surface:

   (a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-06-041-F-FM-I.

(4) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans around the perimeter of the support column remnant and over cracks in the concrete:

(a) Perform SPA-3 by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing ______ QA signature: ______

(2) Date/time of commencement of HP-100 measurements QA signature: ______

(3) Date/time of commencement of SPA-3 measurement QA signature: ______

(4) Date/time of commencement of ISOCS measurements QA signature: ______

* Voice mail notification or E-mail notification to Trudeau@yankeerowe.com with a copy to Calsyn@yankeerowe.com satisfies this step.

FSI point(s) (y/n) n Specify: ______

Prepared by J. Bisson Date 9-6-05
FSS Radiological Engineer

Reviewed by G. Hummer Date 9-6-05
FSS Radiological Engineer

Approved by D.C. Smith/ [signature] Date 9-6-05
FSS Project Manager

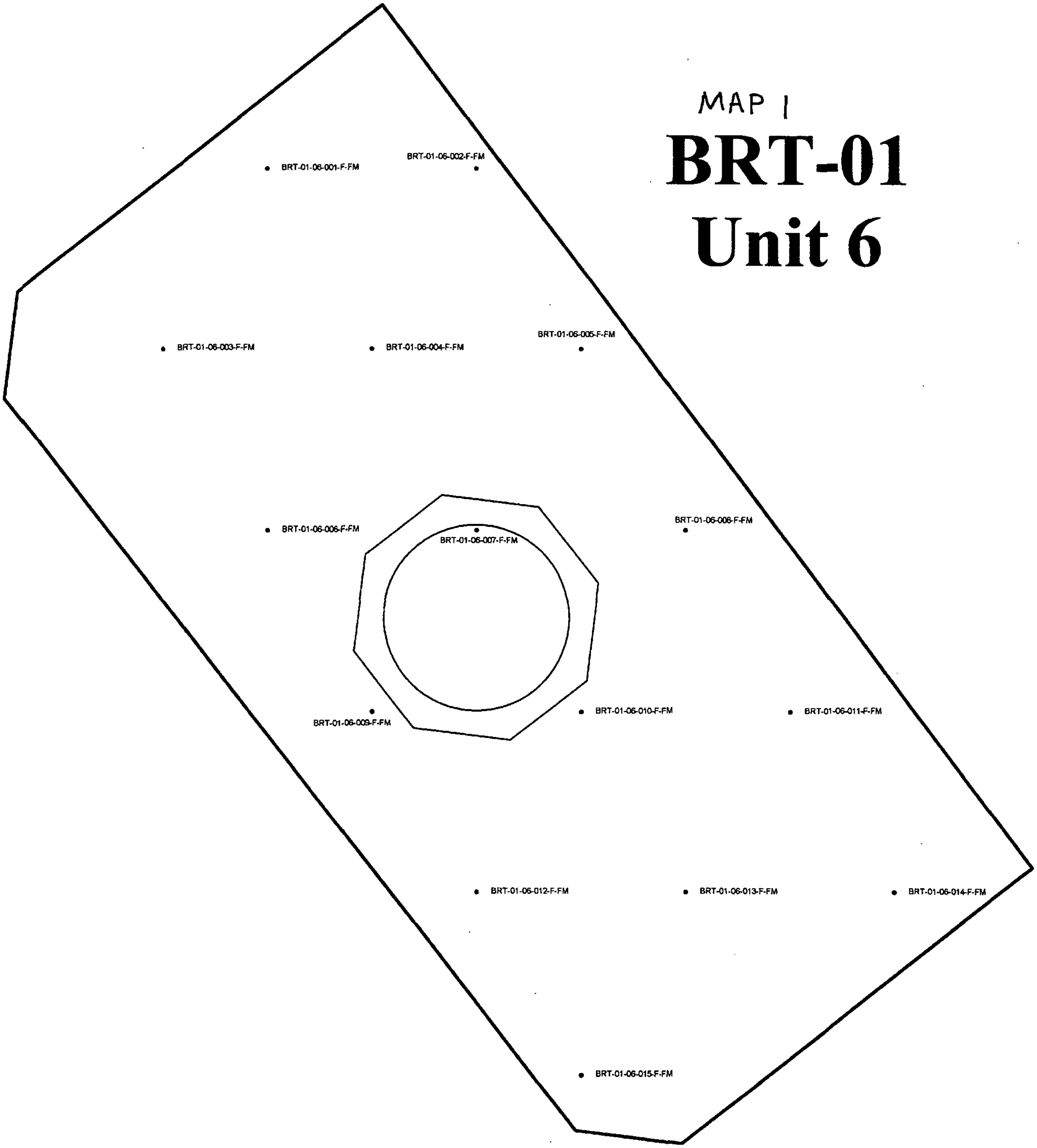
MDCR/MDC Table for Survey Unit BRT01-06

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

detector = HP-100 (1-in efficiency factor)

MAP 1

BRT-01
Unit 6

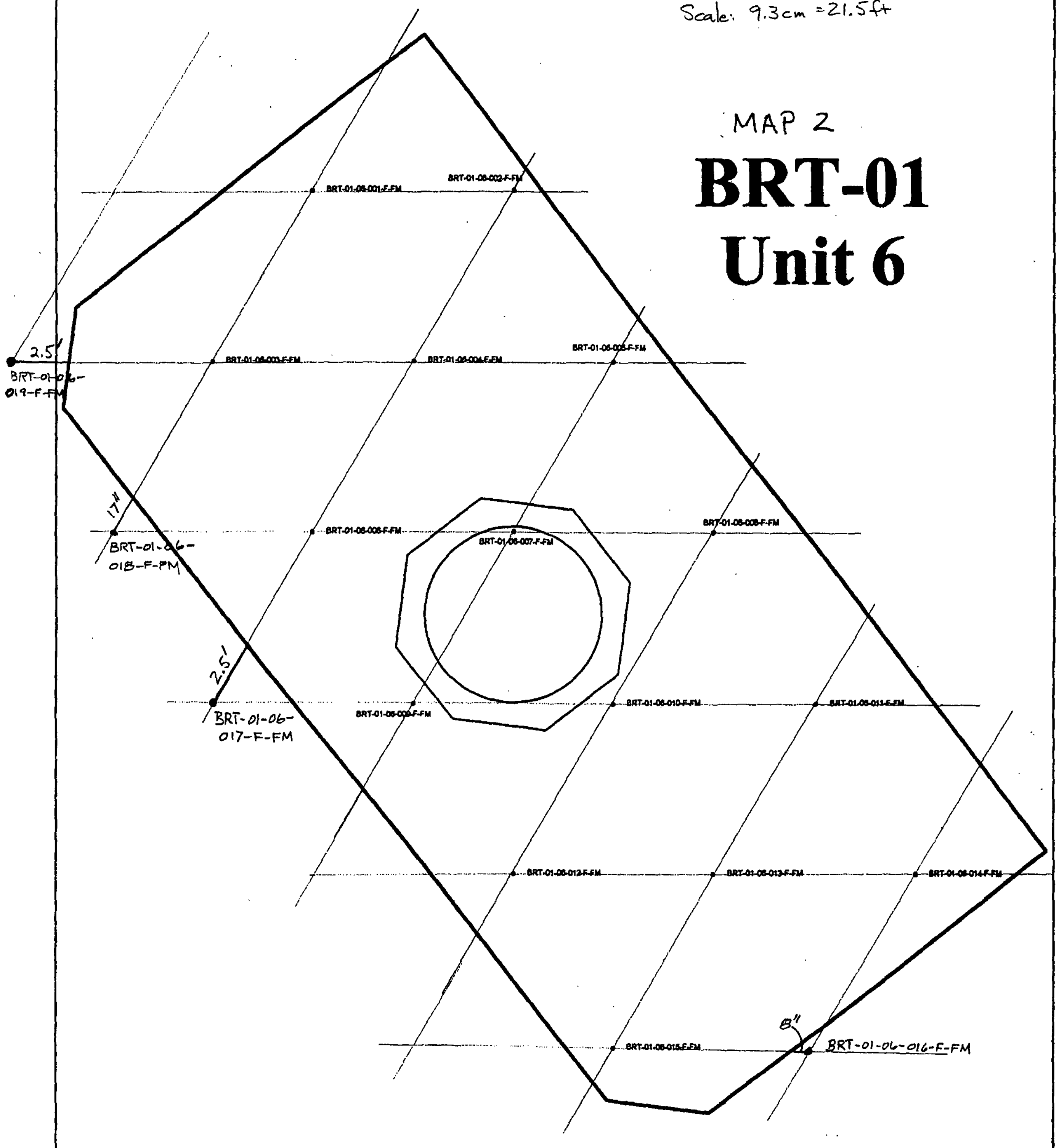


Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 22, 2005	Survey Area & Unit: BRT-01-06 Grid Pattern: __ Square ✓ Triangular __N/A No. of Samples: Area size: 930 ft2 (86 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9/2-05

Scale: 9.3cm = 21.5ft

MAP 2

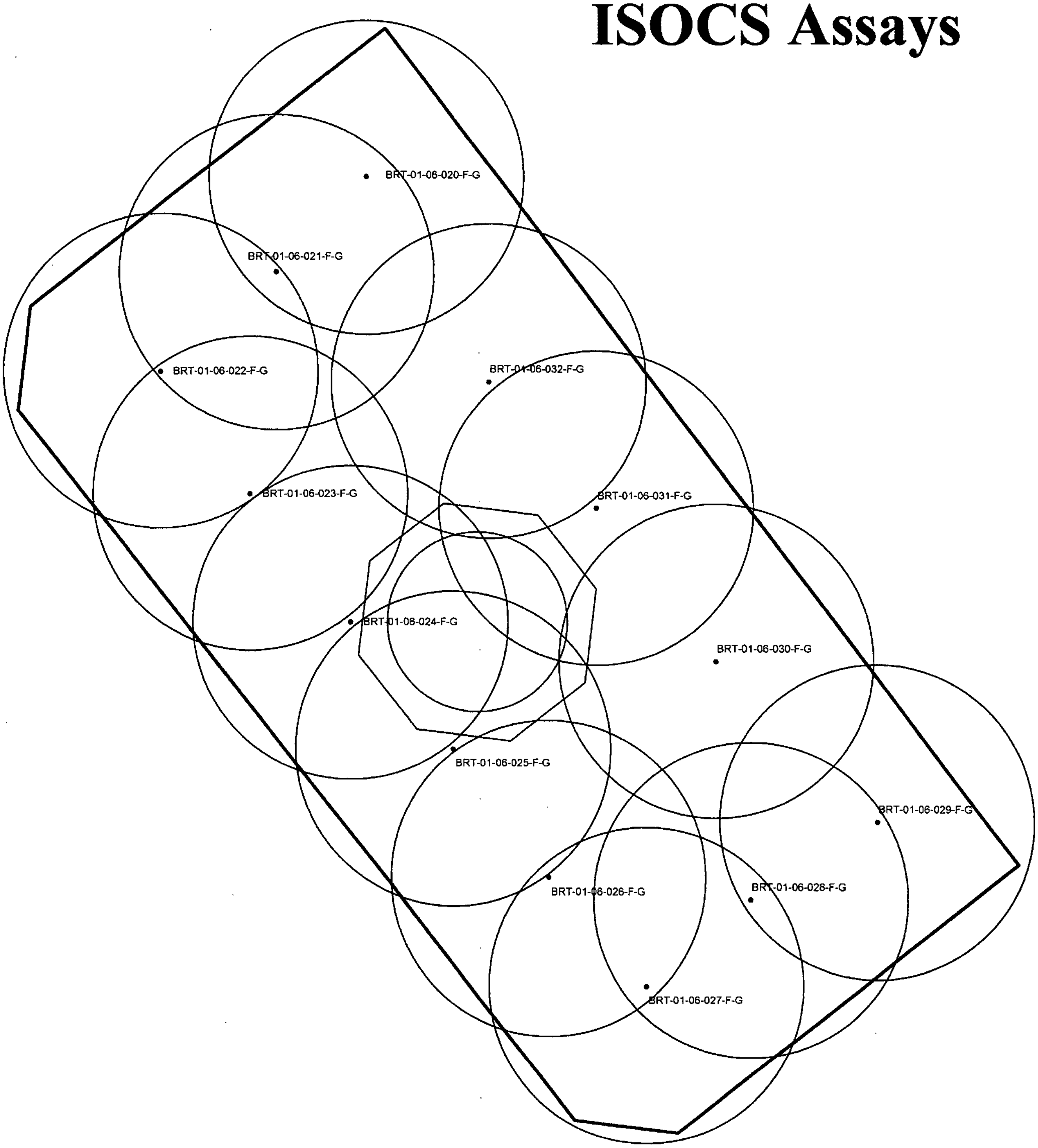
BRT-01
Unit 6



Legend	Map current as of	Survey Area & Unit: BRT-01-06	Yankee Atomic Power Company	Reviewed by: JWB
～ = Survey Unit Boundary		Grid Pattern: __ Square __ Triangular __N/A		
DPF-8865.1	August 22, 2005	No. of Samples:	Sample Location Map	Date: 9/2-05
		Area size: 930 ft2 (86 m2)		

MAP 3

BRT-01 Unit 6
ISOCS Assays



Legend = Survey Unit Boundary DPF-8865.1	Map current as of September 6, 2005	Survey Area & Unit: BRT-01-06 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 930 ft2 (86 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-6-05

BRT-01-06-GPS

1	272345.2392	3093543.0877
2	272353.7025	3093543.0877
3	272341.0076	3093535.7583
4	272349.4709	3093535.7583
5	272357.9341	3093535.7583
6	272345.2392	3093528.4289
7	272353.7025	3093528.4289
8	272362.1657	3093528.4289
9	272349.4709	3093521.0995
10	272357.9341	3093521.0995
11	272366.3974	3093521.0995
12	272353.7025	3093513.7701
13	272362.1657	3093513.7701
14	272370.6290	3093513.7701
15	272357.9341	3093506.4407
20	272349.1067	3093543.4644
21	272345.3486	3093539.5052
22	272340.5136	3093535.3799
23	272344.2313	3093530.2671
24	272348.3957	3093524.8867
25	272352.6617	3093519.6078
26	272356.6229	3093514.2274
27	272360.6858	3093509.7606
28	272365.0533	3093513.3137
29	272370.3350	3093516.5623
30	272363.6313	3093523.2624
31	272358.6544	3093529.6580
32	272354.1852	3093534.9369

Form 1
Background Data

Survey Unit BRT01-06
Instrument No.: ___________

Location	Measurement No.	Measurement (cpm)
North end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
Center of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
South end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-06
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)
BRT-01-06-001-F-FM	
BRT-01-06-002-F-FM	
BRT-01-06-003-F-FM	
BRT-01-06-004-F-FM	
BRT-01-06-005-F-FM	
BRT-01-06-006-F-FM	
BRT-01-06-007-F-FM	
BRT-01-06-008-F-FM	
BRT-01-06-009-F-FM	
BRT-01-06-010-F-FM	
BRT-01-06-011-F-FM	
BRT-01-06-012-F-FM	
BRT-01-06-013-F-FM	
BRT-01-06-014-F-FM	
BRT-01-06-015-F-FM	
BRT-01-06-016-F-FM	
BRT-01-06-017-F-FM	
BRT-01-06-018-F-FM	
BRT-01-06-019-F-FM	

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 07
Survey Unit Name: RSS Footprint – Northeast (Philley) Concrete Slab	
FSSP Number: YNPS-FSSP-BRT01-07-01 **(Rev 1 changes are in 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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Unit BRT01-07 consists of a relatively new 8-inch thick concrete pad (AKA the Philley slab) that was poured when the reactor pressure vessel was removed. It overlies the NE corner of the mat foundation and part of the NE quadrant of the RSS ring foundation, making both of those areas inaccessible for FSS. The surface area of Survey Unit BRT01-07 is approximately 1020 ft^2 (95 m^2). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-07 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover survey supports this assumption for this survey unit.

The operational RP turnover survey of the concrete surface of the northeast slab consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements was 329±151 dpm/100cm^2, which is significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). FSS planning for the northeast slab used survey data from the ring foundation (883 ± 727 dpm/100cm2) because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test. The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The top surfaces of the ring foundation and parts of the support column remains contain pits and irregular surfaces, which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. Most of the pits and irregularities increase the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the top surface of the ring foundation and the irregular surfaces of the support column because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the top surfaces, the vertical walls of the ring foundation and parts of the support columns are relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces, such as the vertical walls of the ring foundation and parts of the vertical side of the support columns. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.6 = 1.0E4 dpm/100cm^2

- for smooth concrete surface: 1.0E4 dpm/100cm^2 * 0.0603 c/d = 6.1E2 cpm/100cm^2
- for pitted/irregular surface: 1.0E4 dpm/100cm2 * 0.0373 c/d = 3.7E2 cpm/100cm^2.

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >6.1E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >3.7E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m (side) assays: 1.7E4 dpm/100cm^2 (Co-60)

2m (overhead) assays: 2.91E3 dpm/100cm^2 (Co-60)

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (12.6m^2 for overhead assays and 3.14m^2 for side assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.0E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.0E3	Sb-125	5.6E3	Eu-152	2.1E3
Nb-94	1.5E3	Cs-134	1.6E3	Eu-154	1.9E3
Ag-108m	1.4E3	Cs-137	3.5E3	Eu-155	3.6E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 8m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: 100% of the accessible concrete surface area on the vertical walls. Beta scans using the HP-100 on smooth areas of the vertical walls and SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete. **SPA-3 scans along the east boundary at the end of solid concrete. Note: fall protection will be required for these scans.**

ISOCS measurements: ISOCS measurements providing 100% coverage of the top surface of the concrete slab.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected ambient background for the HP-100 range is 200 - 400 cpm.

Note: If the ambient background for the HP-100 exceeds 1000 cpm, notify the FSS Radiological Engineer before proceeding with the survey.

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

4.0 Define the boundaries of the survey:

Boundaries of BRT01-07 are as shown on the attached maps. Map 1 shows the footprint of the survey unit with the fixed-point locations on the top surface. Map 2 shows the overlapping fields of view for the ISOCS assays to assure 100% coverage of the top surface. Also shown in Map 2 are the codes assigned to the ISOCS assays. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-07 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: **3 samples of the gravel/soil (beyond the solid concrete along the east boundary).**

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the sampling points at the locations shown in the attached map.

   (a) If a measurement location is obstructed such that a sample cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface at the north end, center, and south end of the survey unit.

   (b) Record the background data on the attached Form 1(even if the measurement was logged

4. Collect 15 systematic fixed-point measurements in accordance with DP-8534.

   (a) Designate the fixed-point measurements as BRT-01-07-001-F-FM through BRT-01-07-015-F-FM, corresponding to the grid locations 001 through 015 on Map 1.

   (b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

4a. Collect 3 samples of gravel/soil at the locations indicated on map 1. Designate these 3 samples as BRT-01-07-030-F-B, BRT-01-07-031-F-B, and BRT-01-07-032-F-B.

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Collect 14 ISOCS measurements in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

   (a) Position the ISOCS at 2m directly above (and perpendicular to) the assay center point (the center of the field of view for the ISOCS assay). Each ISOCS assay has been assigned a measurement code, which appears at the center of the fields of view shown in Map 2. The designations of the ISOCS measurements are BRT-01-07-016-F-G through BRT-01-07-029-F-G.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan.

7. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

8. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance.

9. The job hazards associated with this survey are addressed in the JHA for BRT-01 concrete survey units.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans on smooth concrete areas of the vertical walls:

   (a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

   (b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

   (c) If the HP-100 scan investigation level is exceeded:

      (1) confirm that the above background indication is reproducible and cannot be attributed to a nearby source,

      (2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the highest

reading observed during the scan,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-07-030-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) clearly mark the location of any fixed-point measurement collected during this level of investigation. The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Gamma scans on the irregular surfaces of the vertical walls, cracks in the concrete**, and along the east boundary beyond the solid concrete**:

(a) Perform SPA-3 scans on the irregular surfaces and over cracks by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning with the survey instrument in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

3. The 3 gravel/soil samples will be received and prepared in accordance with DP-8813, and analyzed by onsite chemistry using the standard FSS protocol per DP-8813.

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

((1) Date/time of initial pre-survey briefing — QA signature: ____________

(2) Date/time of commencement of HP-100 measurements — QA signature: ____________

(3) Date/time of commencement of SPA-3 measurement — QA signature: ____________

(4) Date/time of commencement of ISOCS measurements — QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankeerowe.com with a copy to Calsyn@yankeerowe.com satisfies this step.

FSI point(s) (y/n) n Specify: ____________

Prepared by J. Bisson — Date 9-8-05
FSS Radiological Engineer

Reviewed by G. Hummer — Date 9-8-05
FSS Radiological Engineer

Approved by D.C. Smith — Date 9/8/05
FSS Project Manager

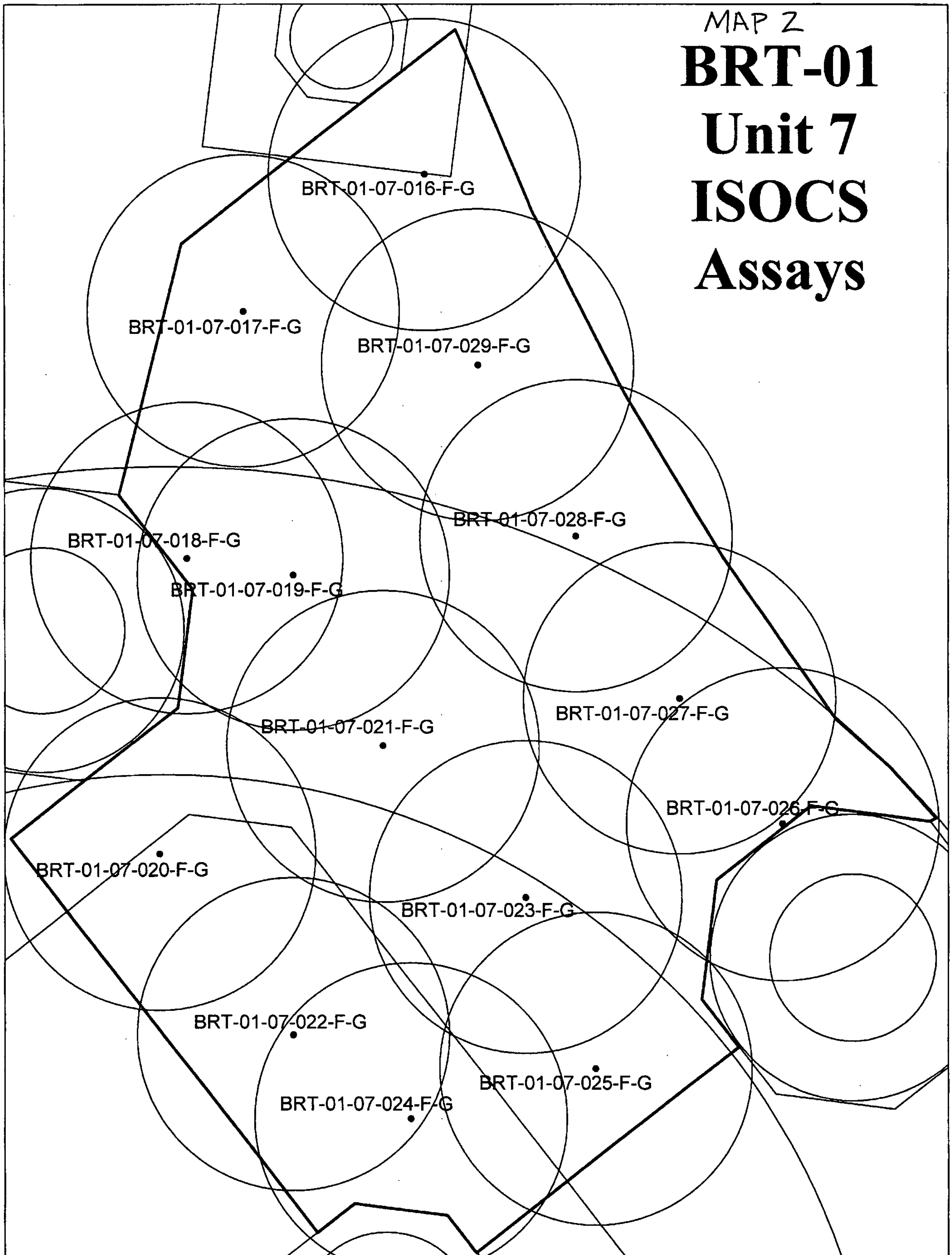
MDCR/MDC Table for Survey Unit BRT01-07

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

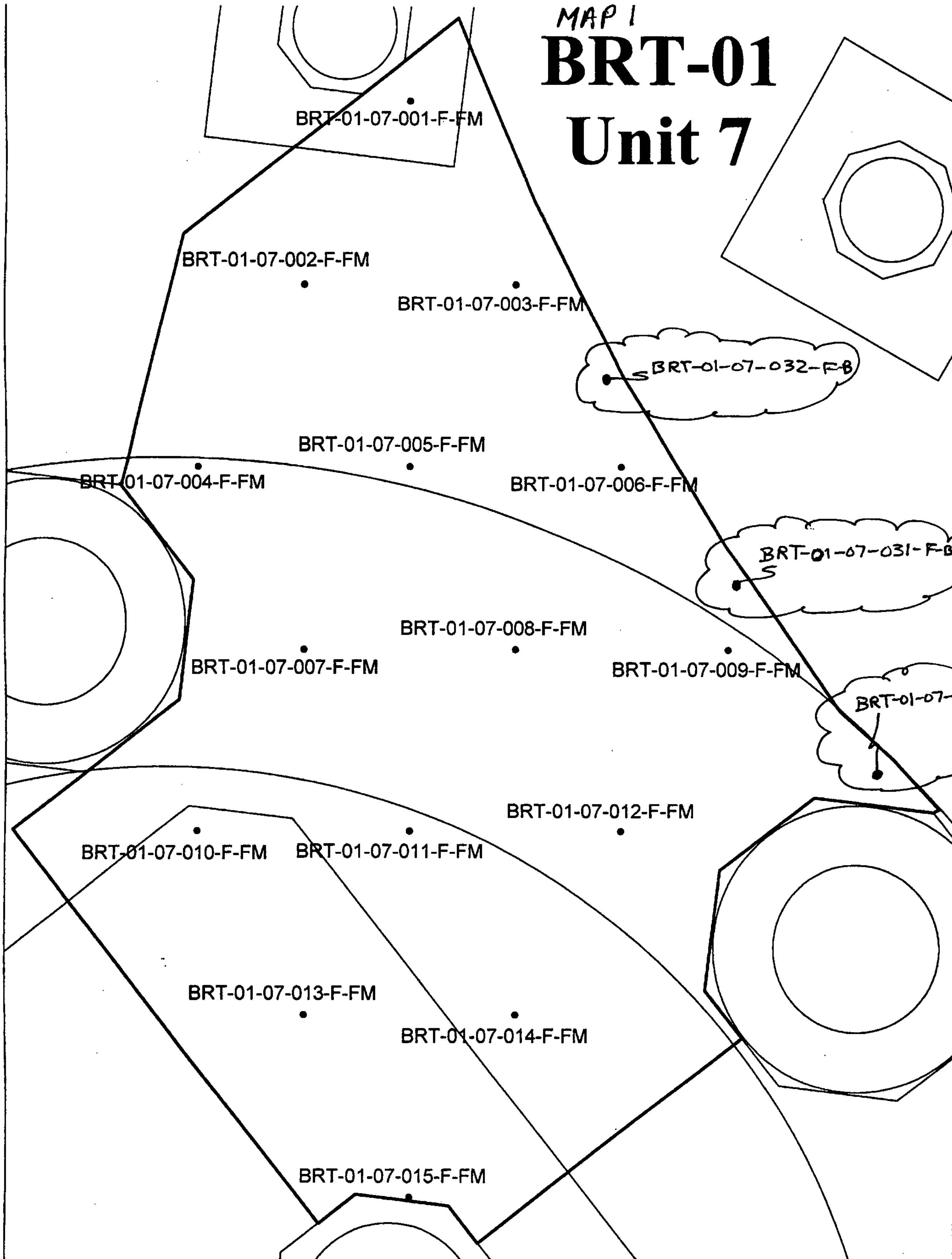
detector = HP-100 (1-in efficiency factor)

MAP 2

BRT-01 Unit 7 ISOCS Assays



Legend = Survey Unit Boundary DPF-8865.1	Map current as of September 8, 2005	Survey Area & Unit: BRT-01-07 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 1,020 ft2 (95 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-8-05



Legend = Survey Unit Boundary DPF-8865.1	Map current as of August 22, 2005	Survey Area & Unit: BRT-01-07 Grid Pattern: __ Square ✓ Triangular __N/A No. of Samples: Area size: 1,020 ft2 (95 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-6-05

BRT-01-07-GPS

1	272373.3348	3093590.4500
2	272368.9036	3093582.7750
3	272377.7660	3093582.7750
4	272364.4724	3093575.0999
5	272373.3348	3093575.0999
6	272382.1972	3093575.0999
7	272368.9036	3093567.4249
8	272377.7660	3093567.4249
9	272386.6284	3093567.4249
10	272364.4724	3093559.7498
11	272373.3348	3093559.7498
12	272382.1972	3093559.7498
13	272368.9036	3093552.0748
14	272377.7660	3093552.0748
15	272373.3348	3093544.3997
16	272374.0534	3093587.7596
17	272366.4331	3093582.0221
18	272364.0552	3093571.6284
19	272368.5250	3093570.9219
20	272362.9043	3093559.1795
21	272372.2953	3093563.7201
22	272368.5250	3093551.6117
23	272378.2880	3093557.3812
24	272373.4653	3093548.0793
25	272381.2286	3093550.1987
26	272389.0835	3093560.4710
27	272384.7574	3093565.7411
28	272380.4053	3093572.5704
29	272376.2883	3093579.7529

Form 1
Background Data

Survey Unit BRT01-07
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
North end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
Center of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
South end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-07
Instrument No.: ___________

Location	Measurement (cpm/100cm²)
BRT-01-07-001-F-FM	
BRT-01-07-002-F-FM	
BRT-01-07-003-F-FM	
BRT-01-07-004-F-FM	
BRT-01-07-005-F-FM	
BRT-01-07-006-F-FM	
BRT-01-07-007-F-FM	
BRT-01-07-008-F-FM	
BRT-01-07-009-F-FM	
BRT-01-07-010-F-FM	
BRT-01-07-011-F-FM	
BRT-01-07-012-F-FM	
BRT-01-07-013-F-FM	
BRT-01-07-014-F-FM	
BRT-01-07-015-F-FM	

ENVIRONMENTAL HAZARDS ASSESSMENT

Final Status Survey in BRT01 Concrete Survey Units — Activity

8/29/05 — Date to start

HAZARD ITEM:	Refer to safety manual and safety procedures for guidance	*	YES	NO	SPECIFIC CONTROLS
VISION HAZARDS:	particles, chemicals, temperatures, vapors		✓		Safety glasses required per site safety policy.
NOISE HAZARDS:	hand or power tools, equipment in area			✓	
HEAD HAZARDS:	falling objects, bump hazards, electrical		✓		Hardhat required per site safety policy.
FOOT HAZARDS:	falling, rolling objects, sharp objects		✓		Safety shoes required per site safety policy.
FACE HAZARDS:	sparks, splash, particles			✓	
RESPIRATORY:	dusts, fumes, oxygen deficiency, toxic gas, See AP-0627, other	*		✓	
SILICA/DUST HAZARDS:	sandblasting, concrete work, abatement on concrete surfaces, demolition	*		✓	
LEAD HAZARDS:	dust, fumes, AP-0713, AP-0625	*		✓	
ASBESTOS HAZARDS:	insulation, abatement activities, AP-0709	*		✓	
PCB HAZARDS:	dust, paint chips, vapors, AP-0630, AP-0629	*		✓	
VENTILATION REQUIREMENTS:	local exhaust, area exhaust, dilution, intrinsic, OP-8536	*		✓	
AIR MONITORING REQUIRED:	personal bza's, area monitors, hazards sampled	*		✓	
HAND HAZARDS:	sharps, temperatures, hazardous substances			✓	
FALL HAZARDS:	anchor points, prior to use equipment inspection, floor or wall openings, uneven surface, trip hazards, written plan, working over water, AP-0628	*	✓		While working near the edges of the ring foundation, be cognizant of the areas where fall protection is required and adhere to site safety requirements when in these areas. A concrete barrier is available as a tie-off point.
MATERIAL HANDLING:	slings, prior to use equipment inspection, lifting, rigging, fork trucks, pinch points, DP-5950, OP-5972			✓	
WEATHER CONDITION HAZARDS:	heat/cold, AP-0618, overhead/underfoot snow & ice, storms, forecast, monitor if <50 or >80 °F		✓		Dress appropriately for current and projected conditions.
VC SNOW INSPECTION REQUIRED:	November-April, complete inspection per APF-0626.3			✓	
CONFINED SPACE HAZARDS:	AP-0619, confined space work permit	*		✓	
EXCAVATION HAZARDS:	OSHA 1926 Subpart P, soil classification, underground utilities, cave-in protection, competent person, fall hazards			✓	

ENVIRONMENTAL HAZARDS ASSESSMENT

HAZARD ITEM: Refer to safety manual and safety procedures for guidance	*	YES	NO	SPECIFIC CONTROLS
RESCUE HAZARDS/RESCUE PLAN: Access, Layout, Stage equipment for rescue	*		✓	
CHEMICAL AND BODY FLUID EXPOSURE HAZARDS: review MSDS's, HMIS label, AP-0031, AP- 0622, PPE required			✓	
FIRE HAZARDS: AP-5005, AP-0050, AP-0051 Welding, Grinding, Burning, Flammable Materials, Explosion Hazards			✓	
ACCESS HAZARDS: scaffolds, layout of work area, ladders, AP-0617, required department access to proposed work area (security, operations, RP, etc)		✓		Access point to FSS areas within the RSS footprint is located on the west side. Stepladders are available for use when ascending to and descending from the concrete, and should be used as appropriate. Remain watchful of trip/slip hazards.
ELECTRICAL HAZARDS: assured grounding protection, GFCI, AP-0623, power lines			✓	
SWITCHING AND TAGGING: electrical, hydraulic, pneumatic energy sources, pressurized systems, AP-0017			✓	
COMMUNICATION DIFFICULTIES: radio, speakers		✓		Radio may be required for communicating with the ISOCS crane operators.
ERGONOMIC CONCERNS: repeated motion, awkward position, proper lifting			✓	
EQUIPMENT/TOOL HAZARDS: guards, intrinsic ventilation required, proper training and use			✓	
WORK PRACTICES: policy and procedure compliance, worker positioning, proper tool use, housekeeping		✓		Wear orange vests as required by site safety policy. Load carried by one person should be limited to no greater than 40 lbs.
INTERFACE WITH OTHER DEPARTMENTS: Security Impact, Radiation Protection Impact, Operations Impact, QA, Health and Safety, Other:			✓	
ENVIRONMENTAL HAZARD VERIFICATION: CONTACT SAFETY OVERSIGHT DEPARTMENT hazardous waste generation or disposal concerns, environmental impact from activity, water runoff, sampling needed, APF-0626.4 "Environmental Hazards Assessment"	**		✓	
RADIATION HAZARDS: AP-0801				
POSTING NEEDED: barricades, signs, per safety manual	*			
FME PLAN REQUIRED: written plan per AP-0216				

*** Health and Safety Department review required prior to briefing and start of activity**
**** Contact Safety Oversight Department for verification of hazards and additional requirements**
Comments: ______________________

Completed by: J. Beason **Date:** 8/25/05 **Health and Safety Department Review*** [signature] **Date:** 8-30-0
Additional Reviews Required: ______________________ **Date:** ______

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 08

Survey Unit Name: RSS Footprint – East Vertical Edge of the Electrical Duct Tray

FSSP Number: YNPS-FSSP-BRT01-08-00

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

The electrical duct tray is a concrete structure that runs north to south on the west side of the RSS footprint, forming the west boundary of Survey Unit NOL06-01. The length of electrical duct tray is approximately 132 ft (40m). Survey Unit BRT01-08 is the surface area of the east vertical edge of the electrical duct tray that was exposed during the excavation campaigns to remove radiologically contaminated soil and PCB-contaminated soil from the RSS area. The amount of the exposed concrete surface varies along the length of the duct tray. The east vertical edge is totally exposed from the PAB foundation at the south end to approximately the mid-point of the mat foundation, whereas it is only partially exposed from the mid-point of the mat foundation to the turbine building foundation at the north end of the duct tray. The total exposed concrete surface area has been estimated to be approximately 261 ft^2 ($24m^2$). The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-08 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover surveys of the RSS ring and mat foundations supports this assumption for this survey unit.

The operational RP turnover surveys of the concrete surface of the RSS ring and mat foundations consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 $dpm/100cm^2$. The mean value for the net detectable radioactivity from the fixed-point measurements from the mat foundation was 516±298 $dpm/100cm^2$ and the mean value for the net detectable radioactivity from the fixed-point measurements from the ring foundation was 883 ± 727 dpm/100cm2. The mean values from both surveys were significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). The FSS planning for Survey Unit BRT01-08 used survey data from the ring foundation (883 ± 727 dpm/100cm2) because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test. The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

Although most of the concrete of Survey Unit BRT01-08 has a relatively smooth surface, some localized areas contain pits and irregular surfaces (typical depths in these areas are approximately ¼ - ½ inch, although some increase it as much as 1 inch), which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. These irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the pitted/irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the localized pitted/irregular areas, most of the concrete of the east vertical wall is relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *4.1 = 2.6E4 dpm/100cm^2

- for smooth concrete surface: 2.6E4 dpm/100cm^2 * 0.0603 c/d = 1.6E3 cpm/100cm^2
- for pitted/irregular surface: 2.6E4 dpm/100cm2 * 0.0373 c/d = 9.7E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >1.6E3 cpm/100cm^2 above background

- for pitted/irregular (i.e., top) concrete surface: >9.7E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(fDCGL$_{EMC}$) values by various background levels.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8534. Pre- and post-use instrument QC checks will be performed.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-08 are defined by the termination of the vertical surface of the east edge of the duct tray. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the DCGL$_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the DCGL$_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-08 exceeds the release criteria.
Probability of type I error: 0.05
Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Mark the sampling points at the locations as follows:

(a) Locate and mark the random start point for the grid at a point 22.5 ft from the turbine building foundation and 4.5 inches from the top of the duct tray.

(b) Locate and mark other fixed-point measurement locations at intervals of 4.5 ft to the north and south of the random start location. These locations are also 4.5 inches from the top of the duct tray.

(c) If a measurement location appearing on the survey map is obstructed by soil such that the measurement cannot be collected, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing down but approximately 1m above the concrete surface of the duct tray at the north end and at the center of the duct tray.

(b) Collect 7 one-minute readings with the shielded detector 1m away but facing the east vertical surface (where it is fully exposed) at the south end of the survey unit.

(b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Starting at the south end of the survey unit, collect 29 fixed-point (1-min) measurements in accordance with DP-8534 at each of the marked locations.

(a) Designate the fixed-point measurements as BRT-01-08-001-F-FM through BRT-01-08-029-F-FM (note: measurement BRT-01-08-001-F-FM should be collected at the marked location closest to the PAB foundation).

(b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

7. The applicable job hazards associated with this survey are addressed in the JHA for the RSS footprint.

8. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-08-030-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). The FSS Radiological Engineer is responsible for assessing the need for further investigation. If further investigation is required, it will be conducted

under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing	QA signature:
(2) Date/time of commencement of HP-100 measurements	QA signature:
(3) Date/time of commencement of SPA-3 measurements	QA signature:

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) n Specify:

Prepared by J. Bussm FSS Radiological Engineer	Date 9-15-05
Reviewed by J. Hummer FSS Radiological Engineer	Date 9-15-05
Approved by Jim Babineau FSS Project Manager	Date 9/15/05

MDCR/MDC Table for Survey Unit BRT01-08

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.2
1000	2	239	0.4

detector = HP-100 (1-in efficiency factor)

Form 1
Background Data

Survey Unit BRT01-08
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
North end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
Center of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	
South end of survey unit	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-08
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)
BRT-01-08-001-F-FM	
BRT-01-08-002-F-FM	
BRT-01-08-003-F-FM	
BRT-01-08-004-F-FM	
BRT-01-08-005-F-FM	
BRT-01-08-006-F-FM	
BRT-01-08-007-F-FM	
BRT-01-08-008-F-FM	
BRT-01-08-009-F-FM	
BRT-01-08-010-F-FM	
BRT-01-08-011-F-FM	
BRT-01-08-012-F-FM	
BRT-01-08-013-F-FM	
BRT-01-08-014-F-FM	
BRT-01-08-015-F-FM	
BRT-01-08-016-F-FM	
BRT-01-08-017-F-FM	
BRT-01-08-018-F-FM	
BRT-01-08-019-F-FM	
BRT-01-08-020-F-FM	
BRT-01-08-021-F-FM	
BRT-01-08-022-F-FM	
BRT-01-08-023-F-FM	
BRT-01-08-024-F-FM	
BRT-01-08-025-F-FM	
BRT-01-08-026-F-FM	
BRT-01-08-027-F-FM	
BRT-01-08-028-F-FM	
BRT-01-08-029-F-FM	

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 09
Survey Unit Name: RSS Footprint – North Vertical Edge of the PAB Foundation	
FSSP Number: YNPS-FSSP-BRT01-09-01 **(Rev 1 changes appear in 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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Portions of the PAB foundation (originally below-grade, but exposed during the excavation campaigns to remove radiologically contaminated and PCB-contaminated soil from the RSS area) form boundaries with survey units NOL01-01 and NOL06-01. Before the RSS area can be back-filled with clean soil, a final status survey must first be performed for the vertical concrete surface of the PAB foundation to demonstrate the residual plant-related contamination meet the acceptance criteria in the LTP. For FSS purposes, the currently exposed concrete surface of the PAB foundation has been identified as survey unit BRT01-09.

Survey Unit BRT01-09 includes 3 primary areas of concrete surface that serve as boundary for NOL01-01 and NOL06-01:

- The vertical face of the PAB foundation at the south end of the east boundary of NOL01-01, approximately 91ft^2 (8.5m^2)
- The vertical face of the PAB foundation that serves as the south boundary of NOL01-01 and part of the south boundary for NOL06-01, approximately 400ft^2 (37m^2)
- The vertical face along the jog in the PAB foundation at the west end of south boundary of NOL06-01, approximately 186ft^2 (17m^2)

Unit BRT01-09 also includes secondary (smaller) areas of concrete surface found at the jog in the foundation line near the west end and the horizontal surface of the ledge (extending east to west along the bottom of the PAB foundation). The secondary concrete surface represent <20 m^2 of total surface area.

The total (2-dimensional) area for these 3 primary regions, approximately 677ft^2 (63m^2), was used as the planning basis for the systematic grid, which was then extended to the secondary surface areas lying outside the 3 primary areas. This approach (i.e., the use of a surface area that is smaller than the actual total surface area) produced a tighter grid (i.e., the area between grid points is smaller than the area would have been if the total surface area was used a the basis for the grid), which in turn results in the collection of more fixed-point measurements than are actually needed to support statistical tests.

The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-08 meet LTP release criteria.

inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2
- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.9 = 1.2E4 dpm/100cm^2
- for smooth concrete surface: 1.2E4 dpm/100cm^2 * 0.0603 c/d = 7.2E2 cpm/100cm^2
- for pitted/irregular surface: 1.2E4 dpm/100cm^2 * 0.0373 c/d = 4.5E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:
- for smooth (i.e., vertical side) concrete surface: >7.2E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >4.5E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m assays: 1.7E4 dpm/100cm^2 (Co-60)
2m assays: 2.9E3 dpm/100cm^2 (Co-60)

Note: The investigation level for the ISOCS assays was derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (3.14m^2 for 1m assays and 12.6m^2 for 2m assays) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation level developed in this manner is sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.2E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.2E3	Sb-125	6.6E3	Eu-152	2.5E3
Nb-94	1.7E3	Cs-134	1.9E3	Eu-154	2.3E3
Ag-108m	1.7E3	Cs-137	4.2E3	Eu-155	4.3E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 6m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

***MDCs for analyses of HTD nuclides in concrete core samples*:**

Nuclide	**MDC (pCi/g)**	**Nuclide**	**MDC (pCi/g)**	**Nuclide**	**MDC (pCi/g)**
H-3	**3.5E0**	**Sr-90**	**2.8E-2**	**Pu-241**	**5.2E0**
C-14	**2.6E-1**	**Tc-99**	**2.2E0**	**Am-241**	**1.5E-1**
Fe-55	**5.2E0**	**Pu-238**	**3.5E-1**	**Cm-243**	**1.7E-1**
Ni-63	**3.7E0**	**Pu-239/240**	**3.2E-1**		

Note: The MDCs listed in the above table are 10% of the DCGL values for concrete debris (LTP Table 6-1 values

adjusted to 8.73 mrem/y). If those MDC values cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the horizontal ledge and of vertical surface areas not covered by the ISOCS assays. Supplemental SPA-3 scans on the irregular surfaces of the vertical surface and cracks in the concrete.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(fDCGL$_{EMC}$) values by various background levels.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8504. Pre- and post-use instrument QC checks will be performed. QC checks for the ISOCS will be in accordance with DP-8869 and DP-8871.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-09 are defined by the termination of the vertical surfaces of the PAB foundation. Diagram 1 provides the location and identities of the locations for fixed-point measurements. Diagrams 3 through 4 show the locations (and overlapping coverage) of the ISOCS assays. The survey is to be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the DCGL$_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the DCGL$_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-09 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: 3 (core samples)

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Mark the sampling points at the locations as follows:

(a) Locate and mark the random start point for the grid at a point 44.75 ft from the east end of the south PAB foundation wall and 3.2 ft from the top of the PAB foundation. Note: the random start point for the systematic grid is located in a soil area where part of the PAB foundation was removed.

(b) Use diagram 1 as a guide to locate and mark fixed-point measurement locations in the first (upper) row at intervals of 7.2 ft to the east and west of the random start location. These locations are also 3.2 ft inches from the top of the PAB foundation.

(c) Locate and mark a measurement location in the second (lower) row by finding the mid-point of 2 locations in the first row and dropping down a distance of 6.2 ft. Mark the locations for other fixed-point measurements at intervals of 7.2 ft to the east and west of the second row location that was just marked. If a measurement location falls on soil, do not mark the point but use it as a reference to continue the grid pattern.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing towards the vertical surface of the PAB foundation but approximately 1m away from the concrete surface at the center of each of the primary concrete surface areas (east PAB wall, south PAB wall, and west PAB wall).

(b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Collect fixed-point (1-min) measurements in accordance with DP-8534.

(a) Designate the fixed-point measurements as BRT-01-09-001-F-FM through BRT-01-09-025-F-FM, corresponding to measurement locations as numbered in diagram 1.

(b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

(c) If a measurement location falls on a concrete surface that is too irregular to obtain a fixed-point measurement, select an alternate location in accordance with DP-8856.

(d) If a fixed-point measurement location falls on soil, identify it as being outside the survey unit and record that reason in the comment section of Form 2.

5. Perform HP-100 of the horizontal concrete surface area on the ledge at the bottom of the PAB foundation and of vertical surface area of the <u>PAB Foundation – East</u> not covered by the ISOCS assays (see Diagram 3). Perform supplemental SPA-3 scans on the irregular surfaces of the vertical surface and cracks in the concrete. The scanning methods for the HP-100 and SPA-3 are described in the Specific Instructions.

6. Collect 22 ISOCS measurements in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

(a) Locate and mark the center for each ISOCS assay using the dimensions provided in diagram 2, 3, and 4. These 3 diagrams also provide information regarding the surface to detector distance for each of the primary vertical surface areas.

(b) Diagram 2, <u>PAB foundation – east</u>: Position the ISOCS at 1m the from the marked location on the face of the concrete surface, angling the detector as necessary to keep it perpendicular to the area being surveyed. Designate the ISOCS assays as BRT-01-09-026-F-G through BRT-01-09-031-F-G, corresponding to locations 026 through 031 as shown on Diagram 2.

(c) Diagram 3, <u>PAB foundation – south</u>:

(i) Position the ISOCS at 2m the from the marked location on the face of the concrete surface, angling the detector as necessary to keep it perpendicular to the area being surveyed. Designate the ISOCS assays as BRT-01-09-032-F-G through BRT-01-09-035-F-G, corresponding to locations 032 through 035 as shown on Diagram 3.

(ii) Position the ISOCS at 1m the from the marked location on the face of the concrete surface, angling the detector as necessary to keep it perpendicular to the area being surveyed. Designate the ISOCS assays as BRT-01-09-036-F-G through BRT-01-09-041-F-G, corresponding to locations 036 through 041 as shown on Diagram 3.

(d) Diagram 4, <u>PAB foundation – west</u>: Position the ISOCS at 1m the from the marked location on the face of the concrete surface, angling the detector as necessary to keep it perpendicular to the area being surveyed. Designate the ISOCS assays as BRT-01-09-042-F-G through BRT-01-09-047-F-G, corresponding to locations 042 through 047 as shown on Diagram 4.

Note: If the ISOCS assay results exceed the investigation level, an investigation will be conducted under a separate survey plan

7. Collect 1 core to a depth of 6-inches at the bottom of each of the 3 primary regions of the PAB foundation in accordance

with DP-8121. Ensure that the outer surface of each core is identified.

(a) Designate the core sample from the east PAB foundation area as BRT-01-09-048-F-CR, the core sample from the south PAB foundation area as BRT-01-09-049-F-CR, and the core sample from the west PAB foundation as BRT-01-09-050-F-CR.

(b) These 3 core samples will be received and prepared in accordance with DP-8813.

(c) Each core sample is to be sliced into 1-inch sections. Label each slice from a single core using the sample number plus a letter of the alphabet as a suffix. The letters used as suffixes must reflect the slicing sequence. For example, the first slice (= slice containing the outer surface) of sample BRT-01-09-048-F-CR should be labeled BRT-01-09-048-F-CRA, the second slice should be labeled BRT-01-09-048-F-CRB, the third slice should be labeled BRT-01-09-048-F-CRC, etc.

(d) Preparation of the core samples for onsite analysis will not include drying because all of the core samples will be sent to an offsite laboratory for analyses of H-3 and all other LTP-listed HTD nuclides.

(e) After onsite gamma analysis, each slice will be pulverized and its entire pulverized volume placed in an appropriately labeled sealed container (e.g., bag, jar) to minimize loss of water content and sent to the offsite laboratory for H-3 and other HTD nuclide analyses.

8. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

9. ISOCS: Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance

10. The applicable job hazards associated with this survey are addressed in the JHA for the RSS footprint. Safe use of ladders/staging is to be addressed as applicable to FSS activities during the daily pre-job briefing.

11. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-09-051-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) mark the location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode.

Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2

NOTIFICATION POINTS

QA notification* point(s) (y/n) __y

(1) Date/time of initial pre-survey briefing ____ QA signature: ____________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________

(3) Date/time of commencement of SPA-3 measurement QA signature: ____________

(4) Date/time of commencement of ISOCS measurements QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) __n____ Specify: ____________

Prepared by J. Buem Date 9-27-05
FSS Radiological Engineer

Reviewed by J. Hummer Date 9-27-05
FSS Radiological Engineer

Approved by [signature] / BCS for JH+ Date 10/11/05
FSS Project Manager

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 10
Survey Unit Name: RSS Footprint – South Vertical Edge of the Turbine Building Foundation	
FSSP Number: YNPS-FSSP-BRT01-10-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

A portion of the Turbine Building (TB) foundation (originally below-grade, but exposed during the excavation campaigns to remove radiologically contaminated and PCB-contaminated soil from the RSS area) forms the north boundary with survey unit NOL06-01. Before the RSS area can be back-filled with clean soil, a final status survey must first be performed for the vertical concrete surface of the TB foundation to demonstrate the residual plant-related contamination meet the acceptance criteria in the LTP. For FSS purposes, the currently exposed concrete surface of the TB foundation has been identified as survey unit BRT01-10.

Survey Unit BRT01-10 includes the vertical surface of the TB foundation plus the horizontal surface of a ledge that runs along the length of the foundation. The FSS planning for the unit used an estimated vertical surface area for the TB foundation plus the horizontal surface area of the ledge equal to 335 ft^2 ($31 m^2$).

The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-10 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover surveys of the RSS ring and mat foundations supports this assumption for this survey unit.

The operational RP turnover surveys of the concrete surface of the RSS ring and mat foundations consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements from the mat foundation was 516±298 dpm/100cm^2 and the mean value for the net detectable radioactivity from the fixed-point measurements from the ring foundation was 883 ± 727 dpm/100cm2. The mean values from both surveys were significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

A turnover survey for the vertical surface of the PAB foundation was not performed. The FSS planning for Survey Unit BRT01-10 defaulted to the survey data from the ring foundation (883 ± 727 dpm/100cm2) because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

Although most of the concrete of Survey Unit BRT01-08 has a relatively smooth surface, some localized areas contain pits and irregular surfaces (typical depths in these areas are approximately ¼ - ½ inch, although some increase it as much as 1 inch), which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. These irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the pitted/irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the localized pitted/irregular areas, most of the concrete of the vertical wall is relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *2.4 = 1.5E4 dpm/100cm^2

- for smooth concrete surface: 1.5E4 dpm/100cm^2 * 0.0603 c/d = 9.0E2 cpm/100cm^2

- for pitted/irregular surface: 1.5E4 dpm/100cm2 * 0.0373 c/d = 5.6E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >9.0E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >5.6E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(f$DCGL_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8534. Pre- and post-use instrument QC checks will be performed.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-10 are defined by the termination of the vertical surface on the south face of the TB foundation. Diagram 1 provides the location and identification of the FSS fixed-point measurements. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-08 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Mark the locations of the fixed-point measurement as indicated by Diagram 1.

