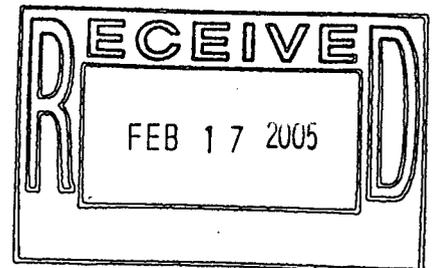


Eberline Services
Rocky Flats Environmental Test Site
Building 771 Stack
LARADS Radiological Survey Report



Eberline Services
3200 George Washington Way
Richland, WA 99352
(509) 371-1506



ADMIN RECORD

B771-A-000302

1/41

Executive Summary

Eberline Services and TMR Associates conducted a radiological survey of the interior surface of B771 Exhaust Stack.

This survey was performed using the LARADS system, a radiological data logging system interfacing 100 sq. cm alpha detectors. The detection system was mounted to a mobile platform that was raised, lowered, and rotated within the stack to the proper position for collection of data. Use of this system allows the collection of radiological data while lowering total labor cost, eliminates scaffolding costs, and greatly enhances worker safety.

A number of radiological readings at specific locations exceeded the specified action level. These locations were reinvestigated using longer count times to obtain better statistics. Two specific locations above +20' elevation of the stack were investigated a third time collecting data in a sq. meter pattern. These specific locations do meet radiological release criteria pending regulatory approval of use of the sq. meter average results.

Deliverables include this document, database files of the LARADS survey results, and CAD generated drawing showing color-coded radiological reading locations.

I. Introduction

Eberline Services (ESI), in conjunction with teaming partner, TMR Associates, performed a radiological survey of the interior surface of the B771 Exhaust Stack at the Rocky Flats Environmental Test Site (RFETS).

This survey was performed utilizing the Eberline Services Laser Assisted Ranging and Data System (LARADS) radiological mapping equipment mounted on TMR's Mobile Assisted Positioning System (MAPS).

Radiological instrumentation used consisted of Thermo Eberline's E600 count rate meter and their 380AB detector operated in scaler mode.

II. Overview

The MAPS platform was suspended from a support arch at the top of the stack. A crane and rigger was used to install the arch and rigging. The platform was attached to the rigged cable and winch, enabling it to be raised or lowered to the required elevations inside the stack.

The central part of the platform, the hub, has two horizontal arms that are also pneumatically controlled to provide linear positioning. This allows the arm carrying the detector to maintain its place on the stack wall, or to pull away from the wall to perform the required background measurements. Additionally, the positioning devices allowed the detector to be rotated to all parts of the inner circumference of the stack wall.

The LARADS' core modular components consist of an auto-tracking theodolite, RF data modems, a field computer with customized software, and radiological meters.

A modified civil surveyor's auto-tracking theodolite or "total station" determined range, azimuth, and elevation to a target. The target for the LARADS was a prism mounted in close proximity to the radiological detector. The total station relays the coordinates of the target's position to the system computer at user-set intervals, typically once per second.

LARADS interfaces a commercially available count rate meter, the Eberline E-600. This meter contains circuitry that may be configured to support a variety of detector types. The Eberline E-600 can also be configured with various gamma detectors to establish dose-rate profiles within the facility. The Eberline E-600 has been field-tested and meets the criteria specified by the American National Standards Institute (ANSI N42.17A-1989).

A RFETS Technical Basis Document approving use of the E600\380AB's was prepared prior to field operations at RFETS.

III. Technical Approach

Kaiser-Hill (K-H) provided a Statement of Work (SOW) requiring four survey measurements and one background reading to be taken at each foot of elevation within the stack area (the four survey measurements to be taken at each cardinal point of the compass).

Minimum Detectable Activity (MDA) was to be 50 dpm/100 cm².

Modifications to the original SOW were made in the field by the KH supervisor of this activity. At their request the following protocols were used:

- Four survey readings and 1 background reading taken at each foot elevation.
- Scaler count times for initial survey were set at 90-seconds.
- One-hour background readings were taken for each detector used at the base of the stack interior.
- Obtain 4 equally spaced readings around the circumference of each foot elevation, but these do not have to be cardinal compass point spaced.
- Areas that exceed 75 dpm/100 cm² using the average background for each detector or 100 dpm/100 cm² using the one-hour background information and that are located above +20' elevation to be re-investigated with a 180-second scaler count.
- Areas located below +20' elevation and exceed 200 dpm/100 cm² using either background method to be re-investigated with 180-second scaler counts.

Distance from the detector face to stack surface was ¼". Constant detector to surface geometry was accomplished by use of a plastic jig to maintain this offset.

The contaminant of concern was Weapons Grade Plutonium.

Minimum Detectable Concentration (MDC) was calculated using the guidance provided in NUREG-1507.

IV. Radiological Instrument Calibrations & Operation Checks

The E600 and 380AB instrumentation were calibrated for Pu-239 alpha detection at the Pacific Northwest National Laboratory (PNNL) located at Richland, Washington. Copies of calibration information are included as Attachment I.

Relative alpha efficiency of 15.2% for Detector # 1551 and 15.4% for Detector # 1697 was reported by PNNL.

Operational checks were performed on each detector used both prior to and after each use. All operational check results were well within the $\pm 20\%$ guideline established by ANSI and Eberline Services procedure. Attachment II contains the operation check information.

V. Information on Survey Data Coordinate System

The LARADS collects and electronically stores both positional and radiological information every second. If a Site or State Plane coordinate system exists for a survey area, the LARADS can