(a) Locate and mark the random start point for the grid at a point 52.75 ft from the west end turbine building foundation and 6.1ft from the top of the foundation. The 6.1 ft from the top of the foundation should include the width of the ledge that runs along the foundation.

(b) Locate and mark other fixed-point measurement locations along a line parallel to the ledge at intervals of 5 ft to the west and east of the random start location.

(c) Locate and mark a measurement location in the second (upper) row by finding the mid-point of 2 locations in the first row and measuring up a distance of 4.3 ft. Mark the locations for other fixed-point measurements on a line parallel to the first line at intervals of 5 ft to the east and west of the point that was just marked.

(d) If the fixed-point measurement location falls on a point where the concrete surface does not allow the collection of a measurement, select an alternate location in accordance with DP-8856.

Note: If a fixed-point location (as shown in Diagram 1) falls on soil rather than concrete, do not mark the location but use it as a reference point to continue the grid.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing the TB foundation at 3 different locations along the length of the foundation where the detector can be held approximately 1m from the concrete surface and approximately 1m above the ground.

(b) Record the location and background data on the attached Form 1(even if the measurement was logged).

4. Collect fixed-point (1-min) measurements in accordance with DP-8534 at each of the marked locations.

(a) Designate the fixed-point measurements as BRT-01-10-001-F-FM through BRT-01-10-022-F-FM, corresponding to locations 001 through 022 on Diagram 1.

(b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

(c) If a measurement is not collected because the grid location fell on soil, record the reason in the comment section on Form 2

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

7. The applicable job hazards associated with this survey are addressed in the JHA for the RSS footprint.

8. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-10-023-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than

0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2

NOTIFICATION POINTS

QA notification* point(s) (y/n) __y

(1) Date/time of initial pre-survey briefing QA signature: ____________

(2) Date/time of commencement of HP-100 measurements QA signature: ____________

(3) Date/time of commencement of SPA-3 measurements QA signature: ____________

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) __n__ Specify: ____________

Prepared by J. Buron Date 9-21-05
FSS Radiological Engineer

Reviewed by J. Hummer Date 9-21-05
FSS Radiological Engineer

Approved by Jim Balinecin Date 9/21/05
FSS Project Manager

MDCR/MDC Table for Survey Unit BRT01-10

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.4
1000	2	239	0.6

detector = HP-100 (1-in efficiency factor)

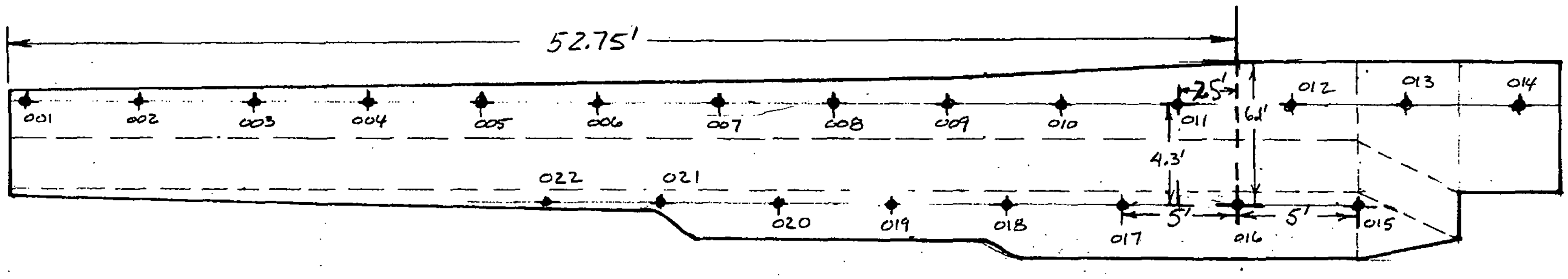


Diagram 1: Fixed-Point Measurement Locations

scale: 1cm = 2.9 ft

Form 1
Background Data

Survey Unit BRT01-10
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-10
Instrument No.: __________

Location	Measurement (cpm/100cm^2)	Comment
BRT-01-10-001-F-FM		
BRT-01-10-002-F-FM		
BRT-01-10-003-F-FM		
BRT-01-10-004-F-FM		
BRT-01-10-005-F-FM		
BRT-01-10-006-F-FM		
BRT-01-10-007-F-FM		
BRT-01-10-008-F-FM		
BRT-01-10-009-F-FM		
BRT-01-10-010-F-FM		
BRT-01-10-011-F-FM		
BRT-01-10-012-F-FM		
BRT-01-10-013-F-FM		
BRT-01-10-014-F-FM		
BRT-01-10-015-F-FM		
BRT-01-10-016-F-FM		
BRT-01-10-017-F-FM		
BRT-01-10-018-F-FM		
BRT-01-10-019-F-FM		
BRT-01-10-020-F-FM		
BRT-01-10-021-F-FM		
BRT-01-10-022-F-FM		
BRT-01-10-023-F-FM		
BRT-01-10-024-F-FM		
BRT-01-10-025-F-FM		

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 11
Survey Unit Name: RSS Footprint – Miscellaneous Concrete Structures	
FSSP Number: YNPS-FSSP-BRT01-11-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

The RSS footprint area includes the demolition remains for several VC legs (columns), which were originally below-grade, but exposed during the excavation campaigns to remove radiologically contaminated and PCB-contaminated soil from the RSS area. Four columns are located north of the RSS ring foundation and 4 are located south of it. Only the 4 columns located south of the ring foundation have significant height (4.5 to 7.5 ft) and, therefore, significant vertical surface area. The RSS excavation campaigns also unearthed the 10ft by 10ft concrete bases for 6 of the 8 columns. For FSS purposes, the 8 columns (and their associated bases) have been identified as miscellaneous concrete and form a single survey unit, BRT01-11. The total footprint area for these miscellaneous concrete structures is approximately 669 ft^2 (62 m^2).

Before the RSS area can be back-filled with clean soil, a final status survey must first be performed for these concrete structures to demonstrate that the residual plant-related contamination meets the acceptance criteria in the LTP. The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surfaces of Survey Unit BRT01-11 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, gamma scans, and ISOCS assays.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure). The following discussion of the data from the operational RP turnover surveys of the RSS ring and mat foundations supports this assumption for this survey unit.

The operational RP turnover surveys of the concrete surface of the RSS ring and mat foundations consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements from the mat foundation was 516±298 dpm/100cm^2 and the mean value for the net detectable radioactivity from the fixed-point measurements from the ring foundation was 883 ± 727 dpm/100cm2. The mean values from both surveys were significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). The operational RP survey of the ring foundation included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring foundation. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

A turnover survey was not performed for the demolition remains of the VC legs. The FSS planning for Survey Unit BRT01-11 defaulted to the survey data from the ring foundation because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed as a conservative measure)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

The concrete surfaces of the tops and sections of the sides of the columns contain pits and irregular surfaces (typical depths in these areas are approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches), which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. These irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the pitted/irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *1.9 = 1.2E4 dpm/100cm^2

- for smooth concrete surface: 1.2E4 dpm/100cm^2 * 0.0603 c/d = 7.2E2 cpm/100cm^2
- for pitted/irregular surface: 1.2E4 dpm/100cm2 * 0.0373 c/d = 4.5E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >7.2E2 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >4.5E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for ISOCS assays: 1m assays: 1.7E4 dpm/100cm^2 (Co-60)

Note: The investigation level for the ISOCS assays was derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (3.14m^2) to the MDC for a 1m^2 area at the edge of the full field of view. The investigation levels developed in this manner are sensitive enough to detect the Co-60 $DCGL_{EMC}$ value based on the grid area (1.2E4 dpm/100cm^2). If other LTP-listed gamma-emitting radionuclides are identified in the ISOCS assays, the investigation level will be evaluated using the same criteria applied in the development of the investigation level for Co-60.

MDCs forISOCS measurements:

Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)	Nuclide	MDC (dpm/100cm^2)
Co-60	1.2E3	Sb-125	6.6E3	Eu-152	2.5E3
Nb-94	1.7E3	Cs-134	1.9E3	Eu-154	2.3E3
Ag-108m	1.7E3	Cs-137	4.2E3	Eu-155	4.3E4

Note: The MDCs listed in the above table are 10% of the $DCGL_{EMC}$ values (based on concrete surface DCGLs & nuclide-specific AF value for 6m^2 from LTP, Appendix 6S). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls of the columns and the horizontal and vertical surface of the bases. Supplemental SPA-3 scans on the irregular surfaces and cracks in the concrete.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

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

4.0 Define the boundaries of the survey:

Boundaries of BRT01-11 are limited to the unearthed concrete of each structure. Map 1 identifies each column by number and shows the location for the systematic (grid) fixed-point measurement to be collected from the horizontal surface. Diagram 1 shows the extension of the systematic grid to vertical surfaces of columns 1 through 4 (the only columns with significant wall surface area). Map 2 identifies the ISOCS assays for the tops of the columns. The survey will be performed under normal weather conditions and in daylight hours (allowing adequate daylight time for ingress and egress).

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-11 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 $cm^2 \div 2$ = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15. Refer to the completed DPF-8853.1 in the survey package file.

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the fixed-point measurement points at the locations shown in MAP 1.

(a) If a fixed-point measurement location falls on a point where the concrete surface does not permit the collection of a measurement, select an alternate location in accordance with DP-8856.

3. Locate and mark the fixed-point measurement points on the vertical side of columns 1 through 4 as indicated in Diagram 1. Note: the starting point for each column is the east edge of the north side.

(a) If the fixed-point measurement location falls on a point where the concrete surface does not permit the collection of a measurement, select an alternate location in accordance with DP-8856.

4. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings from columns 1, 2, and 3 with the shielded detector facing towards the concrete surface but approximately 1m away and also approximately 1m above the ground.

(b) Record the location and background data on the attached Form 1(even if the measurement was logged).

5. Collect 32 fixed-point (1-min) measurements in accordance with DP-8534 at each of the marked locations.

(a) Designate the fixed-point measurements as BRT-01-11-001-F-FM through BRT-01-11-032-F-FM, corresponding to locations 001 through 017 on Map 1 and locations 018 through 032 on Diagram 1.

(b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

6. Collect 8 ISOCS measurements in accordance with DP-8871. In all assays, use the 90° collimator and a preset count time ensuring that the MDC values listed in DQO 3.0 are met.

(a) Position the ISOCS at 1m directly above (and perpendicular to) the center of the top of the column. Designate the ISOCS assays as BRT-01-11-033-F-G through BRT-01-11-040-F-G as shown in Map 2.

7. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

8. Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

9. Operation of the ISOCS will be in accordance with DP-8871, with QC checks performed once per shift in accordance with DP-8869 and DP-8871. Any flag encountered during the ISOCS QC source count must be corrected/resolved prior to surveying. If an anomaly cannot be corrected or resolved, contact the cognizant FSS Engineer for assistance.

10. The applicable job hazards associated with this survey are addressed in the JHA for the RSS footprint. Job hazards not addressed in the JHA will be addressed through the Daily Activity Plan and daily job briefing as they arise.

11. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source,

(2) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(3) the designation for a fixed-point measurement collected during a first-level investigation will continue in sequence beginning with BRT-01-11-033-F-FM-I. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(4) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 scans of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing QA signature: ______

(2) Date/time of commencement of HP-100 measurements QA signature: ______

(3) Date/time of commencement of SPA-3 measurement QA signature: ______

(4) Date/time of commencement of ISOCS measurements QA signature: ______

* Voice mail notification or E-mail notification to Trudeau@yankee.com with a copy to Calsyn@yankee.com satisfies this step.

FSI point(s) (y/n) n Specify: ______

Prepared by J. Bisson Date 9-22-05
FSS Radiological Engineer

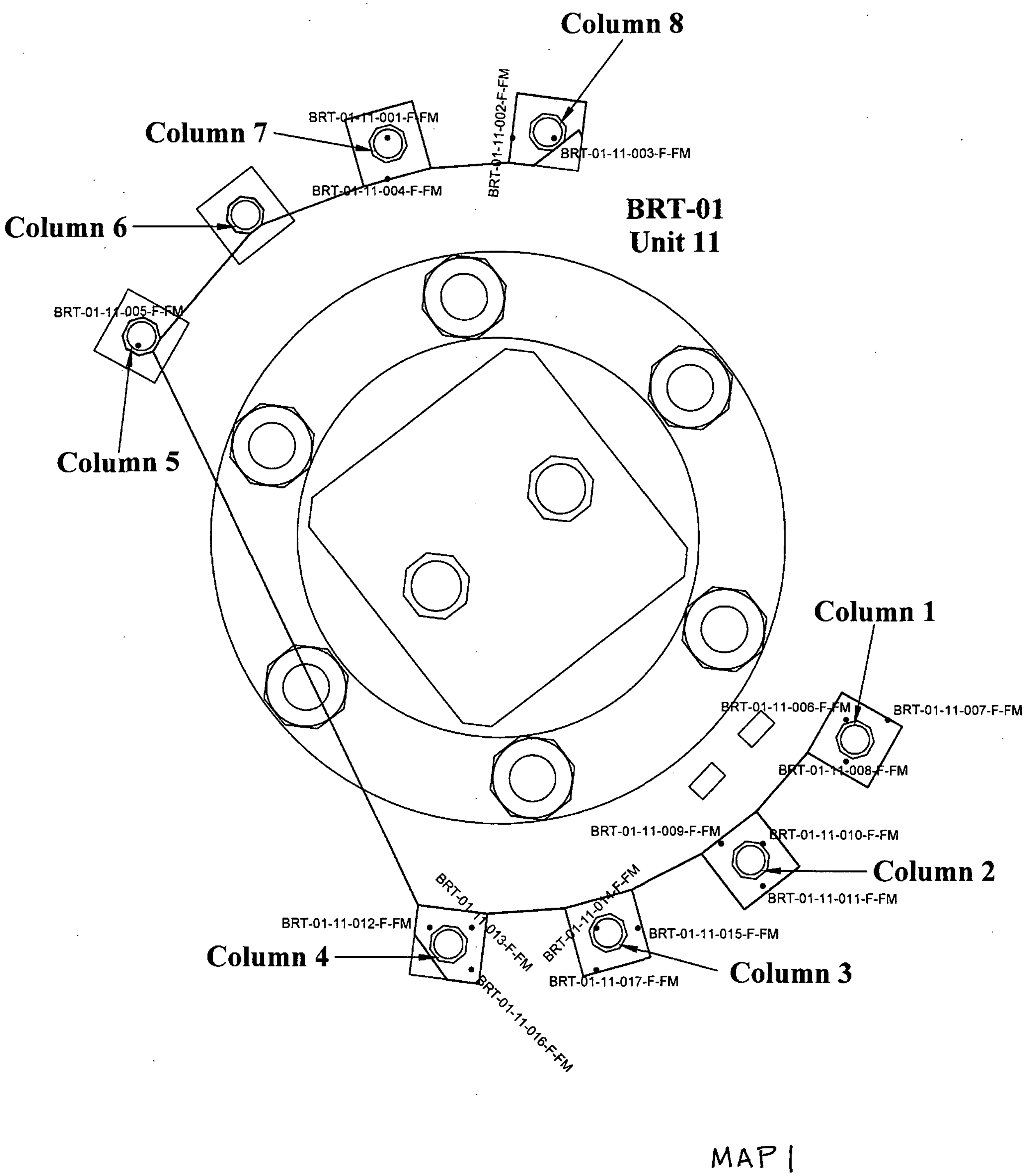
Reviewed by J. Hummer Date 9-22-05
FSS Radiological Engineer

Approved by GM Babineau Date 9/22/05
FSS Project Manager

MDCR/MDC Table for Survey Unit BRT01-11

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

detector = HP-100 (1-in efficiency factor)



Legend = Survey Unit Boundary DPF-8865.1	Map current as of September 21, 2005	Survey Area & Unit: BRT-01-11 Grid Pattern: __ Square __ Triangular __N/A No. of Samples: Area size: 669 ft2 (62 m2)	Yankee Atomic Power Company Sample Location Map	Reviewed by: JWB Date: 9-21-05

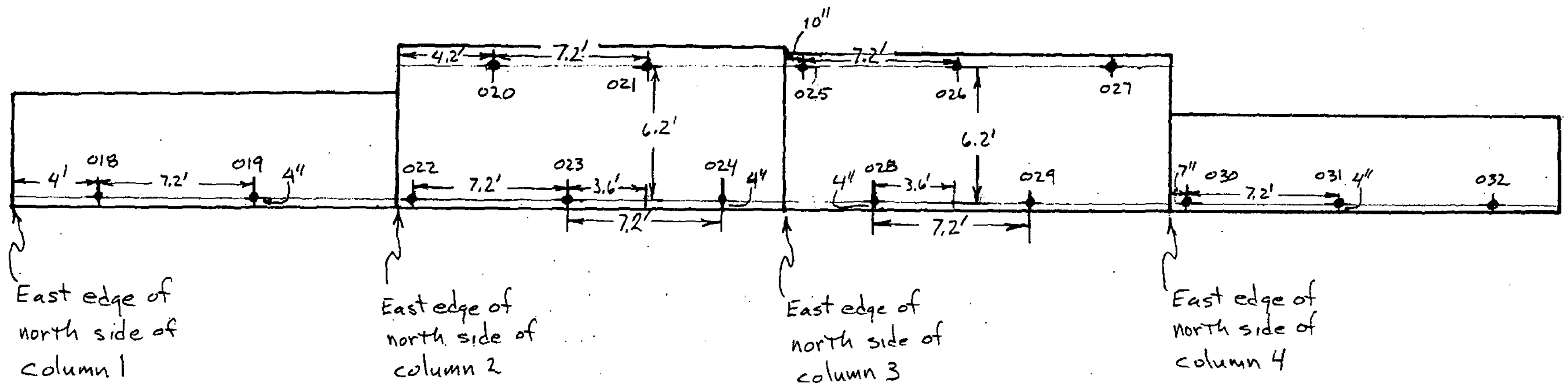
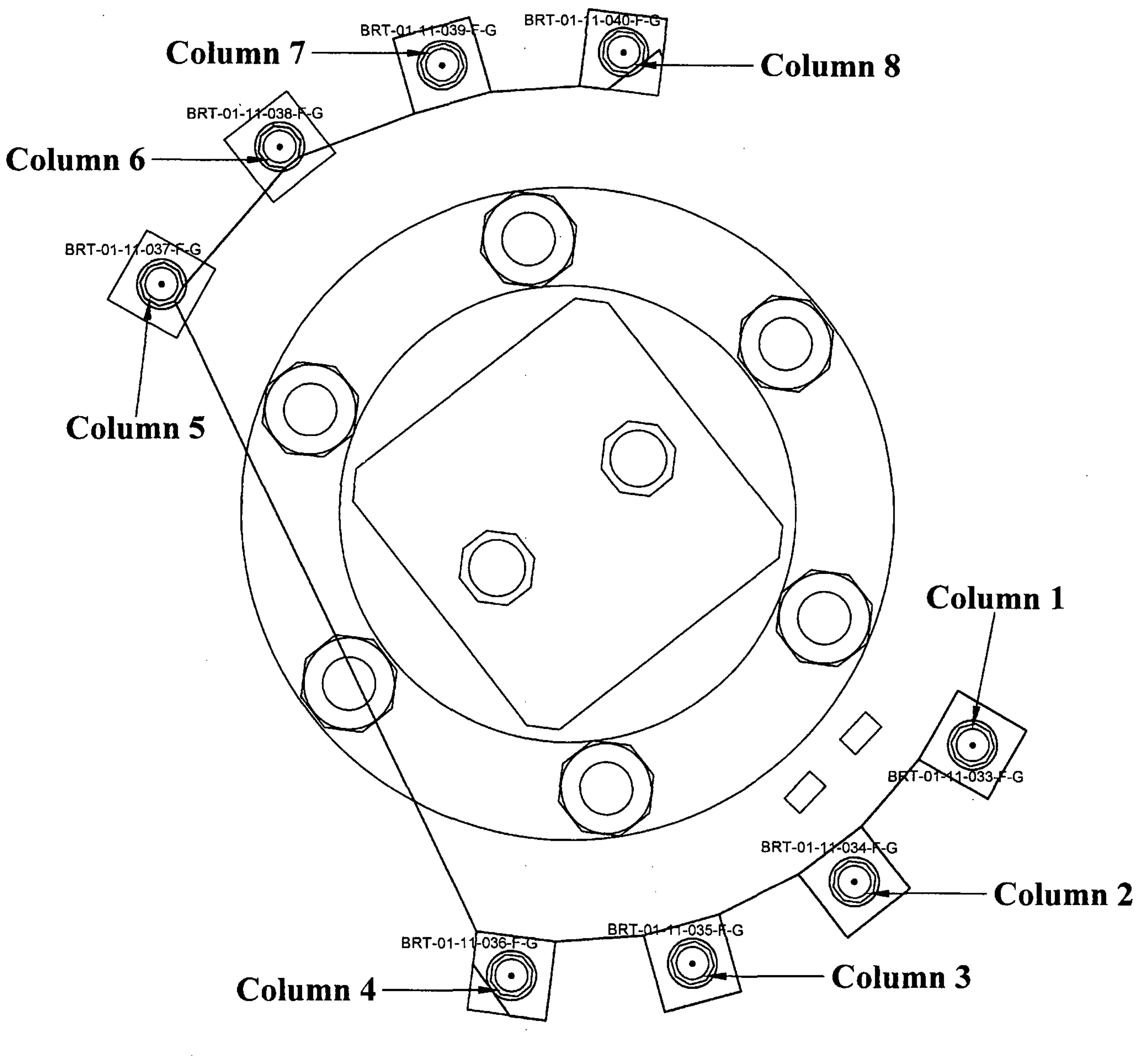


Diagram 1: Fixed-Point Measurement Locations on vertical surfaces of columns 1-4

BRT-01 Unit 11
ISOCS Assays



MAP 2

Legend	Map current as of	Survey Area & Unit: BRT-01-11	Yankee Atomic Power Company	Reviewed by: JWB
~ = Survey Unit Boundary		Grid Pattern: __ Square __ Triangular __N/A		
DPF-8865.1	September 21, 2005	No. of Samples:	Sample Location Map	Date: 9-22-05
		Area size: 669 ft2 (62 m2)		

Form 1
Background Data

Survey Unit BRT01-11
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
Column 1	1	
	2	
	3	
	4	
	5	
	6	
	7	
Column 2	1	
	2	
	3	
	4	
	5	
	6	
	7	
Column 3	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-11
Instrument No.: ___________

Location	Measurement ($cpm/100cm^2$)	Comment
BRT-01-11-001-F-FM		
BRT-01-11-002-F-FM		
BRT-01-11-003-F-FM		
BRT-01-11-004-F-FM		
BRT-01-11-005-F-FM		
BRT-01-11-006-F-FM		
BRT-01-11-007-F-FM		
BRT-01-11-008-F-FM		
BRT-01-11-009-F-FM		
BRT-01-11-010-F-FM		
BRT-01-11-011-F-FM		
BRT-01-11-012-F-FM		
BRT-01-11-013-F-FM		
BRT-01-11-014-F-FM		
BRT-01-11-015-F-FM		
BRT-01-11-016-F-FM		
BRT-01-11-017-F-FM		
BRT-01-11-018-F-FM		
BRT-01-11-019-F-FM		
BRT-01-11-020-F-FM		
BRT-01-11-021-F-FM		
BRT-01-11-022-F-FM		
BRT-01-11-023-F-FM		
BRT-01-11-024-F-FM		
BRT-01-11-025-F-FM		
BRT-01-11-026-F-FM		
BRT-01-11-027-F-FM		
BRT-01-11-028-F-FM		
BRT-01-11-029-F-FM		
BRT-01-11-030-F-FM		
BRT-01-11-031-F-FM		
BRT-01-11-032-F-FM		

Field MDAs for 3.14 m2 FOV for 900 sec count on red rover (6264)

Nuclide	MDA-dpm/m2
Co-60	7.78E+04
Ag-108m	8.29E+04
Cs-134	8.89E+04
Cs-137	9.10E+04

Field MDAs for 1.0 m2 FOV for 900 sec count on red rover (6264) @ 0.5 meter offset

Nuclide	MDA-dpm/m2		1m90d adjustment factors	**1m90d adjustment factor**	
Co-60	2.05E+05	Co-60	3.80E-01	3.80E-01	
Ag-108m	2.19E+05	Ag-108m	3.79E-01	**0.380**	Rounded down
Cs-134	2.34E+05	Cs-134	3.80E-01		
Cs-137	2.39E+05	Cs-137	3.81E-01		

Adjusted Investigation levels (1m90d) based on DCGLemc*MDA@3.14 m2/MDA @1m2 offset

Nuclide	dpm/m2	
Co-60	**1.74E+06**	= 1.74E+1 dpm/100 cm²
Ag-108m	**2.39E+06**	
Cs-134	**2.84E+06**	
Cs-137	**6.35E+06**	

Note: These above investigation levels not surrogated!

Maximum Adjusted Investigation levels (1m90d) based on DCGLemc*MDA@3.14 m2/MDA @1m2 offset

Nuclide	dpm/m2		dpm/100 cm2 (included for reference)
Co-60	**1.74E+06**	NS	1.74E+04
Ag-108m	**2.39E+06**	NS	2.39E+04
Cs-134	**2.84E+06**	NS	2.84E+04
Cs-137	**6.35E+06**	NS	6.35E+04

Note: (NS) Not Surrogated
Investigation levels calculated/derived IAW YA-REPT-00-018-05 Rev 0

Nuclide	Table 6-1 DCGLw-Bldg Surface dpm/100cm2	*8.73/25 mRem Corrected DCGLw dpm/100cm2	1M2 AF from LTP-BLDG Surfaces-6S	DCGLemc for 1M2 dpm/100cm2	
Co-60	1.80E+04	**6.29E+03**	7.3E+00	4.59E+04	
Ag108m	2.50E+04	**8.73E+03**	7.2E+00	6.29E+04	
Cs-134	2.90E+04	**1.01E+04**	7.4E+00	7.49E+04	
Cs-137	6.30E+04	**2.20E+04**	7.6E+00	1.67E+05	
Detector Field of View (M2)		**1.0**	**12.6**	**3.14**	
Plane Radius (m)			2.0	1.0	
Detector Height-90 degree (m)			2.0	1.0	
Assumed Concrete Density (g/cc)-LTP 6.4.3.3	2.5				
Assumed Depth (cm)	5				
Concrete Total Mass (g)		1.25E+05	1.57E+06	3.93E+05	
Co-60 Investigation level	dpm/100cm2	4.59E+04	3.65E+03	1.46E+04	info only
Ag-108m Investigation level	dpm/100cm2	6.29E+04	5.00E+03	2.00E+04	info only
Cs-134 Investigation level	dpm/100cm2	7.49E+04	5.96E+03	2.39E+04	info only
Cs-137 Investigation level	dpm/100cm2	1.67E+05	1.33E+04	5.32E+04	info only

Assumptions:

1) Only the 1m2 activity (source term) at the DCGLemc distributed throughout the FOV
2) Various sum of Fractions not accounted for in calculation
3) No correction for geometry offset

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 12
Survey Unit Name: RSS Footprint – East End of Vertical Edge of the Turbine Building Foundation	
FSSP Number: YNPS-FSSP-BRT01-12-00	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

The turbine building foundation was exposed during the excavation campaigns to remove radiologically contaminated soil and PCB-contaminated soil from the RSS area. Most of the vertical edge of the turbine building foundation (survey unit BRT01-10), which served as the north boundary for unit NOL06-01, has passed an FSS. Survey Unit BRT01-12, the east end of the vertical edge of the turbine building foundation, is contiguous to BRT01-10 and serves as the north boundary for survey unit NOL06-03. It is approximately 192 ft^2 ($17.8 m^2$) of concrete surface area. The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surface of Survey Unit BRT01-12 meets LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure for the reasons stated in YNPS-FSSP-BRT01-10-00).

FSS planning for unit BRT01-12 used the FSS data from unit BRT01-10 because there is no reason to expect the radiological characteristics of BRT01-12 to be different from BRT01-10 since that unit is contiguous to unit BRT01-12 and consist of the same concrete.

The mean value of fixed-point measurements from BRT01-10 was 1.8E3 dpm/100cm^2 ± 4.8E2 dpm/100cm^2. The FSS net measurements ranged from no detectable to 2.8E3 dpm/100cm^2 (or 44% of the DCGL for Co-60).

Average radiation level: 1.8E3 dpm/100cm^2 (mean of FSS data for BRT01-10)

Standard deviation (σ): 4.8E2 dpm/100cm^2 (standard deviation of FSS data for BRT01-10)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

Although most of the concrete of Survey Unit BRT01-12 has a relatively smooth surface, some localized areas contain pits and irregular surfaces (typical depths in these areas are approximately ¼ - ½ inch, although some increase it as much as 1 inch), which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. These irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the pitted/irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the localized pitted/irregular areas, most of the concrete of the east vertical wall is relatively smooth. The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *4.1 = 2.6E4 dpm/100cm^2

- for smooth concrete surface: 2.6E4 dpm/100cm^2 * 0.0603 c/d = 1.6E3 cpm/100cm^2
- for pitted/irregular surface: 2.6E4 dpm/100cm2 * 0.0373 c/d = 9.6E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >1.6E3 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >9.6E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area on the vertical walls. Supplemental SPA-3 scans on the irregular surfaces of the vertical walls and cracks in the concrete

MDCR for HP-100: The accompanying table provides MDCR values by various background levels. The expected background for the HP-100 range is 100 - 400 cpm.

MDC(fDCGL$_{EMC}$) for HP-100 scans: The accompanying table provides MDC(fDCGL$_{EMC}$) values by various background levels.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8534. Pre- and post-use instrument QC checks will be performed.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-12 are defined by the termination of the vertical surface of the NE section of the turbine building foundation. The survey will be performed under normal weather conditions.

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.

(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-12 exceeds the release criteria.

Probability of type I error: 0.05

Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 $cm^2 \div 2 =$ 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Mark the measurement locations (using Figure 1 as a guide) as follows:

(a) Locate and mark the random start point for the grid at a point 42 inches from the west boundary line and 11.5 inches from the top of the foundation.

(b) Locate and mark other fixed-point measurement locations at intervals of 46 inches to the west and east of the random start location. These locations are also 11.5 inches from the top of the foundation.

(c) If a measurement location shown in Figure 1 falls at a location that is obstructed (e.g., by soil) or from which a fixed-point measurement cannot be collected, select an alternate location in accordance with DP-8856.

Note: It may be necessary to adjust the grid shown in Figure 1 to fit the actual shape of the foundation surface. Adjustments to the grid are acceptable as long as the random start point is used, the general grid structure is maintained, and at least 15 fixed-point measurement locations are identified.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

(a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings with the shielded detector facing towards but approximately 1m from the concrete surface (and approximately 1 m above the soil) at the west end, center, and east end of the survey unit.

(b) Record the background data on the attached Form 1(even if the measurement was logged).

4. Collect a fixed-point (1-min) measurement in accordance with DP-8534 at each of the marked locations.

(a) Designate the fixed-point measurements sequentially beginning with BRT-01-12-001-F-FM.

(b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

(c) When recording the measurements on Form 2, identify those measurements collected from an irregular concrete surface with an asterisk (*).

(d) Note on Form 2 any measurement location that was omitted or added due to field adjustments of the planned grid.

5. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

6. Survey instrument: Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

7. The applicable job hazards associated with this survey will be addressed in the Yankee Rowe Project Daily Activity Plan and reviewed by the FSS Field Supervisor during the pre-survey briefing.

8. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source (e.g., waste pile or container),

(2) if a nearby source is identified, have it removed or shielded, document the finding on DP-8856.2, and repeat the scan,

(3) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(4) the designation for a fixed-point measurement collected during a first-level investigation will be BRT-01-12-0XX-F-FM-I, where "XX" continues the numbering sequence for fixed-point measurements. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(5) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location. Designate the investigation fixed-point measurement as described in step 1(c)(3) above. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2

NOTIFICATION POINTS

QA notification* point(s) (y/n) y

(1) Date/time of initial pre-survey briefing QA signature: ______

(2) Date/time of commencement of HP-100 measurements QA signature: ______

(3) Date/time of commencement of SPA-3 measurements QA signature: ______

(4) Time(s) of daily pre-shift briefing (for each shift that the FSS is performed) QA signature: ______

* Voice mail notification or E-mail notification to Trudeau@yankeerowe.com with a copy to ~~Calsyn@yankeerowe.com~~ Marchi@cyapco.com satisfies this step. gwB 11-17-05

FSI point(s) (y/n) n Specify: ______

Prepared by J. Buckley — FSS Radiological Engineer — Date 11-17-05

Reviewed by Martin C. Erickson — FSS Radiological Engineer — Date 11/17/05

Approved by J C Smith / [signature] — FSS Project Manager — Date 11/22/05

MDCR/MDC Table for Survey Unit BRT01-~~01~~ 12 gwB 11-16-05

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.2
1000	2	239	0.4

detector = HP-100 (1-in efficiency factor)

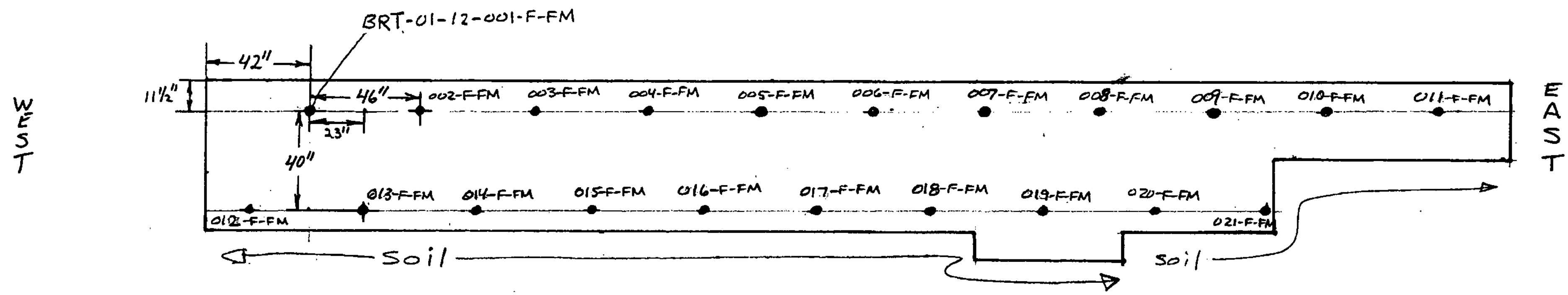


Figure 1: Locations of Fixed-Point Measurements

YNPS-FSSP-BRT01-12-00

Form 1
Background Data

Survey Unit BRT01-12
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
BG location 1	1	
	2	
	3	
	4	
	5	
	6	
	7	
BG location 2	1	
	2	
	3	
	4	
	5	
	6	
	7	
BG location 3	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-12
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)
BRT-01-12-001-F-FM	
BRT-01-12-002-F-FM	
BRT-01-12-003-F-FM	
BRT-01-12-004-F-FM	
BRT-01-12-005-F-FM	
BRT-01-12-006-F-FM	
BRT-01-12-007-F-FM	
BRT-01-12-008-F-FM	
BRT-01-12-009-F-FM	
BRT-01-12-010-F-FM	
BRT-01-12-011-F-FM	
BRT-01-12-012-F-FM	
BRT-01-12-013-F-FM	
BRT-01-12-014-F-FM	
BRT-01-12-015-F-FM	
BRT-01-12-016-F-FM	
BRT-01-12-017-F-FM	
BRT-01-12-018-F-FM	
BRT-01-12-019-F-FM	
BRT-01-12-020-F-FM	
BRT-01-12-021-F-FM	

Final Status Survey Planning Worksheet

GENERAL SECTION

Survey Area #: BRT-01	Survey Unit #: 13
Survey Unit Name: Miscellaneous Concrete Structures Inside the East Lower RCA Yard (alleyway)	
FSSP Number: YNPS-FSSP-BRT01-13-**02 (Rev 2 changes are in bold type)**	

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. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

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. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Note: Revision 2 to this plan incorporates modification to "General Instructions" for the collection of ambient background measurements and modification to Form 1 "Background Data".

Note: Revision 1 to this plan incorporates the vertical surface of the concrete structure at the east boundary of the survey unit. The additional surface area is estimated at approximately 60 ft^2 (5.6 m^2).

The excavation in the SFP area and the "alleyway" resulted in the uncovering of several miscellaneous concrete structures that will be left in place. These miscellaneous concrete structures have been consolidated into a single survey unit, BRT01-13. The concrete structures consist of an approximately 10-ft square concrete slab (located east of the base for TK-1), a portion of a concrete shelf, a section of the vertical wall of the east side of the RSS ring foundation, the vertical face of a concrete structure at the east boundary, and a portion of the yard crane beam support structure. The FSS planning for BRT01-13 was based on the estimated surface area for the slab, ring foundation, and concrete shelf, approximately 207 ft^2 (19.2 m^2). Using of a surface area that is smaller than the actual area is conservative in that more fixed-point measurements are likely to be collected during the FSS than the number of measurements required for statistical testing. Before the excavated area can be back-filled with clean soil, a final status survey must first be performed for these concrete structures to demonstrate that the residual plant-related contamination meets the acceptance criteria in the LTP. The data collected under this plan will be used to determine whether or not residual plant-related radioactivity on the exposed concrete surfaces of Survey Unit BRT01-13 meet LTP 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.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed LTP release criteria? Alternative actions that may be implemented in this effort are investigations and remediation followed by re-surveying.

3.0 Identify the inputs to the decision:

Sample media: concrete

Types of measurements: Fixed-point measurements, beta scans, and gamma scans.

Radionuclides-of-concern: Co-60 (assumed as a conservative measure for the same reasons discussed in YNPS-FSSP-BRT01-11-00 (the FSS plan for other miscellaneous concrete structures within the RSS footprint) and summarized below).

The concrete in survey unit BRT01-13 is believed to have the same radiological characteristics as other concrete structures located within the RSS foot. Accordingly, operational RP turnover surveys of those other concrete structures (e.g., the RSS ring and mat foundations) were used in the FSS planning for BRT01-13. The turnover survey data for RSS concrete structures (e.g., the ring foundation and mat foundation) consisted of beta scans and fixed-point measurements. The scans did not identify radiation levels greater than 5000 dpm/100cm^2. The mean value for the net detectable radioactivity from the fixed-point measurements from the mat foundation was 516±298 dpm/100cm^2 and the mean value for the net detectable radioactivity from the fixed-point measurements from the ring foundation was 883 ± 727 dpm/100cm2. The mean values from both surveys were significantly lower than the $DCGL_w$ for Co-60 (6.3E3 dpm/100cm^2). The operational RP survey of the ring foundation also included a concrete sample. Onsite gamma spectroscopy of that concrete sample did not identify any LTP-listed gamma-emitting nuclide.

Three characterization concrete core samples were collected from the subsurface region of the ring foundation (specifically, from the bottom 1/3 of the foundation). The lower portion of southeast region of the ring foundation was selected because that region was in contact with ground water and also in the path of a known tritium plume in the shallow aquifer. The concrete core samples were collected to a depth of 6 - 9 inches. Each core was sliced into at least six 1-inch sections, which were then submitted to onsite gamma analysis. Following onsite gamma analysis, each section was sent to an offsite laboratory for H-3 analysis. One slice, the concrete slice containing the outer surface of the lowest sample point (i.e., the outer surface most likely to have been impacted by groundwater), was submitted to additional analyses for other LTP-listed HTD nuclides and TRUs.

The results from onsite gamma analysis did not identify any LTP-listed gamma-emitting radionuclide on any of the concrete core slices. Of the 23 concrete core samples evaluated for H-3, only 1 sample (the outer surface sample from the lowest sampling point on the ring foundation) showed a measurable H-3 concentration (5.2 pCi/g). That sample was also analyzed for all other LTP-listed HTD nuclides and TRUs. Other than H-3, no LTP-listed nuclide was identified. The H-3 concentrations in all other samples from the concrete cores were less than MDA (target MDA in the analyses = 3.5 pCi/g). These results indicate that H-3 is not a radionuclide-of-concern for the ring and mat foundations. Moreover, based on the gamma analysis results for the concrete core slices and the concrete sample from the ring foundation surface (collected as part of the Operational RP turnover survey), the assumption that the detectable activity is Co-60 is a conservative assumption.

A turnover survey was not performed for the miscellaneous concrete structure in BRT01-13. The survey data from the ring foundation was used in the planning for BRT01-13 because of the higher observed variability in that data set, which leads to a more conservative estimate for the number of measurements required to support a statistics test.

Average radiation level: 883 dpm/100cm^2 (from Operational RP turnover survey)

Standard deviation (σ): 727 dpm/100cm^2 (from Operational RP turnover survey)

DCGLs:

(1) Applicable $DCGL_w$: 6.3E3 dpm/100cm^2 (Co-60 assumed)

Note: the $DCGL_w$ value corresponds to 8.73 mrem/y.

Some of the concrete surfaces contain pits and irregular surfaces (typical depths in these areas are approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches), which will increase the source-to-detector distance for some localized areas under the 100cm^2 window of the detector. These irregularities in the concrete surfaces will be taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the pitted/irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). The ε_i value for a distance of ½ inch will be applied to HP-100 data collected from smooth concrete surfaces. The efficiency factors provided in YA-REPT-00-015-04 are used below:

- ε_i = 0.2413 c/e for smooth concrete surfaces (reflects a source to detector distance = ½ inch), and
  = 0.149 c/e for pitted/irregular surfaces (reflects a source to detector distance = 1 inch)
- ε_s = 0.25 e/d (consistent with the Co-60 assumption made in this plan)
- total efficiency for smooth surface = $\varepsilon_i \cdot \varepsilon_s$ = 0.2413 c/e · 0.25 e/d = 0.0603 c/d
- total efficiency for pitted/irregular surfaces = $\varepsilon_i \cdot \varepsilon_s$ = 0.149 c/e · 0.25 e/d = 0.0373 c/d

(2) Gross measurement $DCGL_w$ (for HP-100): 6.3E3 dpm/100cm^2

- for smooth concrete surface: 6.3E3 dpm/100cm^2 * 0.0603 c/d = 3.8E2 cpm/100cm^2
- for pitted/irregular surface: 6.3E3 dpm/100cm2 * 0.0373 c/d = 2.3E2 cpm/100cm^2

(3) Applicable $DCGL_{EMC}$ for fixed-point measurements: $DCGL_w$ * AF = 6.3E3 dpm/100cm^2 *4.1 = 2.6E4 dpm/100cm^2

- for smooth concrete surface: 2.6E4 dpm/100cm^2 * 0.0603 c/d = 1.6E3 cpm/100cm^2
- for pitted/irregular surface: 2.6E4 dpm/100cm2 * 0.0373 c/d = 9.7E2 cpm/100cm^2

Note: the DCGL and $DCGL_{EMC}$ value refer to above-background radioactivity.

Investigation Level for fixed-point measurement:

- for smooth (i.e., vertical side) concrete surface: >1.6E3 cpm/100cm^2 above background
- for pitted/irregular (i.e., top) concrete surface: >9.7E2 cpm/100cm^2 above background

Investigation Level for HP-100 scan: Reproducible indication above background using the audible feature with headphones

Investigation Level for SPA-3 scan: Reproducible indication above background using the audible feature with headphones

Scan coverage: Beta scan with HP-100: 100% of the accessible concrete surface area of unit BRT01-13. Supplemental SPA-3 scans on the irregular surfaces and cracks in the concrete.

MDCR for HP-100: The accompanying table provides MDCR values by various background levels.

MDC(f$DCGL_{EMC}$) for HP-100 scans: The accompanying table provides MDC(f$DCGL_{EMC}$) values by various background levels.

Note: The expected background for the HP-100 range is 100 - 400 cpm.

QC checks and measurements: QC checks for the survey instruments will be performed in accordance with DP-8534. Pre- and post-use instrument QC checks will be performed.

4.0 Define the boundaries of the survey:

Boundaries of BRT01-13 are limited to the unearthed (exposed) concrete area of each structure. Diagram 1 shows the location for the fixed-point measurements based on a random-start, systematic grid extended over the estimated surface areas for the miscellaneous concrete structures. The survey will be performed under weather conditions that permit safe surveying.

5.0 Develop a decision rule:

(a) If all the FSS data show that residual levels of plant-related radioactivity are below the $DCGL_w$, reject the null hypothesis (i.e., Survey Unit meets the release criteria).
(b) If the investigation level is exceeded, then perform an investigation.
(c) If the average of the FSS 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 of the FSS measurements exceeds the $DCGL_w$, then accept the null hypothesis (i.e., Survey Unit fails to meet the release criteria).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in Survey Unit BRT01-13 exceeds the release criteria.
Probability of type I error: 0.05
Probability of type II error: 0.05

7.0 *LBGR*: 6.3E3 dpm/100 cm^2 ÷ 2 = 3.2E3 dpm/100 cm^2

8.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

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

Number samples (per DP-8853): 15.

Biased Measurements: None

GENERAL INSTRUCTIONS

1. The FSS Field Supervisor is responsible for contacting the QA Department regarding the FSS activities identified as QA notification points.

2. Locate and mark the fixed-point measurement points using Diagram 1 as a reference. Note: as dictated by safety concerns, reasonable approximations in lieu of exact measurements for the locations are acceptable.

   (a) Locate the random start point on the concrete slab by measuring 5 ft, 9 inches from the west corner on the north side and 8 ft, 1 inch south of the north edge. Designate this location as 001.

   (b) Locate points 002 through 008 on the top surface of the slab by using the measurements provided in Diagram 1.

   (c) Locate points 009 through 013 on the east vertical surface of the ring foundation as shown in Diagram 1. If a planned measurement point falls on soil but is within 1 meter of concrete surface, mark the location on the closest concrete surface. If the actual surface area of the ring foundation allows additional measurement locations through further extension of the grid, mark and designate any additional location continuing in sequence with number 020.

   (d) Locate points 014 and 015 on the concrete shelf as shown in Diagram 1. If a planned measurement point falls on soil but is within 1 meter of concrete surface, mark the location on the closest concrete surface. If the actual surface area of the concrete shelf allows additional measurement locations with further extension of the systematic grid, designate any additional locations continuing with the numbering sequence.

   (e) Locate points 016 through 019 on the crane beam support as shown in Diagram 1. If a planned measurement point falls on soil but is within 1 meter of concrete surface, mark the location on the closest concrete surface. If the actual surface area of the beam support structure allows additional measurement locations with further extension of the systematic grid, designate any additional locations continuing with the numbering sequence.

   (f) Locate points on the vertical face of the concrete structure at the east boundary as shown in Diagram 1. These measurement locations begin at the north end of the concrete structure. Identify these locations in sequence beginning with 032.

   (g) If a fixed-point measurement location falls on a point where the concrete surface does not permit the collection of a measurement, select an alternate location in accordance with DP-8856.

3. Collect a series of ambient background measurements in accordance with step B.1.c in DP-8866 with the following variation of step B.1.c.2) using the HP-100 that is to be used to collect the fixed-point measurements:

   (a) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 7 one-minute readings from the center of the concrete slab with the detector facing towards the concrete surface but approximately 1m away.

   (b) Following the same procedure described in step 3(a), collect **15** one-minute readings from the center of the exposed vertical surface of the ring foundation with the covered detector facing towards the concrete surface but approximately 1m away.

   (c) Following the same procedure described in step 3(a), collect 7 one-minute readings from the center of the exposed vertical surface of the south face of the crane beam support structure with the covered detector facing towards the concrete surface but approximately 1m away (and also approximately 1m away from soil). ?, 12/20/05

   (d) Following the same procedure described in step 3(a), collect a total of ~~15~~ 14 one-minute readings, 7 from the center of the exposed north facing vertical surface and 7 from the center of the exposed west facing vertical surface of the shelf of the ring foundation with the covered detector facing toward the concrete surface but approximately 1m away.

   (e) Cover the detector with a 1/8-inch Lucite (or equivalent) shield and collect 15 (evenly spaced) one-minute readings along the vertical surface of the concrete structure (duct bank). Begin at the north end of the east boundary.

   (f) Record the background data on the attached Form 1(even if the measurement was logged).

5. Collect a fixed-point (1-min) measurement at each identified location in accordance with DP-8534 at each of the marked locations.

   (a) Use the code format BRT-01-13-0XX-F-FM, where "0XX" corresponds to the measurement location number, when recording the fixed-point measurements.

   (b) Record each fixed-point measurement "as read" (in units of cpm) on the attached Form 2 (even if the reading was logged).

   (c) When recording the measurements on Form 2, identify those measurements collected from an irregular concrete surface with an asterisk (*).

11/30/06

(d) Note on Form 2 any measurement location that was omitted or added due to field adjustments of the planned grid.

6. Perform HP-100 and SPA-3 scans as described in the Specific Instructions.

8. Operation of the E-600 will be in accordance with DP-8534. Pre- and post-use QC checks for survey instruments are to be performed.

9. The applicable job hazards associated with this survey will be addressed in the Daily Activity Plan and reviewed in the pre-survey briefing.

10. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. Beta scans:

(a) Perform the HP-100 scans by moving the detector at a speed no greater than 2 inches per second, using a ½ inch standoff.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the investigation level.

(c) If the HP-100 scan investigation level is exceeded:

(1) confirm that the elevated scan reading is reproducible and not the result of a nearby source (e.g., waste pile or container),

(2) if a nearby source is identified, have it removed or shielded, document the finding on DP-8856.2, and repeat the scan,

(3) if reproducible and not caused by a nearby source, collect a fixed-point measurement at the location of the greater-than-investigation level reading,

(4) the designation for a fixed-point measurement collected during a first-level investigation will be BRT-01-13-0XX-F-FM-I, where "XX" continues the numbering sequence for fixed-point measurements. Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged).

(5) mark the location of the fixed-point measurement location for further investigation if it exceeds the investigation level for a fixed-point measurement. If a fixed-point measurement location has been identified for further investigation, the investigation will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the HP-100 scans on DPF-8856.2.

2. Perform SPA-3 scans:

(a) Perform SPA-3 of the irregular surfaces and over cracks in the concrete by moving the detector slowly (no greater than 0.25m/s) and keeping it < 3 inches from the surface.

(b) FSS Technicians will wear headphones while scanning and the survey instrument will be in the rate-meter mode. Surveyors will listen for upscale readings and respond to readings that exceed the SPA-3 investigation level.

(c) If a SPA-3 reading exceeds the investigation level:

(1) confirm that the above-background indication is reproducible and cannot be attributed to a nearby source,

(2) if a nearby source is identified, have it removed or shielded, document the finding on DP-8856.2, and repeat the scan,

(3) if the reading is reproducible and not caused by a nearby source, collect a fixed-point measurement with the HP-100 at the highest reading observed during the scan and clearly mark that location.

(4) Designate the investigation fixed-point measurement as described in step 1(c)(3) above.

(5) Record all investigation fixed-point measurements "as read" (in units of cpm) on the attached Form 2 (even if the measurement was logged). If further investigation is required, it will be conducted under a separate survey plan.

(d) The FSS Field Supervisor will record information relevant to the SPA-3 scans on DPF-8856.2.

NOTIFICATION POINTS	
QA notification* point(s) (y/n) __y	
(1) Date/time of initial pre-survey briefing ______	QA signature: ____________________
(2) Date/time of commencement of HP-100 measurements	QA signature: ____________________
(3) Date/time of commencement of SPA-3 measurements	QA signature: ____________________
(4) Time(s) of daily pre-shift briefing (for each shift that the FSS is performed)	QA signature: ____________________
* Voice mail notification or E-mail notification to Marchi@cyapco.com satisfies this step.	
FSI point(s) (y/n) __n______	Specify: ____________________

Prepared by [signature] FSS Radiological Engineer Date 12-21-05

Reviewed by Mark C. [signature] FSS Radiological Engineer Date 12/21/05

Approved by D.C. Smith/[signature] FSS Project Manager Date 12/21/05

MDCR/MDC Table for Survey Unit BRT01-13

Background (cpm)	scan speed (in/s)	MDCR (cpm)	MDC(fDCGL(emc))
400	2	151	0.5
1000	2	239	0.8

detector = HP-100 (1-in efficiency factor)

Form 1
Background Data

Survey Unit BRT01-13
Instrument No.: ____________

Location	Measurement No.	Measurement (cpm)
Concrete pad (center)	1	
	2	
	3	
	4	
	5	
	6	
	7	
Ring foundation	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
Ring foundation shelf	**1**	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
East boundary (Duct Bank)	**1**	
	2	
	3	
	4	
	5	
	6	

	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
Crane beam support structure (south face)	1	
	2	
	3	
	4	
	5	
	6	
	7	

Form 2
FSS Fixed-Point Measurements

Survey Unit BRT01-13
Instrument No.: ___________

Location	Measurement (cpm/100cm^2)	Comment
BRT-01-13-001-F-FM		
BRT-01-13-002-F-FM		
BRT-01-13-003-F-FM		
BRT-01-13-004-F-FM		
BRT-01-13-005-F-FM		
BRT-01-13-006-F-FM		
BRT-01-13-007-F-FM		
BRT-01-13-008-F-FM		
BRT-01-13-009-F-FM		
BRT-01-13-010-F-FM		
BRT-01-13-011-F-FM		
BRT-01-13-012-F-FM		
BRT-01-13-013-F-FM		
BRT-01-13-014-F-FM		
BRT-01-13-015-F-FM		
BRT-01-13-016-F-FM		
BRT-01-13-017-F-FM		
BRT-01-13-018-F-FM		
BRT-01-13-019-F-FM		
BRT-01-13-020-F-FM		
BRT-01-13-021-F-FM		
BRT-01-13-022-F-FM		
BRT-01-13-023-F-FM		
BRT-01-13-024-F-FM		
BRT-01-13-025-F-FM		
BRT-01-13-026-F-FM		
BRT-01-13-027-F-FM		
BRT-01-13-028-F-FM		
BRT-01-13-029-F-FM		
BRT-01-13-030-F-FM		
BRT-01-13-031-F-FM		
BRT-01-13-032-F-FM		
BRT-01-13-033-F-FM		
BRT-01-13-034-F-FM		
BRT-01-13-035-F-FM		
BRT-01-13-036-F-FM		
BRT-01-13-037-F-FM		
BRT-01-13-038-F-FM		
BRT-01-13-039-F-FM		
BRT-01-13-040-F-FM		
BRT-01-13-0__-F-FM		
BRT-01-13-0__-F-FM		
BRT-01-13-0__-F-FM		

TECHNICAL REPORT TITLE PAGE

COPY

Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at Yankee Rowe

Title

YA-REPT-00-015-04
REV. 0

Technical Report Number

Approvals	(Print & Sign Name)		
Preparer:	[signature]	Date:	10-7-04
Reviewer:	James R. Hummer	Date:	10/7/04
Approver (Cognizant Manager):	[signature]	Date:	10/7/04

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Tables

Appendix

1.0 Executive Summary:

The minimum detectable concentration (MDC) of the field survey instrumentation is an important factor affecting the quality of the final status survey (FSS). The efficiency of an instrument inversely impacts the MDC value. The objective of this report is to determine the instrument and source efficiency values used to calculate MDC. Several factors were considered when determining these efficiencies and are discussed in the body of this report. Instrument efficiencies (ε_i), and source efficiencies (ε_s), for alpha beta detection equipment under various field conditions, and instrument conversion factors (E_i), for gamma scanning detectors were determined and the results are provided herein.

2.0 Introduction:

Before performing Final Status Surveys of building surfaces and land areas, the minimum detectable concentration (MDC) must be calculated to establish the instrument sensitivity. Table 5.4 of the License Termination Plan (LTP) [8.6] lists the available instrumentation and nominal detection sensitivities; however for the purposes of this basis document, efficiencies for the 100cm^2 gas proportional and the 2"x2" NaI (Tl) detectors will be determined. Efficiencies for the other instrumentation listed in the LTP shall be determined on an as needed basis. The 100 cm^2 gas proportional probe will be used to perform surveys (i.e. fixed point measurements). A 2" x2" NaI (Tl) detector will be used to perform gamma surveys (i.e., surface scans) of portions of land areas and possibly supplemental structural scans at the Yankee Rowe site. Although surface scans and fixed point measurements can be performed using the same instrumentation, the calculated MDCs will be quite different. MDC is dependent on many factors and may include but is not limited to:

- instrument efficiency
- background
- integration time
- surface type
- source to detector geometry
- source efficiency

A significant factor in determining an instrument MDC is the total efficiency, which is dependent on the instrument efficiency, the source efficiency and the type and energy of the radiation. MDC values are inversely affected by efficiency, as efficiencies increase, MDC values will decrease. Accounting for both the instrument and source components of the total efficiency provides for a more accurate assessment of surface activity.

3.0 Calibration Sources:

For accurate measurement of surface activity it is desirable that the field instrumentation be calibrated with source standards similar to the type and energy of the anticipated contamination. The nuclides listed in Table 3.1 illustrate the nuclides found in soil and building surface area DCGL results that are listed in the LTP.

Instrument response varies with incident radiations and energies; therefore, instrumentation selection for field surveys must be modeled on the expected surface activity. For the purposes of this report, isotopes with max beta energies less than that of C-14 (0.158 MeV) will be considered difficult to detect (reference table 3.1). The detectability of radionuclides with max beta energies less than 0.158 MeV, utilizing gas proportional detectors, will be negligible at typical source to detector distances of approximately 0.5

inches. The source to detector distance of 1.27 cm (0.5 inches) is the distance to the detector with the attached standoff (DP-8534 "Operation and Source Checks of Proportional Friskers")[8.5]. Table 3.1 provides a summary of the LTP radionuclides and their detectability using Radiological Health Handbook [8.4] data.

Table 3.1
Nuclides and Major Radiations: Approximate Energies (Reference 8.4)

Nuclide	α Energy (MeV)	$E_{\beta max}$ (MeV)	Average E_β (MeV)	Photon Energy (MeV)	α Detectable w/ Gas Proportional	β Detectable w/ Gas Proportional	γ Detectable w/ NaI 2x2"
H-3		0.018	0.005				
C-14		0.158	0.049				
Fe-55				0.23 (0.004%) bremsstrahlung			
Co-60		0.314	0.094	1.173 (100%), 1.332 (100%)		√	√
Ni-63		0.066	0.017				
Sr-90		0.544 2.245 (Y-90)	0.200 0.931			√	
Nb-94		0.50	0.156	0.702 (100%), 0.871 (100%)		√	√
Tc-99		0.295	0.085			√	
Ag-108m		1.65 (Ag-108)	0.624 (Ag-108)	0.434 (0.45%), 0.511 (0.56%) 0.615 (0.18%), 0.632 (1.7%)			√
Sb-125		0.612	0.084	0.6, 0.25, 0.41, 0.46, 0.68, 0.77, 0.92, 1.10, 1.34		√	√
Cs-134		1.453	0.152	0.57 (23%), 0.605 (98%) 0.796 (99%), 1.038 (1.0%) 1.168 (1.9%), 1.365 (3.4%)		√	√
Cs-137		1.167	0.195	0.662 (85%) Ba-137m X-rays		√	√
Eu-152		1.840	0.288	0.122 (37%), 0.245 (8%) 0.344 (27%), 0.779 (14%) 0.965 (15%), 1.087 (12%) 1.113 (14%), 1.408 (22%)		√	√
Eu-154		1.850 (10%)	0.228				
Eu-155		0.247	0.044	0.087 (32%), 0.105 (20%)		√	
Pu-238	5.50 (72%) 5.46 (28%)			0.099 (8E-3%) 0.150 (1E-3%) 0.77 (5E-5%)	√		
Pu-239	5.16 (88%) 5.11 (11%)			0.039 (0.007%), 0.052 (0.20%), 0.129 (0.005%)...	√		
Pu-241	4.90 (0.0019%) 4.85 (0.0003%)	0.021	0.005	0.145 (1.6E-4%)			
Am-241	5.49 (85%) 5.44 (13%)			0.060 (36%), 0.101 (0.04%)...	√		
Cm-243	6.06 (6%) 5.99 (6%) 5.79 (73%) 5.74 (11.5%)			0.209 (4%), 0.228 (12%), 0.278 (14%)	√		

NUREG-1507 and ISO 7503-1 provide guidance for selecting calibration sources and their use in determining total efficiency. It is common practice to calibrate instrument efficiency for a single beta energy; however the energy of this reference source should not be significantly greater than the beta energy of the lowest energy to be measured.

Tc-99 (0.295 MeV max) and Th-230 (4.68 MeV at 76% and 4.62 MeV at 24%) have been selected as the beta and alpha calibration standards respectively, because their energies conservatively approximate the beta and alpha energies of the plant specific radionuclides.

4.0 Efficiency Determination:

Typically, using the instrument 4π efficiency exclusively provides a good approximation of surface activity. Using these means for calculating the efficiency often results in an under estimate of activity levels in the field. Applying both the instrument 2π efficiency and the surface efficiency components to determine the total efficiency allows for a more accurate measurement due to consideration of the actual characteristics of the source surfaces. ISO 7503-1 [8.2] recommends that the total surface activity be calculated using:

$$A_s = \frac{R_{S+B} - R_B}{(\varepsilon_i)(W)(\varepsilon_s)},$$

where:

A_s is the total surface activity in dpm/cm^2,
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
ε_i is the instrument or detector 2π efficiency
ε_s is the efficiency of the source
W is the area of the detector window (cm^2)

4.1 Alpha and Beta Instrument Efficiency (ε_i):

Instrument efficiency (ε_i) reflects instrument characteristics and counting geometry, such as source construction, activity distribution, source area, particles incident on the detector per unit time and therefore source to detector geometry. Theoretically the maximum value of ε_i is 1.0, assuming all the emissions from the source are 2π and that all emissions from the source are detected. The ISO 7503-1 methodology for determining the instrument efficiency is similar to the historical 4π approach; however the detector response, in cpm, is divided by the 2π surface emission rate of the calibration source. The instrument efficiency is calculated by dividing the net count rate by the 2π surface emission rate ($q_{2\pi}$) (includes absorption in detector window, source detector geometry). The instrument efficiency is expressed in ISO 7503-1 by:

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi}}$$

where:
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
$q_{2\pi}$ is the 2π surface emission rate in reciprocal seconds

Note that both the 2π surface emission rate and the source activity are usually stated on the certification sheet provided by the calibration source manufacturer and certified as National Institute of Standards and Technology (NIST) traceable. Table 4.1 depicts instrument efficiencies that have been determined during calibration using the 2π surface emission rate of the source.

Table 4.1
Instrument Efficiencies (ε_i)

Source	Emission	Active Area of Source (cm^2)	Effective Area of Detector	100 cm^2 Gas Proportional HP-100 Instrument Efficiency (ε_i) (Contact)
Tc-99	β	*15.2*	100 cm^2	0.4148
Th-230	α	*15.2*	100 cm^2	0.5545

4.2 Source to Detector Distance Considerations:
A major factor affecting instrument efficiency is source to detector distance. Consideration must be given to this distance when selecting accurate instrument efficiency. The distance from the source to the detector shall to be as close as practicable to geometric conditions that exist in the field. A range of source to detector distances has been chosen, taking into account site specific survey conditions. In an effort to minimize the error associated with geometry, instrument efficiencies have been determined for source to detector distances representative of those survey distances expected in the field. The results shown in Table 4.2 illustrate the imposing reduction in detector response with increased distance from the source. Typically this source to detector distance will be 0.5 inches for fixed point measurements and 0.5 inches for scan surveys on flat surfaces, however they may differ for other surfaces. Table 4.2 makes provisions for the selection of source to detector distances for field survey conditions of up to 2 inches. If surface conditions dictate the placement of the detector at distances greater than 2 inches instrument efficiencies will be determined on an as needed basis.

4.2.1 Methodology:
The practical application of choosing the proper instrument efficiency may be determined by averaging the surface variation (peaks and valleys narrower than the length of the detector) and adding 0.5 inches, the spacing that should be maintained between the detector and the highest peaks of the surface. Select the source to detector distance from Table 4.2 that best reflects this pre-determined geometry.

Table 4.2
Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters

Source to Detector Distance (cm)	**Instrument Efficiency (ε_i)**	
	Tc-99 Distributed	**Th-230 Distributed**
Contact	0.4148	0.5545
1.27 (0.5 in)	0.2413	0.1764
2.54 (1 in)	0.1490	0.0265
5.08 (2 in)	0.0784	0.0002

4.3 Source (or Surface) Efficiency (ε_s) Determination:

Source efficiency (ε_s), reflects the physical characteristics of the surface and any surface coatings. The source efficiency is the ratio between the number of particles emerging from surface and the total number of particles released within the source. The source efficiency accounts for attenuation and backscatter. ε_s is nominally 0.5 (no self-absorption/attenuation, no backscatter)--backscatter increases the value, self-absorption decreases the value. Source efficiencies may either be derived experimentally or simply selected from the guidance contained in ISO 7503-1. ISO 7503-1 takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. However, this approach may prove to be too conservative for radionuclides with max beta energies that are marginally lower than 0.400 MeV, such as Co-60 with a βmax of 0.314 MeV. In this situation, it may be more appropriate to determine the source efficiency by considering the energies of other beta emitting radionuclides. Using this approach it is possible to determine weighted average source efficiency. For example, a source efficiency of 0.375 may be calculated based on a 50/50 mix of Co-60 and Cs-137. The source efficiencies for Co-60 and Cs-137 are 0.25 and 0.5 respectively, since the radionuclide fraction for Co-60 and Cs-137 is 50% for each, the weighted average source efficiency for the mix may be calculated in the following manner:

$$(0.25)(0.5)+(0.5)(0.5)=0.375$$

Table 4.3 lists guidance on source efficiencies from ISO 7503-1.

Table 4.3
Source Efficiencies as listed in ISO 7503-1

	$> 0.400\ MeV_{max}$	$\leq 0.400\ MeV_{max}$
Beta emitters	$\varepsilon_s = 0.5$	$\varepsilon_s = 0.25$
Alpha emitters	$\varepsilon_s = 0.25$	$\varepsilon_s = 0.25$

It should be noted that source efficiency is not typically addressed for gamma detectors as the value is effectively unity.

5.0 Instrument Conversion Factor (E) (Instrument Efficiency for Scanning):

Separate modeling analysis (Microshield™) was conducted using the common gamma emitters with a concentration of 1 pCi/g of uniformly distributed contamination throughout the volume. MicroShield is a comprehensive photon/gamma ray shielding and dose assessment program, which is widely used throughout the radiological safety community. An activity concentration of 1 pCi/g for the nuclides was entered as the source term. The radial dimension of the cylindrical source was 28 cm, the depth was 15 cm, and the dose point above the surface was 10 cm with a soil density of 1.6 g/cm^3. The instrument efficiency when scanning, E_i, is the product of the modeled exposure rate (MicroShield™) in mRhr^{-1}/pCi/g for and the energy response factor in cpm/mR/hr as derived from the energy response curve provided by Eberline Instruments (Appendix O). Table 5.1 demonstrates the derived efficiencies for the major gamma emitting isotopes listed in Table 3.1.

TABLE 5.1

Energy Response and Efficiency for Photon Emitting Isotopes

Isotope	Calculations for E_i See appendix A through L	E_i (cpm/pCi/g)
Co-60	See Appendix Aand B	379
Nb-94	See Appendix C and D	416
Ag-108m	See Appendix E and F	637
Sb-125	See Appendix G and H	210
Cs-134	See Appendix I and J	506
Cs-137	See Appendix K and L	188
Eu-152	See Appendix M and N	344

When performing gamma scan measurements on soil surfaces the effective source to detector geometry is as close as is reasonably possible (less than 3 inches).

6.0 Applying Efficiency Corrections Based on the Effects of Field Conditions for Total Efficiency:

The total efficiency for any given condition can now be calculated from the product of the instrument efficiency ε_i and the source efficiency ε_s.

$$\varepsilon_{tot} = \varepsilon_i \text{ X } \varepsilon_s$$

The following example illustrates the process of determining total efficiency. For this example we will assume the following:

- Surface activity readings need to be made in the Primary Auxiliary Building (PAB) on the concrete wall surfaces using the E-600 and C-100 gas proportional detector.
- Data obtained from characterization results from the PAB indicate the presence of beta emitters with energies greater than 0.400 Mev.
- The source (activity on wall) to detector distance is 1.27 cm (0.5 in detector stand off). To calculate the total efficiency, ε_{tot}, refer to Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters" to obtain the appropriate ε_i value.
- Contamination on all surfaces is distributed relative to the effective detector area.

- When performing fixed point measurements with gas proportional instrumentation the effective source to detector geometry is representative of the calibrated geometries listed in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters".
- Corrections for temperature and pressure are not substantial.

In this example, the value for ε_i is 0.2413 as depicted in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters". The ε_s value of 0.5 is chosen refer to Table 4.3 "Source Efficiencies as listed in ISO 7503-1". Therefore the total efficiency for this condition becomes $\varepsilon_{tot} = \varepsilon_i \times \varepsilon_s = 0.2413 \times 0.5 = 0.121$ or 12.1%.

7.0 Conclusion:

Field conditions may significantly influence the usefulness of a survey instrument. When applying the instrument and source efficiencies in MDC calculations, field conditions must be considered. Tables have been constructed to assist in the selection of appropriate instrument and source efficiencies. Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α-β Emitters" lists instrument efficiencies (ε_i) at various source to detector distances for alpha and beta emitters. The appropriate ε_i value should be applied, accounting for the field condition, i.e. the relation between the detector and the surface to be measured.

Source efficiencies shall be selected from Table 4.3 "Source Efficiencies as listed in ISO 7503-1". This table lists conservative ε_s values that correct for self-absorption and attenuation of surface activity. Table 5.1 "Energy Response and Efficiency for Photon Emitting Isotopes" lists E_i values that apply to scanning MDC calculations. The Microshield™ model code was used to determine instrument efficiency assuming contamination conditions and detector geometry cited in section 5.6.2.4.4 "MDCs for Gamma Scans of Land Areas" of the License Termination Plan [8.6].

Detector and source conditions equivalent to those modeled herein may directly apply to the results of this report.

8.0 References

8.1 NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," 1998

8.2 ISO 7503-1, "Evaluation of Surface Contamination – Part I: Beta Emitters and Alpha Emitters," 1988-08-01.

8.3 ISO 8769, "Reference Sources for the Calibration of Surface Contamination Monitors-Beta-emitters (maximum beta energy greater 0.15MeV) and Alpha-emitters," 1988-06-15.

8.4 "Radiological Health Handbook," Revised Edition 1970.

8.5 DP-8534, "Operation and source Checks of Portable Friskers".

8.6 Yankee Nuclear Plant Site License Termination Plan, Rev.0, November 2003.

APPENDIX A

MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Co-60.ms6	**Date**	:
Run Date	: September 10, 2004	**By**	:
Run Time	: 8:56:50 AM	**Checked**	:
Duration	: 00:00:00		

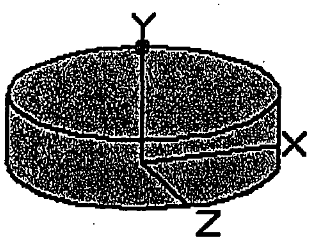
Case Title: SPA3-EFF-Co-60
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Co-60
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in



Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Co-60	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.230e-01	9.055e-06	1.590e-05	1.748e-08	3.070e-08
1.1732	1.367e+03	1.098e-01	1.669e-01	1.962e-04	2.982e-04
1.3325	1.367e+03	1.293e-01	1.904e-01	2.244e-04	3.303e-04
Totals	**2.734e+03**	**2.391e-01**	**3.573e-01**	**4.205e-04**	**6.286e-04**

APPENDIX B

Co-60
Microsoft Excel E_i Calculation Sheet

	Energy MeV	Energy kev	Exposure Rate (mR/hr-pCi/g)	Energy Response (cpm/mR/h)	E_i (cpm/pCi/g)
694	0.6938	694	3.07E-08	1,112.630	0
1173	1.1732	1,173	2.98E-04	660.557	197
1333	1.3325	1,333	3.30E-04	552.233	182
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E_i) Total:	379

APPENDIX C

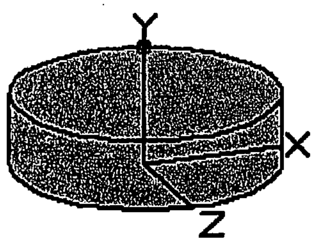
MicroShield v6.02 (6.02-00253)

Page	:1		**File Ref**	:
DOS File	:SPA3-EFF-Nb-94.ms6		**Date**	:
Run Date	: September 16, 2004		**By**	:
Run Time	: 3:22:38 PM		**Checked**	:
Duration	: 00:00:00			

Case Title: SPA3-EFF-Nb-94
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Nb-94
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Nb-94	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0023	9.067e-02	1.391e-10	1.430e-10	1.861e-10	1.913e-10
0.0174	4.834e-01	8.762e-09	9.129e-09	4.729e-10	4.927e-10
0.0175	9.260e-01	1.719e-08	1.792e-08	9.104e-10	9.491e-10
0.0196	2.720e-01	7.924e-09	8.356e-09	2.925e-10	3.085e-10
0.7026	1.367e+03	5.643e-02	9.872e-02	1.088e-04	1.904e-04
0.8711	1.367e+03	7.464e-02	1.228e-01	1.405e-04	2.312e-04
Totals	**2.736e+03**	**1.311e-01**	**2.216e-01**	**2.493e-04**	**4.216e-04**

APPENDIX D

Nb-94					
	Energy MeV	Energy keV	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
2	0.0023	2	1.91E-10		0
17	0.0174	17	4.93E-10		0
18	0.0175	18	9.49E-10		0
20	0.0196	20	3.09E-10		0
703	0.7026	703	1.90E-04	1,110,370	211
871	0.8711	871	2.31E-04	884,689	205
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	416

APPENDIX E

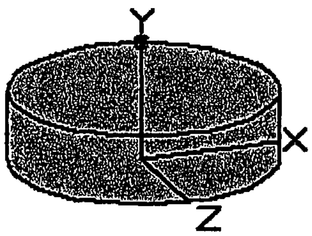
MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Ag-108m.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:30:40 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Ag-108m
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Ag-108m
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Ag-108m	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0028	6.580e+01	1.252e-07	1.287e-07	1.351e-07	1.388e-07
0.003	7.853e+00	1.568e-08	1.612e-08	1.612e-08	1.657e-08
0.021	2.491e+02	9.534e-06	1.015e-05	2.824e-07	3.007e-07
0.0212	4.727e+02	1.862e-05	1.985e-05	5.389e-07	5.744e-07
0.022	7.024e+00	3.202e-07	3.434e-07	8.233e-09	8.831e-09
0.0222	1.330e+01	6.251e-07	6.714e-07	1.568e-08	1.685e-08
0.0238	1.501e+02	9.273e-06	1.010e-05	1.863e-07	2.029e-07
0.0249	4.289e+00	3.145e-07	3.464e-07	5.492e-09	6.050e-09
0.0304	2.902e-04	4.431e-11	5.248e-11	4.230e-13	5.010e-13
0.0792	9.687e+01	2.008e-04	4.802e-04	3.190e-07	7.629e-07
0.4339	1.229e+03	2.705e-02	5.514e-02	5.294e-05	1.079e-04
0.6144	1.236e+03	4.282e-02	7.808e-02	8.347e-05	1.522e-04
0.7229	1.237e+03	5.300e-02	9.194e-02	1.019e-04	1.768e-04
Totals	**4.768e+03**	**1.231e-01**	**2.257e-01**	**2.398e-04**	**4.389e-04**

APPENDIX F

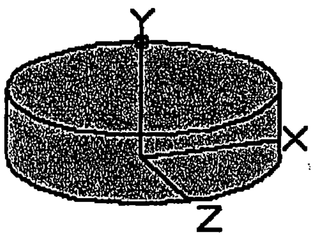
	Ag-108m Microsoft Excel E_i Calculation Sheet				
	Energy MeV	Energy keV	Exposure Rate (mR/hr / 1/pCi/g)	Energy Response cpm/mR/h	Ei (cpm/pCi/g)
3	0.0028	3	1.39E-07		0
3	0.003	3	1.66E-08		0
21	0.021	21	3.01E-07		0
21	0.0212	21	5.74E-07		0
22	0.022	22	8.83E-09		0
22	0.0222	22	1.69E-08		0
24	0.0238	24	2.03E-07		0
25	0.0249	25	6.05E-09		0
30	0.0304	30	5.01E-13	1086720	0
79	0.0792	79	7.63E-07	11696000	9
434	0.4339	434	1.08E-04	2061265	222
614	0.6144	614	1.52E-04	1402440	213
723	0.7229	723	1.77E-04	1086291	192
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E_i) Total:	637

APPENDIX G

MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Sb-125.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:34:07 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Sb-125
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Sb-125
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	Becquerels	μCi/cm³	Bq/cm³
Sb-125	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0038	6.762e+01	1.708e-07	1.756e-07	1.388e-07	1.427e-07
0.0272	1.748e+02	1.785e-05	2.020e-05	2.376e-07	2.689e-07
0.0275	3.262e+02	3.453e-05	3.922e-05	4.461e-07	5.067e-07
0.031	1.132e+02	1.857e-05	2.221e-05	1.670e-07	1.997e-07
0.0355	5.693e+01	1.492e-05	1.918e-05	9.090e-08	1.169e-07
0.117	3.568e+00	1.380e-05	3.715e-05	2.146e-08	5.778e-08
0.159	9.531e-01	5.634e-06	1.499e-05	9.416e-09	2.505e-08
0.1726	2.478e+00	1.634e-05	4.295e-05	2.787e-08	7.326e-08
0.1763	9.422e+01	6.392e-04	1.674e-03	1.096e-06	2.870e-06
0.2041	4.410e+00	3.630e-05	9.230e-05	6.435e-08	1.636e-07
0.2081	3.324e+00	2.805e-05	7.103e-05	4.994e-08	1.264e-07
0.2279	1.796e+00	1.708e-05	4.229e-05	3.098e-08	7.670e-08
0.321	5.701e+00	8.474e-05	1.899e-04	1.620e-07	3.632e-07
0.3804	2.045e+01	3.792e-04	8.052e-04	7.364e-07	1.564e-06
0.408	2.486e+00	5.051e-05	1.049e-04	9.853e-08	2.047e-07
0.4279	4.009e+02	8.668e-03	1.774e-02	1.695e-05	3.470e-05
0.4435	4.130e+00	9.356e-05	1.894e-04	1.832e-07	3.709e-07
0.4634	1.415e+02	3.395e-03	6.781e-03	6.658e-06	1.330e-05
0.6006	2.430e+02	8.174e-03	1.501e-02	1.595e-05	2.930e-05
0.6066	6.864e+01	2.340e-03	4.283e-03	4.564e-06	8.355e-06
0.6359	1.548e+02	5.609e-03	1.012e-02	1.091e-05	1.967e-05
0.6714	2.478e+01	9.640e-04	1.710e-03	1.867e-06	3.311e-06
Totals	**1.916e+03**	**3.060e-02**	**5.901e-02**	**6.046e-05**	**1.158e-04**

APPENDIX H

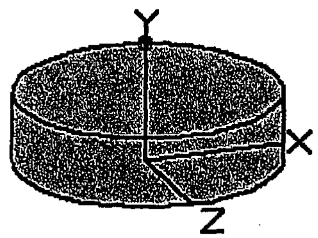
Sb-125					
	Energy MeV	Energy keV	Exposure Rate (mR/hr / pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
4	0.0038	4	1.43E-07	6,618,312	0
27	0.0272	27	2.69E-07	510,290	0
28	0.0275	28	5.07E-07	554,334	0
31	0.031	31	2.00E-07	1,219,281	0
36	0.0355	36	1.17E-07	2,418,948	0
117	0.117	117	5.78E-08	9,167,000	1
159	0.159	159	2.51E-08	8917000	0
173	0.1726	173	7.33E-08	6859000	1
176	0.1763	176	2.87E-06	6192600	18
204	0.2041	204	1.64E-07	6011300	1
208	0.2081	208	1.26E-07	4073050	1
228	0.2279	228	7.67E-08	3110500	0
321	0.321	321	3.63E-07	3000500	1
380	0.3804	380	0.000001564	2348000	4
408	0.408	408	2.047E-07	2155800	0
428	0.4279	428	0.0000347	2083165	72
444	0.4435	444	3.709E-07	2026225	1
463	0.4634	463	0.0000133	1953590	26
601	0.6006	601	0.0000293	1452810	43
607	0.6066	607	0.000008355	1430910	12
636	0.6359	636	0.00001967	1323965	26
671	0.6714	671	0.000003811	1194390	4
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(Ei) Total:	210

APPENDIX I

MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Cs-134.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:39:09 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Cs-134
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Cs-134
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Cs-134	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0045	1.222e+00	3.658e-09	3.760e-09	2.507e-09	2.577e-09
0.0318	2.931e+00	5.271e-07	6.386e-07	4.391e-09	5.320e-09
0.0322	5.407e+00	1.014e-06	1.236e-06	8.157e-09	9.943e-09
0.0364	1.968e+00	5.611e-07	7.321e-07	3.188e-09	4.160e-09
0.2769	4.839e-01	5.931e-06	1.391e-05	1.113e-08	2.610e-08
0.4753	1.996e+01	4.950e-04	9.808e-04	9.712e-07	1.924e-06
0.5632	1.146e+02	3.545e-03	6.648e-03	6.940e-06	1.302e-05
0.5693	2.109e+02	6.619e-03	1.237e-02	1.295e-05	2.421e-05
0.6047	1.334e+03	4.529e-02	8.300e-02	8.836e-05	1.619e-04
0.7958	1.167e+03	5.668e-02	9.564e-02	1.079e-04	1.820e-04
0.8019	1.193e+02	5.852e-03	9.853e-03	1.113e-05	1.874e-05
1.0386	1.367e+01	9.377e-04	1.472e-03	1.717e-06	2.696e-06
1.1679	2.461e+01	1.964e-03	2.990e-03	3.514e-06	5.349e-06
1.3652	4.156e+01	4.055e-03	5.936e-03	6.993e-06	1.024e-05
Totals	**3.058e+03**	**1.254e-01**	**2.189e-01**	**2.405e-04**	**4.202e-04**

APPENDIX J

Cs-134
Microsoft Excel E_i Calculation Sheet

	Energy MeV	Energy keV	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
5	0.0045	5	2.58E-09		0
32	0.0318	32	5.32E-09	1,406.947	0
32	0.0322	32	9.94E-09	1,505.273	0
36	0.0364	36	4.16E-09	2,696.122	0
277	0.2769	277	2.61E-08	3,637.000	0
475	0.4753	475	1.92E-06	1,910.155	4
563	0.5632	563	1.30E-05	1,589.320	21
569	0.5693	569	2.42E-05	1,567.055	38
605	0.6047	605	1.62E-04	1,437.845	233
796	0.7958	796	1.82E-04	998.082	182
802	0.8019	802	1.87E-05	939.149	18
1039	1.0386	1,039	2.70E-06	752.085	2
1168	1.1679	1,168	5.35E-06	664.161	4
1365	1.3652	1,365	1.02E-05	573.136	6
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(Ei) Total:	**506**

APPENDIX K

MicroShield v6.02 (6.02-00253)

Page	:1		**File Ref**	:
DOS File	:SPA3-EFF-Cs-137.ms6		**Date**	:
Run Date	: September 10, 2004		**By**	:
Run Time	: 8:52:18 AM		**Checked**	:
Duration	: 00:00:00			

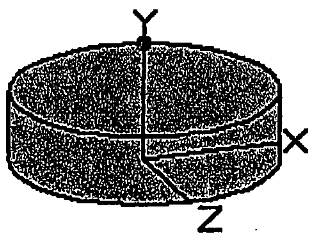
Case Title: SPA3-EFF-Cs-137
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Cs-137 and Daughters
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in



Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Ba-137m	3.4950e-008	1.2932e+003	9.4600e-007	3.5002e-002
Cs-137	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0045	1.342e+01	4.020e-08	4.133e-08	2.755e-08	2.833e-08
0.0318	2.677e+01	4.815e-06	5.834e-06	4.011e-08	4.860e-08
0.0322	4.939e+01	9.260e-06	1.129e-05	7.452e-08	9.084e-08
0.0364	1.797e+01	5.126e-06	6.688e-06	2.912e-08	3.800e-08
0.6616	1.164e+03	4.442e-02	7.913e-02	8.611e-05	1.534e-04
Totals	**1.271e+03**	**4.444e-02**	**7.915e-02**	**8.628e-05**	**1.536e-04**

APPENDIX L

Cs-137
Microsoft Excel E Calculation Sheet

	Energy MeV	Energy kev	Exposure Rate (mR/hr / 1 pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
5	0.0045	5	2.83E-08		0
32	0.0318	32	4.86E-08	1,406,947	0
32	0.0322	32	9.08E-08	1,505,273	0
36	0.0364	36	3.80E-08	2,696,122	0
662	0.6616	662	1.53E-04	1,228,700	188
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
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0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	**188**

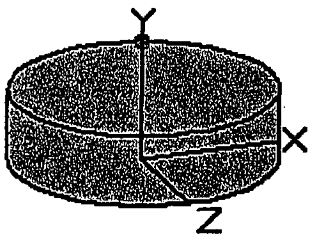
APPENDIX M

MicroShield v6.02 (6.02-00253)

Page	:1
DOS File	:SPA3-EFF-Eu-152.ms6
Run Date	: October 7, 2004
Run Time	: 11:25:11 AM
Duration	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

Case Title: SPA-3-EFF-Eu-152
Description: SPA-3 Soil scan - 28cm radius 1 pCi/cm3 Eu-152
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Eu-152	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.077e+02	2.087e-06	2.146e-06	1.790e-07	1.841e-07
0.04	8.088e+02	3.131e-04	4.331e-04	1.385e-06	1.916e-06
0.05	2.022e+02	1.507e-04	2.467e-04	4.014e-07	6.572e-07
0.1	3.887e+02	1.189e-03	3.118e-03	1.819e-06	4.770e-06
0.2	1.024e+02	8.207e-04	2.097e-03	1.448e-06	3.700e-06
0.3	3.696e+02	5.029e-03	1.151e-02	9.540e-06	2.184e-05
0.4	8.590e+01	1.701e-03	3.555e-03	3.314e-06	6.926e-06
0.5	7.711e+00	2.043e-04	3.984e-04	4.010e-07	7.819e-07
0.6	5.797e+01	1.948e-03	3.579e-03	3.802e-06	6.985e-06
0.8	2.434e+02	1.190e-02	2.005e-02	2.263e-05	3.813e-05
1.0	5.849e+02	3.820e-02	6.058e-02	7.042e-05	1.117e-04
1.5	3.171e+02	3.490e-02	4.999e-02	5.871e-05	8.411e-05
Totals	**3.376e+03**	**9.635e-02**	**1.556e-01**	**1.740e-04**	**2.817e-04**

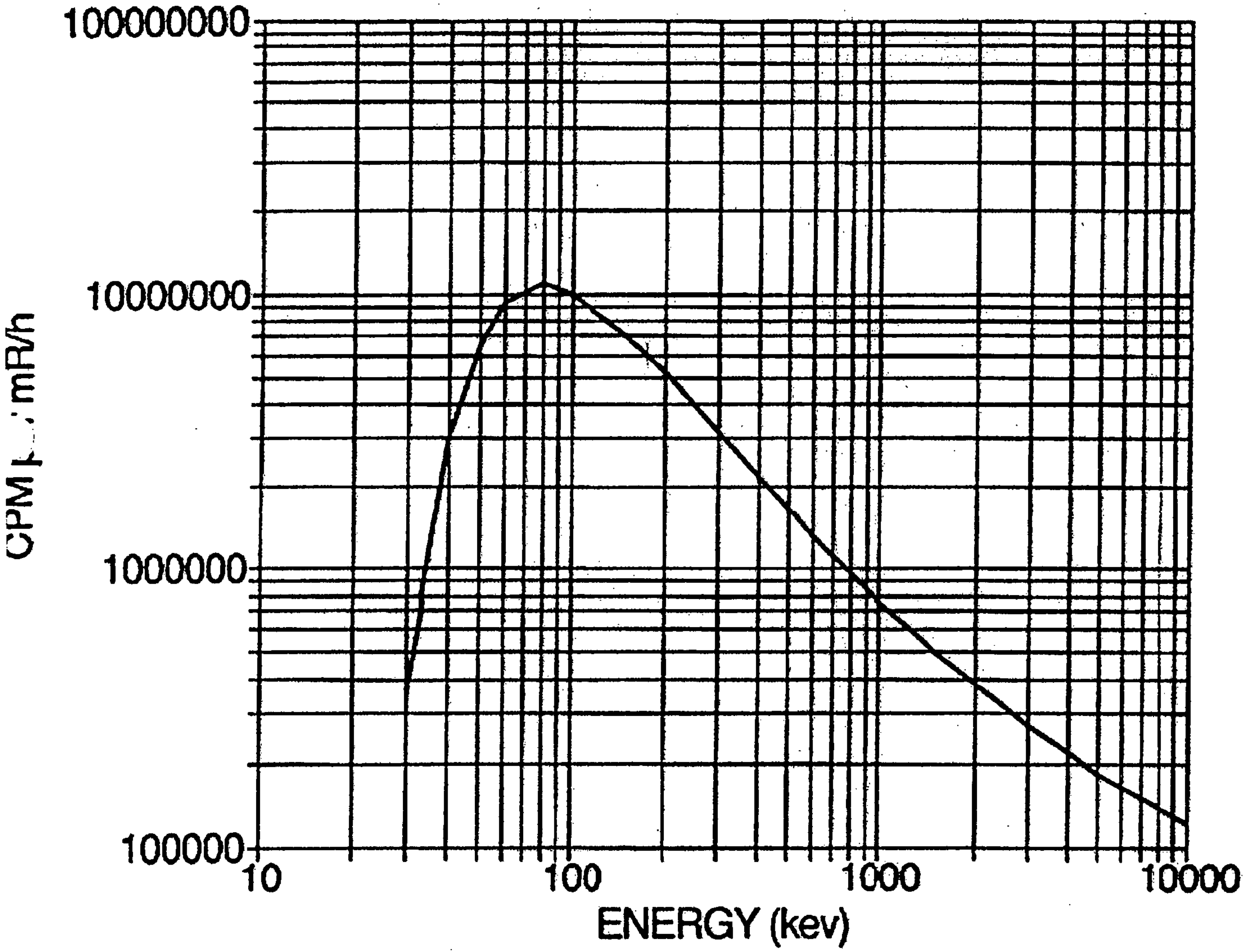
APPENDIX N

Eu-152					
	Energy MeV	Energy keV	Exposure Rate (mR/h-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
15	0.015	15	1.84E-07		0
40	0.04	40	1.92E-06	3,897,600	7
50	0.05	50	6.57E-07	6,500,000	4
100	0.1	100	4.77E-06	9,958,333	48
200	0.2	200	3.70E-06	4,850,000	18
300	0.3	300	2.18E-05	3,200,000	70
400	0.4	400	6.93E-06	2,185,000	15
500	0.5	500	7.82E-07	1,820,000	1
600	0.6	600	6.99E-06	1,455,000	10
800	0.8	800	3.81E-05	993,000	38
1000	1	1,000	1.12E-04	783,019	87
1500	1.5	1,500	8.41E-05	530,000	45
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	344

APPENDIX O

Calculated Energy Response
(Eberline Instruments)

CPM/mR/h



ALARA Analysis Worksheet

Survey Area: BRT-01 **Survey Unit:** 01, and 03 through 08	
A. Estimation of Total Cost ($Cost_T$)	
1. Cost of performing remediation work ($Cost_R$) (assume 3-staff crew for 1 day@average $60 per hour; cost for heavy equipment not included)	$ 1800
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume: 1 m^3 b. cost of waste disposal: $670/$m^3$	$ 670
3. Cost of workplace accident ($Cost_{ACC}$) = $3,000,000 $person^{-1}$ · $4.2x10^{-8}$ h^{-1} · (3.a) a. time to perform remediation action: 30 person-hours	$ 3.78
4. Cost of traffic fatality ($Cost_{TF}$) = {$3,000,000 · $3.8x10^{-8}$ km^{-1} · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment: 4100 km b. waste volume per shipment: 13.6 m^3, if unknown, use 13.6m^3 as a default value	$ 34.37
5. Cost of worker dose ($Cost_{WDose}$) = $2,000 per person-rem · (5.a) · (5.b) a. worker TEDE: ____________ rem/h b. remediation exposure time __________ person-hour	$ 0
$Cost_T$	$ 2508

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. Co-60	a. 6622 dpm/100cm^2	b. 1	c. 5.271	d. 0.13
2. ______	a. ______	b. ______	c. ______	d. ______
3. ______	a. ______	b. ______	c. ______	d. ______
4. ______	a. ______	b. ______	c. ______	d. ______
5. ______	a. ______	b. ______	c. ______	d. ______
6. ______	a. ______	b. ______	c. ______	d. ______
7. ______	a. ______	b. ______	c. ______	d. ______
8. ______	a. ______	b. ______	c. ______	d. ______

Total Concentration: ______________

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated: 1.0
2. Monetary discount rate: $0.03\ y^{-1}$
3. Number of years over which the collective dose is calculated: 1000 y
4. Population density for the critical group: $0.0004\ people/m^2$
5. Area being evaluated: $100\ m^2$

6. AL for each radionuclide-of-interest:

a. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1.d)\cdot C.3}\} \cdot \{B.1.b\} =$ 1356

b. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2.d)\cdot C.3}\} \cdot \{B.2.b\} =$ ______

c. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3.d)\cdot C.3}\} \cdot \{B.3.b\} =$ ______

d. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4.d)\cdot C.3}\} \cdot \{B.4.b\} =$ ______

e. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5.d)\cdot C.3}\} \cdot \{B.5.b\} =$ ______

f. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6.d)\cdot C.3}\} \cdot \{B.6.b\} =$ ______

g. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7.d)\cdot C.3}\} \cdot \{B.7.b\} =$ ______

h. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8.d)\cdot C.3}\} \cdot \{B.8.b\} =$ ______

7\. .... Sum of ALs (= ALARA AL) = 1356

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. Co-60	a 6622 dpm/100cm²	b. (B.1.a)/(D.1.a) = 1.0
2. ______	a. ______	b. (B.2.a)/(D.3.a) = ______
3. ______	a. ______	b. (B.3.a)/(D.4.a) = ______
4. ______	a. ______	b. (B.4.a)/(D.5.a) = ______
5. ______	a. ______	b. (B.5.a)/(D.6.a) = ______
6. ______	a. ______	b. (B.7.a)/(D.7.a) = ______
7. ______	a. ______	b. (B.8.a)/(D.8.a) = ______
8. ______	a. ______	b. (B.9.a)/(D.9.a) = ______

9\. ....Sum of DCGL Fractions = 1.0

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL _____

12. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by J. Bisson Date 7/27/05
FSS Radiological Engineer

Reviewed by [signature] / B.C. Smith Date 8/26/05
FSS Project Manager

ALARA Analysis Worksheet

Survey Area: BRT-01 **Survey Unit:** 02

A. Estimation of Total Cost ($Cost_T$)	
1. Cost of performing remediation work ($Cost_R$)	$ ________
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume ____________ m^3 b. cost of waste disposal ____________ $\$/m^3$	$ ________
3. Cost of workplace accident ($Cost_{ACC}$) = \$3,000,000 $person^{-1} \cdot 4.2x10^{-8} h^{-1}$ · (3.a) a. time to perform remediation action ____________ person-hours	$ ________
4. Cost of traffic fatality ($Cost_{TF}$) = {\$3,000,000 · $3.8x10^{-8} km^{-1}$ · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment __________ km b. waste volume per shipment ____________ m^3, if unknown, use $13.6m^3$ as a default value	$ ________
5. Cost of worker dose ($Cost_{WDose}$) = \$2,000 per person-rem · (5.a) · (5.b) a. worker TEDE __________ rem/h b. remediation exposure time _________ person-hour	$ ________
$Cost_T$	$ ________

SEE ATTACHMENT B

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. ______	a. ____________	b. __________	c. ________	d. __________
2. ______	a. ____________	b. __________	c. ________	d. __________
3. ______	a. ____________	b. __________	c. ________	d. __________
4. ______	a. ____________	b. __________	c. ________	d. __________
5. ______	a. ____________	b. __________	c. ________	d. __________
6. ______	a. ____________	b. __________	c. ________	d. __________
7. ______	a. ____________	b. __________	c. ________	d. __________
8. ______	a. ____________	b. __________	c. ________	d. __________

SEE ATTACHMENT C

Total Concentration: ____________

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated ________________
2. Monetary discount rate ______________ y^{-1}
3. Number of years over which the collective dose is calculated ________________ y
4. Population density for the critical group ________________ people/m^2
5. Area being evaluated ________________ m^2

SEE ATTACHMENT D

6. AL for each radionuclide-of-interest:

a. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1..d) \cdot C.3}\} \cdot \{B.1.b\} =$ ________________

b. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2..d) \cdot C.3}\} \cdot \{B.2.b\} =$ ________________

c. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3..d) \cdot C.3}\} \cdot \{B.3.b\} =$ ________________

d. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4..d) \cdot C.3}\} \cdot \{B.4.b\} =$ ________________

e. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5..d) \cdot C.3}\} \cdot \{B.5.b\} =$ ________________

f. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6..d) \cdot C.3}\} \cdot \{B.6.b\} =$ ________________

g. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7..d) \cdot C.3}\} \cdot \{B.7.b\} =$ ________________

h. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8..d) \cdot C.3}\} \cdot \{B.8.b\} =$ ________________

SEE ATTACHMENT D

7. .... Sum of ALs (= ALARA AL) = ________________

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. ____________	a ____________	b. (B.1.a)/(D.1.a) = ____________
2. ____________	a. ____________	b. (B.2.a)/(D.3.a) = ____________
3. ____________	a. ____________	b. (B.3.a)/(D.4.a) = ____________
4. ____________	a. ____________	b. (B.4.a)/(D.5.a) = ____________
5. ____________	a. ____________	b. (B.5.a)/(D.6.a) = ____________
6. ____________	a. ____________	b. (B.7.a)/(D.7.a) = ____________
7. ____________	a. ____________	b. (B.8.a)/(D.8.a) = ____________
8. ____________	a. ____________	b. (B.9.a)/(D.9.a) = ____________

SEE ATTACHMENT

9. .... Sum of DCGL Fractions = ________________

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL ____

11. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by [signature] Date 6/6/05
FSS Radiological Engineer

Reviewed by [signature] / D C Smith * Date 6/7/05
FSS Project Manager/Radiation Protection Manager

* In considering the radiological condition of the RSS, it is noted that pre-demolition concentrations in some very small, localized surface areas, in comparison to the surface area of the RSS, were in excess of the concrete debris DCGLs. However, in all cases, conditions beneath the surface were such that consideration of volumetric activity at any significant depth resulted conditions that met LTP-required volumetric DCGLs.

In reviewing these conditions with Yankee management and considering license-based commitments and agreements with the state of Massachusetts, and considering the ultimate disposition of the debris – that is, it will be monitored and found to contain no detectable activity at levels equivalent to or below environmental levels specified in the Offsite Dose Calculation Manual or rejected from beneficial use – the material is considered to have reasonably been determined to contain concentrations of radioactivity consistent with requirements to initiate Final Status Surveys.

ATTACHMENT A

Table 1
Radionuclides Potentially Present During Final Status Survey

Radionuclide[a]	Half-Life[a] (y)
H-3	12.28
C-14	5,730
Fe-55	2.7
Co-60	5.271
Ni-63	100
Sr-90	28.6
Nb-94	$2.03x10^4$
Tc-99	$2.13x10^5$
Ag-108m	$1.27x10^2$
Sb-125	2.77
Cs-134	2.062
Cs-137	30.17
Eu-152	13.6
Eu-154	8.8
Eu-155	4.96
Pu-238	87.75
Pu-239[b]	$2.413x10^4$
Pu-241	14.4
Am-241	432.2
Cm-243[b]	28.5

[a] Source: Table 2-6 in the LTP [1].

[b] Represents the paired radionuclides Pu-239/Pu-240 and Cm-243/Cm-244 respectively.

ATTACHMENT A
(continued)

Table 2

Parameter Values for Use in ALARA Analyses

Parameter	Acceptable Value	
	Building	Land
Population density for critical group scenario	0.09 person/m^2	0.0004 person/m^2
Monetary discount rate	0.07 y^{-1}	0.03 y^{-1}
Number of years over which the collective dose is calculated	70 y	1000 y

Information source: YNPS LTP [1].

ATTACHMENT B
Cost Calculation

Survey Area: BRT-01 **Survey Unit: 02**	
1. Cost of performing remediation work ($Cost_R$)	\$254,894
2. Cost of waste disposal ($Cost_{WD}$)= (2.a) * (2.b) a. estimated waste volume 6.9 m^3 b. cost of waste disposal 810 $\$/m^3$	\$5,589
3. Cost of workplace accident ($Cost_{ACC}$) = \$3,000,000 $person^{-1}$ * 4.2 x 10^{-8} h^{-1} * (3.a) a. time to perform remediation action 2240 person-hours	\$282
4. Cost of traffic fatality ($Cost_{TF}$) = {\$3,000,000 * 3.8 x 10^{-8} km^{-1} * (2.a) * (4.a)}/(4.b) a. total distance traveled per shipment 1481 km b. waste volume per shipment 13.6 m^3, if unknown, use 13.6m^3 as a default value	\$ 86
5. Cost of worker dose ($Cost_{WDose}$) = \$2,000 per person-rem * (5.a) * (5.b) a. worker TEDE 0.00001 rem/h b. remediation exposure time 1600 person-hour	\$32
$Cost_T$	\$260,883

ATTACHMENT C
DCGL Fractions

Radionuclide	Total Activity *pci*	Total Weight of RSS gms	Ave. Conc *pci*/gm	DCGL *pci*/gm	Relative Fraction	DCGL Fraction
H-3	1.75E+12	1.35E+10	1.30E+02	280	0.999784537	0.4630
C-14	1.53E+07	1.35E+10	1.13E-03	2.2	8.74E-06	0.0005
Fe-55		1.35E+10	0.00E+00	150	0.00E+00	0.0000
Co-60	6.35E+07	1.35E+10	4.70E-03	15	3.63E-05	0.0003
Ni-63		1.35E+10	0.00E+00	110	0.00E+00	0.0000
Sr-90		1.35E+10	0.00E+00	0.8	0.00E+00	0.0000
Nb-94		1.35E+10	0.00E+00	7.4	0.00E+00	0.0000
Tc-99		1.35E+10	0.00E+00	64	0.00E+00	0.0000
Ag-108m		1.35E+10	0.00E+00	7.4	0.00E+00	0.0000
Sb-125		1.35E+10	0.00E+00	33	0.00E+00	0.0000
Cs-134	3.54E+07	1.35E+10	2.62E-03	606	2.02E-05	0.0000
Cs-137	2.63E+08	1.35E+10	1.95E-02	4.2	1.50E-04	0.0046
Eu-152		1.35E+10	0.00E+00	10	0.00E+00	0.0000
Eu-154		1.35E+10	0.00E+00	9.6	0.00E+00	0.0000
Eu-155		1.35E+10	0.00E+00	400	0.00E+00	0.0000
Pu-238		1.35E+10	0.00E+00	10	0.00E+00	0.0000
Pu-239		1.35E+10	0.00E+00	9.3	0.00E+00	0.0000
Pu-241		1.35E+10	0.00E+00	150	0.00E+00	0.0000
Am-241		1.35E+10	0.00E+00	4.3	0.00E+00	0.0000
Cm-243		1.35E+10	0.00E+00	4.9	0.00E+00	0.0000
		Total Concentration	1.30E+02			

Total DCGL Fraction	0.47

ATTACHMENT D
ALARA Action Levels

Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated 0.01 for H^3, 0.20 for remaining
2. Monetary discount rate 0.03 y^{-1}
3. Number of years over which the collective dose is calculated 1000 y
4. Population density for the critical group 0.0004 people/m^2
5. Survey unit area 249.2 m^2

Radionuclide	AL
H-3	4.51E+05
C-14	1.38E-02
Fe-55	<MDA
Co-60	3.07E-01
Ni-63	<MDA
Sr-90	<MDA
Nb-94	<MDA
Tc-99	<MDA
Ag-108m	<MDA
Sb-125	<MDA
Cs-134	3.88E-01
Cs-137	4.17E-01
Eu-152	<MDA
Eu-154	<MDA
Eu-155	<MDA
Pu-238	<MDA
Pu-239/240	<MDA
Pu-241	<MDA
Am-241	<MDA
Cm-243/244	<MDA

Sum of Als	4.51E+05

DCGL Fraction < ALARA AL?	**YES**

Inter-Office Memorandum

To: BRT-01-02 FSS Plan File
From: Dann Smith
Subject: RSS Survey Unit Size

Date: June 6, 2005

File: RP-05-036

References:

1. YNPS License Termination Plan (LTP)
2. NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)"
3. NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Volume 2

Discussion:
The purpose of this memorandum is to document the consideration given to survey units of RSS debris insofar as the proper size for such units.

The conventional reference guidance for survey unit size limitations specifically addresses structures and land areas rather than volumetric debris, as is the subject of concern. More specifically, the LTP addresses the limits as "surface area limits" and states that the values provide are "for structures and land areas." Given the typical nature of structures and land areas and the relatively unique condition of the RSS debris, it was necessary to consider the need for any size limitations to RSS debris survey units. In addition to the conventional definition of survey units, factors considered were:

- A key factor in defining site-specific survey units is the ability to measure residual radioactivity to the extent that it can be ascertained if the study area is above or below DCGL values.
- To meet FSS acceptance criteria, a survey unit must be within DCGLW values or must meet elevated measurement DCGLEMC values.
- Survey unit data must be compiled into an FSS Report for NRC submittal.

In considering the RSS survey techniques (past scoping and characterization direct surveying and sampling of the structure and upcoming FSS truck monitoring of the debris), as well as the acceptance criteria (any container of debris with measurable activity in excess of $DCGL_W$ values will be rejected), it was determined that the objectives of establishing survey units are being accomplished through the containerized truck monitoring of the debris regardless of survey unit size definitions. In essence, each container is being treated as a separate survey unit in that any indication in excess of $DCGL_W$ values will lead to the rejection of that container rather than allowing the consideration of a $DCGL_{EMC}$. However, ultimately, the method of surveying and the application of DCGLs to debris just simply do not lead to a need to consider any structure-specific survey unit size constraints as long as survey techniques and controls enable the determination of residual radioactivity in comparison to $DCGL_W$ values and there is no attempt to accept elevated measurements.

Inter-Office Memorandum
June 6, 2005
RSS Survey Unit Size
File: RP-05-036

In considering FSS reporting, it was viewed as significantly detrimental to identify each container of debris as its own survey unit, given that approximately 700 containers will be monitored.

In conclusion:

- The RSS debris survey area, BRT-01-02, is considered as one survey unit in and of itself. This practice does not lead to any noncompliance with LTP requirements or criteria.
- Each container surveyed by the truck monitor shall be uniquely identified by an FSS Plan serialized number, such as BRT-01-02-XXX…, where "XXX" is the sequential number of the container being monitored.
- The FSS Report for that survey area will be comprised of survey data form truck monitoring and other associated sampling/surveying of all of the RSS debris.

cc: G. Babineau
M. Erickson
R. Trudeau

ALARA Analysis Worksheet

Survey Area: BRT-01 **Survey Unit:** 09 through 11

A. Estimation of Total Cost ($Cost_T$)

1. Cost of performing remediation work ($Cost_R$) (assume 3-staff crew for 1 day@average \$60 per hour; cost for heavy equipment not included)	\$ 1800
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume: 1 m^3 b. cost of waste disposal: \$670/m^3	\$ 670
3. Cost of workplace accident ($Cost_{ACC}$) = \$3,000,000 $person^{-1}$ · $4.2x10^{-8}$ h^{-1} · (3.a) a. time to perform remediation action: 30 person-hours	\$ 3.78
4. Cost of traffic fatality ($Cost_{TF}$) = {\$3,000,000 · $3.8x10^{-8}$ km^{-1} · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment: 4100 km b. waste volume per shipment: 13.6 m^3, if unknown, use 13.6m^3 as a default value	\$ 34.37
5. Cost of worker dose ($Cost_{WDose}$) = \$2,000 per person-rem · (5.a) · (5.b) a. worker TEDE: __________ rem/h b. remediation exposure time __________ person-hour	\$ 0
$Cost_T$	\$ 2508

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. Co-60	a. 6622 dpm/100cm^2	b. 1	c. 5.271	d. 0.13
2.	a.	b.	c.	d.
3.	a.	b.	c.	d.
4.	a.	b.	c.	d.
5.	a.	b.	c.	d.
6.	a.	b.	c.	d.
7.	a.	b.	c.	d.
8.	a.	b.	c.	d.

Total Concentration: __________

[a] Relative fraction = average concentration divided by the total concentration.

[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated: 1.0

2. Monetary discount rate: 0.03 y^{-1}

3. Number of years over which the collective dose is calculated: 1000 y

4. Population density for the critical group: 0.0004 people/m^2

5. Area being evaluated: 100 m^2

6. AL for each radionuclide-of-interest:

   a. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.1.d)/(1-$e^{-(C.2+B.1..d) \cdot C.3}$} · {B.1.b} = 1356

   b. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.2.d)/(1-$e^{-(C.2+B.2..d) \cdot C.3}$} · {B.2.b} = ________

   c. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.3.d)/(1-$e^{-(C.2+B.3..d) \cdot C.3}$} · {B.3.b} = ________

   d. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.4.d)/(1-$e^{-(C.2+B.4..d) \cdot C.3}$} · {B.4.b} = ________

   e. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.5.d)/(1-$e^{-(C.2+B.5..d) \cdot C.3}$} · {B.5.b} = ________

   f. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.6.d)/(1-$e^{-(C.2+B.6..d) \cdot C.3}$} · {B.6.b} = ________

   g. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.7.d)/(1-$e^{-(C.2+B.7..d) \cdot C.3}$} · {B.7.b} = ________

   h. AL = {$Cost_T$/($2000 · C.4 · 0.025 · C.1 · C.5)} · {(C.2 + B.8.d)/(1-$e^{-(C.2+B.8..d) \cdot C.3}$} · {B.8.b} = ________

7. .... Sum of ALs (= ALARA AL) = 1356

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. Co-60	a 6622 dpm/100cm^2	b. (B.1.a)/(D.1.a) = 1.0
2. ________	a. ________	b. (B.2.a)/(D.3.a) = ________
3. ________	a. ________	b. (B.3.a)/(D.4.a) = ________
4. ________	a. ________	b. (B.4.a)/(D.5.a) = ________
5. ________	a. ________	b. (B.5.a)/(D.6.a) = ________
6. ________	a. ________	b. (B.7.a)/(D.7.a) = ________
7. ________	a. ________	b. (B.8.a)/(D.8.a) = ________
8. ________	a. ________	b. (B.9.a)/(D.9.a) = ________

9. .... Sum of DCGL Fractions = 1.0

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL _____

12. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by J. Bream Date 9-20-05
FSS Radiological Engineer

Reviewed by J. Hummer for D. Smith Date 9-20-05
FSS Project Manager

ALARA Analysis Worksheet

Survey Area: BRT-01 Survey Unit: 12	
A. Estimation of Total Cost ($Cost_T$)	
1. Cost of performing remediation work ($Cost_R$) (assume 3-staff crew for 1 day@average $60 per hour; cost for heavy equipment not included)	$ 1800
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume: 1 m^3 b. cost of waste disposal: $670/$m^3$	$ 670
3. Cost of workplace accident ($Cost_{ACC}$) = $3,000,000 $person^{-1}$ · $4.2x10^{-8}$ h^{-1} · (3.a) a. time to perform remediation action: 30 person-hours	$ 3.78
4. Cost of traffic fatality ($Cost_{TF}$) = {$3,000,000 · $3.8x10^{-8}$ km^{-1} · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment: 4100 km b. waste volume per shipment: 13.6 m^3, if unknown, use 13.6m^3 as a default value	$ 34.37
5. Cost of worker dose ($Cost_{WDose}$) = $2,000 per person-rem · (5.a) · (5.b) a. worker TEDE: ___________ rem/h b. remediation exposure time __________ person-hour	$ 0
$Cost_T$	$ 2508

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. Co-60	a. 6622 dpm/100cm^2	b. 1	c. 5.271	d. 0.13
2.	a.	b.	c.	d.
3.	a.	b.	c.	d.
4.	a.	b.	c.	d.
5.	a.	b.	c.	d.
6.	a.	b.	c.	d.
7.	a.	b.	c.	d.
8.	a.	b.	c.	d.

Total Concentration: ______________

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated: 1.0

2. Monetary discount rate: $0.03\ y^{-1}$

3. Number of years over which the collective dose is calculated: 1000 y

4. Population density for the critical group: $0.0004\ people/m^2$

5. Area being evaluated: $100\ m^2$

6. AL for each radionuclide-of-interest:

a. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1..d) \cdot C.3}\} \cdot \{B.1.b\}$ = 1356

b. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2..d) \cdot C.3}\} \cdot \{B.2.b\}$ = ______

c. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3..d) \cdot C.3}\} \cdot \{B.3.b\}$ = ______

d. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4..d) \cdot C.3}\} \cdot \{B.4.b\}$ = ______

e. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5..d) \cdot C.3}\} \cdot \{B.5.b\}$ = ______

f. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6..d) \cdot C.3}\} \cdot \{B.6.b\}$ = ______

g. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7..d) \cdot C.3}\} \cdot \{B.7.b\}$ = ______

h. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8..d) \cdot C.3}\} \cdot \{B.8.b\}$ = ______

7. .... Sum of ALs (= ALARA AL) = 1356

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. Co-60	a 6622 dpm/100cm²	b. (B.1.a)/(D.1.a) = 1.0
2. ______	a. ______	b. (B.2.a)/(D.3.a) = ______
3. ______	a. ______	b. (B.3.a)/(D.4.a) = ______
4. ______	a. ______	b. (B.4.a)/(D.5.a) = ______
5. ______	a. ______	b. (B.5.a)/(D.6.a) = ______
6. ______	a. ______	b. (B.7.a)/(D.7.a) = ______
7. ______	a. ______	b. (B.8.a)/(D.8.a) = ______
8. ______	a. ______	b. (B.9.a)/(D.9.a) = ______

9. .... Sum of DCGL Fractions = 1.0

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL _____

12. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by J. Buson Date 11-9-05
FSS Radiological Engineer

Reviewed by J C Smith Date 11-22-05
FSS Project Manager

ALARA Analysis Worksheet

Survey Area: BRT-01 **Survey Unit:** 13

A. Estimation of Total Cost ($Cost_T$)

1. Cost of performing remediation work ($Cost_R$) (assume 3-staff crew for 1 day@average $60 per hour; cost for heavy equipment not included)	$ 1800
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume: 1 m^3 b. cost of waste disposal: $670/$m^3$	$ 670
3. Cost of workplace accident ($Cost_{ACC}$) = $3,000,000 $person^{-1} \cdot 4.2x10^{-8} h^{-1}$ · (3.a) a. time to perform remediation action: 30 person-hours	$ 3.78
4. Cost of traffic fatality ($Cost_{TF}$) = {$3,000,000 · $3.8x10^{-8} km^{-1}$ · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment: 4100 km b. waste volume per shipment: 13.6 m^3, if unknown, use 13.6m^3 as a default value	$ 34.37
5. Cost of worker dose ($Cost_{WDose}$) = $2,000 per person-rem · (5.a) · (5.b) a. worker TEDE: ____________ rem/h b. remediation exposure time __________ person-hour	$ 0
$Cost_T$	$ 2508

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. Co-60	a. 6622 dpm/100cm^2	b. 1	c. 5.271	d. 0.13
2.	a.	b.	c.	d.
3.	a.	b.	c.	d.
4.	a.	b.	c.	d.
5.	a.	b.	c.	d.
6.	a.	b.	c.	d.
7.	a.	b.	c.	d.
8.	a.	b.	c.	d.

Total Concentration: _______________

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated: 1.0

2. Monetary discount rate: $0.03\ y^{-1}$

3. Number of years over which the collective dose is calculated: 1000 y

4. Population density for the critical group: 0.0004 people/m^2

5. Area being evaluated: 100 m^2

6. AL for each radionuclide-of-interest:

   a. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1..d) \cdot C.3}\} \cdot \{B.1.b\}$ = 1356

   b. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2..d) \cdot C.3}\} \cdot \{B.2.b\}$ = __________

   c. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3..d) \cdot C.3}\} \cdot \{B.3.b\}$ = __________

   d. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4..d) \cdot C.3}\} \cdot \{B.4.b\}$ = __________

   e. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5..d) \cdot C.3}\} \cdot \{B.5.b\}$ = __________

   f. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6..d) \cdot C.3}\} \cdot \{B.6.b\}$ = __________

   g. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7..d) \cdot C.3}\} \cdot \{B.7.b\}$ = __________

   h. AL = $\{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8..d) \cdot C.3}\} \cdot \{B.8.b\}$ = __________

7. .... Sum of ALs (= ALARA AL) = 1356

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. Co-60	a 6622 dpm/100cm^2	b. (B.1.a)/(D.1.a) = 1.0
2.	a.	b. (B.2.a)/(D.3.a) =
3.	a.	b. (B.3.a)/(D.4.a) =
4.	a.	b. (B.4.a)/(D.5.a) =
5.	a.	b. (B.5.a)/(D.6.a) =
6.	a.	b. (B.7.a)/(D.7.a) =
7.	a.	b. (B.8.a)/(D.8.a) =
8.	a.	b. (B.9.a)/(D.9.a) =

9. .... Sum of DCGL Fractions = 1.0

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL _____

12. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by J. Bisson Date 11-23-05
FSS Radiological Engineer

Reviewed by S C Smith III / [signature] Date 11-29-05
FSS Project Manager

Use Of In-Situ Gamma Spectrum Analysis To Perform
Elevated Measurement Comparisons In Support Of Final Status Surveys

YA-REPT-00-018-05

Approvals	**(Print & Sign Name)**	
Preparer: Greg Astrauckas/	[signature]	Date: 10/10/05
Preparer: Gordon Madison, CHP/	[signature]	Date: 10/11/05
Reviewer: Jim Hummer, CHP/	[signature]	Date: 10/18/05
Approver (FSS Manager): Dann Smith, CHP/	[signature]	Date: 11/4/05

Rev. 0

Technical Report YA-REPT-00-018-05, Rev. 0

Use Of In-Situ Gamma Spectrum Analysis To Perform Elevated Measurement Comparisons In Support Of Final Status Surveys

TABLE OF CONTENTS

Attachments

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1.0 REPORT

1.1 Introduction

The ISOCS In-Situ Gamma Spectrum detector system manufactured by Canberra Industries is being employed to perform elevated measurement comparison (EMC) surveys in support of the Final Status Surveys at Yankee Atomic's Yankee Rowe facility. This system uses an HPGe detector and specialized efficiency calibration software designed to perform in-situ gamma-spectroscopy assays. The ISOCS system will primarily be employed to evaluate survey units for elevated measurement comparisons. The ISOCS system can obtain a static measurement at a fixed distance from a pre-determined location. Count times can be tailored to achieve required detection sensitivities. Gamma spectroscopy readily distinguishes background activity from plant-related licensed radioactivity. This attribute is particularly beneficial where natural radioactivity introduces significant investigation survey efforts. Additionally, background subtraction or collimation can be employed where background influences are problematic due to the presence of stored spent fuel (ISFSI).

This technical report is intended to outline the technical approach associated with the use of ISOCS for implementing a MARSSIM-based Final Status Survey with respect to scanning surveys for elevated measurement comparisons for both open land areas and building surfaces. While the examples and discussions in this report primarily address open land areas, the same approach and methodology will be applied when deriving investigation levels, grid spacing and measurement spacing for evaluating building surfaces.

Validation of the ISOCS software is beyond the scope of this technical report. Canberra Industries has performed extensive testing and validation on both the MCNP-based detector characterization process and the ISOCS calibration algorithms associated with the calibration software. The full MCNP method has been shown to be accurate to within 5% typically. ISOCS results have been compared to both full MCNP and to 119 different radioactive calibration sources. In general, ISOCS is accurate to within 4-5% at high energies and 7-11% at 1 standard deviation for low energies. Additionally, the ISOCS technology has been previously qualified in Yankee Atomic Technical Report YA-REPT-00-022-04, "Use Of Gamma Spectrum Analysis To Evaluate Bulk Materials For Compliance With License Termination Criteria."

1.2 Discussion

1.2.1 Detector Description

Two ISOCS-characterized HPGe detectors manufactured by Canberra Industries have been procured. Each detector is a reverse-electrode HPGe detector rated at 50% efficiency (relative to a NaI detector). Resolution for these detectors is 2.2 keV @ 1332 keV. As the project progresses, other ISOCS detectors (e.g. standard electrode coaxial), if available, may be used to increase productivity. The key element regarding the use of other types of ISOCS® detectors is that specific efficiency calibrations will be developed to account for each detector's unique characteristics.

The HPGe detector is mounted on a bracket designed to hold the detector / cryostat assembly and associated collimators. This bracket may be mounted in a wheeled cart or in a cage-like frame. Both the wheeled cart and frame permit the detector to be oriented (pointed) over a full range from a horizontal to vertical position. The frame's design allows the detector to be suspended above the ground. Photographs of the frame-mounted system are presented in Attachment 1. During evaluations of Class1 areas for elevated radioactivity, the detector will generally be outfitted with the 90-degree collimator. Suspending the detector at 2 meters above the target surface yields a nominal field-of-view of 12.6 m^2.

The InSpector (MCA) unit that drives the signal chain and the laptop computer that runs the acquisition software (Genie-2000) are mounted either in the frame or on the wheeled cart. These components are battery powered. Back-up power supplies (inverter or UPS) are available to support the duty cycle. A wireless network has been installed at the site so that the laptop computers used to run the systems can be completely controlled from any workstation at the facility. This configuration also enables the saving of data files directly to a centralized file server. Radio communication will be used to coordinate system operation.

1.2.2 Traditional Approach

With respect to Class 1 Survey Units, small areas of elevated activity are evaluated via the performance of scan surveys. The size of the potential area of elevated activity affects the $DCGL_{EMC}$ and is typically determined by that area bounded by the grid points used for fixed measurements. This area in turn dictates the area factor(s) used for deriving the associated $DCGL_{EMC}$.

These scan surveys are traditionally conducted with hand-held field instruments that have a detection sensitivity sufficiently low to identify areas of localized activity above the $DCGL_{EMC}$. Occasionally, the detection sensitivity of these instruments is greater than the $DCGL_{EMC}$. In order to increase the $DCGL_{EMC}$ to the point where hand-held instrumentation can be reasonably employed, the survey design is augmented to require additional fixed-point measurements. The effect of these additional measurement points is to tighten the fixed measurement grid spacing, thus reducing the area applied to deriving the $DCGL_{EMC}$ and increasing the detection sensitivity criteria.

Background influences (from the ISFSI) and natural terrestrial sources further impact the sensitivity of these instruments. To address these impacts, the fixed-point grid spacing would again need to be reduced (requiring even more samples) in order to increase the $DCGL_{EMC}$ to the point where hand-held instrumentation can be used. Generally, the collection of additional fixed measurements (i.e. samples) increases project costs.

Survey designs for Class 2 and Class 3 survey units are not driven by the elevated measurement comparison because areas of elevated activity are not expected. In Class 2 areas, any indication of activity above the $DCGL_W$ requires further investigation. Similarly, in Class 3 areas, any positive indication of licensed radioactivity also requires further investigation. Because the $DCGL_{EMC}$ is not applicable to Class 2 or Class 3 areas, adjustments to grid spacing do not occur. However, the increased field-of-view associated with the in-situ gamma spectroscopy system improves the efficiency of the survey's implementation.

1.2.3 Innovative Approach

In-situ assays allow fixed-point grid spacing to be uncoupled from the derivation of applicable investigation levels. In contrast to the traditional approach where the $DCGL_{EMC}$ (based on grid size) determines both investigation levels and detection sensitivities, the use of this technology provides two independent dynamics as follows:

- Detection sensitivity is determined by the $DCGL_{EMC}$ associated with the (optimal) fixed-point grid spacing.
- Investigation levels are based on the detector's field-of-view and adjusted for the smallest area of concern (i.e. 1 m^2).

1.2.4 Investigation Level

Development of the investigation (action) levels applied to in-situ assay results is a departure from the traditional approach for implementing a MARSSIM survey. Examples are provided for both open land areas (i.e. soil) and for building surfaces, however the approach for both is identical.

To support the use of in-situ spectroscopy to evaluate areas of elevated activity the HPGe detector's field-of-view was characterized. Attachment 2 presents data from the field-of-view characterization for a detector configured with a 90-degree collimator positioned 2 meters from the target surface. Alternate configurations will be evaluated in a similar manner before being employed. As exhibited in Attachment 2, when the detector is positioned at 2 meters above the target surface the field-of-view has a radius of at least 2.3

meters. This value was rounded down to 2.0 meters for implementation purposes, introducing a conservative bias (approximately 9%) in reported results. The example provided in this technical report assumes a 2-meter source-to-detector distance, yielding a nominal field-of-view surface area of 12.6 m^2.

Occasionally, alternate source-to-detector distances (using the 90-degree collimator) may be employed, particularly in a characterization or investigation capacity. In such cases, the detector's field-of-view will be calculated by setting the radius equal to the source-to-detector distance, thereby maintaining the conservative attribute previously described. If alternative collimator configurations are used to perform elevated measurement comparisons, then specific evaluations will be documented in the form of a technical evaluation or similar. Associated investigation levels will be derived using the same approach and methodology outlined below in this section.

After the detector's field-of-view is determined, an appropriate investigation level is developed to account for a potential one-meter square area of elevated activity. $DCGL_{EMC}$ values for a one-square meter area are presented in Table 1.

TABLE 1, SOIL $DCGL_{EMC}$ FOR 1 m^2

	Soil $DCGL_W$ (pCi/g) (NOTE 1)	Soil $DCGL_W$ (pCi/g) (NOTE 2)	Area Factor for 1 m^2 (NOTE 3)	$DCGL_{EMC}$ for 1 m^2 (pCi/g) (NOTE 4)
Co-60	3.8	1.4	11	15
Ag-108m	6.9	2.5	9.2	23
Cs-134	4.7	1.7	16	28
Cs-137	8.2	3.0	22	66

NOTE 1 – LTP Table 6-1
NOTE 2 – Adjusted to 8.73 mRem/yr
NOTE 3 – LTP Appendix 6Q
NOTE 4 – Soil $DCGL_W$ (adjusted to 8.73 mRem/yr) for a 1 m^2 area

The $^{1m2}DCGL_{EMC}$ values listed in Table 1 do not account for a source positioned at the edge of the field-of-view. Therefore, the $^{1m2}DCGL_{EMC}$ values are adjusted via a correction factor. To develop this correction factor, a spectrum free of plant-related radioactivity was analyzed using two different efficiency calibrations (i.e. geometries). The first scenario assumes radioactivity uniformly distributed over the detector's 12.6 m^2 field-of-view. The second scenario assumes radioactivity localized over a 1 m^2 situated at the edge of the detector's field-of-view. The resultant MDC values were compared to characterize the difference in detection efficiencies between the two scenarios. As expected, the condition with localized (1 m^2) radioactivity at the edge of the detector's field-of-view yielded higher MDC values. The ratio between the reported MDC values for the two scenarios is used as a correction factor. This correction factor is referred to as the offset geometry adjustment factor. The investigation levels for soils presented in Table 2 were calculated as follows:

Nuclide Investigation Level (pCi/g) = $(DCGL_{EMC}) * CF$

Where: $DCGL_{EMC} = (DCGL_W \text{ or } DCGL_{SURR}) * AF_{(1\ m^2)}$, and
CF = Mean offset geometry adjustment factor

TABLE 2, SOIL INVESTIGATION LEVEL DERIVATION

	MDC pCi/g (NOTE 1)	MDC pCi/g (NOTE 2)	RATIO (NOTE 3)	$DCGL_{EMC}$ for 1 m^2 (NOTE 5)	INVESTIGATION LEVEL pCi/g (NOTE 6)
Co-60	0.121	1.86	0.0651	15	1.0
Ag-108m	0.184	2.82	0.0652	23	1.5
Cs-134	0.189	2.90	0.0652	28	1.8
Cs-137	0.182	2.78	0.0655	66	4.3
Offset Geometry Adjustment Factor (NOTE 4)			**0.0653**		

NOTE 1 – Assumed activity distributed over the 12.6 m^2 field-of-view.
NOTE 2 – Efficiency calibration modeled for a 1 m^2 area situated (off-set) at the edge of the detector's field-of-view. The model assumes that all activity is distributed within the 1 m^2.
NOTE 3 – Ratio = (12.6 m^2 MDC ÷ 1 m^2 MDC).
NOTE 4 – The mean value of the ratios is applied as the off-set geometry adjustment factor.
NOTE 5 – $DCGL_{EMC}$ values for 1 m^2 (from Table 1)
NOTE 6 – Investigation levels derived by applying of the off-set geometry adjustment factor (e.g. 0.0653) to the $DCGL_{EMC}$ for a 1 m^2 area for each radionuclide.

With respect to building surfaces, the development of the investigation level is identical to that for soil surfaces. The one-meter square $DCGL_{EMC}$ for building surfaces are presented in Table 3.

TABLE 3, BUILDING SURFACE $DCGL_{EMC}$ FOR 1 m^2

	Bldg $DCGL_W$ (dpm/100m^2) (NOTE 1)	Bldg $DCGL_W$ (dpm/100cm^2) (NOTE 2)	Area Factor For 1 m^2 (NOTE 3)	$DCGL_{EMC}$ For 1 m^2 (dpm/100cm^2) (NOTE 4)
Co-60	18,000	6,300	7.3	46,000
Ag-108m	25,000	8,700	7.2	62,600
Cs-134	29,000	10,000	7.4	74,000
Cs-137	63,000	22,000	7.6	167,000

NOTE 1 – LTP Table 6-1
NOTE 2 – Adjusted to 8.73 mRem/yr
NOTE 3 – LTP Appendix 6S
NOTE 4 – Building $DCGL_W$ (adjusted to 8.73 mRem/yr) for a 1 m^2 area

Using the same approach described for soils, a correction factor to account for efficiency differences due to geometry considerations is developed the one-meter square $DCGL_{EMC}$. ISOCS efficiency calibrations for activity distributed over the detector's field-of-view and for activity within one-square meter located at the edge of the detector's field-of-view were developed. The MDC values for these two geometries were compared to characterize the difference in detection efficiencies. As expected, the condition with localized (1 m^2)

radioactivity at the edge of the detector's field-of-view yielded higher MDC values. The ratio between the reported MDC values for the two scenarios is used as the offset geometry adjustment factor. The MDC values, the associated ratios, and the derived investigation level for building surfaces are presented in Table 4.

TABLE 4, BUILDING SURFACE INVESTIGATION LEVEL DERIVATION

	12.6 m^2 MDC ($dpm/100cm^2$) (NOTE 1)	1 m^2 MDC ($dpm/100cm^2$) (NOTE 2)	RATIO (NOTE 3)	$DCGL_{EMC}$ For 1 m^2 ($dpm/100cm^2$) (NOTE 5)	BUILDING SURFACE INVESTIGATION LEVEL ($dpm/100cm^2$) (NOTE 6)
Co-60	785	12,400	0.0633	46,000	2,900
Ag-108m	839	13,000	0.0645	62,600	3,900
Cs-134	900	14,200	0.0634	74,000	4,700
Cs-137	922	14,600	0.0632	167,000	10,600
Offset Geometry Adjustment Factor (NOTE 4)			**0.0636**		

NOTE 1 – Assumed activity distributed over the 12.6 m^2 field-of-view.
NOTE 2 – Efficiency calibration modeled for a 1 m^2 area situated (off-set) at the edge of the detector's field-of-view. The model assumes that all activity is distributed within the 1 m^2.
NOTE 3 – Ratio = (12.6 m^2 MDC ÷ 1 m^2 MDC).
NOTE 4 – The mean value of the ratios is applied as the off-set geometry adjustment factor.
NOTE 5 – $DCGL_{EMC}$ values for 1 m^2 (from Table 3)
NOTE 6 – Investigation levels derived by applying of the off-set geometry adjustment factor (e.g. 0.0636) to the one-square meter $DCGL_{EMC}$.

In summary, effective investigation levels for both open land areas (i.e. soils) and for building surfaces can be derived and applied to in-situ gamma spectroscopy results. Note the MDC values associated with the detector's field-of-view were well below the derived investigation levels.

The investigation levels presented in Table 2 and Table 4 do not address the use of surrogate DCGLs. Use of surrogate DCGLs will be addressed in Final Status Survey Plans, particularly where it is necessary to evaluate non-gamma emitting radionuclides on building surfaces. When surrogate DCGLs are employed, investigation levels will be developed on a case-by-case basis using the approach outlined in this document. Similarly, the offset geometry adjustment factor presented in Table 2 and Table 4 will vary for different geometries. Although unlikely, if different geometries are employed, this value will be determined on a case-by-case basis using the methodology reflected in Table 2 and will be documented in the applicable Final Status Survey Plan.

For both open land areas and for building surfaces, when an investigation level is encountered, investigatory protocols will be initiated to evaluate the presence of elevated activity and bound the region as necessary. Such evaluations may include both hand-held field instrumentation as well as the in-situ HPGe detector system. After investigation activities are completed, subsequent (follow-up) scanning evaluations will most likely be conducted using the in-situ gamma spectroscopy system.

1.2.5 Detector Sensitivity

For Class 1 scan surveys, the minimum detectable concentration is governed by the $DCGL_{EMC}$ associated with the grid area used to locate fixed-point measurements. The system's count time can be controlled to achieve the required detection sensitivity. Therefore, the grid spacing for the fixed-point measurements can be optimized thus eliminating unnecessary increases to the number of fixed-point measurements while ensuring that elevated areas between fixed measurement locations can be identified and evaluated.

Based on preliminary work, it has been determined that a count time of 900 seconds will yield an acceptable sensitivity for many areas on the site. This count time provides MDC values well below the investigation levels presented in Table 2 and Table 4. Count times will be adjusted as necessary as survey unit-specific investigation levels are derived or where background conditions warrant to ensure that detection sensitivities are below the applicable investigation level. Since each assay report includes a report of the MDC values achieved during the assay, this information is considered technical support that required MDC values were met.

1.2.6 Area Coverage

Based on the nominal 12.6 m^2 field-of-view, a 3-meter spacing between each survey point will result in well over 100% of the survey unit to be evaluated for elevated activity. This spacing convention typically employs a grid pattern that is completely independent from the grid used to locate fixed-point measurements. An example of the grid pattern and spacing is presented in Attachment 3.

Alternate spacing conventions may be applied on a case-by-case basis. For instance, spacing may be decreased when problematic topographies are encountered. Note that decreased grid spacing in this context is not associated to the fixed-point measurements. Occasionally it may be necessary to position the detector at one meter or less from the target surface to evaluate unusual (e.g. curved) surfaces or to assist in bounding areas of elevated activity. In cases where it may be desirable to increase the field-of-view via collimator or source-to-detector distances, grid-spacing conventions (and applicable investigation levels) will be determined using the approach described in this document.

1.2.7 Moisture Content in the Soil Matrix

In-situ gamma spectroscopy of open land areas is inherently subject to various environmental variables not present in laboratory analyses. Most notably is the impact that water saturation has on assay results. This impact has two components. First, the total activity result for the assay is assigned over a larger, possibly non-radioactive mass introduced by the presence of water. Secondly, water introduces a self-absorption factor.

The increase in sample mass due to the presence of water is addressed by the application of a massimetric efficiency developed by Canberra Industries. Massimetric efficiency units are defined as [counts per second]/[gammas per second per gram of sample]. Mathematically, this is the product of traditional efficiency and the mass of the sample. When the efficiency is expressed this way, the efficiency asymptotically approaches a constant value as the sample becomes very large (e.g. infinite). Under these conditions changes in sample size, including mass variations from excess moisture, have little impact on the counting efficiency. However, the massimetric efficiency does not completely address attenuation characteristics associated with water in the soil matrix.

To evaluate the extent of self-absorption, (traditional) counting efficiencies were compared for two densities. Based on empirical data associated with the monitoring wells, typical nominally dry in-situ soil is assigned a density of 1.7 g/cc. A density of 2.08 g/cc, obtained from a technical reference publication by Thomas J. Glover, represents saturated soil. A density of 2.08 g/cc accounts for a possible water content of 20%. A summary of this comparison is presented in Table 5.

TABLE 5, COUNTING EFFICIENCY COMPARISONS

keV	Efficiencies 1.7 g/cc	Efficiencies 2.08 g/cc	Deviation due to density increase (excess moisture)
434	3.3 E-6	2.7 E-6	-18.7%
661.65	2.9 E-6	2.4 E-6	-17.5%
1173.22	2.5 E-6	2.1 E-6	-15.4%
1332.49	2.4 E-6	2.1 E-6	-14.8%

In cases when the soil is observed to contain more than "typical" amounts of water, potential under-reporting can be addressed in one of two manners. One way is to adjust the investigation level down by 20%. The second way is to reduce the sample mass by 20%. Either approach achieves the same objective: to introduce a conservative mechanism for triggering the investigation level where the presence of water may inhibit counting efficiency. The specific mechanism to be applied will be prescribed in implementing procedures.

The presence of standing water (or ice or snow) on the surface of the soil being assayed will be accounted for in customized efficiency calibrations applied during data analysis activities.

1.2.8 Discrete Particles in the Soil Matrix

Discrete particles are not specifically addressed in the License Termination Plan. However, an evaluation was performed assuming all the activity in the detector's field-of-view, to a depth of 15 cm, was situated in a discrete point-source configuration. A concentration of 1.0 pCi/g (Co-60), corresponding to the investigation level presented in Table 2, correlates to a discrete point-source of approximately 3.2 μCi. This activity value is considered as the discrete particle of concern. Since the presence of any discrete particles will most likely be accompanied by distributed activity, the investigation level may provide an opportunity to detect discrete particles below 3.2 μCi.

Discrete particles exceeding this magnitude would readily be detected during characterization or investigation surveys. The MDCs associated with hand-held field instruments used for scan surveys are capable of detecting very small areas of elevated radioactivity that could be present in the form of discrete point sources. The minimum detectable particle activity for these scanning instruments and methods correspond to a small fraction of the TEDE limit provided in 10CFR20 subpart E. Note that the MDC values presented in Table 2 are significantly lower than those published in Table 5-4 of the License Termination Plan.

When the investigation level in a Class 1 area is observed, subsequent investigation surveys will be performed to include the use of hand-held detectors. The detection sensitivities of instruments used for these surveys have been previously addressed in the LTP. Furthermore, discrete point sources do not contribute to the uniformly distributed activity of the survey unit. It is not expected that such sources at this magnitude would impact a survey unit's ability to satisfy the applicable acceptance criteria.

Noting that Class 2 or Class 3 area survey designs do not employ elevated measurement comparisons, associated investigation levels are based on positive indications of licensed radioactivity above the $DCGL_W$ or above background. Because such areas are minimally impacted or disturbed, potential discrete particles would most likely be situated near the soil surface where detection efficiencies are highest.

1.2.9 Procedures And Guidance Documents

General use of the portable ISOCS system is administrated by departmental implementing procedures that address the calibration and operation activities as well as analysis of the data. These procedures are listed as follows:

- DP-8869, "In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure."
- DP-8871, "Operation Of The Canberra Portable ISOCS Assay System."
- DP-8872, "ISOCS Post Acquisition Processing And Data Review."

Where the portable ISOCS® system is used for Final Status Surveys, the applicable FSS Plan will address detector and collimator configurations, applicable (surrogated) investigation levels, MDC requirements, and appropriate Data Quality Objectives, as applicable.

A secondary application of the portable ISOCS® system is to assay surfaces or bulk materials for characterization or unconditional release evaluations. Use of the portable ISOCS® system for miscellaneous evaluations will be administrated under a specific guidance document (e.g. Sample Plan, etc.). Operating parameters such as physical configuration, efficiency calibrations, count times, and MDCs will be applied so as to meet the criteria in the associated controlling documents. Such documents will also address any unique technical issues associated with the application and may provide guidance beyond that of procedure AP-0052, "Radiation Protection Release of Materials, Equipment and Vehicles."

1.2.10 Environmental Backgrounds

If background subtraction is used, an appropriate background spectrum will be collected and saved. Count times for environmental backgrounds should exceed the count time associated with the assay. In areas where the background radioactivity is particularly problematic (e.g. ISFSI), the background will be characterized to the point of identifying gradient(s) such that background subtractions are either appropriate or conservative. Documentation regarding the collection and application of environmental backgrounds will be provided as a component of the final survey plan.

1.2.11 Quality Control

Quality Control (QC) activities for the ISOCS system ensure that the energy calibration is valid and detector resolution is within specifications. A QC file will be set up for each detector system to track centroid position, FWHM, and activity. Quality Control counts will be performed on a shiftly basis prior to the system's use to verify that the system's energy calibration is valid. The Na-22 has a 1274.5 keV photon which will be the primary mechanism used for performance monitoring. If the energy calibration is found to be out of an acceptable tolerance (e.g. greater than ±4 channels), then the amplifier gain may be adjusted and a follow-up QC count performed. If the detector's resolution is found to be above the factory specification, then an evaluation will be performed to determine if the detector should be removed from service and/or if the data is impacted. Evaluations associated with QC counts shall be documented. Such documentation may be limited to a remark directly on the applicable QC report or in a logbook if the resolution does not render the system out of service. Otherwise the evaluation should be separately documented (e.g. Condition Report, etc.) so as to address the impact of any assay results obtained since the last acceptable QC surveillance.

Where it is determined that background subtraction is necessary, a baseline QC background will be determined specific to that area or region. When background subtraction is required, a QC background surveillance will be performed before a set of measurements are made to verify the applicability of the background to be subtracted. Due to the prevailing variability of the background levels across the site, the nature and extent of such surveillances will be on a case-by-case basis and should be addressed in the documentation associated with the applicable survey plan(s).

In addition to the routine QC counts, each assay report is routinely reviewed with respect to K-40 to provide indications where amplifier drift impacts nuclide identification routines. This review precludes the necessity for specific (i.e. required) after-shift QC surveillances. It also minimizes investigations of previously collected data should the system fail a before-use QC surveillance on the next day of use.

1.2.12 Data Collection

Data collection to support FSS activities will be administered by a specific Survey Plan. Survey Plans may include an index of measurement locations with associated spectrum filenames to ensure that all the required measurements are made and results appropriately managed. Personnel specifically trained to operate the system will perform data collection activities.

Data collection activities will address environmental conditions that may impact soil moisture content. Logs shall be maintained so as to provide a mechanism to annotate such conditions to ensure that efficiency calibration files address the in-situ condition(s). In extreme cases (e.g. standing water, etc.) specific conditions will be addressed to ensure that analysis results reflect the conditions. As previously discussed with respect to water, when unique environmental conditions exist that may impact analysis results, conservative compensatory factors will be applied to the analysis of the data.

1.2.13 Efficiency Calibration

The central feature of the portable ISOCS technology is to support in-situ gamma spectroscopy via the application of mathematically derived efficiency calibrations. Due to the nature of the environment and surfaces being evaluated (assayed), input parameters for the ISOCS efficiency calibrations will be reviewed on a case-by-case basis to ensure the applicability of the resultant efficiency. Material densities applied to efficiency calibrations will be documented. In practice, a single efficiency calibration file may be applied to the majority of the measurements.

The geometry most generally employed will be a circular plane assuming uniformly distributed activity. Efficiency calibrations will address a depth of 15 cm for soil and a depth up to 5 cm for concrete surfaces to account for activity embedded in cracks, etc. Other geometries (e.g. exponential circular plane, rectangular plane, etc.) will be applied if warranted by the physical attributes of the area or surface being evaluated. Efficiency calibrations are developed by radiological engineers who have received training with respect to the ISOCS® software. Efficiency calibrations will be documented in accordance with procedure DP-8869, "In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure."

1.2.14 Data Management

Data management will be implemented in various stages as follows:

- An index or log will be maintained to account for each location where evaluations for elevated activity are performed. Raw spectrum files will be written directly or copied to a central file server.

- Data Analysis – After the spectrum is collected and analyzed, a qualified Radiological Engineer will review the results. The data review process includes application of appropriate background, nuclide libraries, and efficiency calibrations. Data reviews also verify assay results with respect to the applicable investigation levels and the MDCs achieved. Data reviews may include monitoring system performance utilizing K-40. When the data analysis is completed, the analyzed data file will be archived to a unique directory located on a central file server.

- Data Reporting – The results of data files whose reviews have been completed and are deemed to be acceptable may be uploaded to a central database for subsequent reporting and statistical analysis.

- Data Archiving – Routinely (daily) the centralized file server(s) where the raw and analyzed data files are maintained will be backed up to tape.

1.3 Conclusions/Recommendations

The in-situ gamma spectroscopy system is a cost-effective technology well-suited to replace traditional scanning survey techniques to evaluate areas for elevated radioactivity. The static manner in which this system is operated eliminates many variables and limitations inherent to hand-held detectors moving over a surface. This system provides a demonstrably lower detection sensitivity than those offered by hand-held field instruments. This attribute qualifies this system as an alternative technology in lieu of hand-held NaI field instruments in areas where background radiation levels would prohibit the use of such detectors to evaluate for elevated gross activity. The MDC to which this system will be operated satisfies (or exceeds) criteria applied to traditional scan surveys using hand-held field instruments.

Effective investigation levels for both open land areas (i.e. soils) and for building surfaces can be derived and applied to in-situ gamma spectroscopy results. Where surrogate DCGLs are employed, investigation levels will developed on a case-by-case basis using the approach outlined in this document.

The manner in which investigation levels are derived employs several conservative decisions and assumptions. Additionally, adequate spacing applied to scanning survey locations yields an overlap in surface coverage providing 100-percent coverage of Class 1 areas and redundant opportunities in a significant portion of the survey area to detect localized elevated activity.

1.4 <u>References</u>

1. YNPS License Termination Plan, Revision 1
2. Multi-Agency Radiation Survey And Site Investigation Manual (MARSSIM) Revision 1, 2000
3. Canberra User's Manual Model S573 ISOCS Calibration Software, 2002
4. Decommissioning Health Physics - A Handbook for MARSSIM Users, E.W. Abelquist, 2001
5. Canberra's Genie 2000 V3.0 Operations Manual, 2004
6. In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure DP-8869, Revision 0
7. Operation of the Canberra Portable ISOCS Assay System DP-8871 Revision 0
8. Technical Ref., by Thomas J. Glover.

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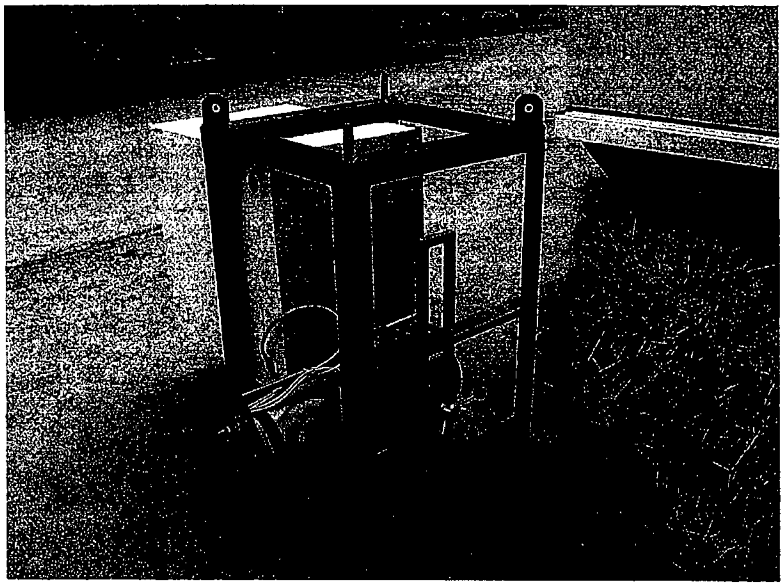
Attachment 1
Portable ISOCS® Detector System Photos



Attachment 2
Field-Of-View Characterization

Generally, the HPGe detector will be outfitted with a 90-degree collimator situated at 2 meters perpendicular to the surface being evaluated. Note that characterizing the detector's field-of-view could be performed without a source by comparing ISOCS-generated efficiencies for various geometries. If a different collimator configuration is to be employed, a similar field-of-view characterization will be performed.

To qualify the field-of-view for this configuration, a series of measurements were made at various off-sets relative to the center of the reference plane. The source used for these measurements was a 1.2 μCi Co-60 point-source with a physical size of approximately 1 cm^3. Each spectrum was analyzed as a point source both with and without background subtract. It was observed that the detector responded quite well to the point source.

Figure 1 presents the results with background subtraction applied. Note that there is a good correlation with the expected nominal activity and that outside the 2-meter radius of the "working" field-of-view (i.e. at 90 inches) some detector response occurs. This validates that the correct attenuation factors are applied to the algorithms used to compute the efficiency calibration.

FIGURE 1

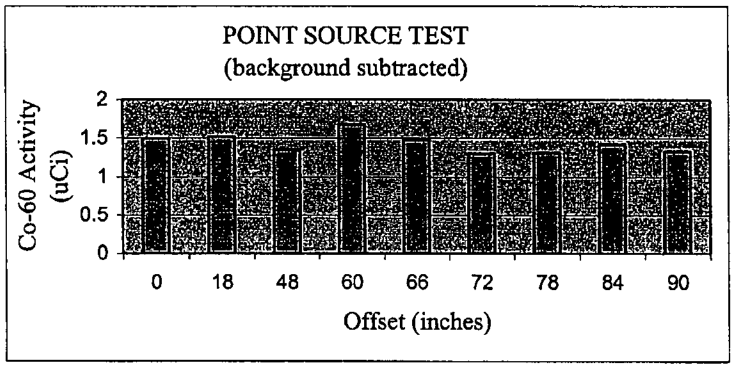
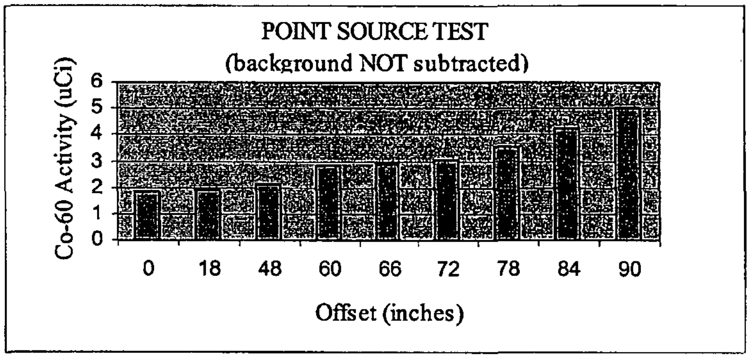


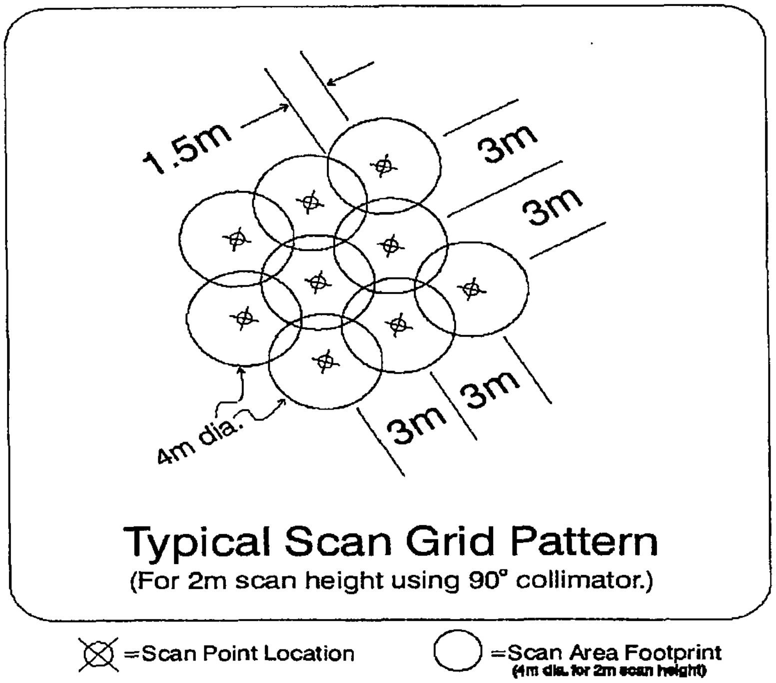
Figure 2 shows the effect of plant-derived materials present in the reference background, which indicates an increasing over-response the further the point source is moved off center. Detector response outside the assumed (i.e. 2-meter) field-of-view would yield conservative results. Normally, source term adjacent to the survey units should be reduced to eliminate background interference.

FIGURE 2


POINT SOURCE TEST
(background NOT subtracted)
Co-60 Activity (uCi)
6
5
4
3
2
1
0
0
18
48
60
66
72
78
84
90
Offset (inches)

19

Attachment 3
Typical Grid Pattern For In-Situ Gamma Spectroscopy



Attachment A – Maps and Posting Plots

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Figure 1 BRT-01 Relative to Structures

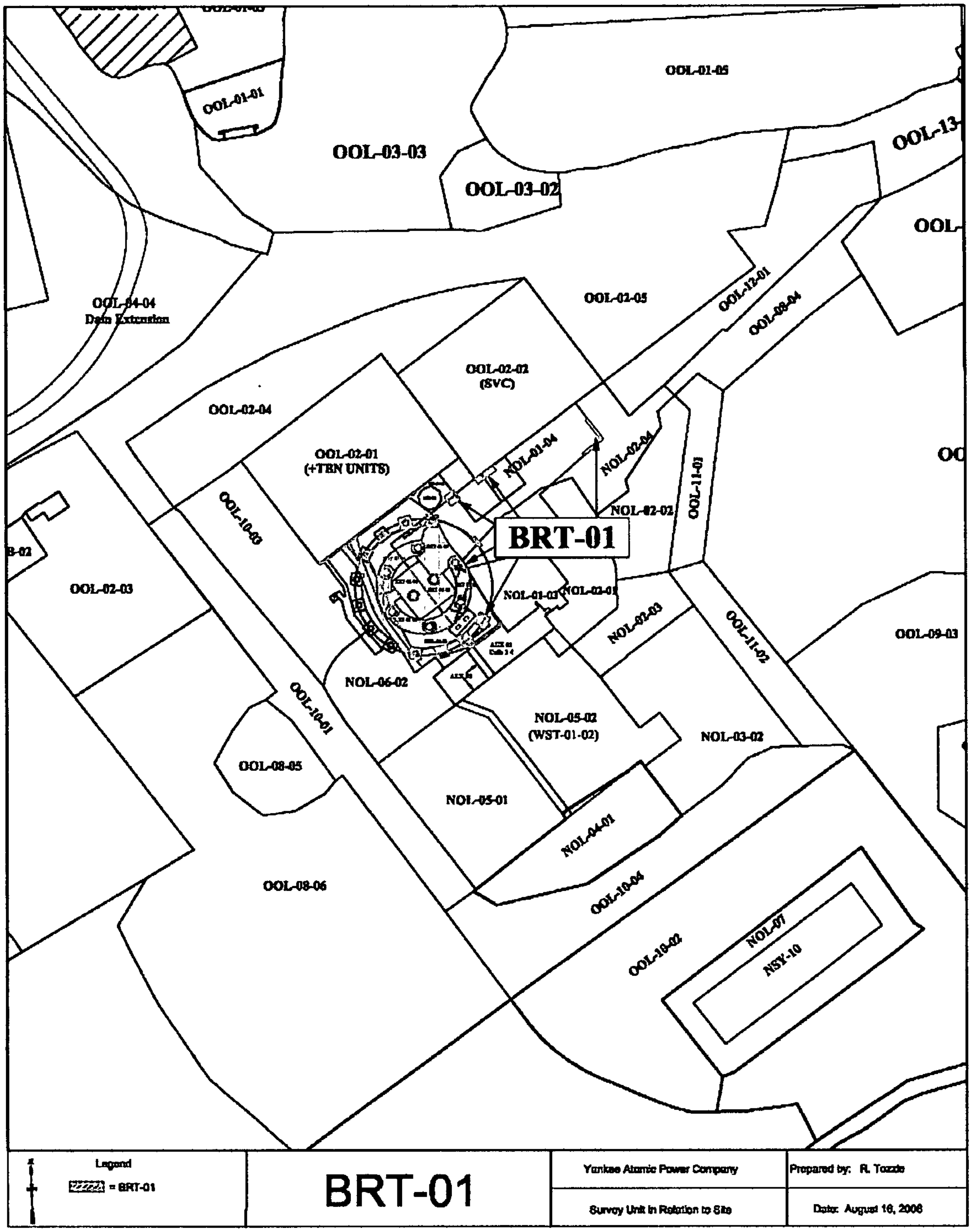


Figure 2 BRT-01-01 Posting Plot

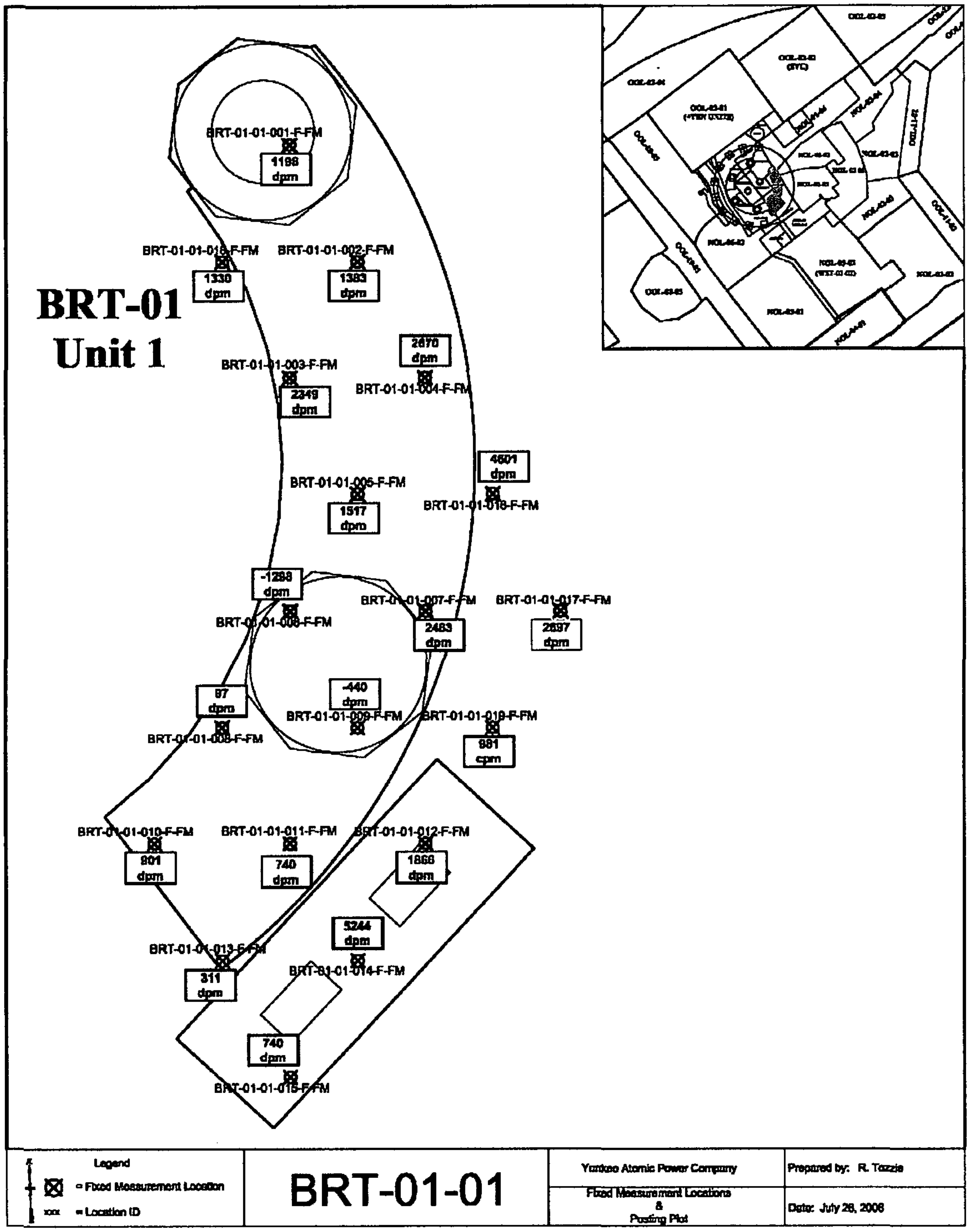


Figure 3 BRT-01-03 Posting Plot

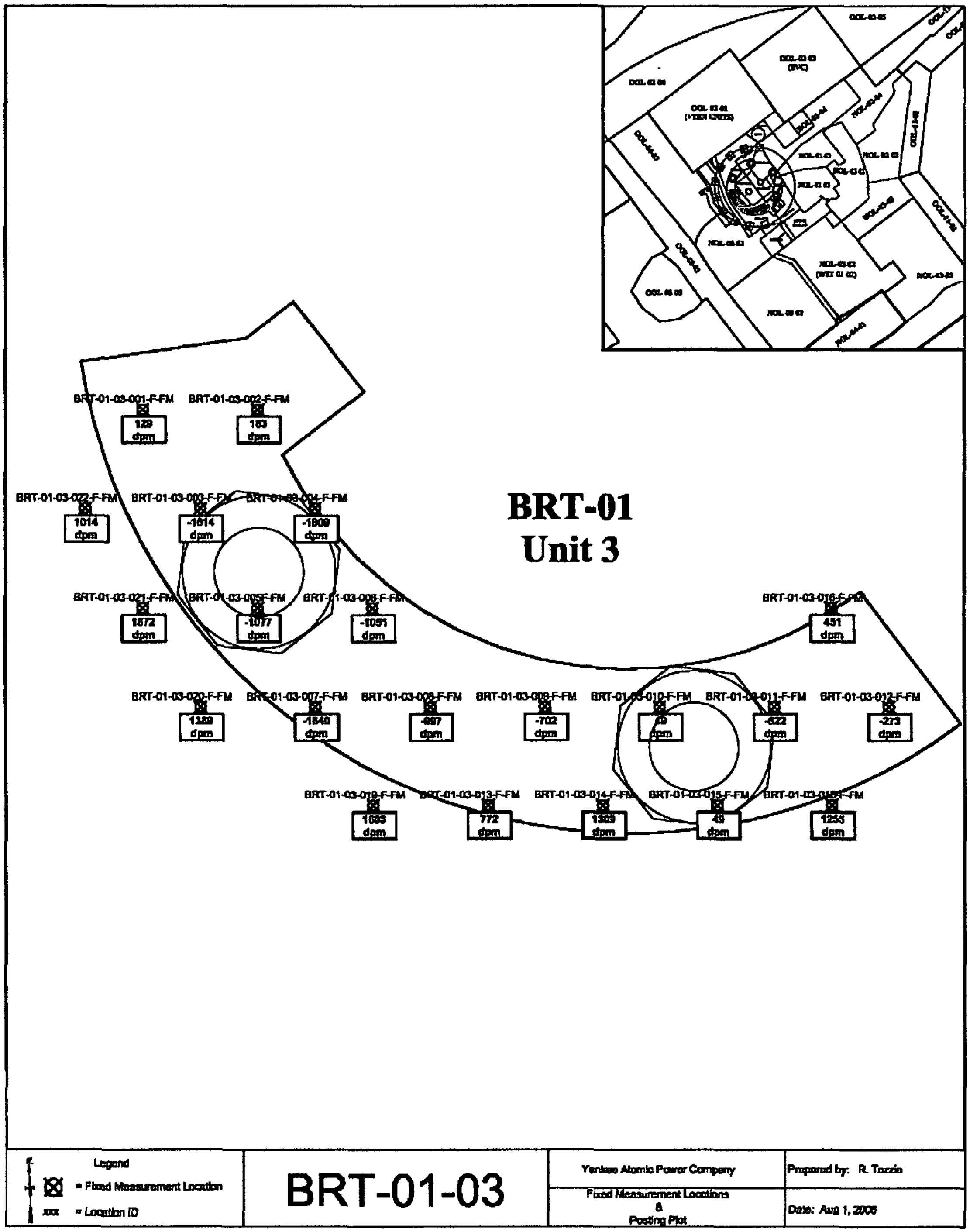


Figure 4 BRT-01-04 Posting Plot

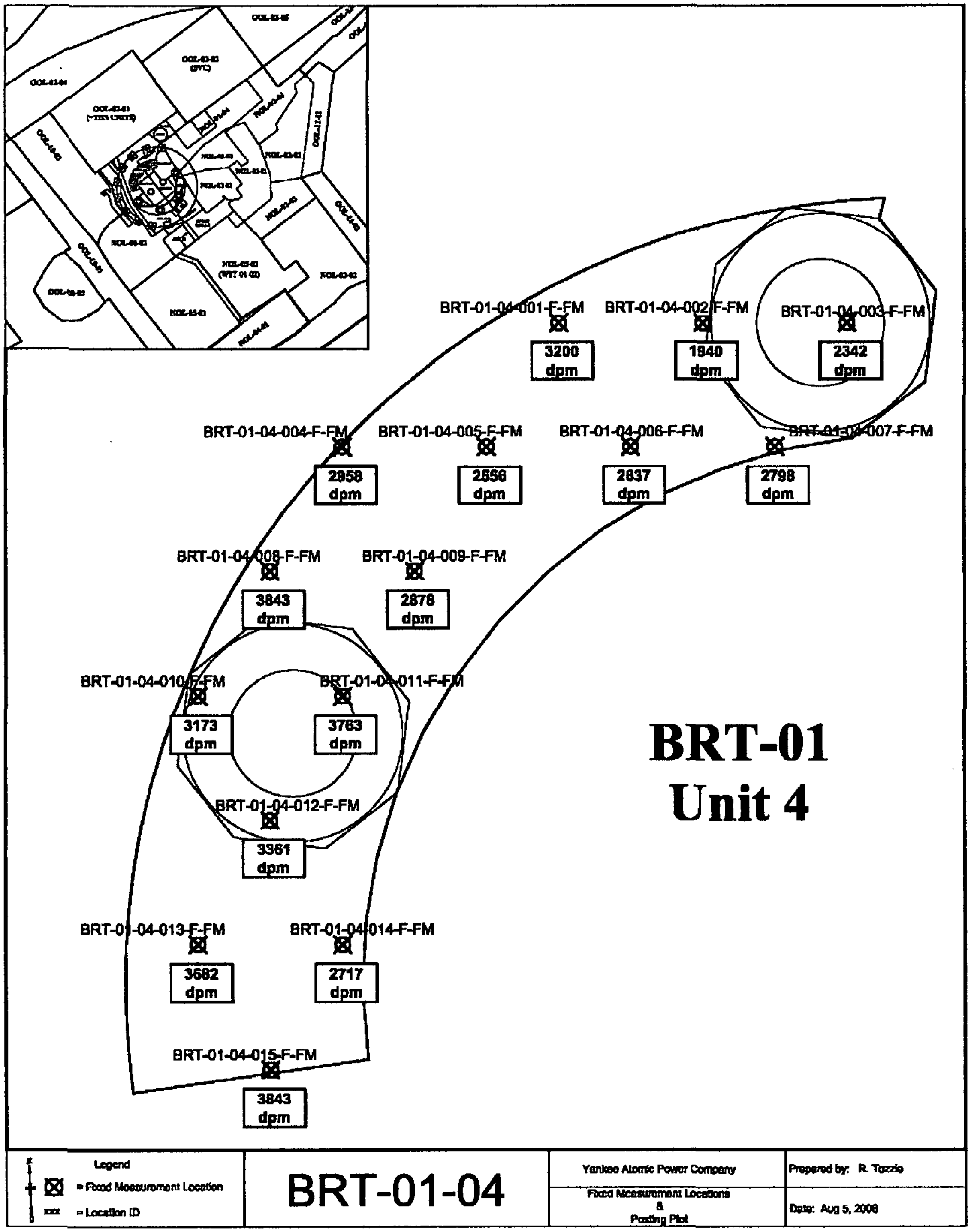


Figure 5 BRT-01-05 Posting Plot

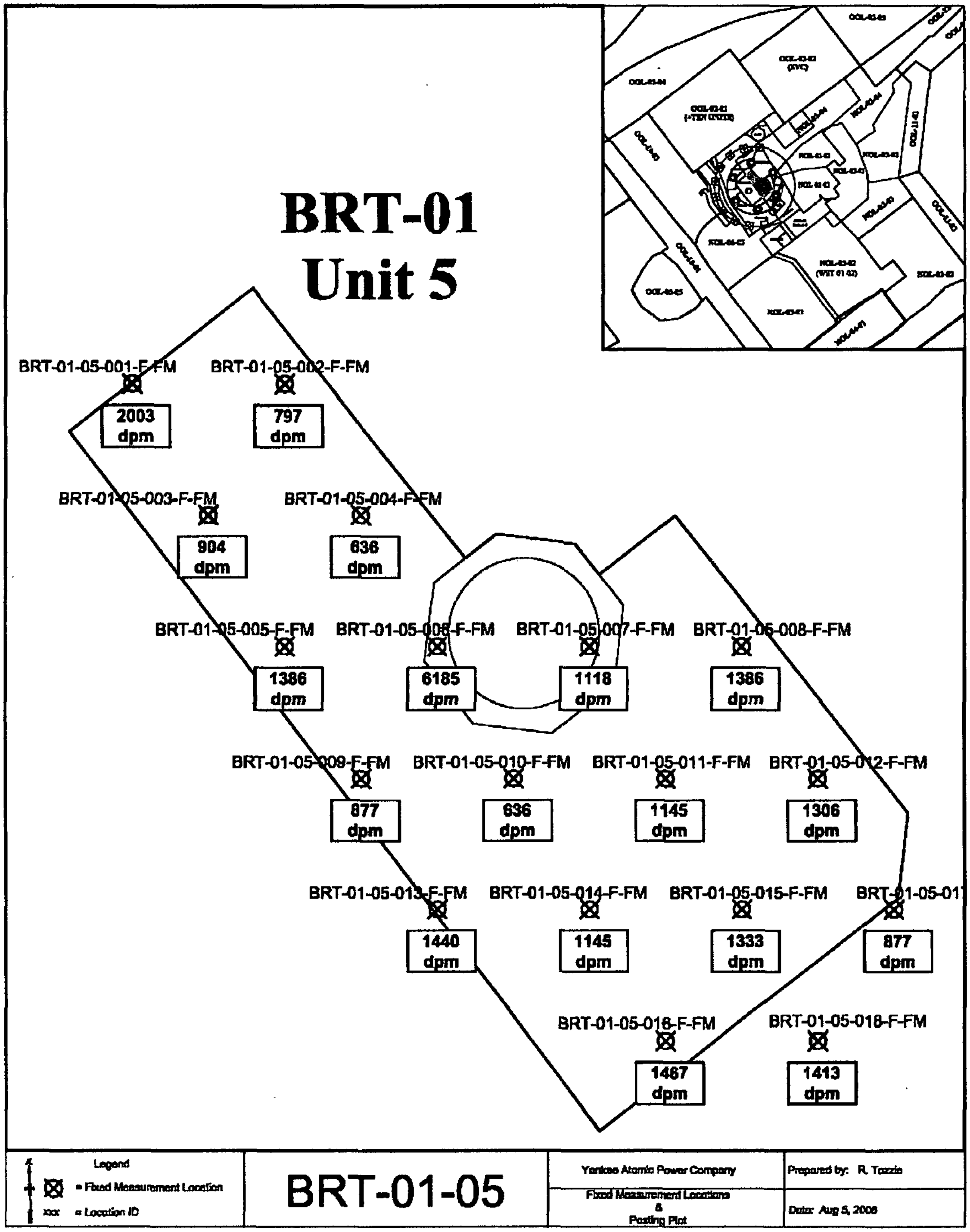


Figure 6 BRT-01-06 Posting Plot

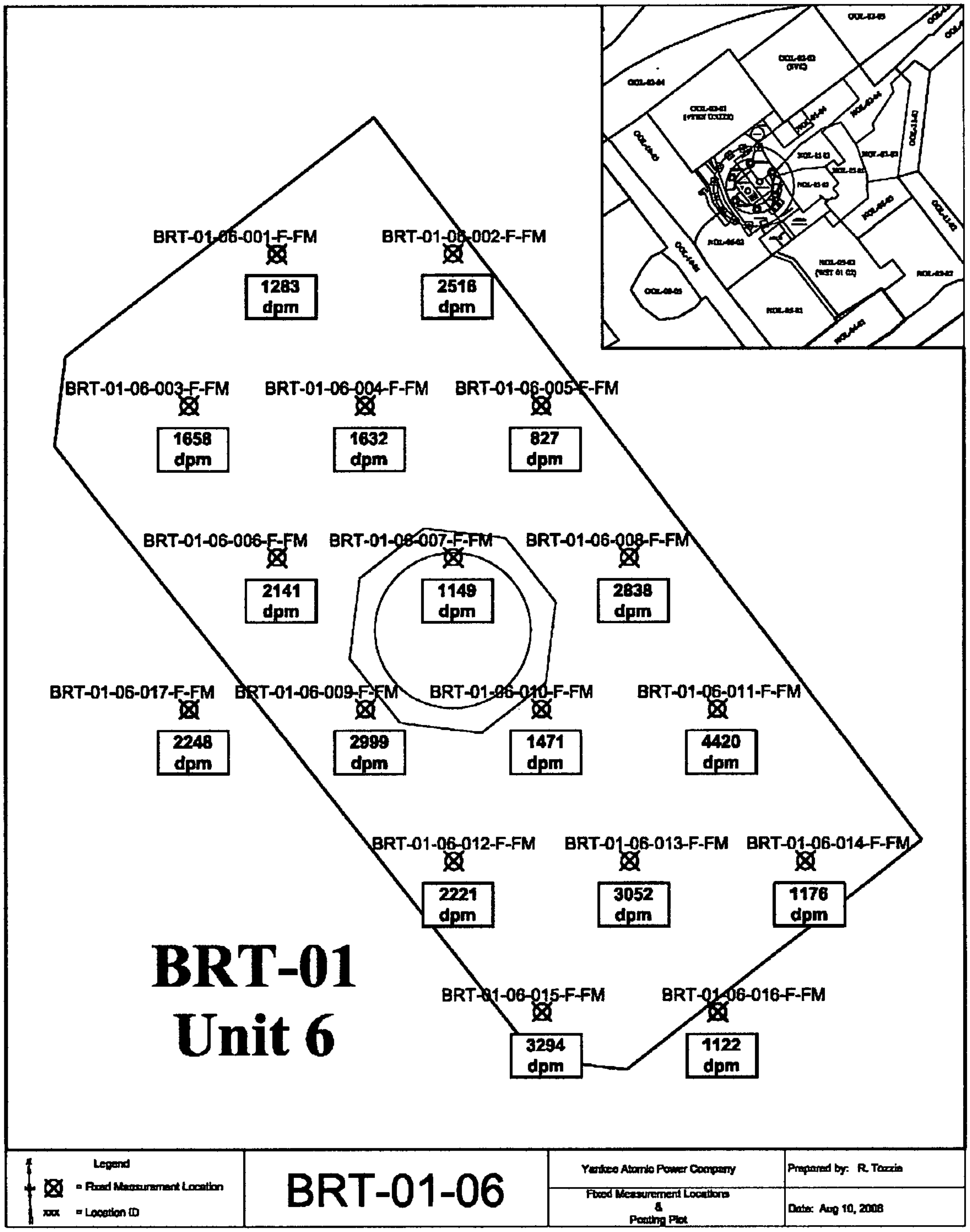


Figure 7 BRT-01-07 Posting Plot

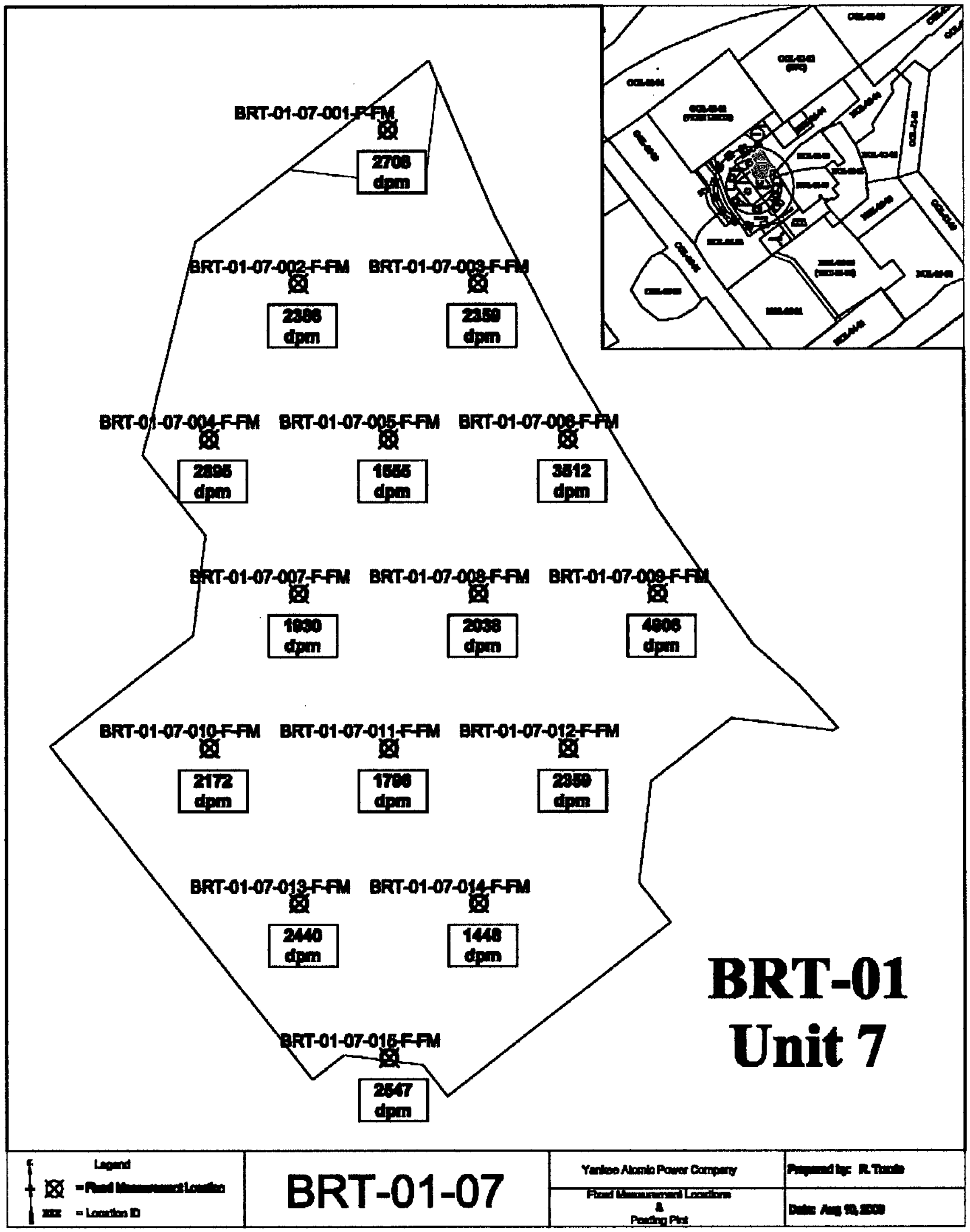


Figure 8 BRT-01-08 Posting Plot

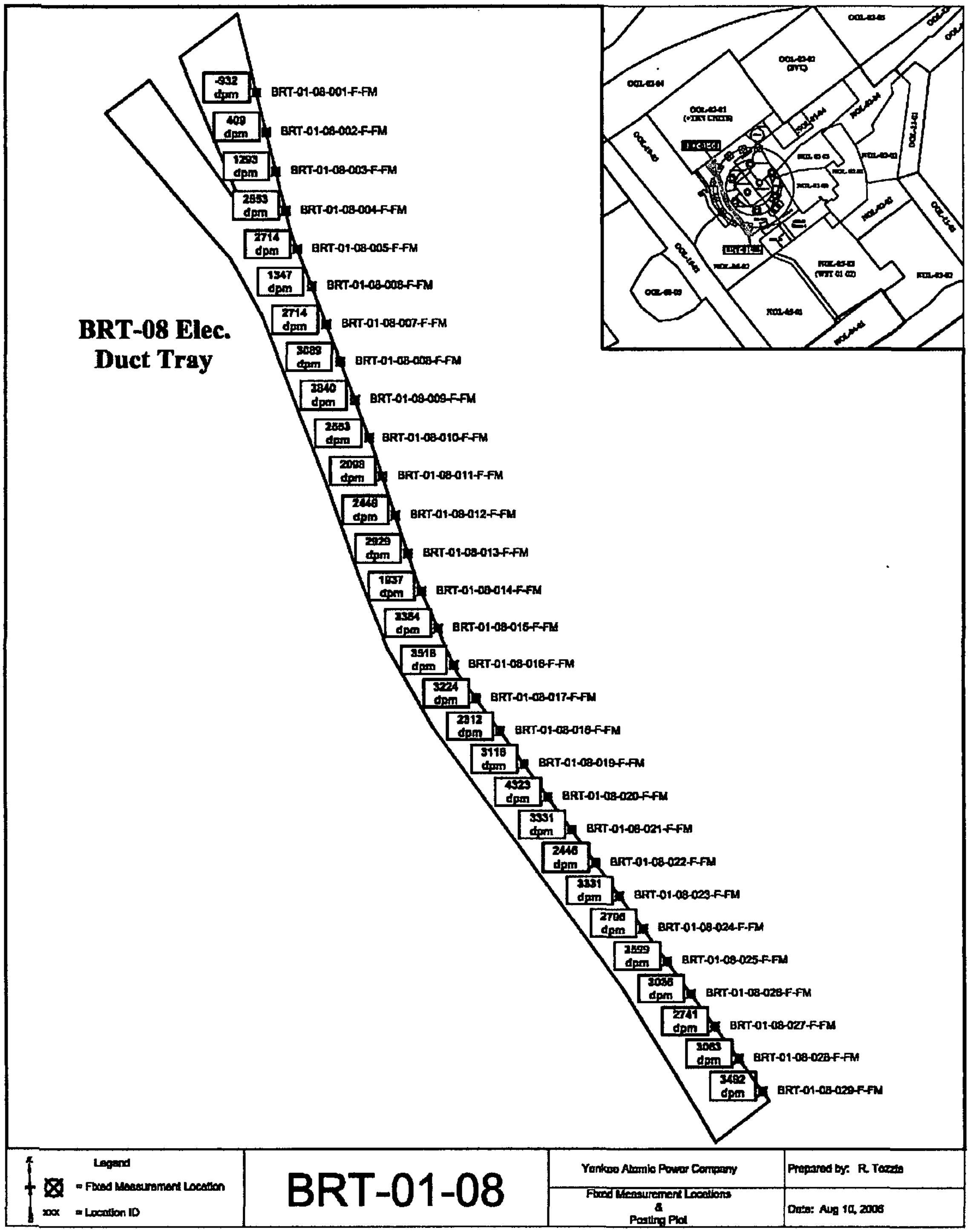


Figure 9 BRT-01-09 Posting Plot

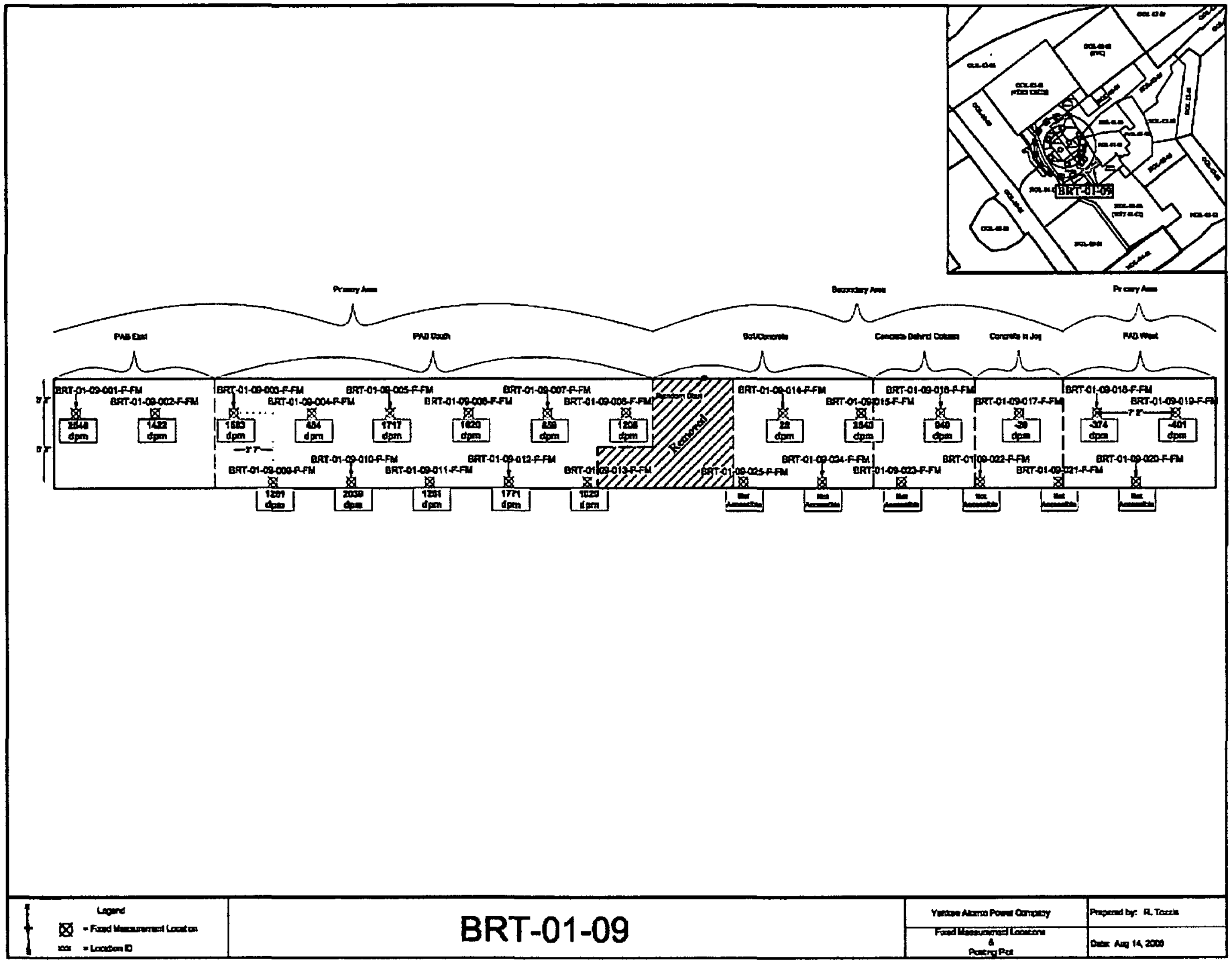


Figure 10 BRT-01-10 Posting Plot

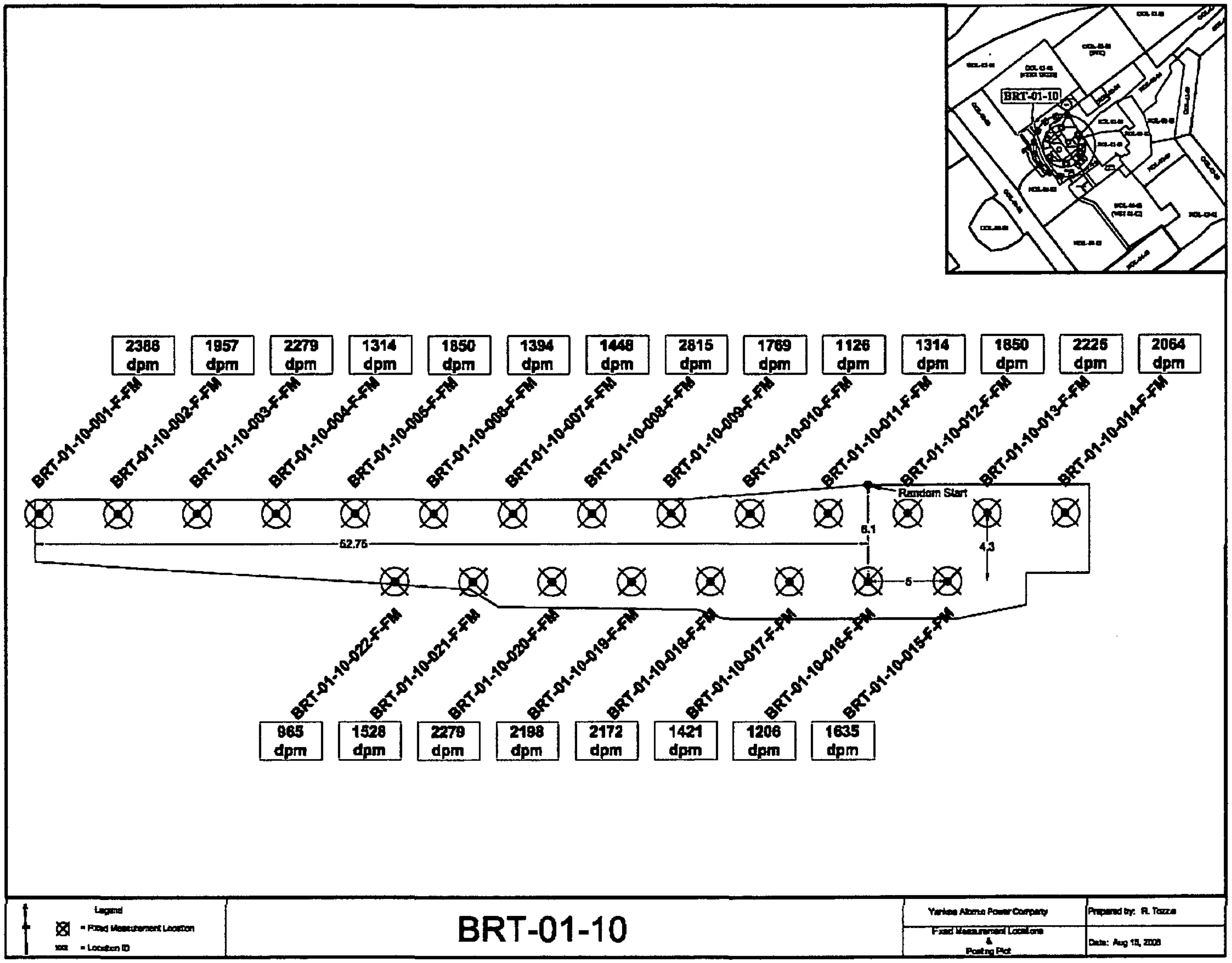


Figure 11 BRT-01-11 Posting Plot

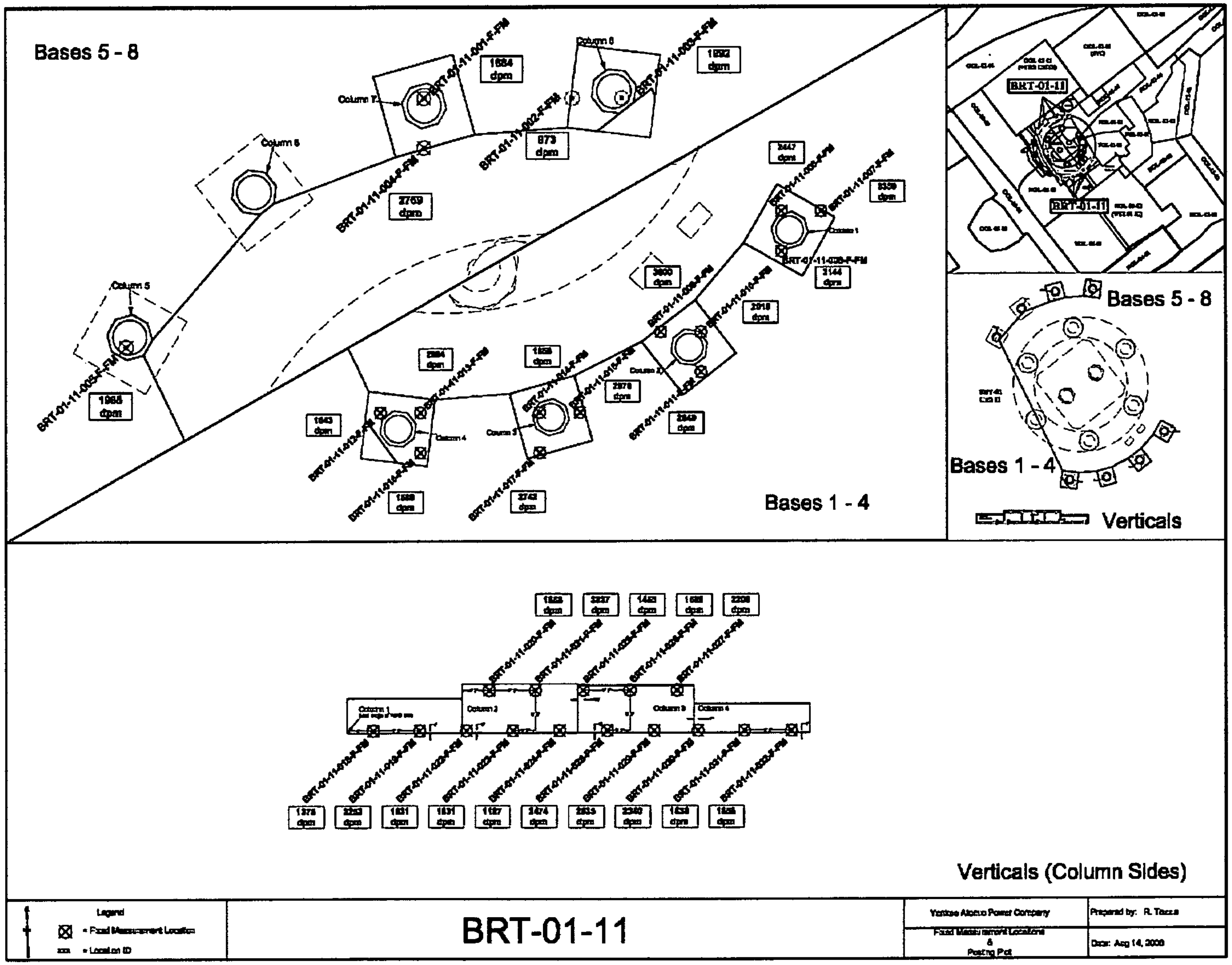


Figure 12 BRT-01-12 Posting Plot

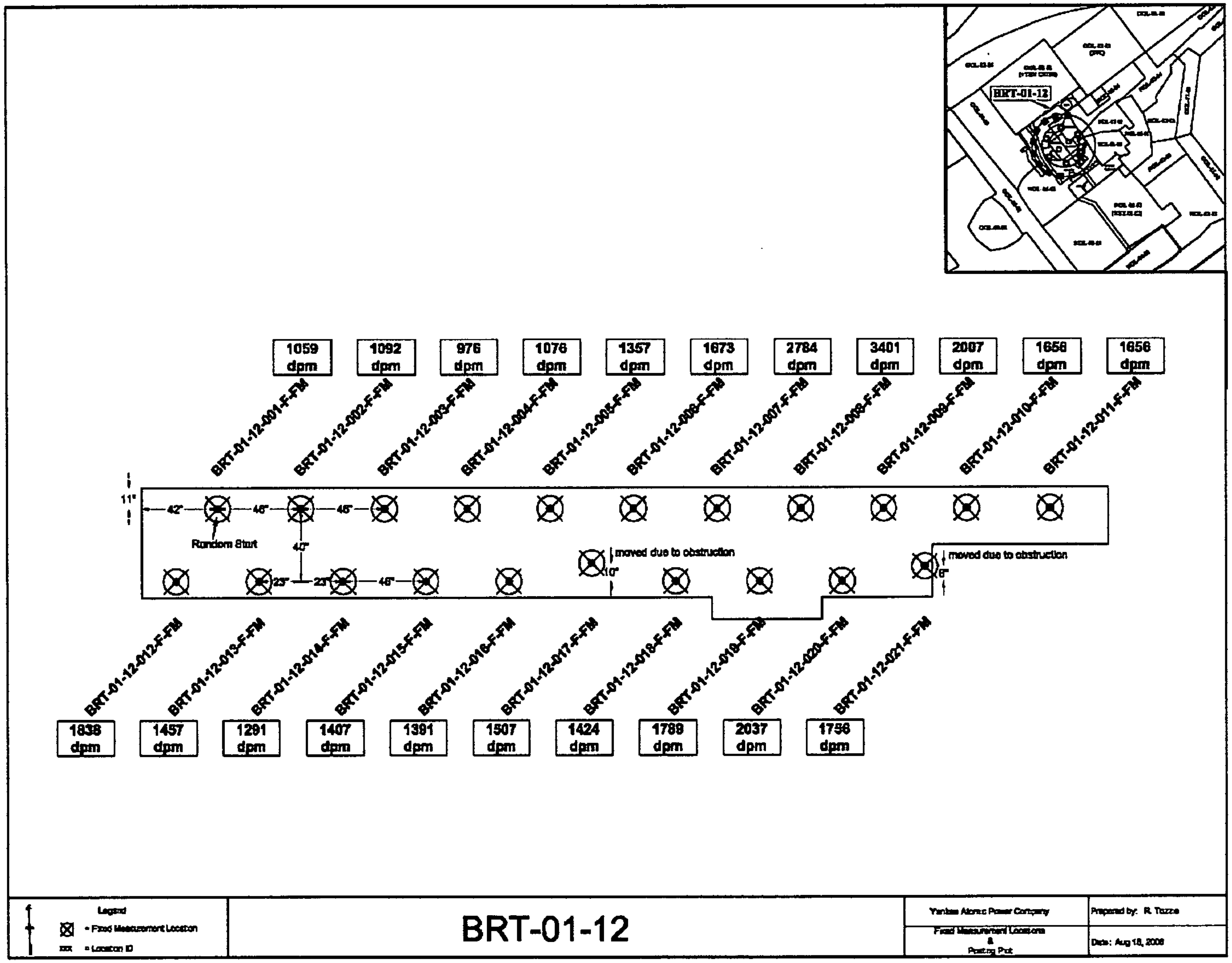
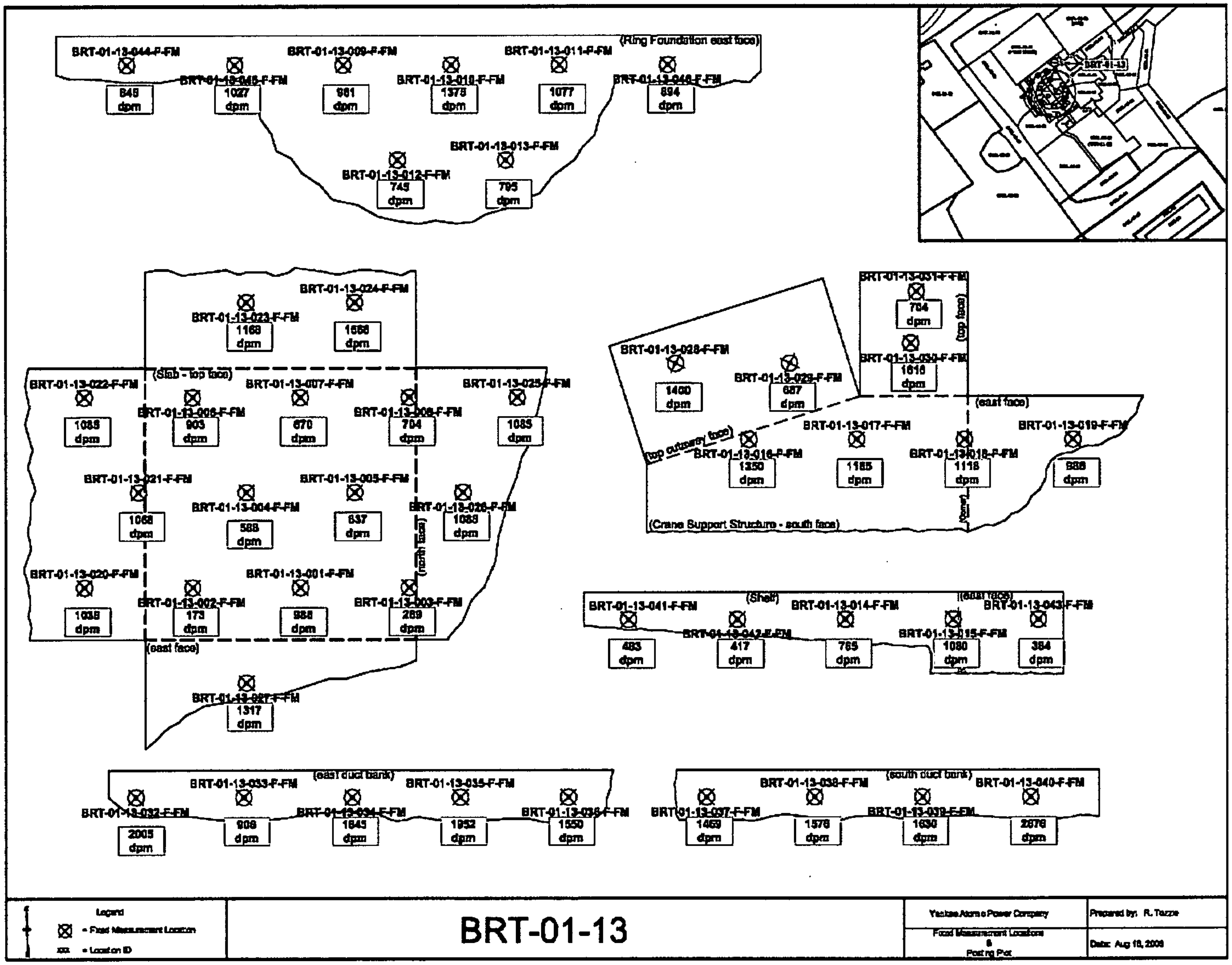


Figure 13 BRT-01-13 Posting Plot



Attachment B

Data Quality Assessment Plots and Curves

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The LBGR on the Power Curves have been adjusted to demonstrate the actual power of the survey.

Figure 1 BRT-01-01 Prospective Power Curve

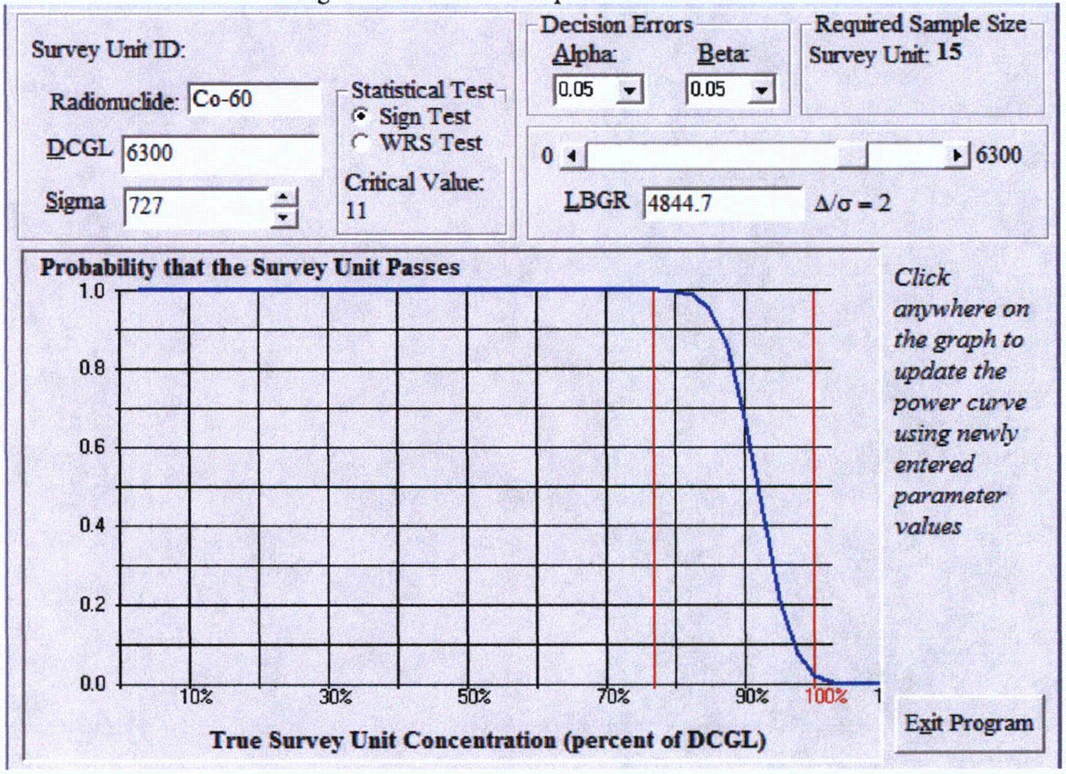

Figure 2 BRT-01-01 Retrospective Power Curve

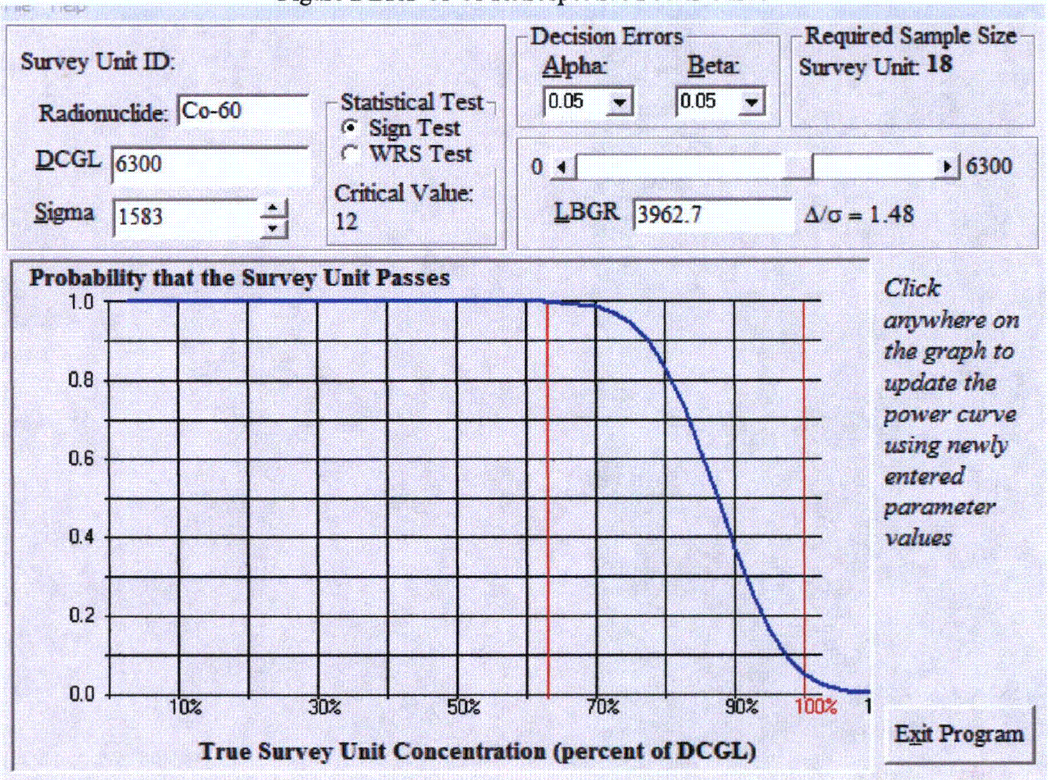

Figure 3 BRT-01-01 Scatter Plot

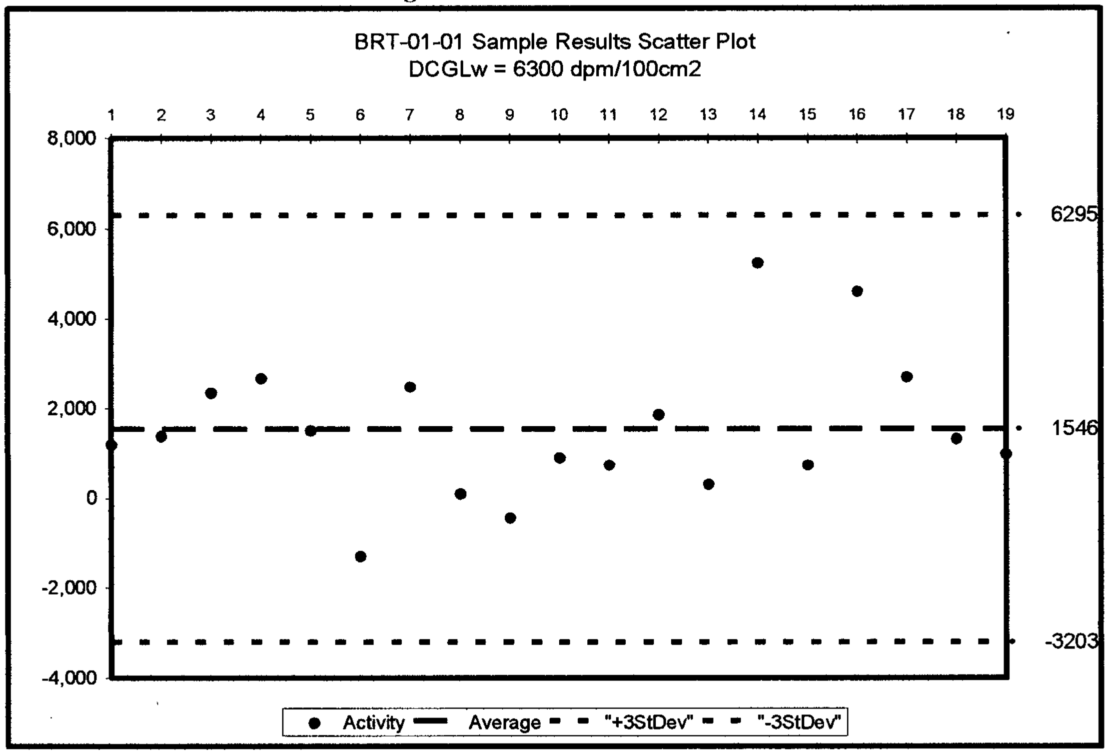

Figure 4 BRT-01-01 Quantile Plot

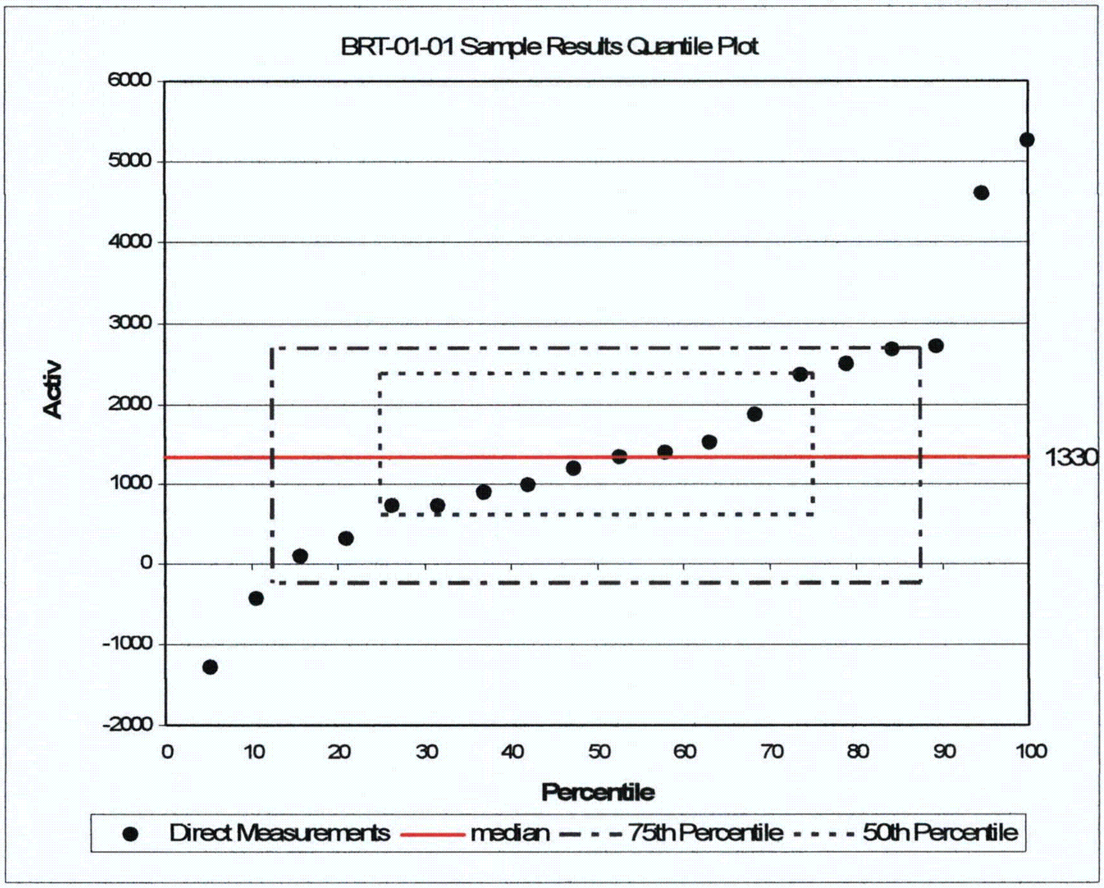

Figure 5 BRT-01-01 Frequency Plot

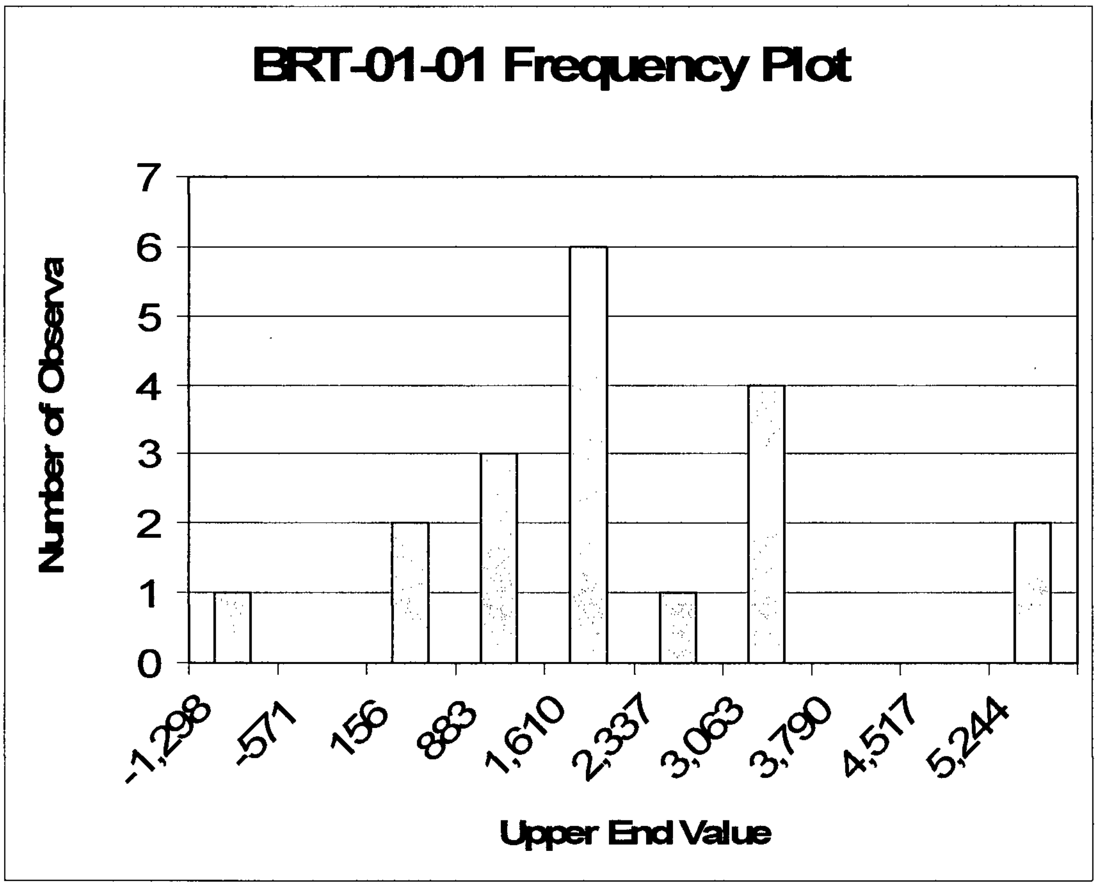

Figure 6 BRT-01-03 Prospective Power Curve

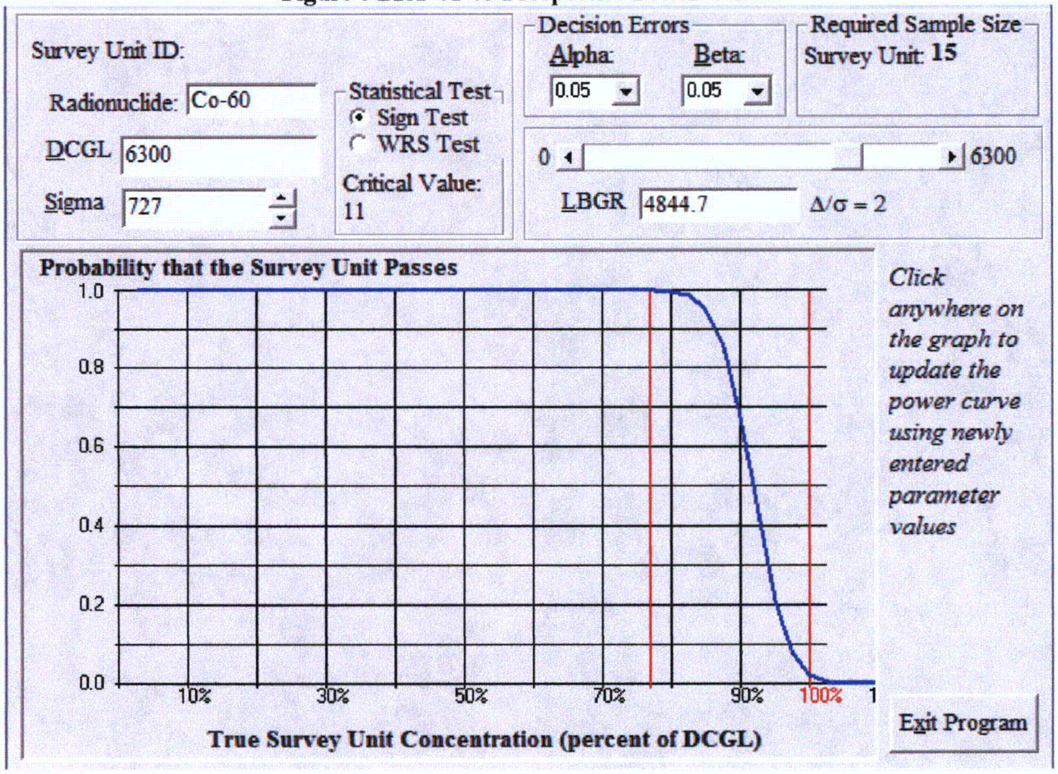

Figure 7 BRT-01-03 Retrospective Power Curve

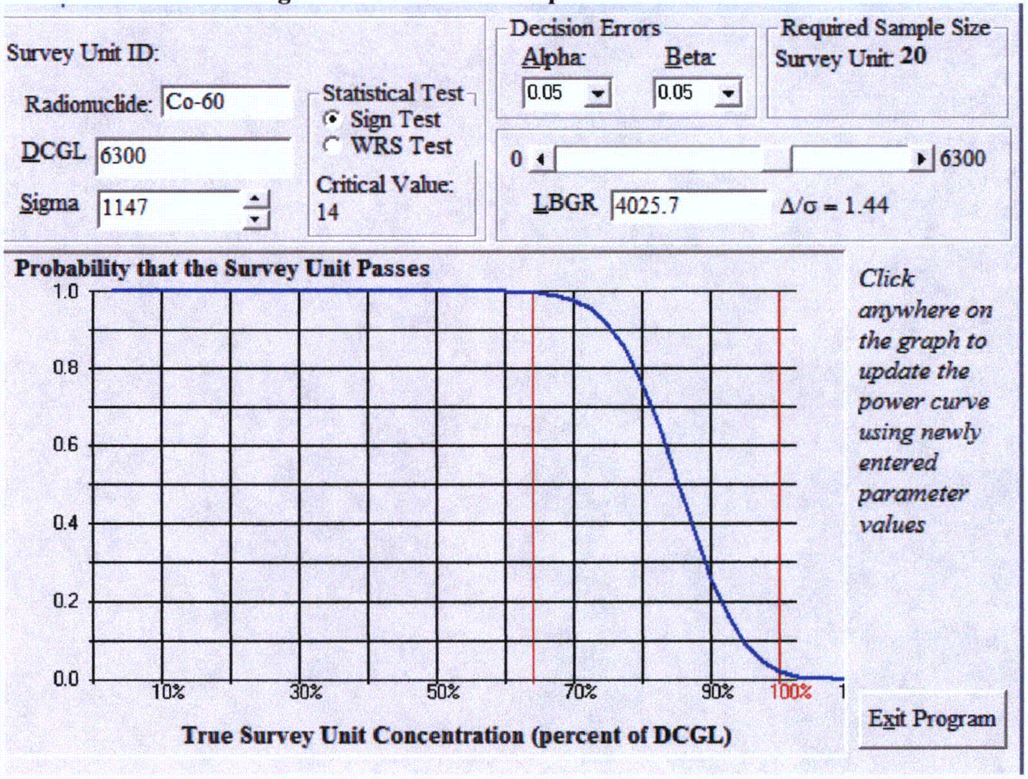

Figure 8 BRT-01-03 Scatter Plot

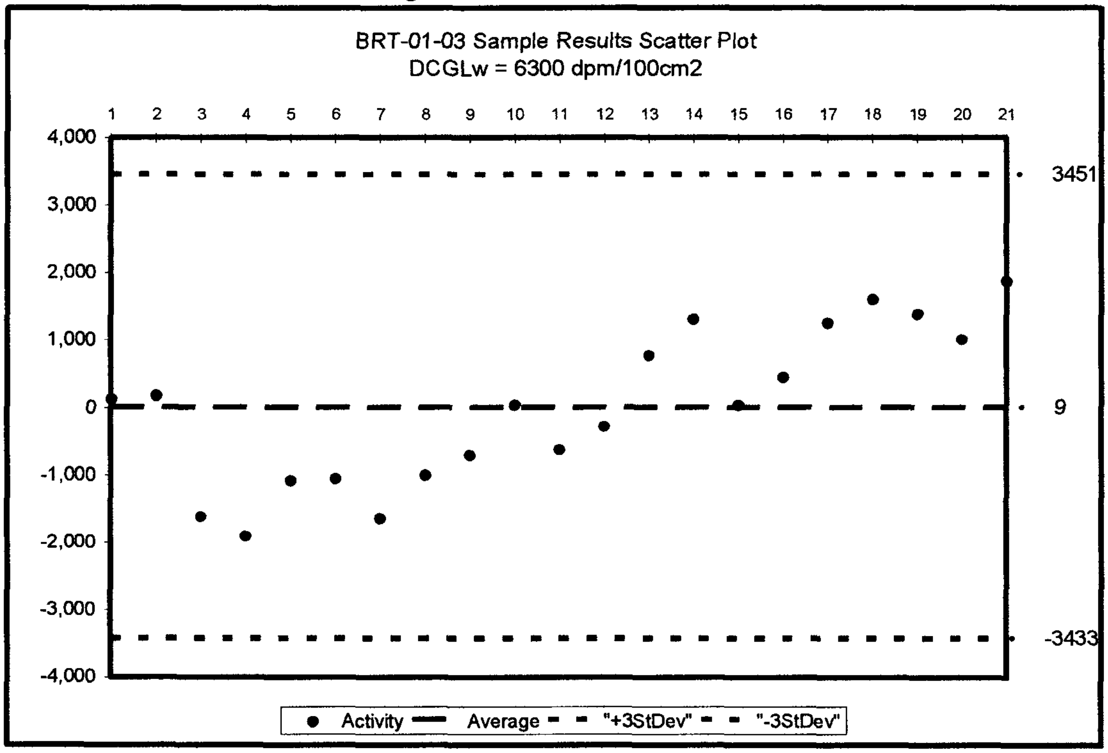

Figure 9 BRT-01-03 Quantile Plot

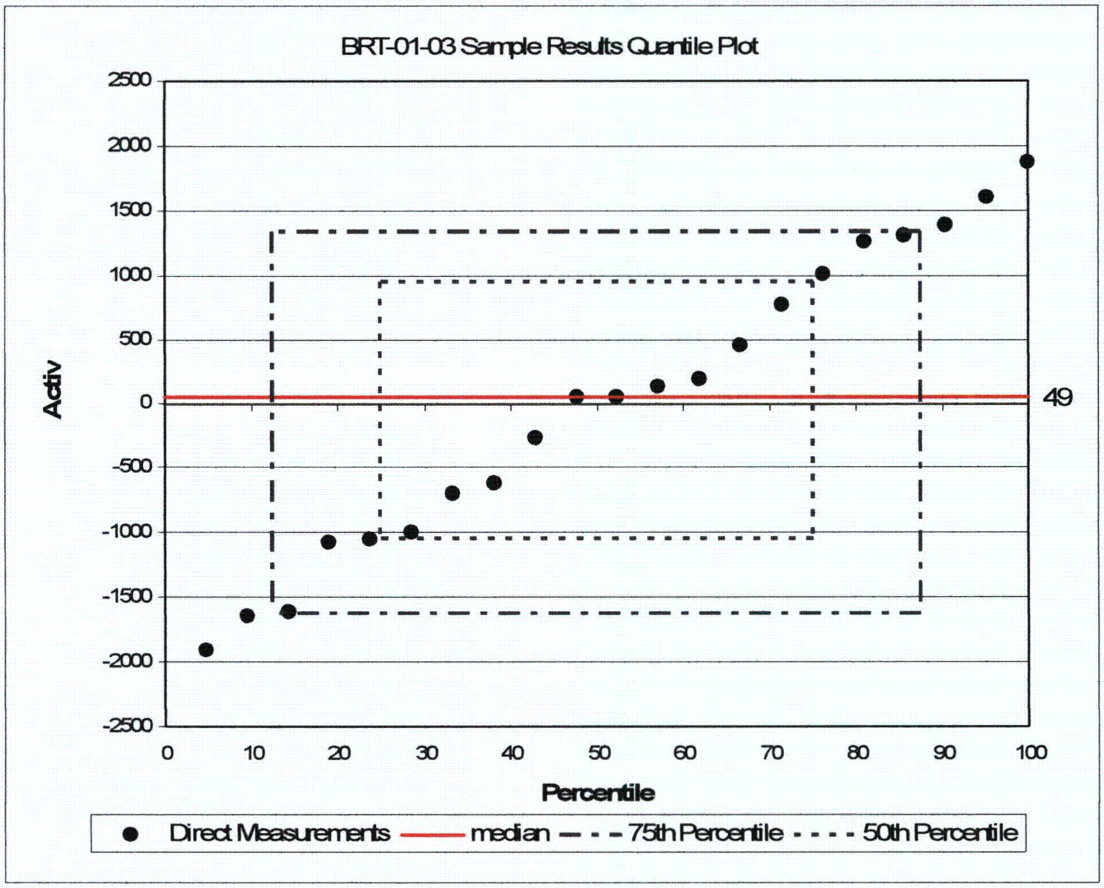

Figure 10 BRT-01-03 Frequency Plot

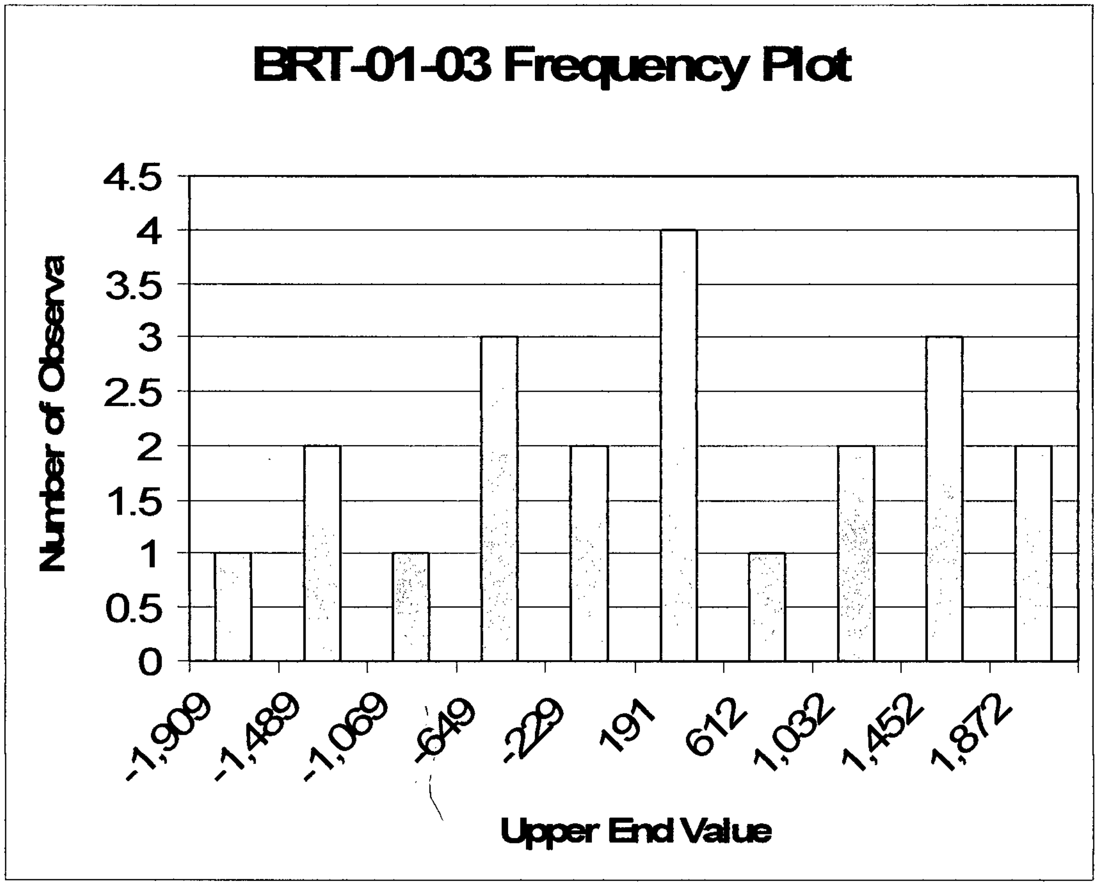

Figure 11 BRT-01-04 Prospective Power Curve

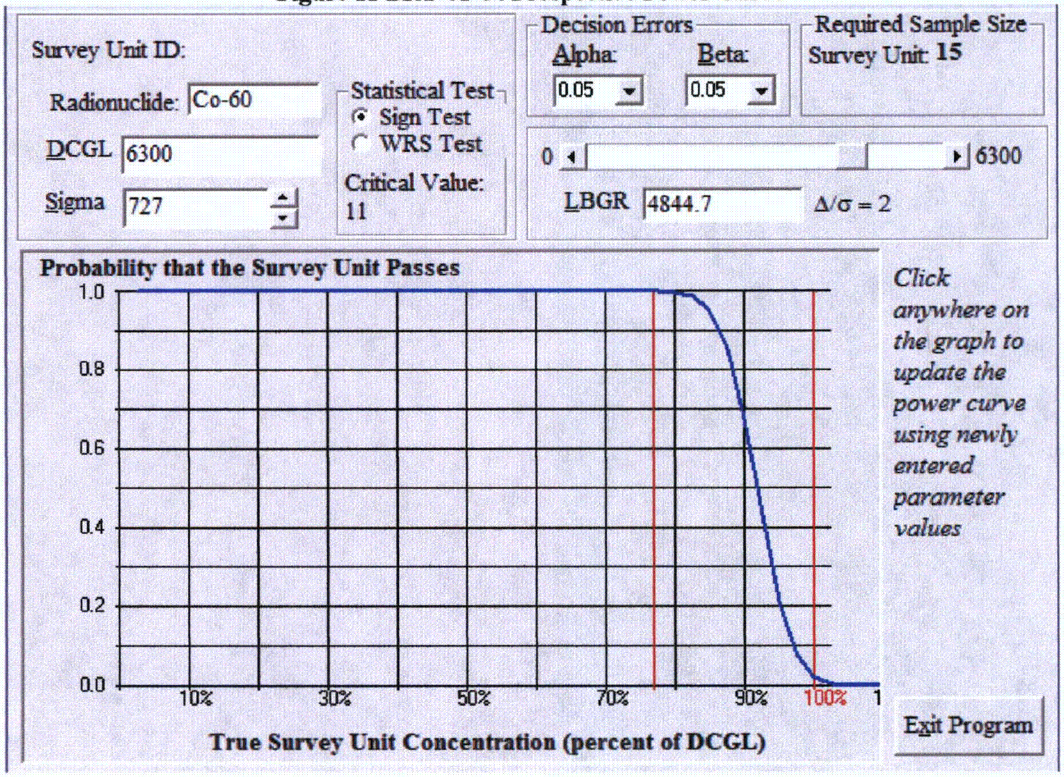

Figure 12 BRT-01-04 Retrospective Power Curve

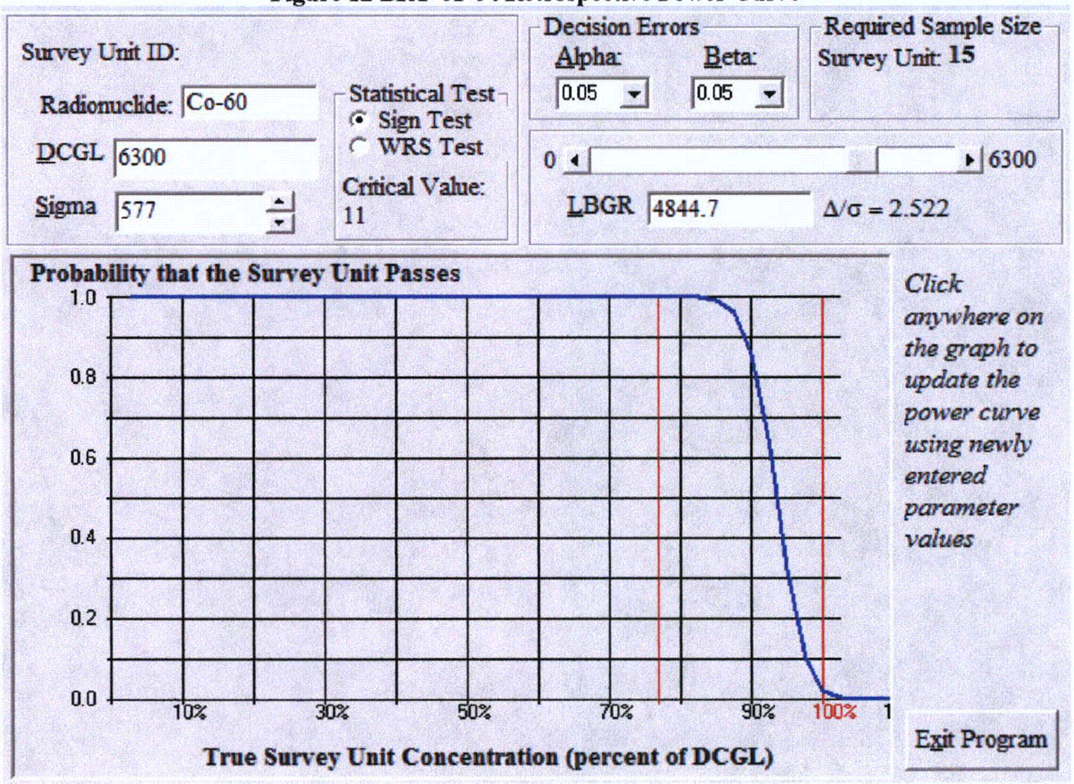

Figure 13 BRT-01-04 Scatter Plot

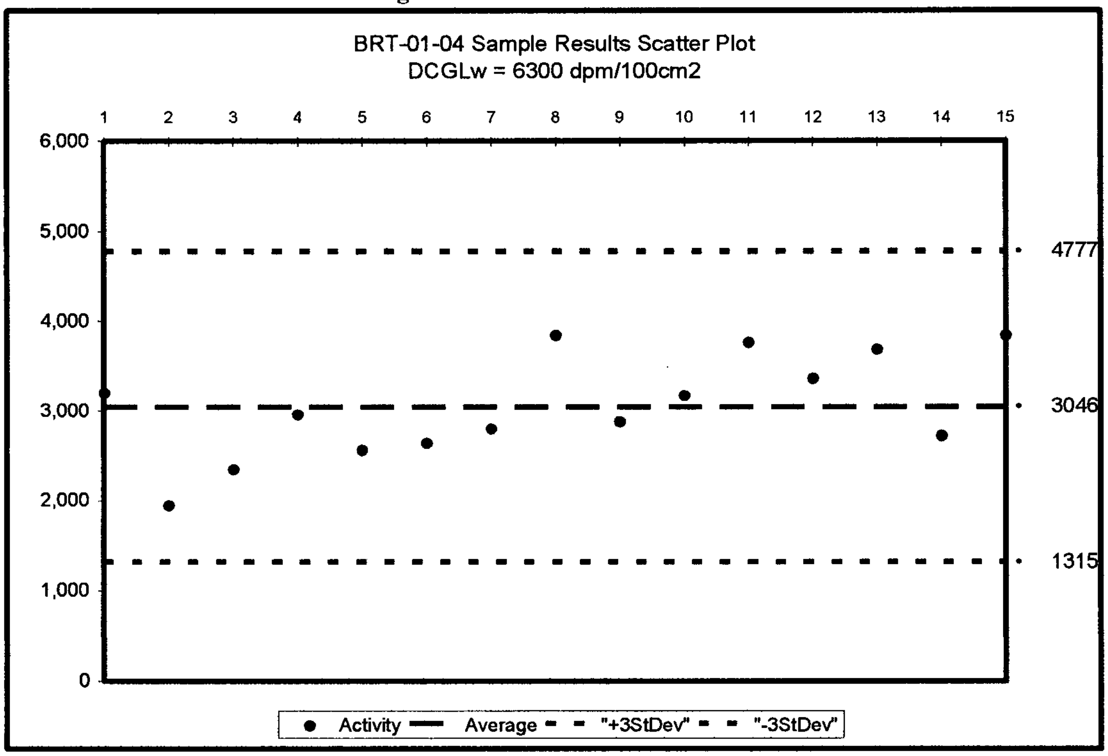

Figure 14 BRT-01-04 Quantile Plot

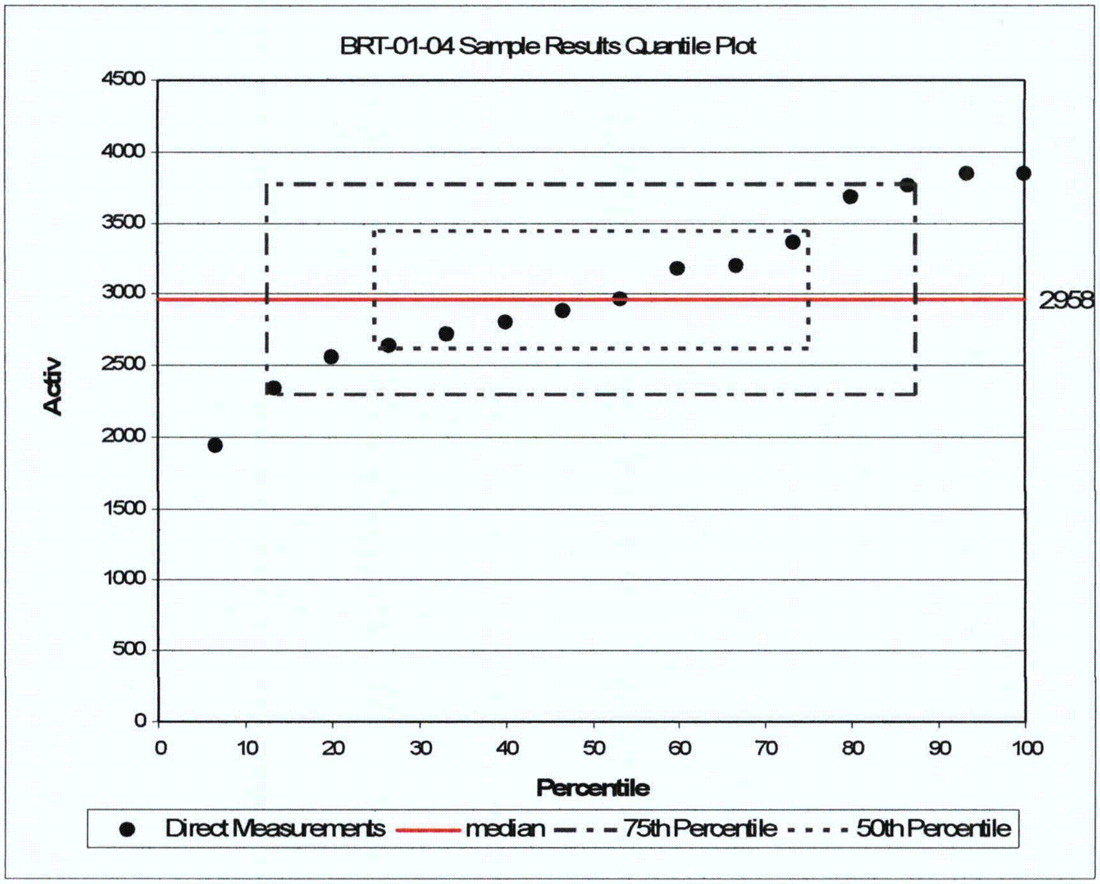

Figure 15 BRT-01-04 Frequency Plot

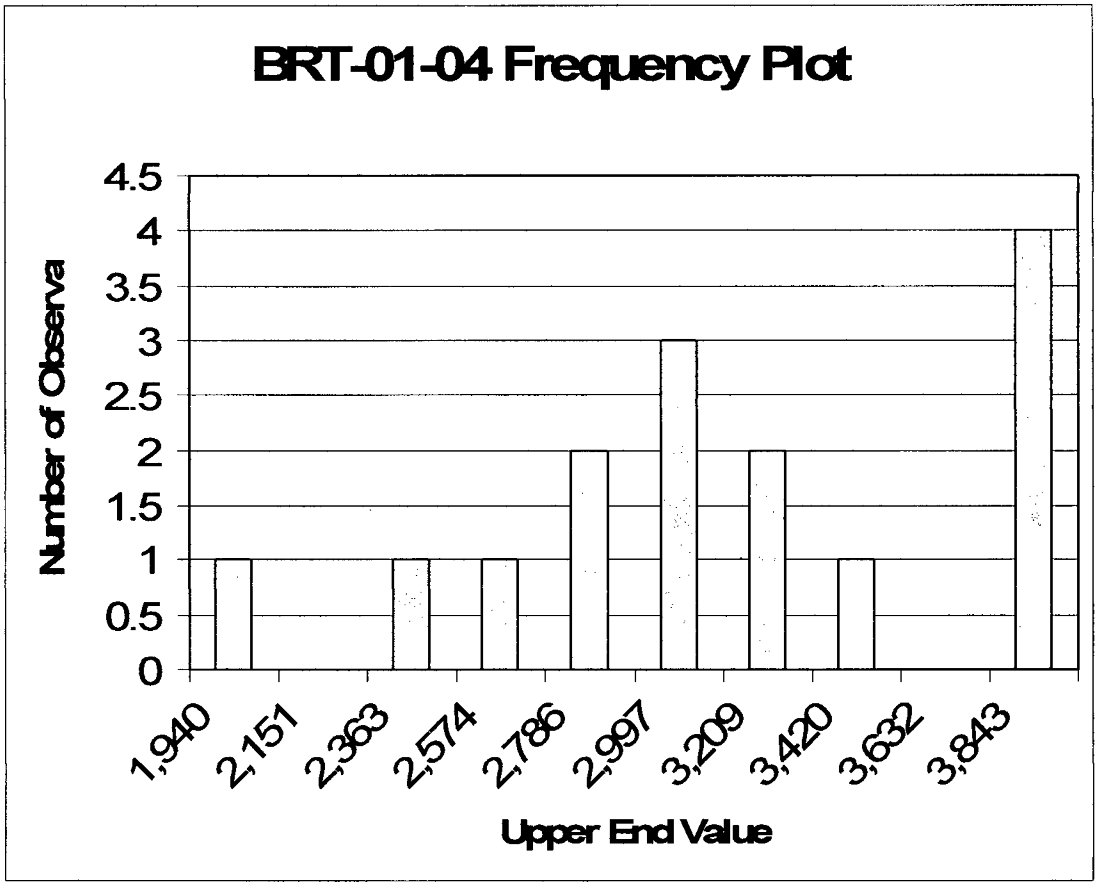

Figure 16 BRT-01-05 Prospective Power Curve

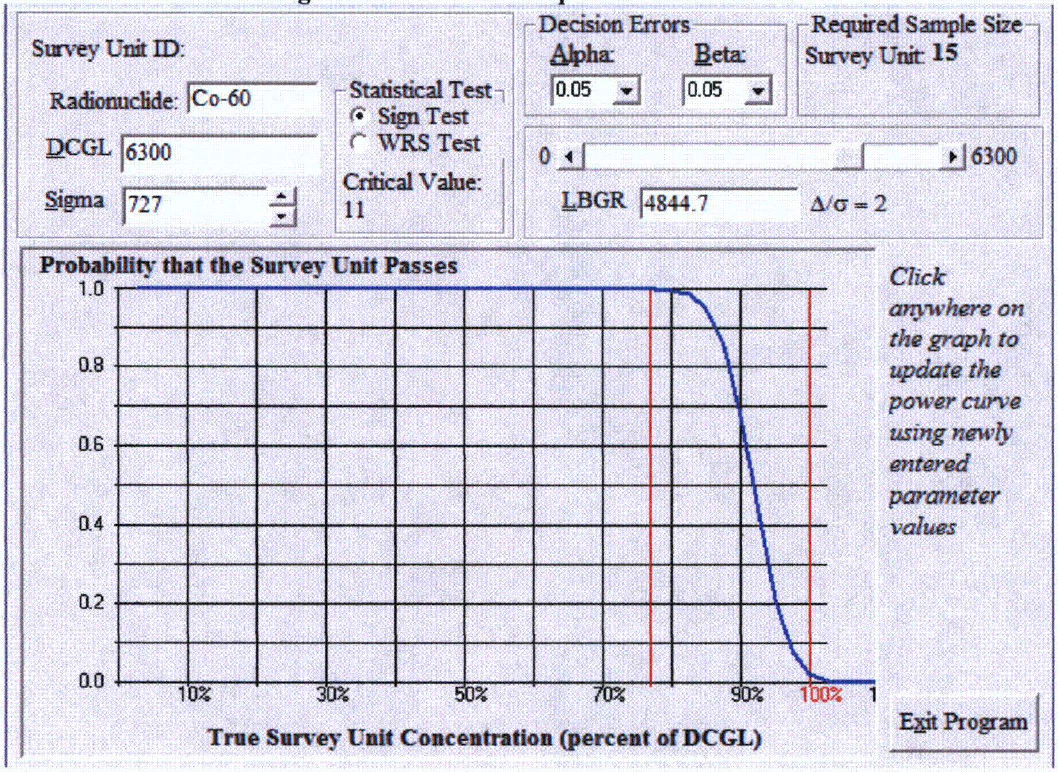

Figure 17 BRT-01-05 Retrospective Power Curve

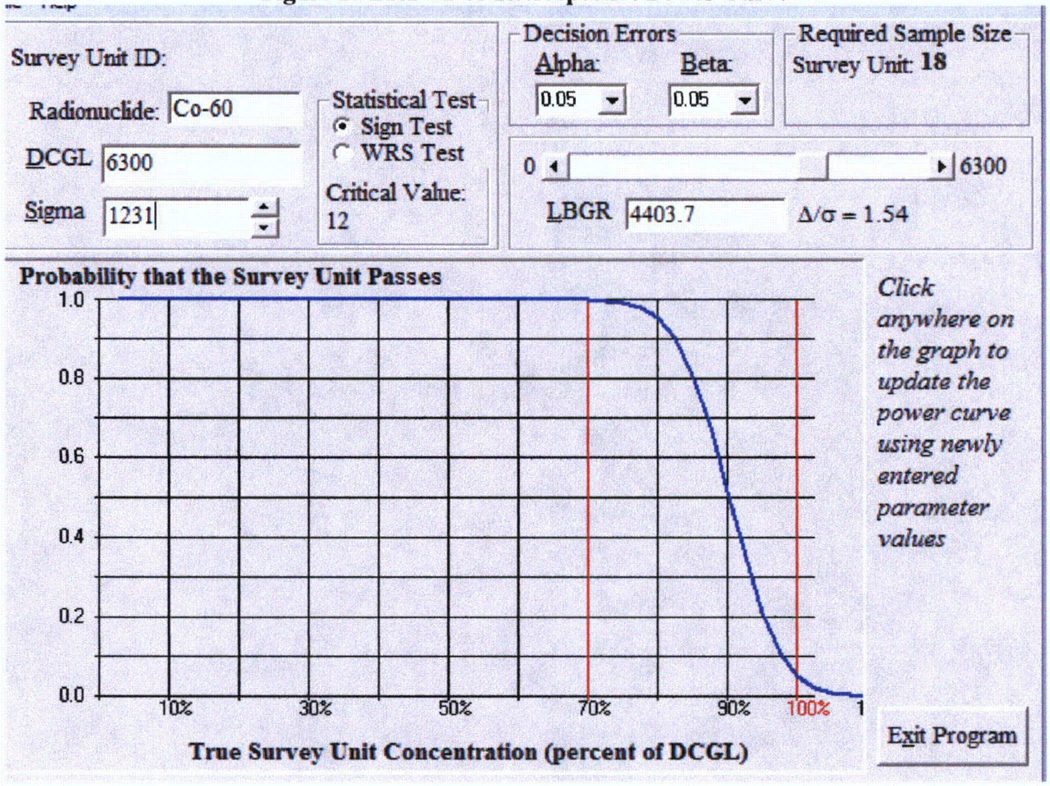

Figure 18 BRT-01-05 Scatter Plot

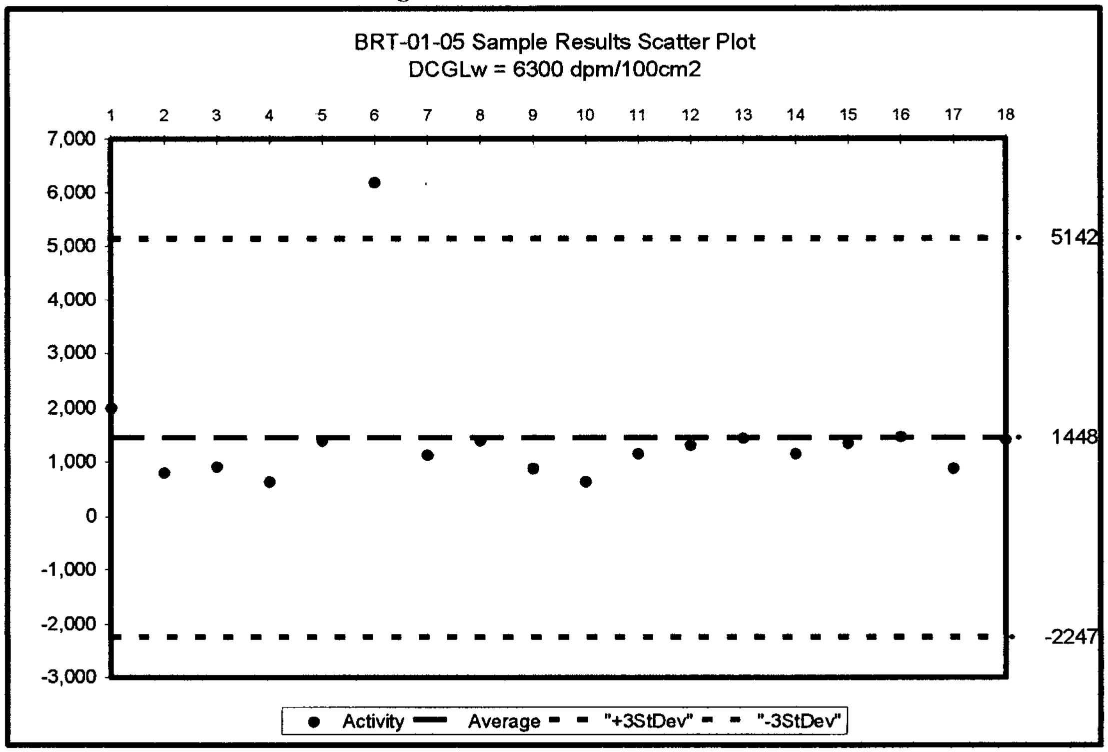

Figure 19 BRT-01-05 Quantile Plot

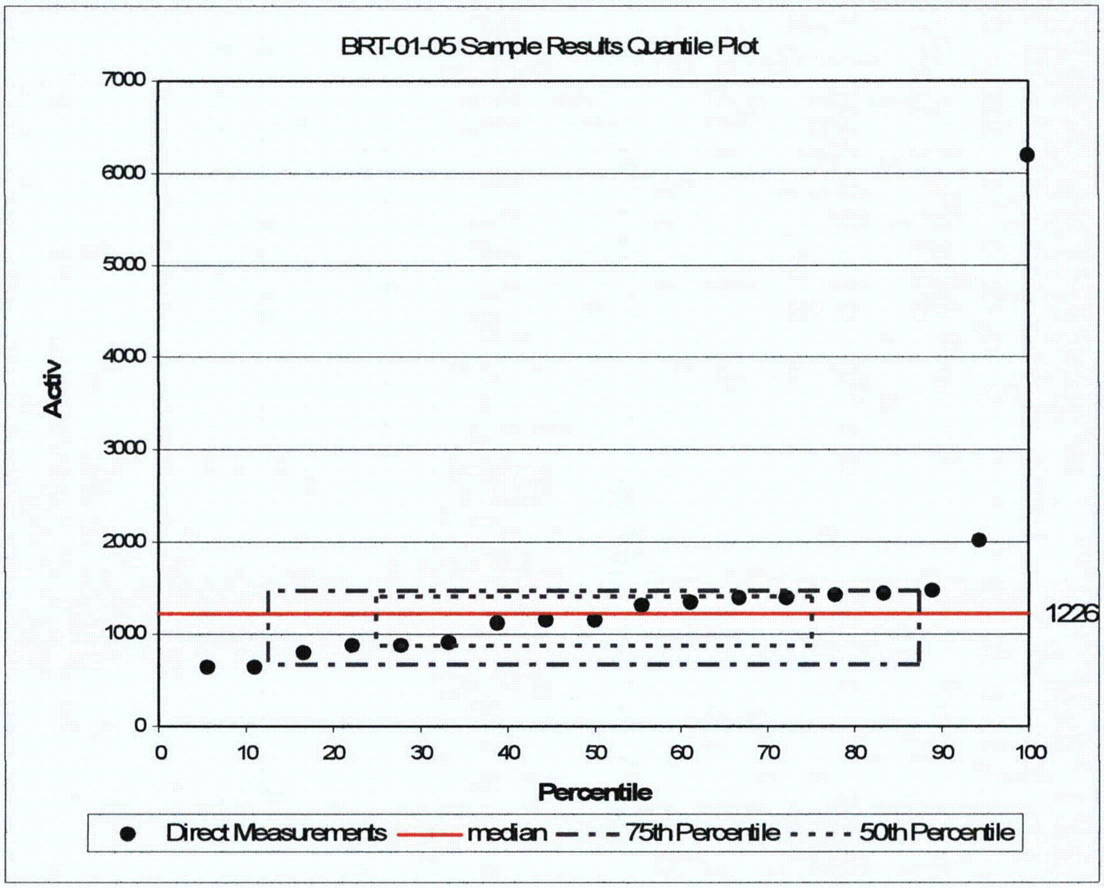

Figure 20 BRT-01-05 Frequency Plot

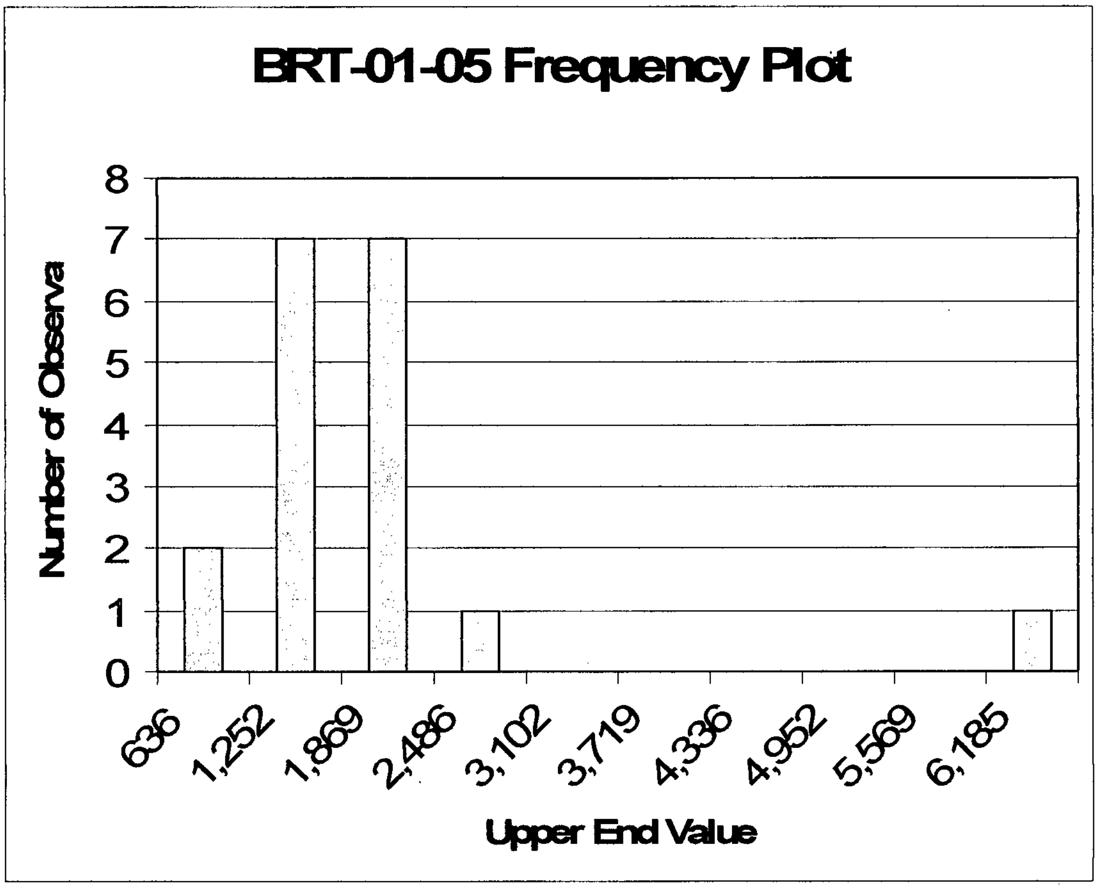

Figure 21 BRT-01-06 Prospective Power Curve

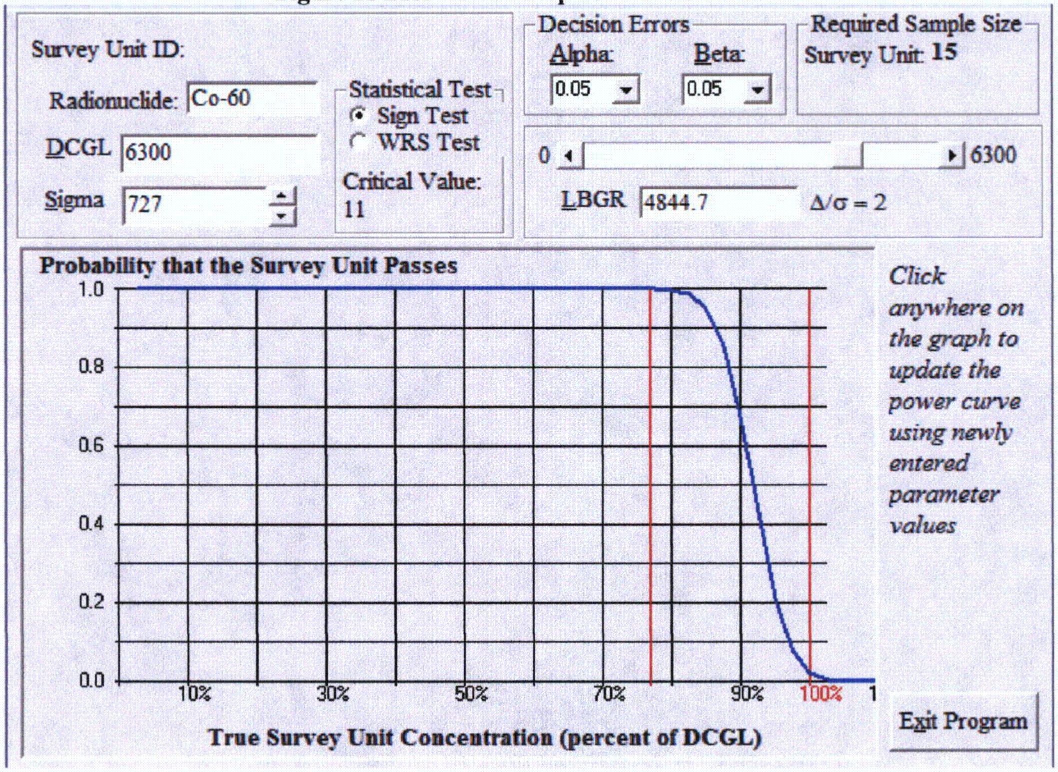

Figure 22 BRT-01-06 Retrospective Power Curve

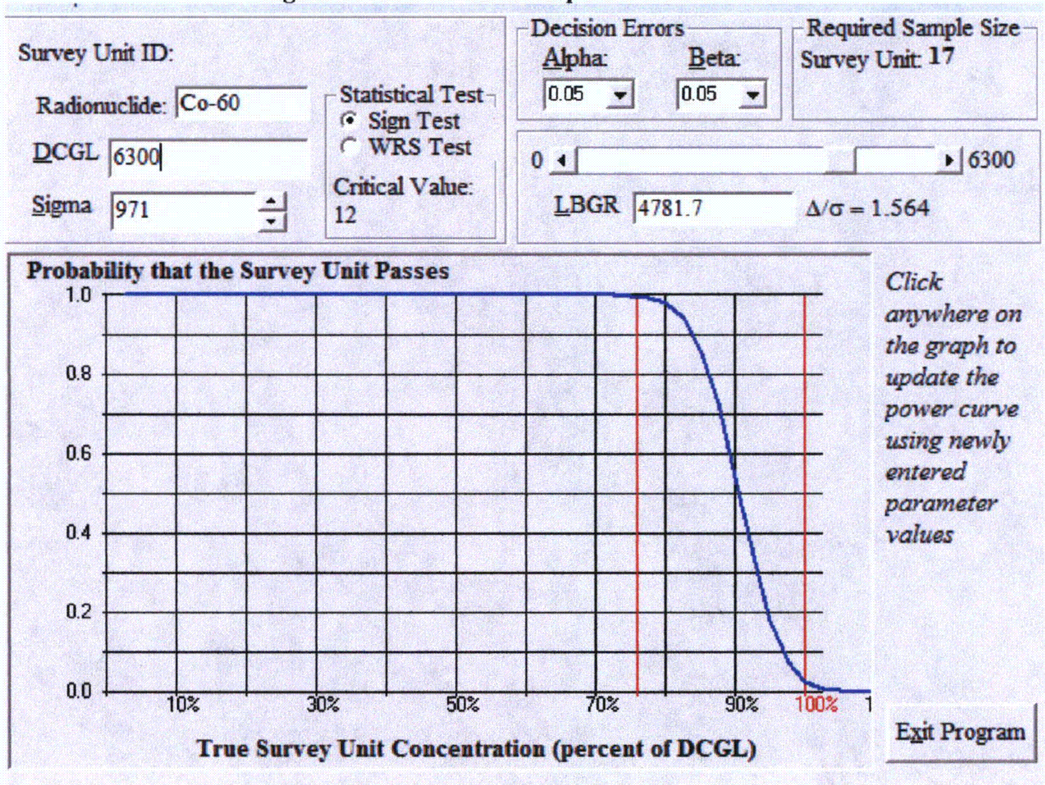

Figure 23 BRT-01-06 Scatter Plot

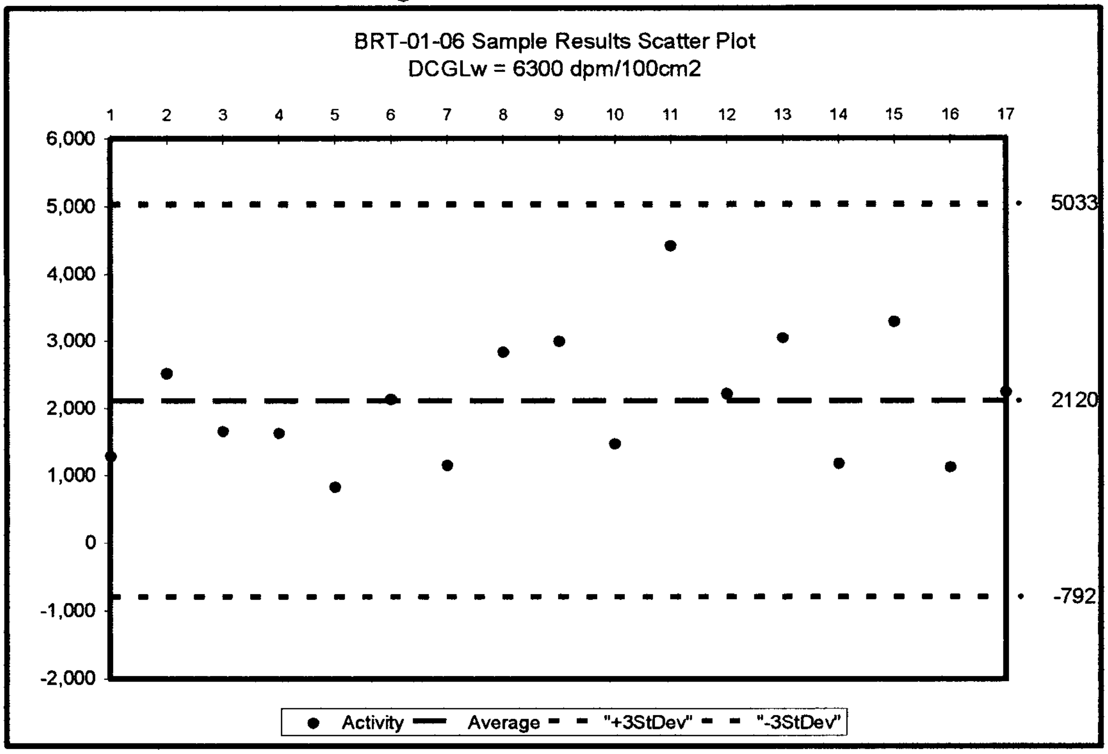

Figure 24 BRT-01-06 Quantile Plot

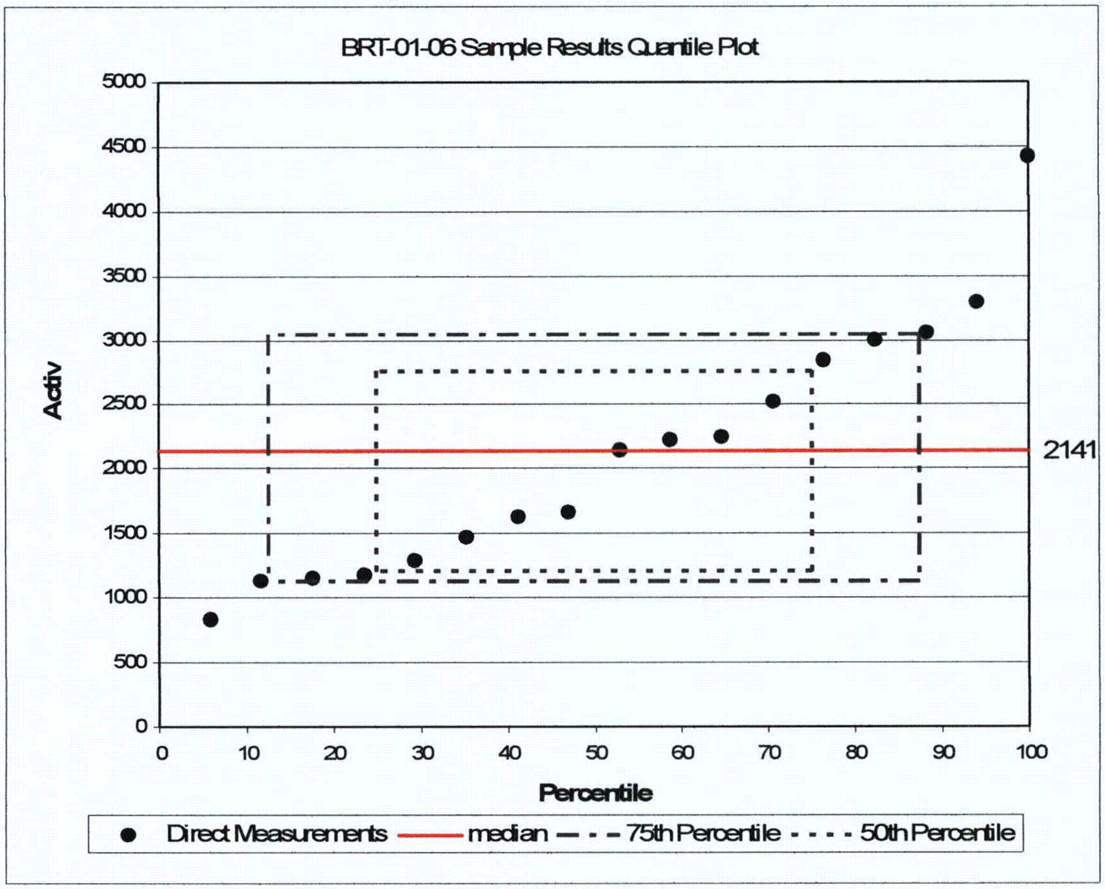

Figure 25 BRT-01-06 Frequency Plot

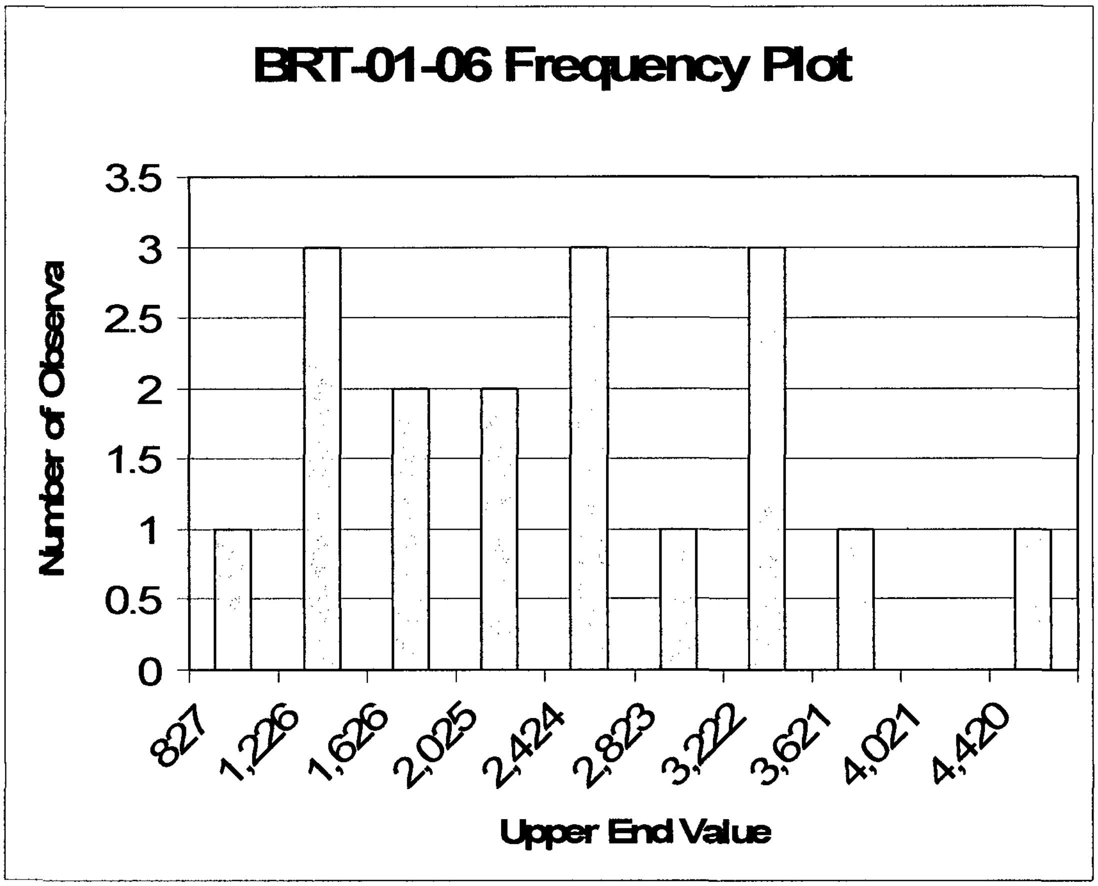

Figure 26 BRT-01-07 Prospective Power Curve

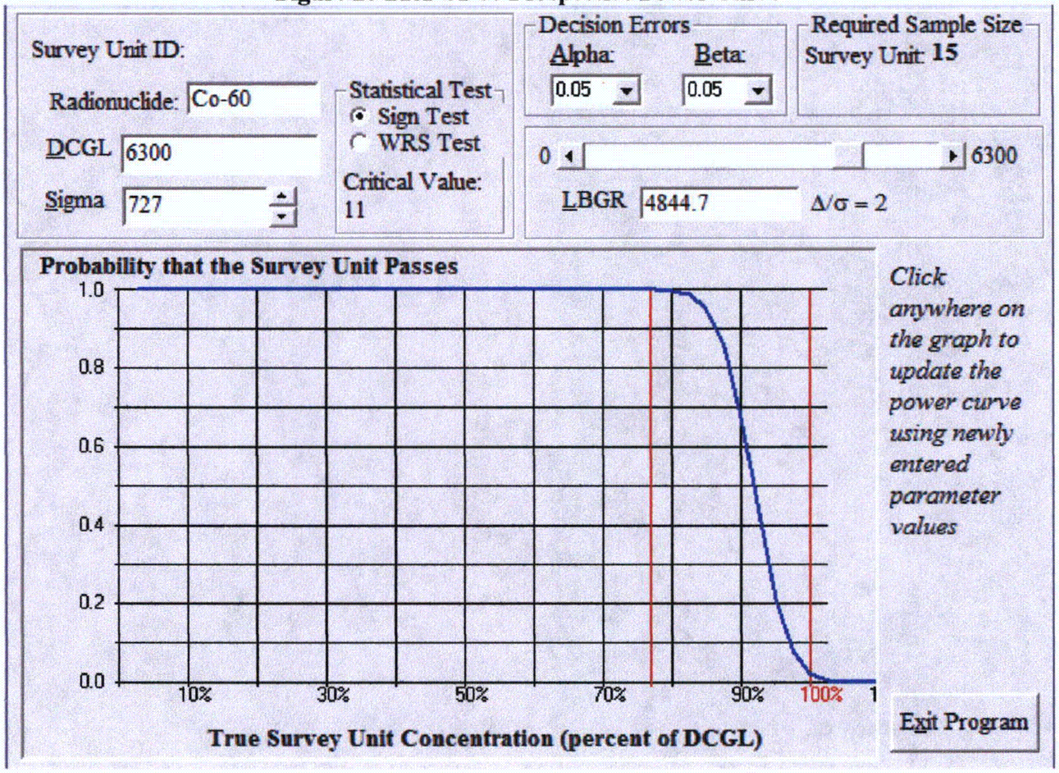

Figure 27 BRT-01-07 Retrospective Power Curve

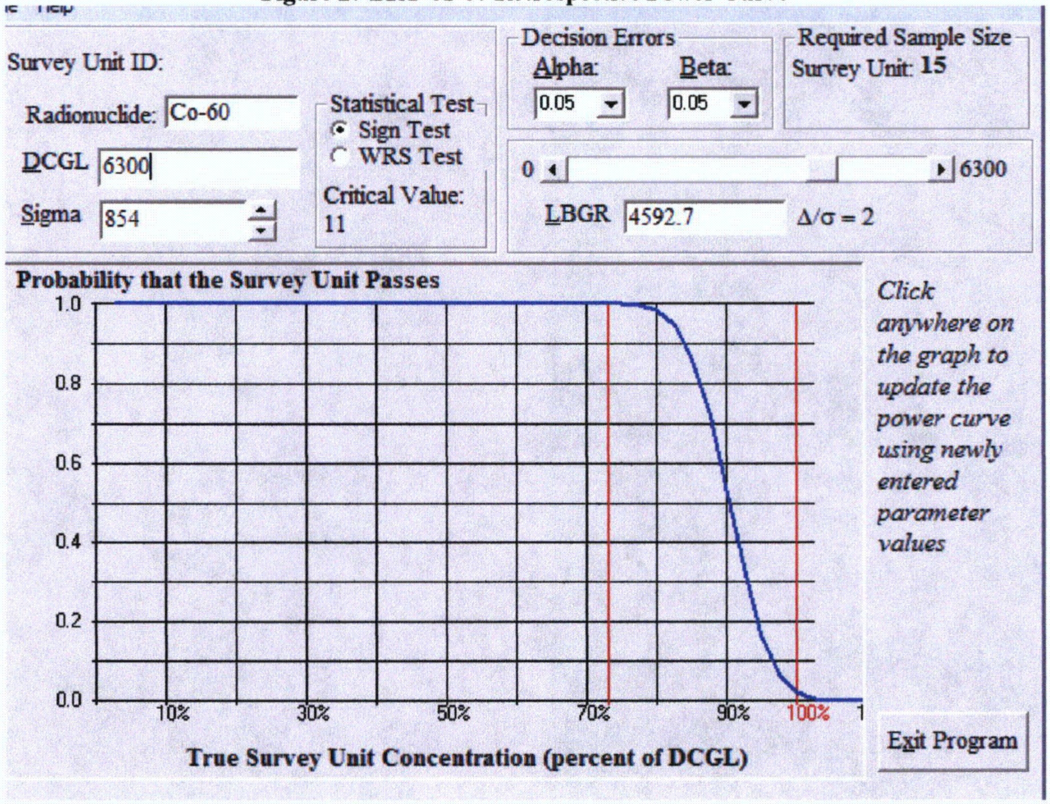

Figure 28 BRT-01-07 Scatter Plot

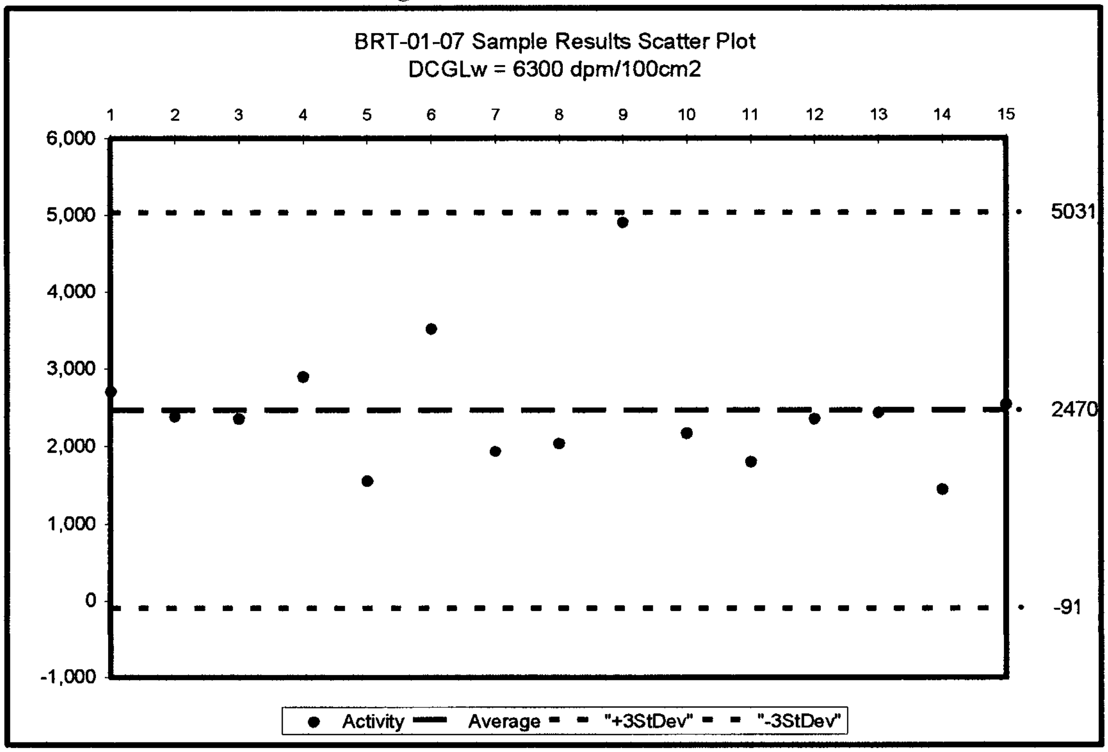

Figure 29 BRT-01-07 Quantile Plot

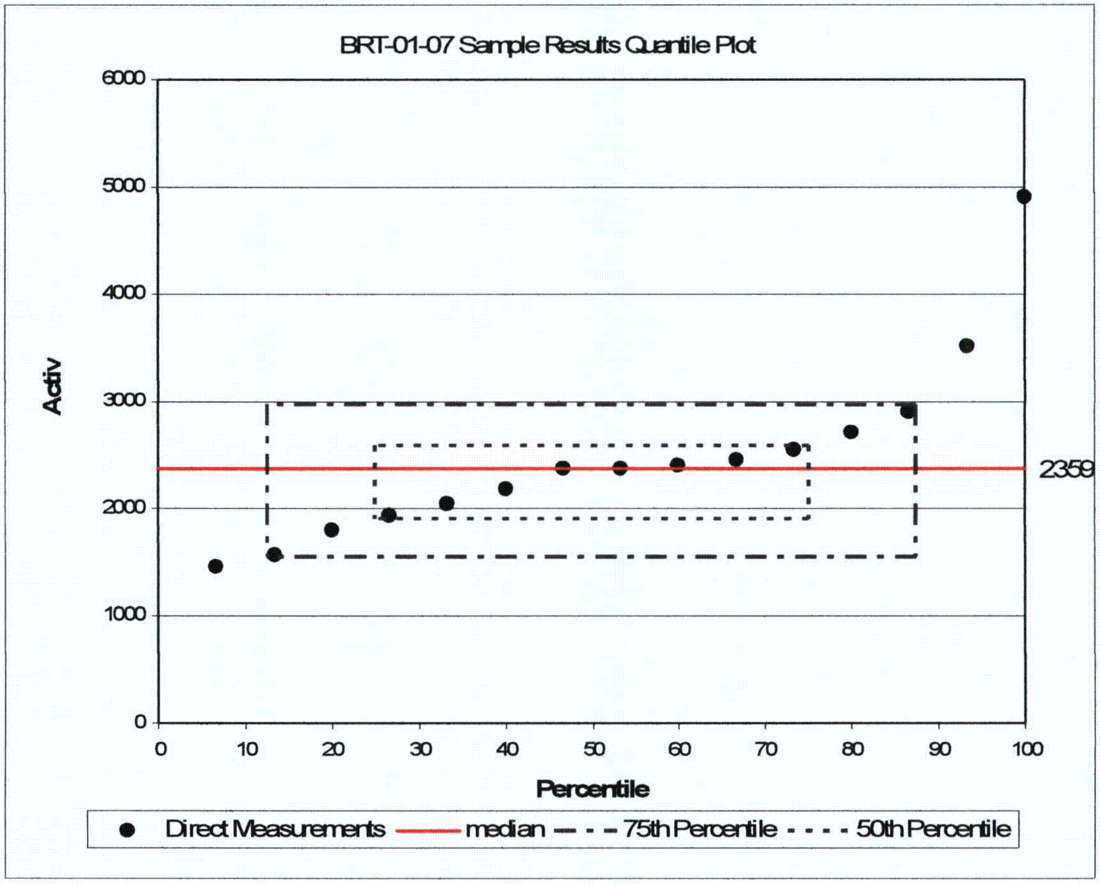

Figure 30 BRT-01-07 Frequency Plot

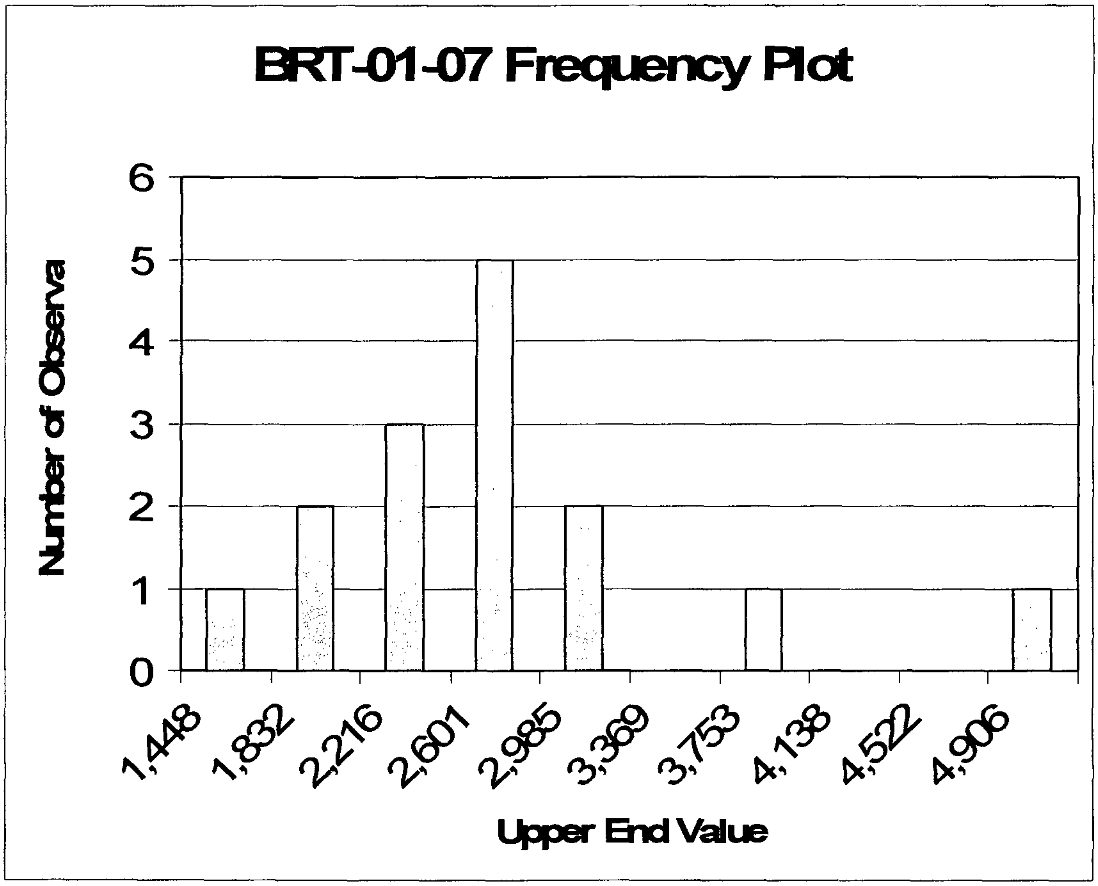

Figure 31 BRT-01-08 Prospective Power Curve

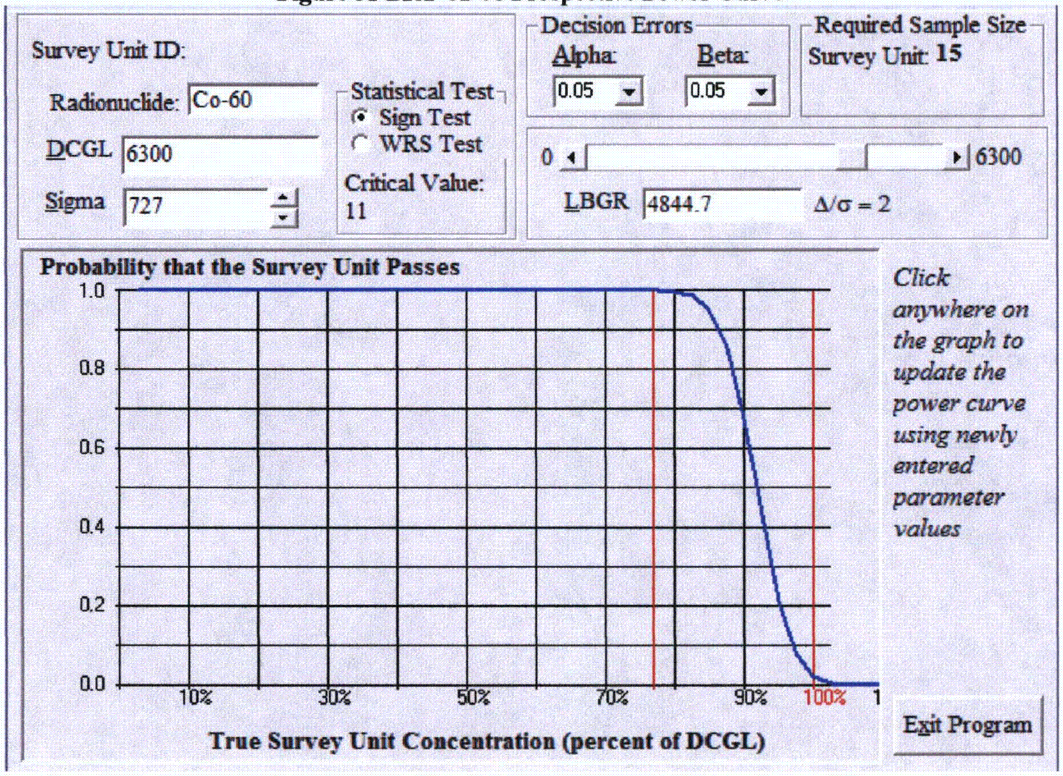

Figure 32 BRT-01-08 Retrospective Power Curve

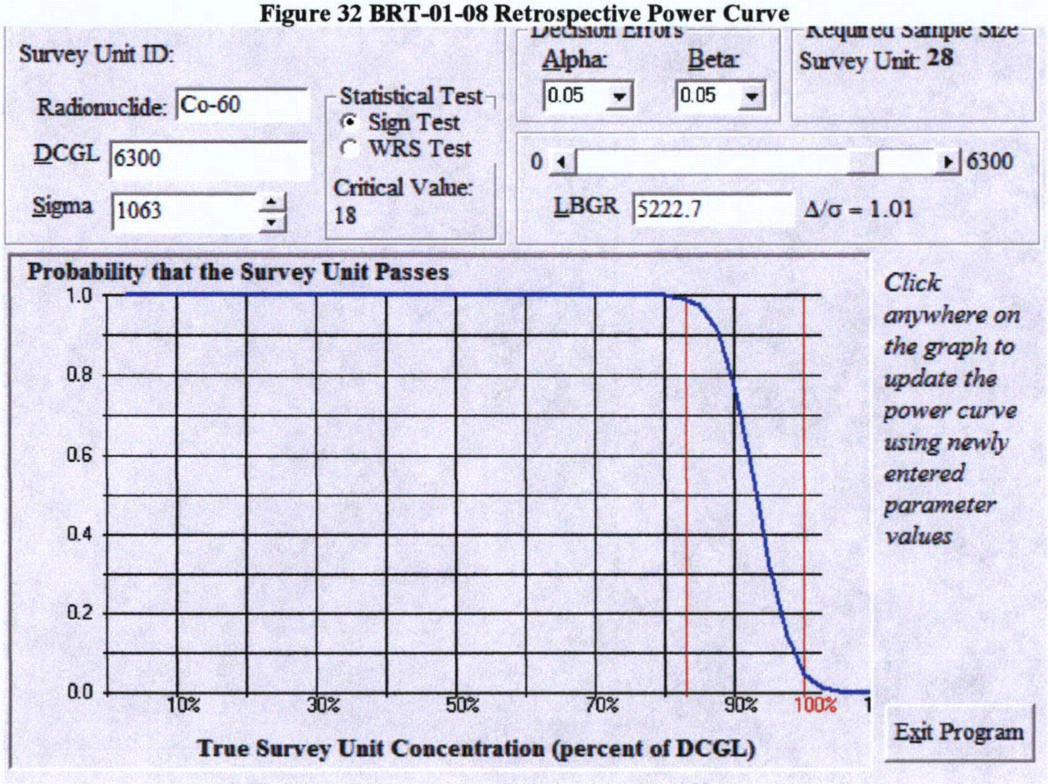

Figure 33 BRT-01-08 Scatter Plot

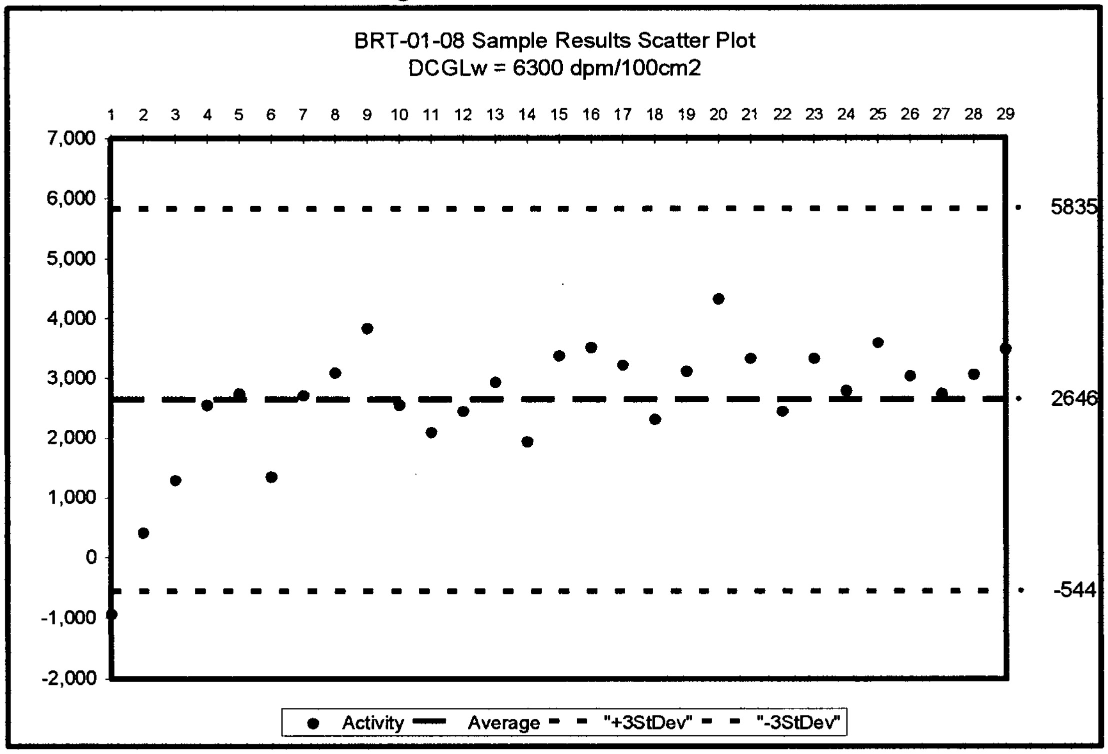

Figure 34 BRT-01-08 Quantile Plot

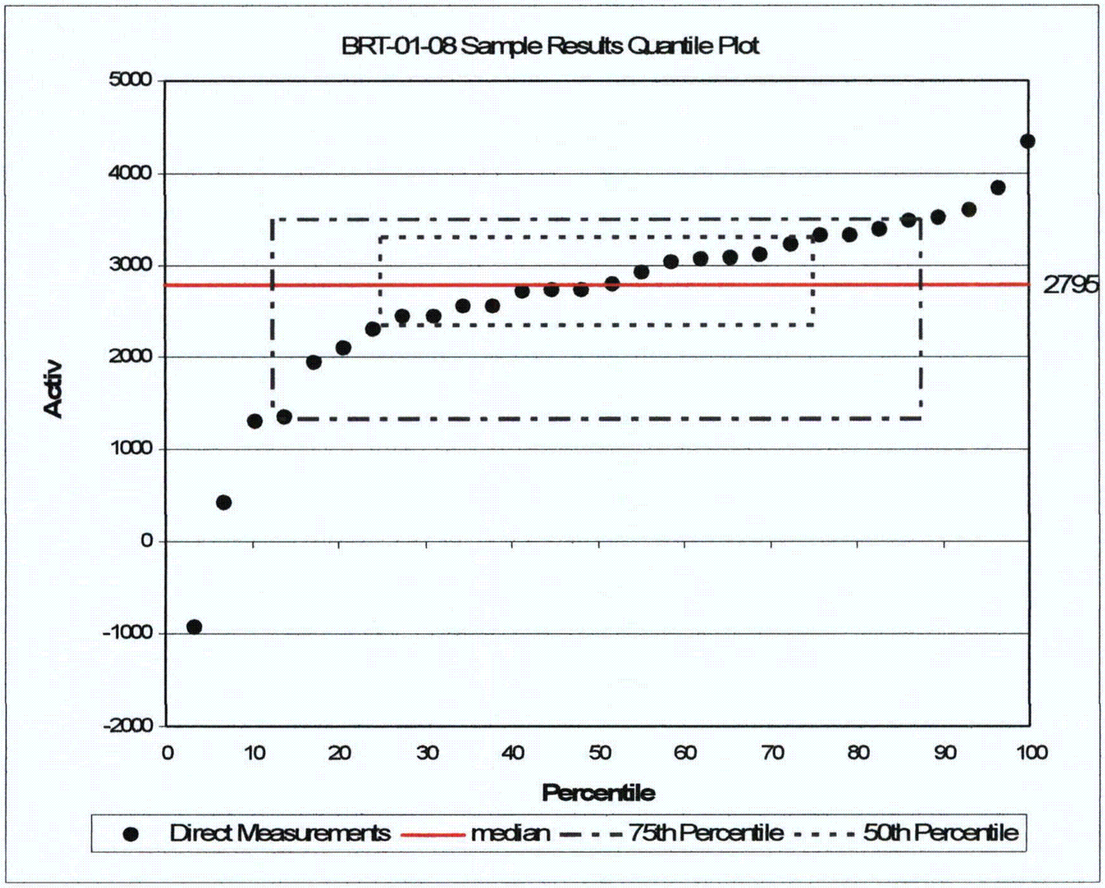

Figure 35 BRT-01-08 Frequency Plot

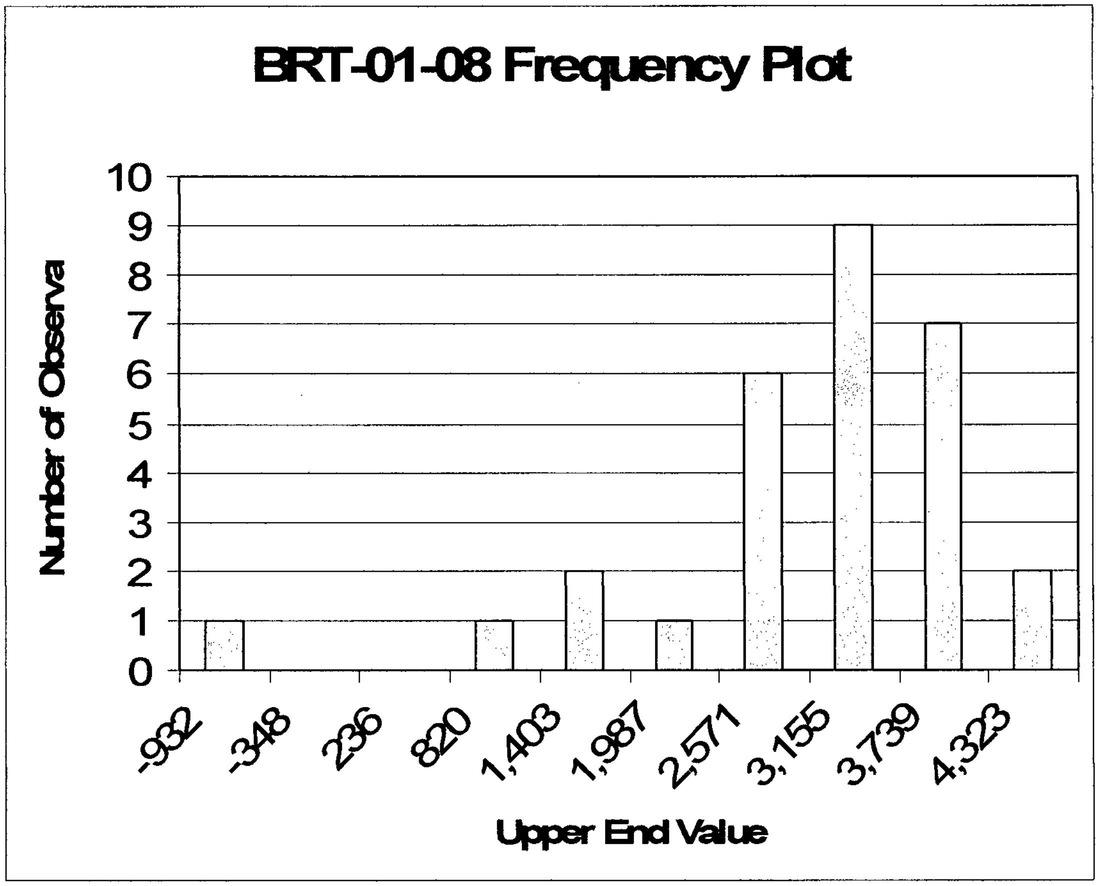

Figure 36 BRT-01-09 Prospective Power Curve

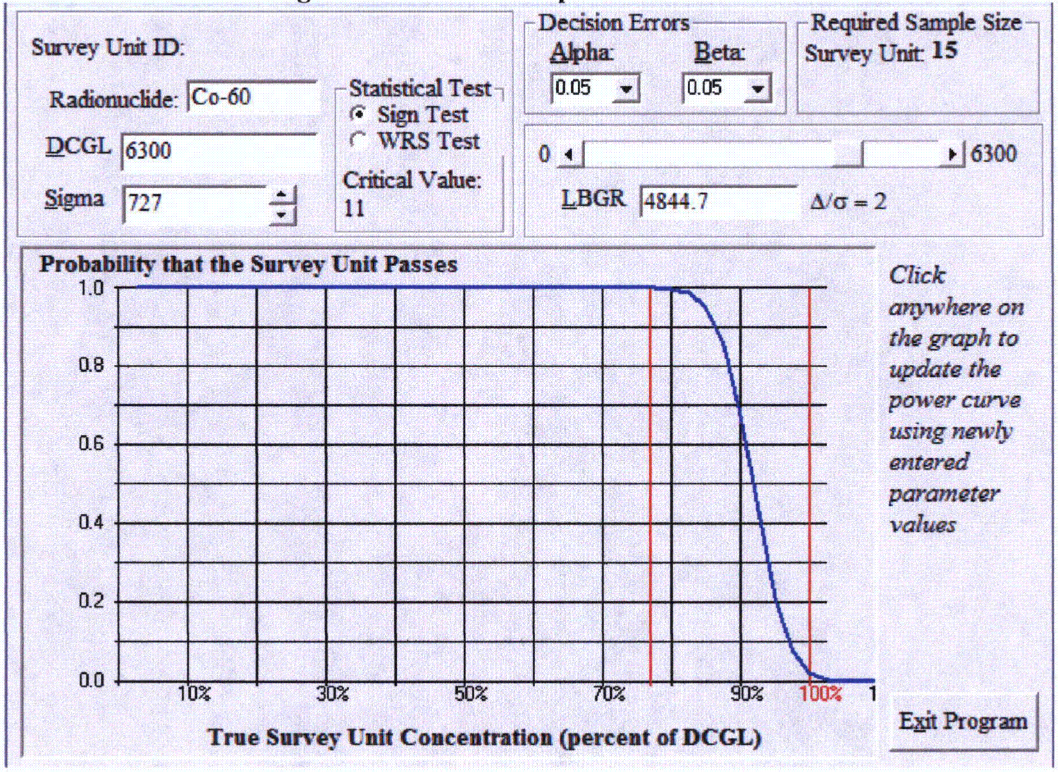

Figure 37 BRT-01-09 Retrospective Power Curve

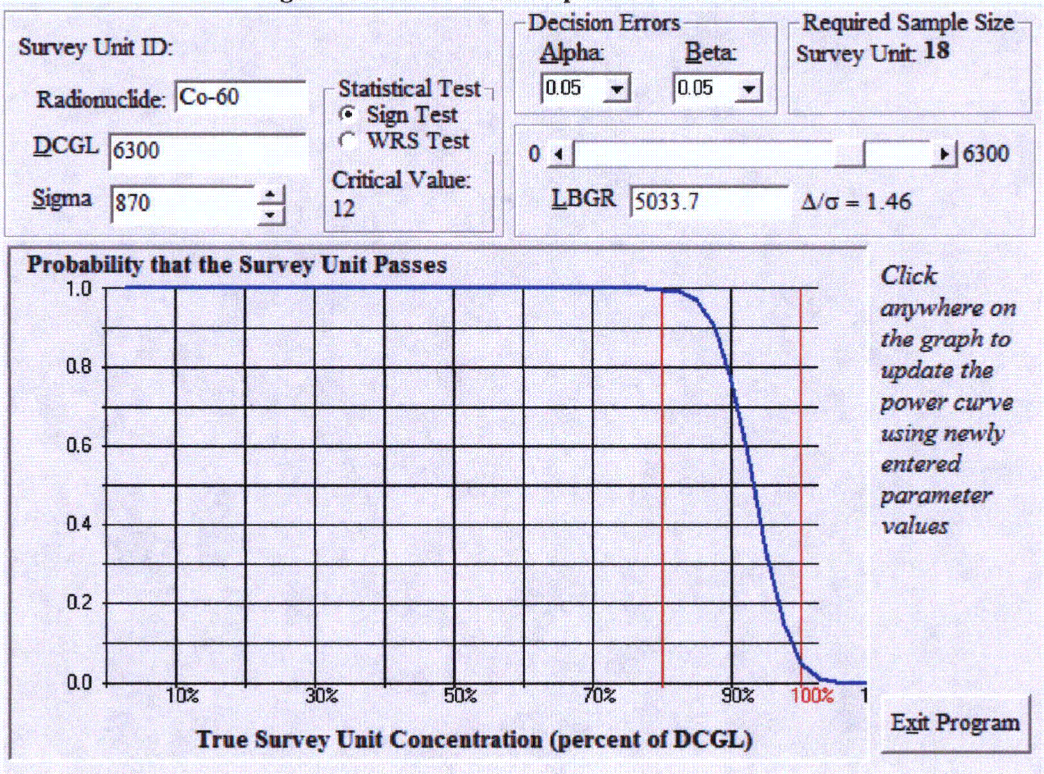

Figure 38 BRT-01-09 Scatter Plot

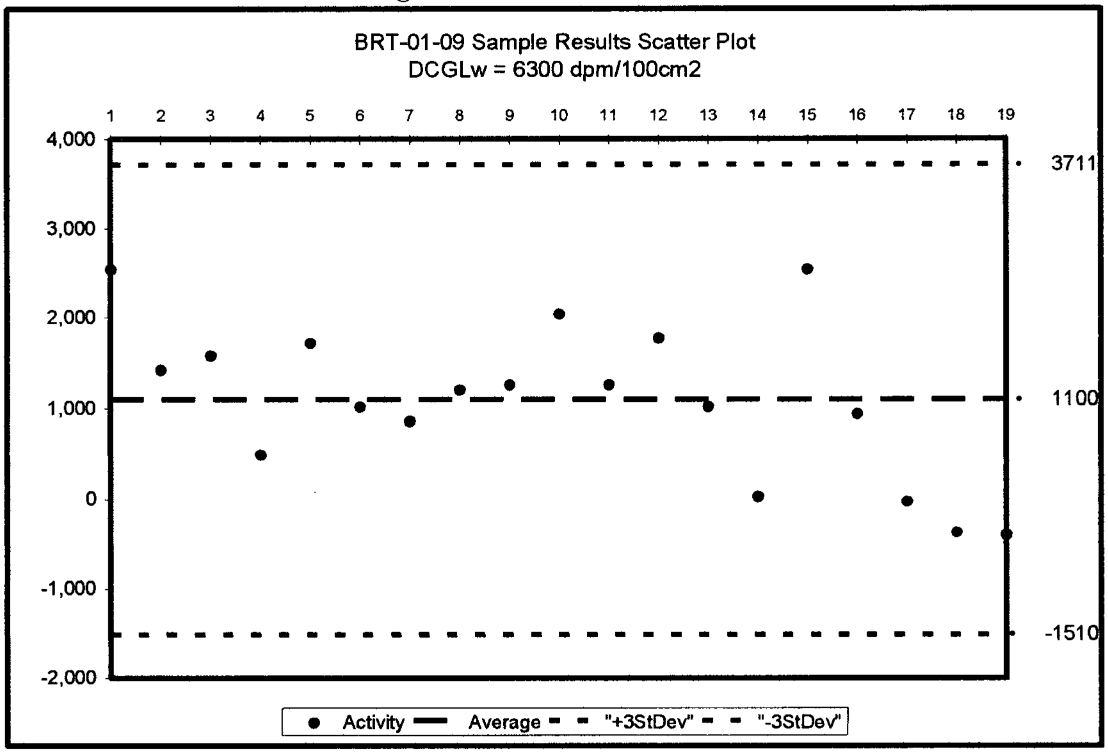

Figure 39 BRT-01-09 Quantile Plot

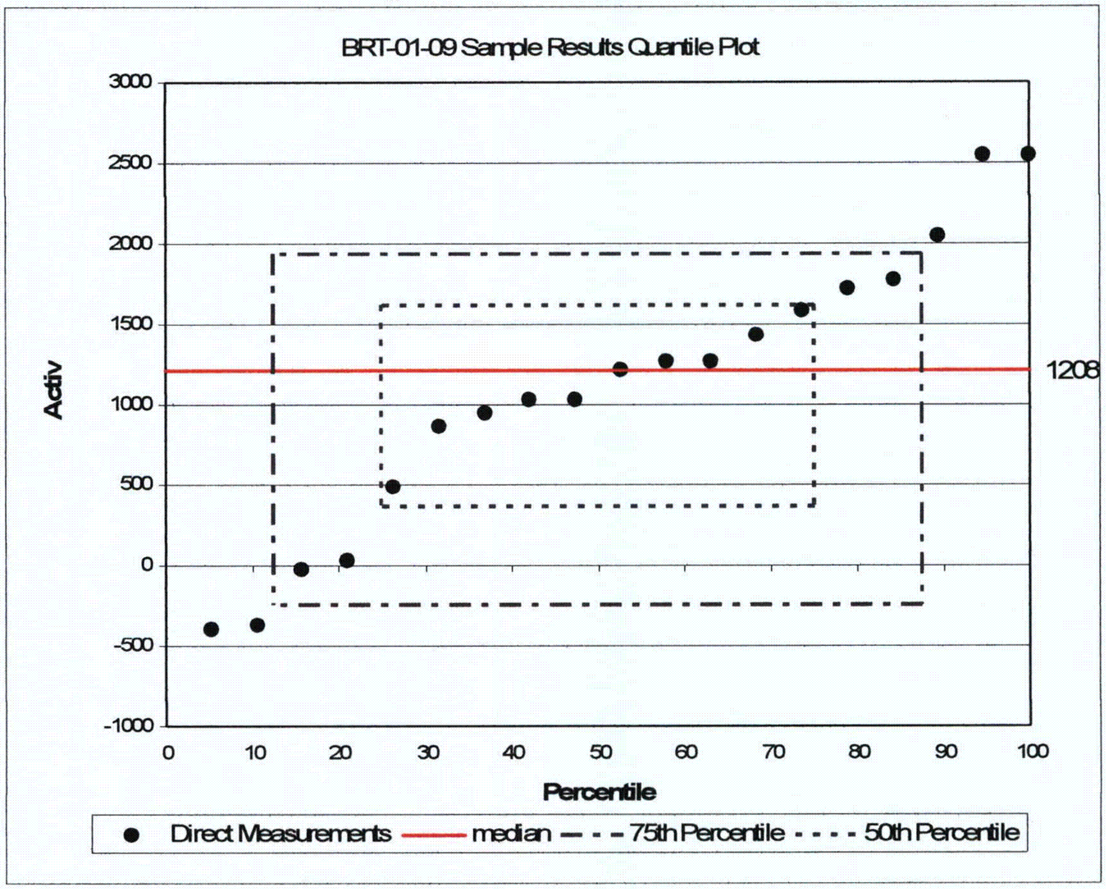

Figure 40 BRT-01-09 Frequency Plot

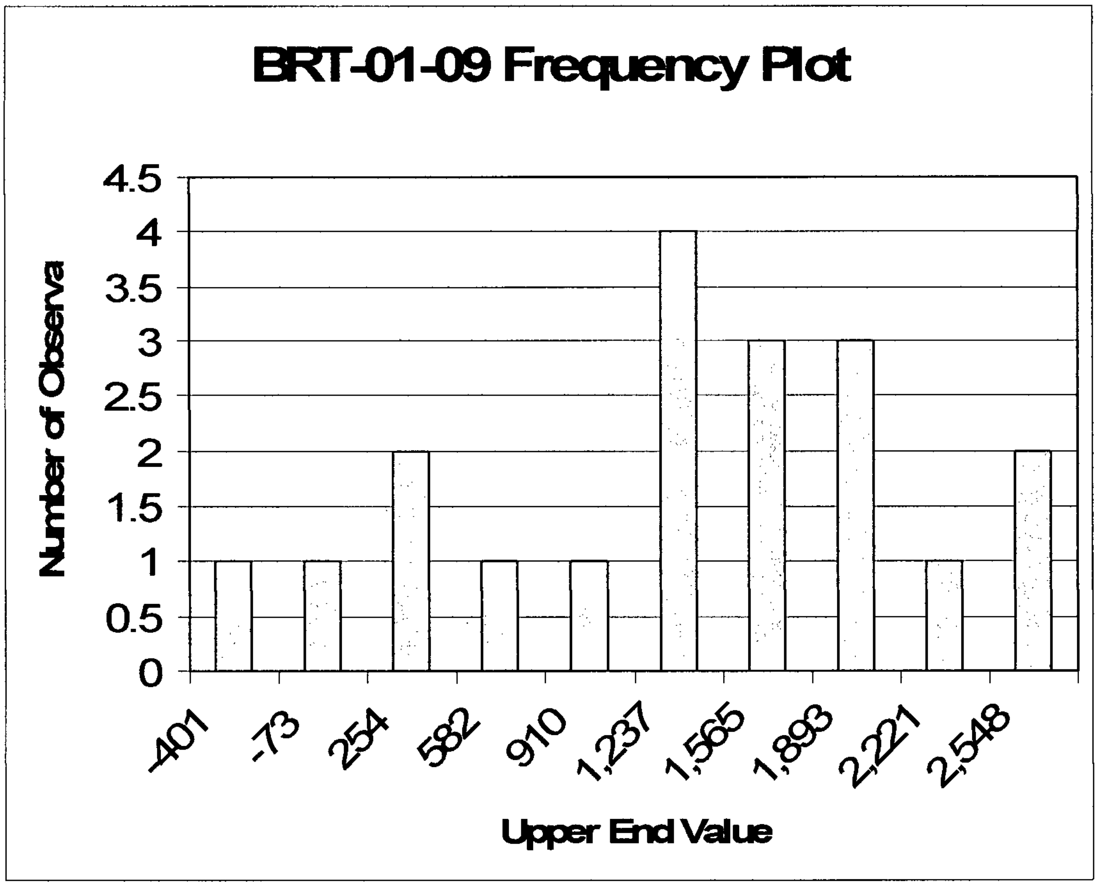

Figure 41 BRT-01-10 Prospective Power Curve

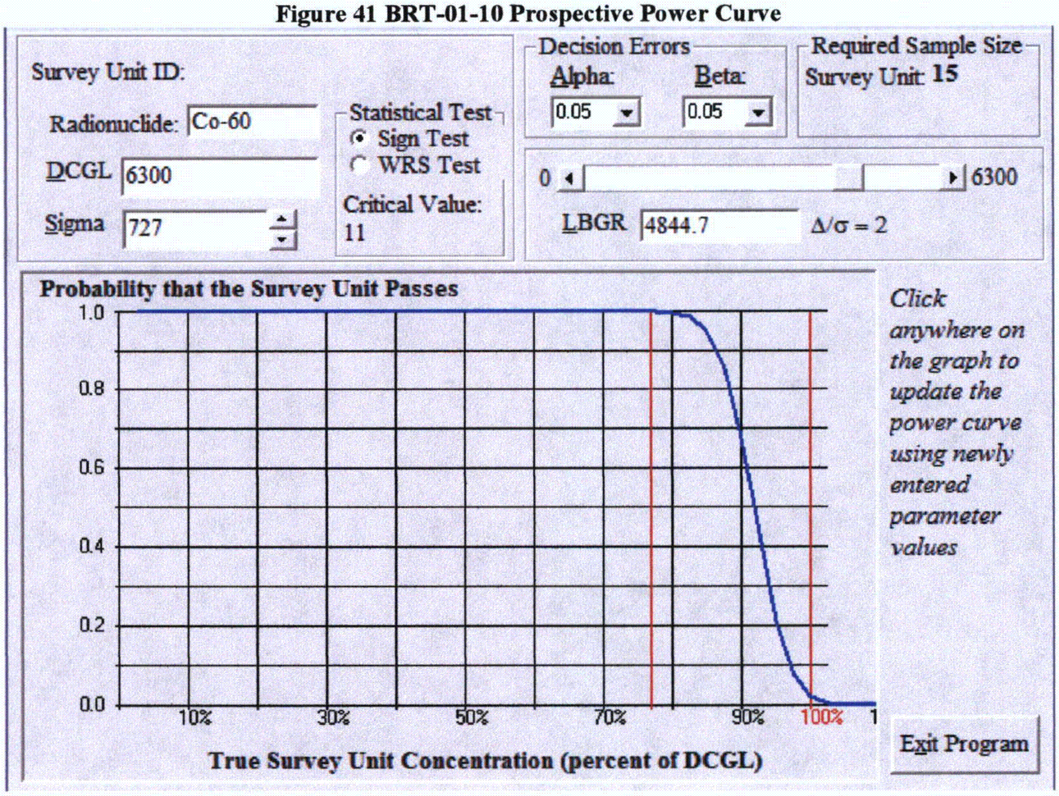

Figure 42 BRT-01-10 Retrospective Power Curve

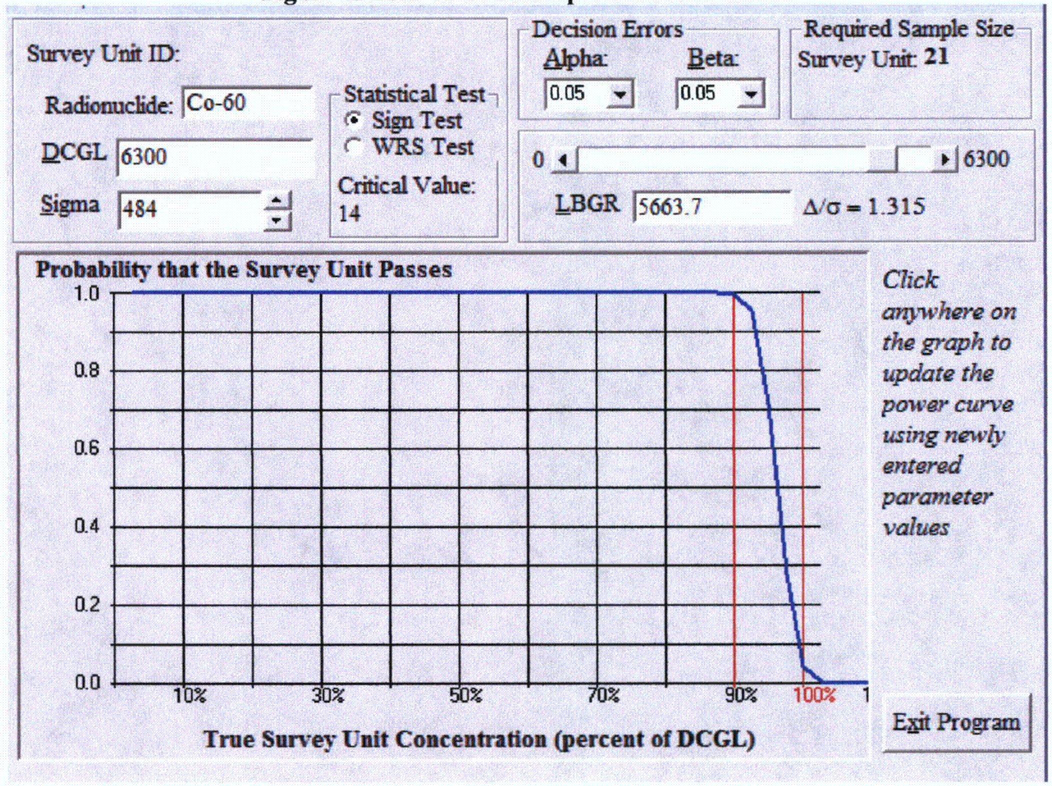

Figure 43 BRT-01-10 Scatter Plot

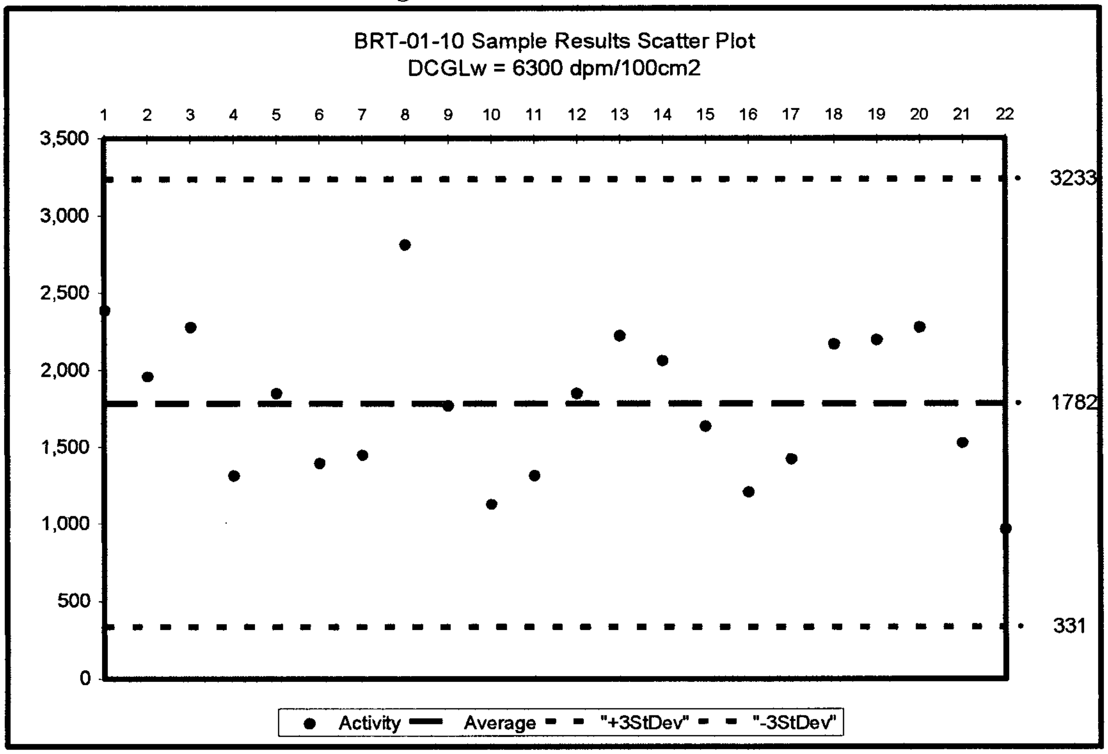

Figure 44 BRT-01-10 Quantile Plot

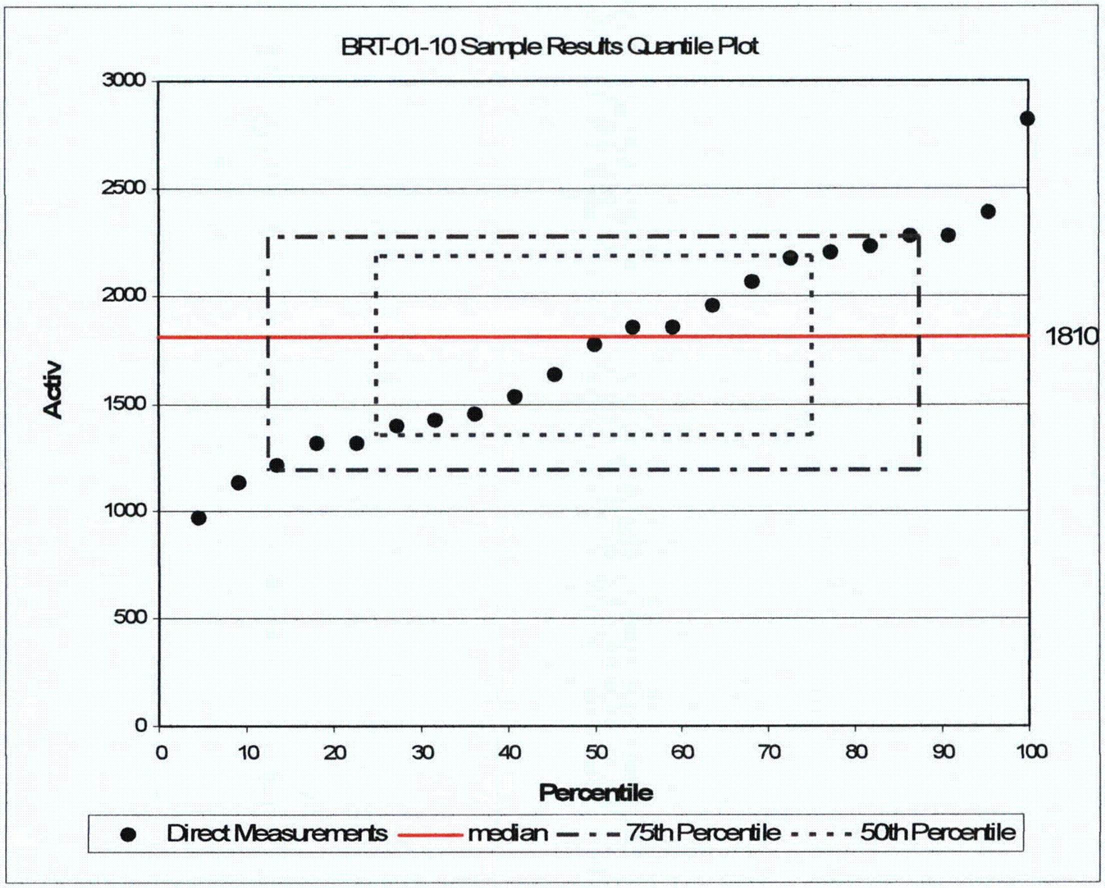

Figure 45 BRT-01-10 Frequency Plot

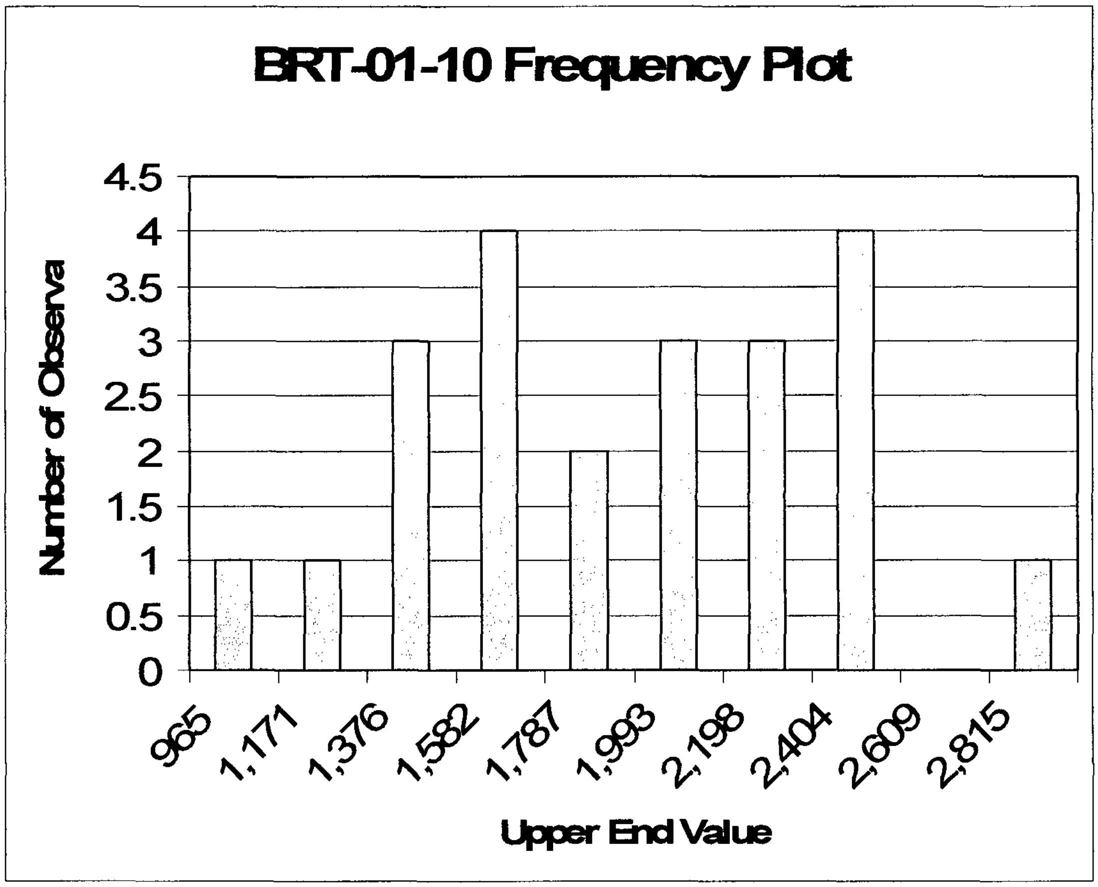

Figure 46 BRT-01-11 Prospective Power Curve

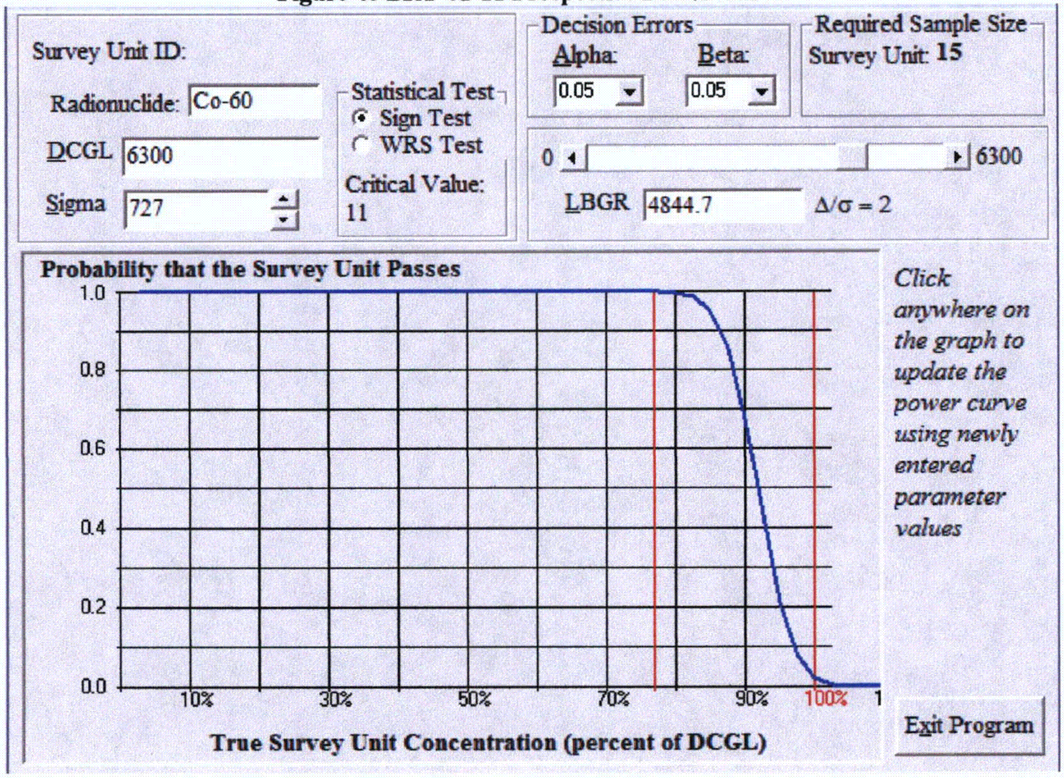

Figure 47 BRT-01-11 Retrospective Power Curve

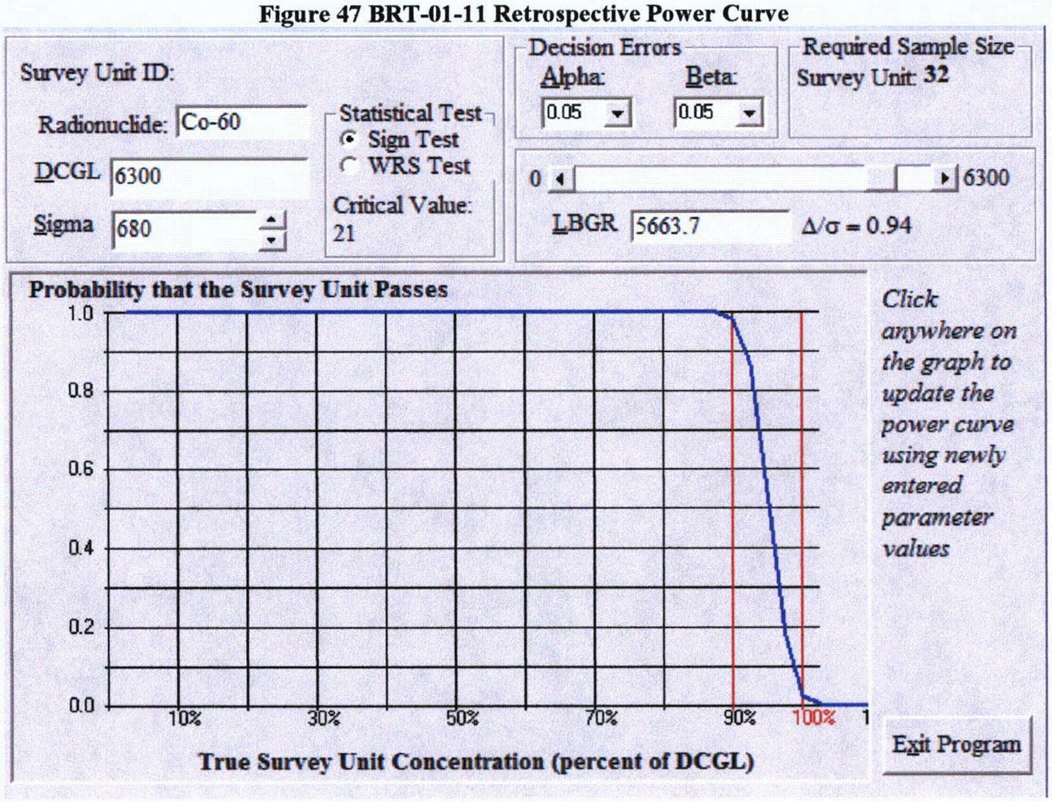

Figure 48 BRT-01-11 Scatter Plot

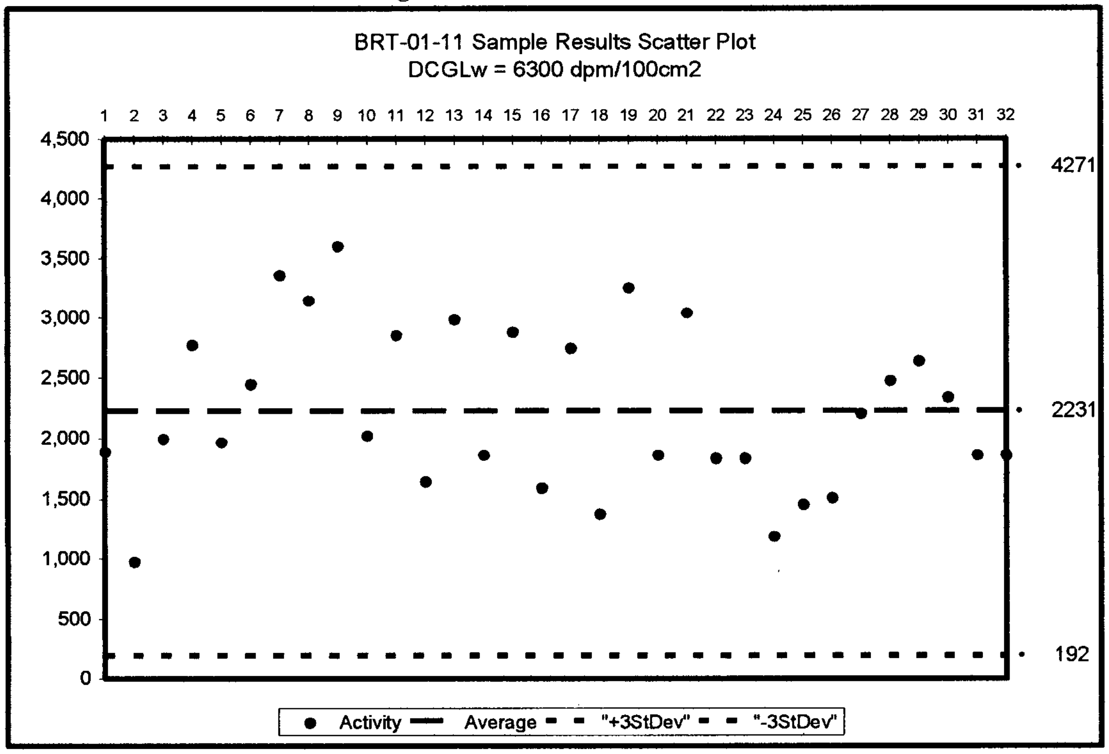

Figure 49 BRT-01-11 Quantile Plot

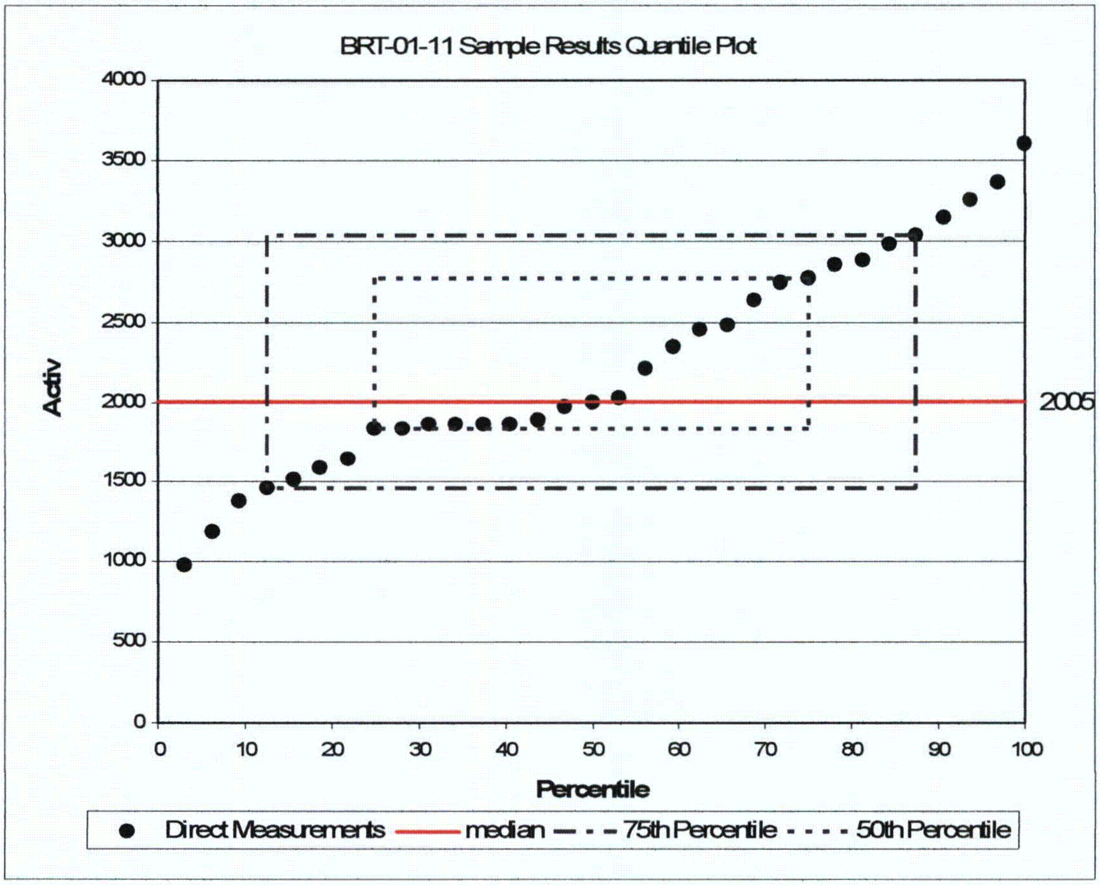

Figure 50 BRT-01-11 Frequency Plot

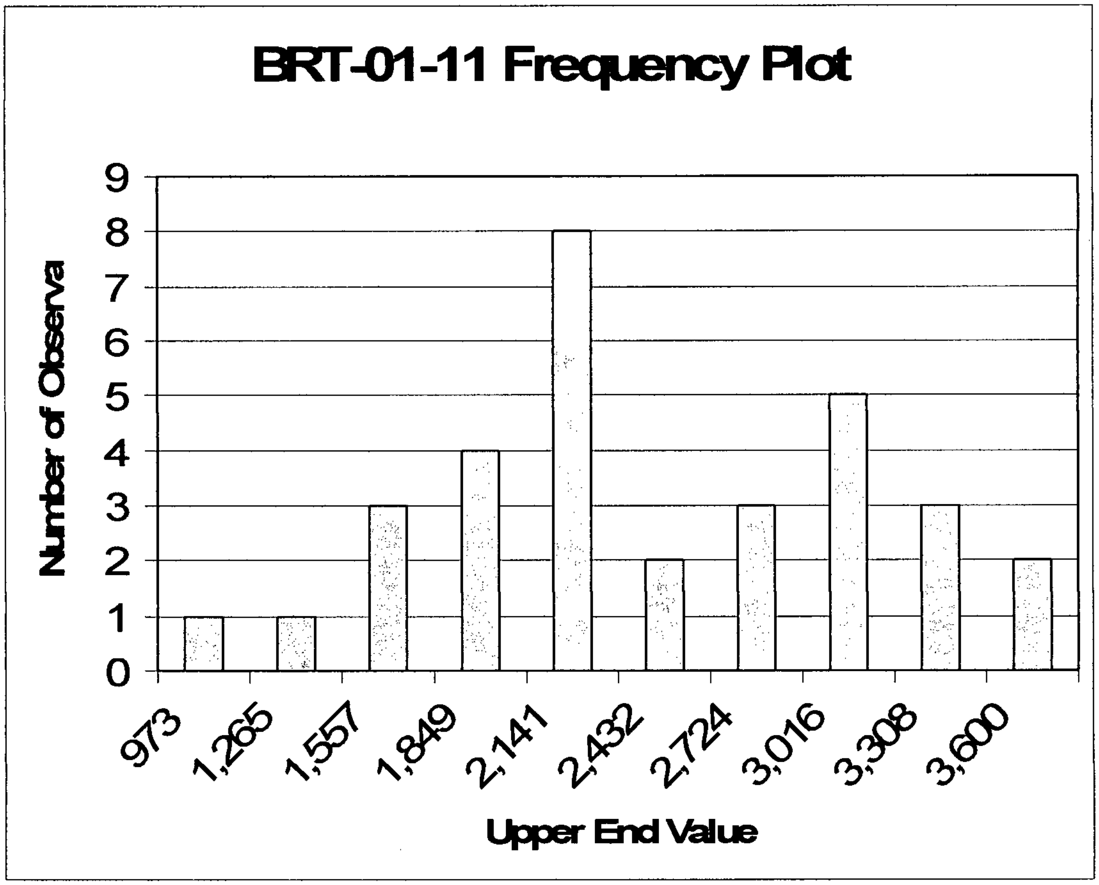

Figure 51 BRT-01-12 Prospective Power Curve

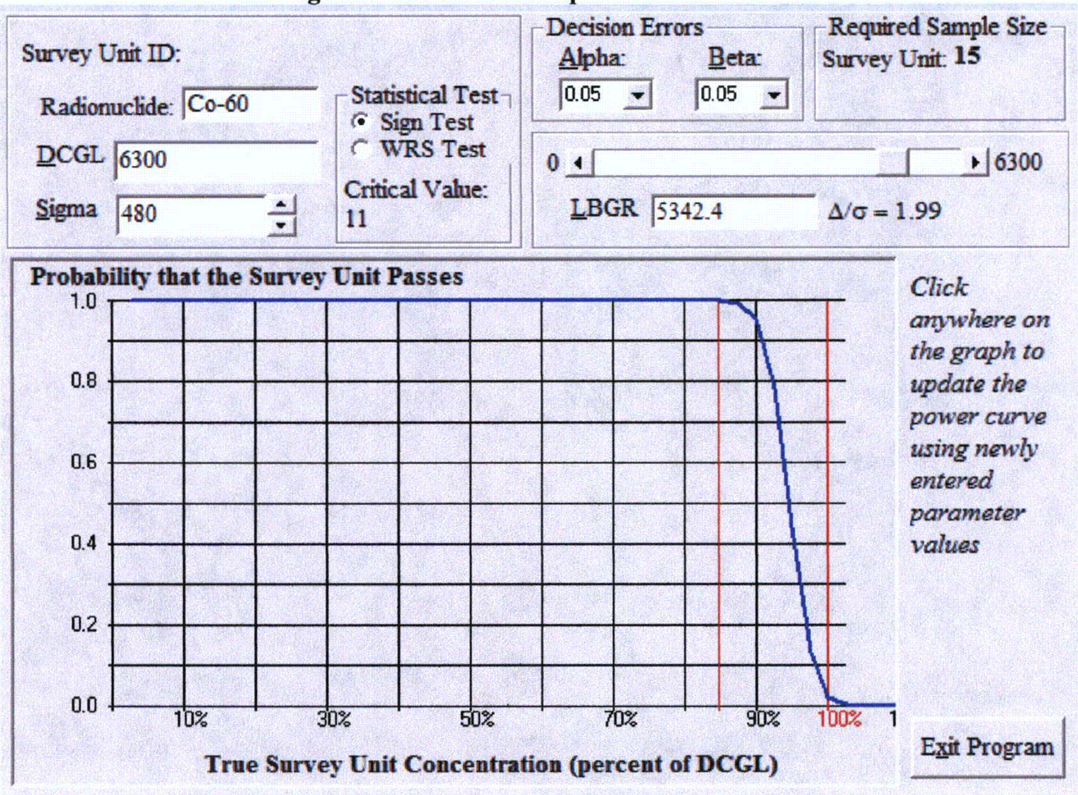

Figure 52 BRT-01-12 Retrospective Power Curve

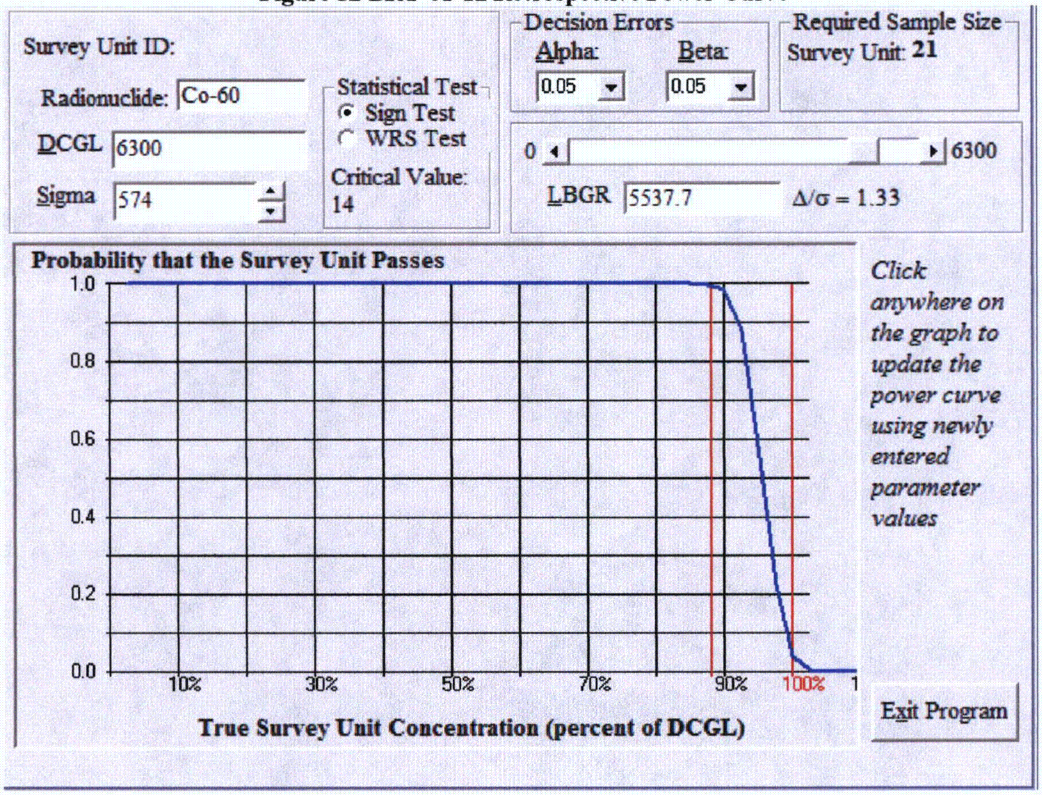

Figure 53 BRT-01-12 Scatter Plot

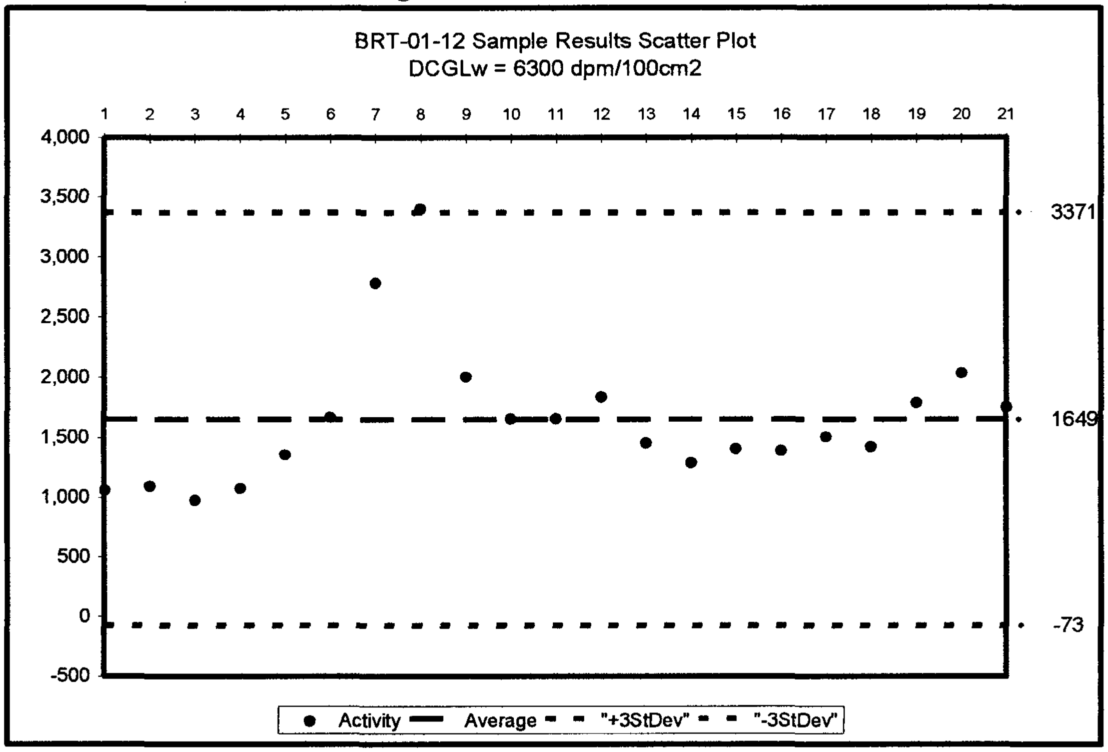

Figure 54 BRT-01-12 Quantile Plot

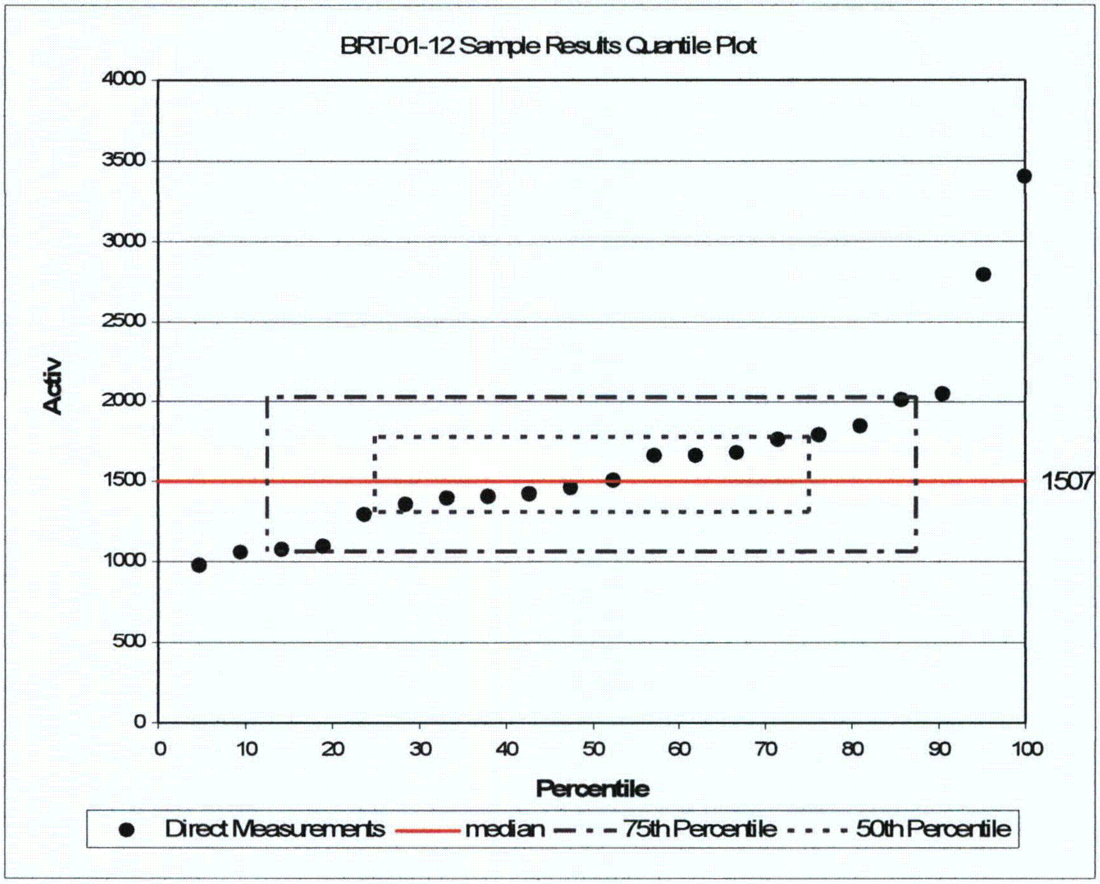

Figure 55 BRT-01-12 Frequency Plot

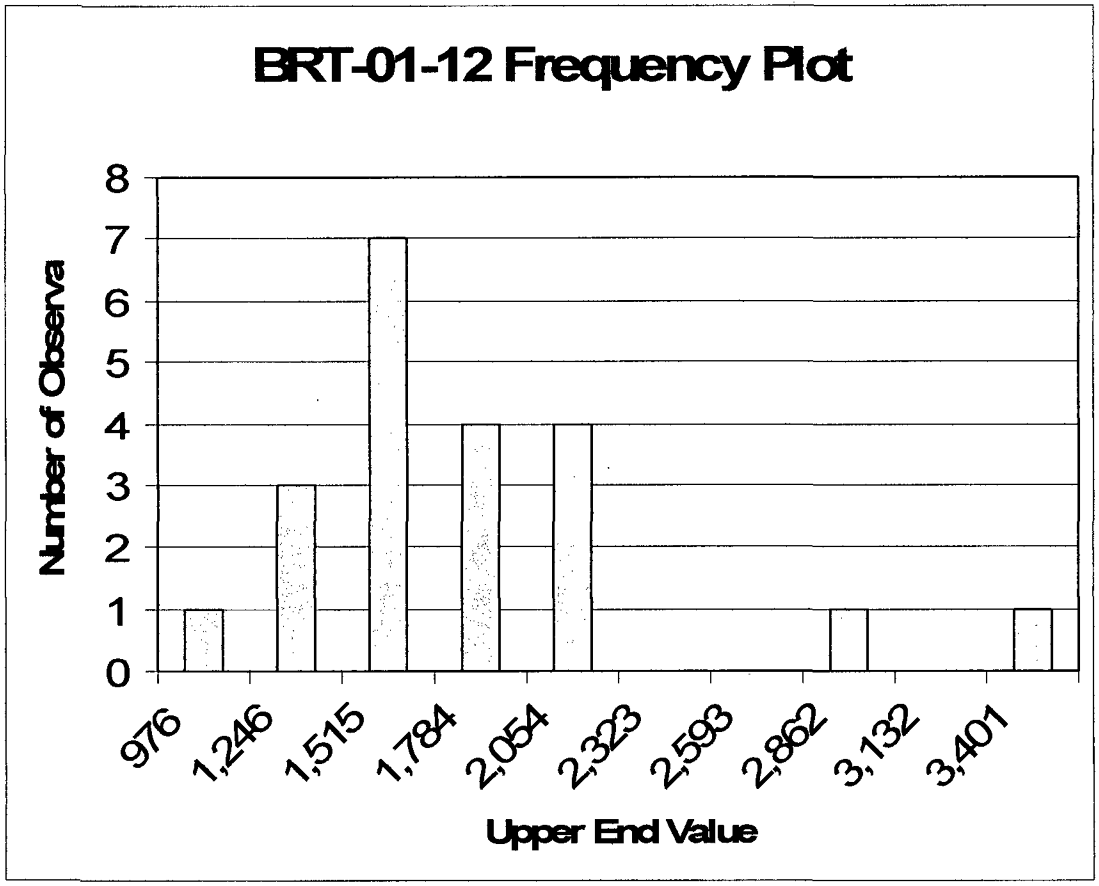

Figure 56 BRT-01-13 Prospective Power Curve

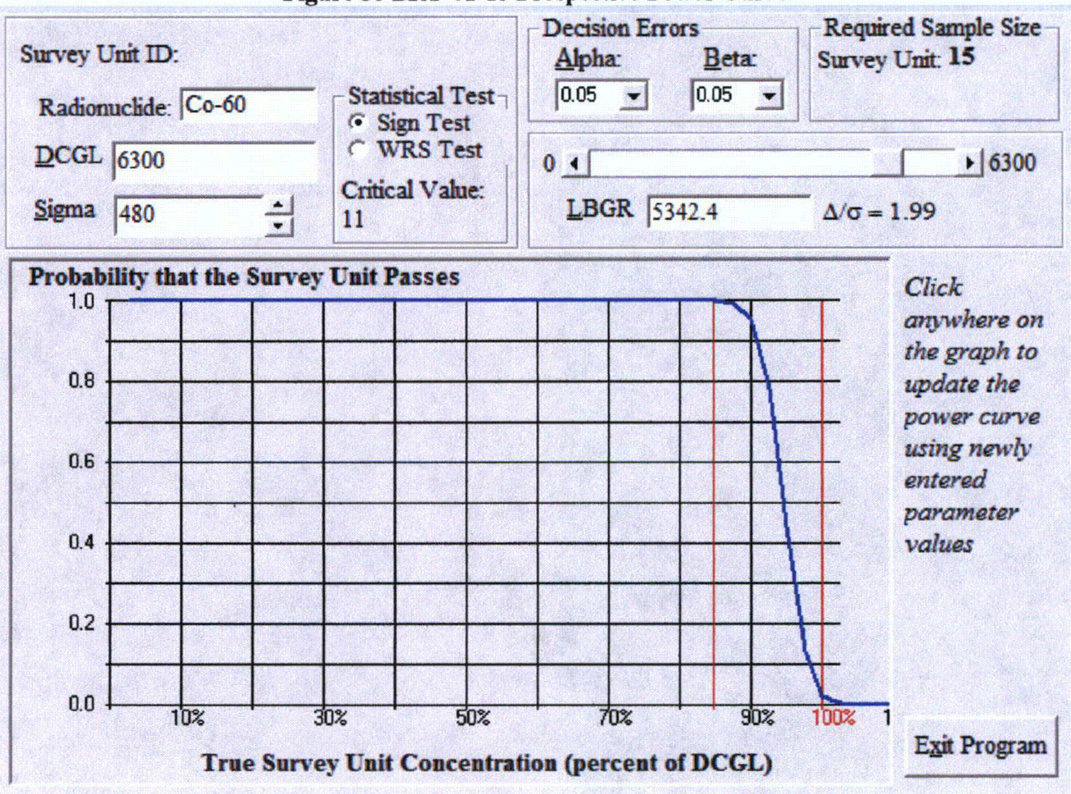

Figure 57 BRT-01-13 Retrospective Power Curve

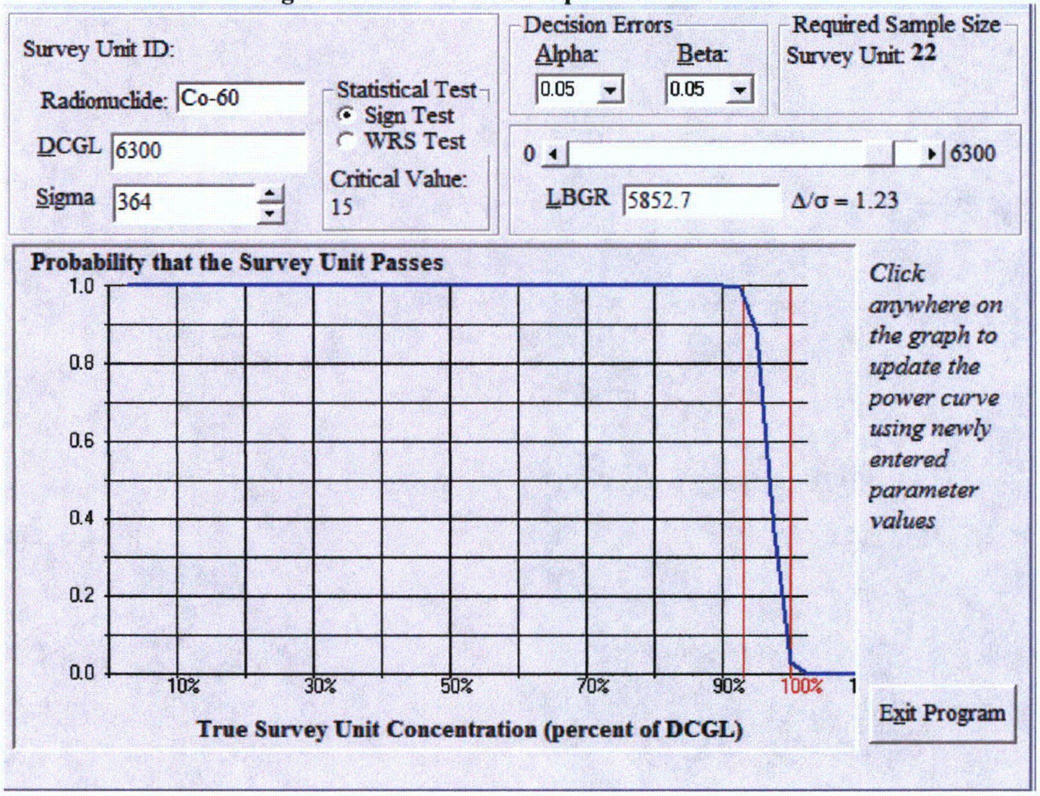

Figure 58 BRT-01-13 Scatter Plot

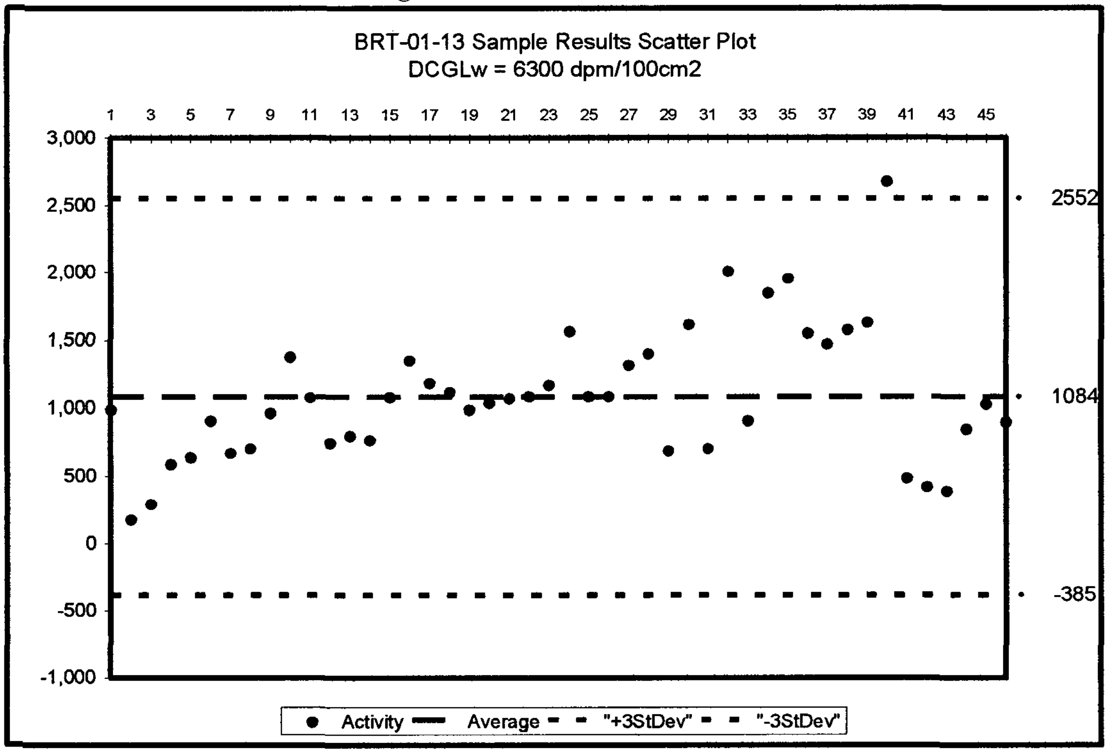

Figure 59 BRT-01-13 Quantile Plot

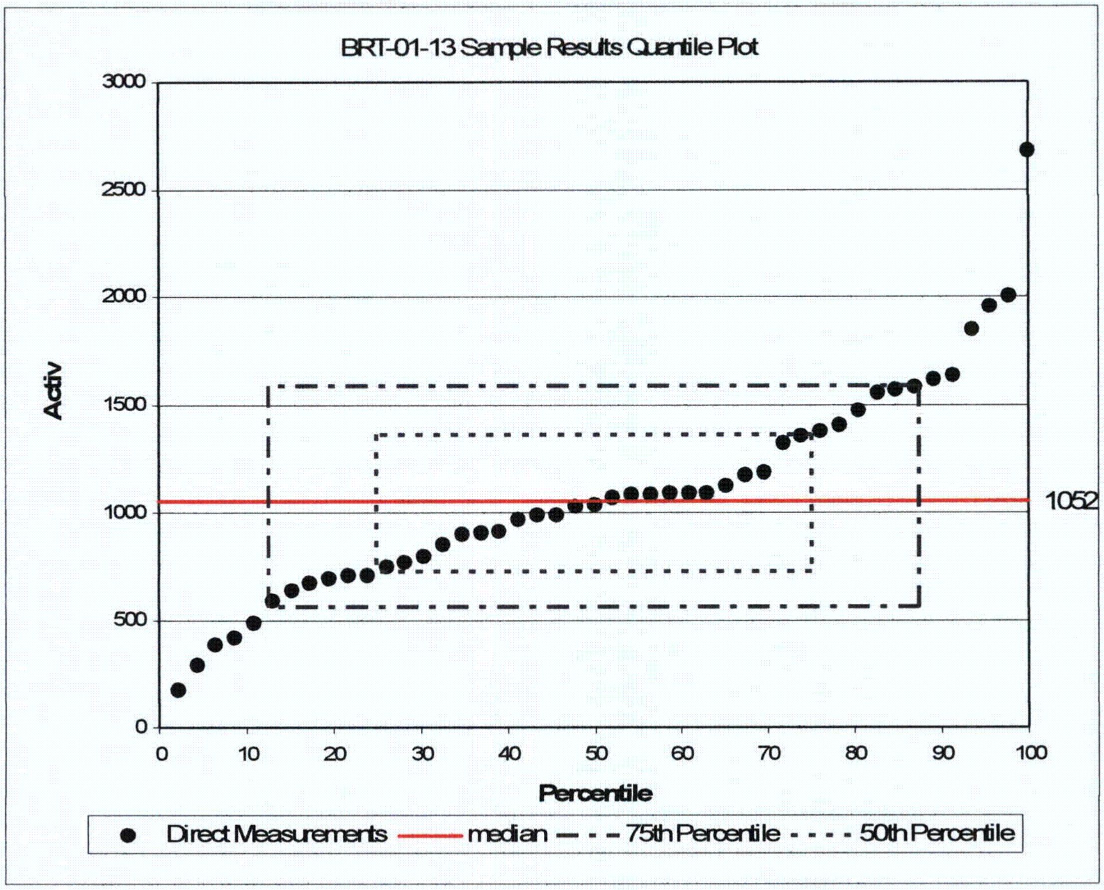

Figure 60 BRT-01-13 Frequency Plot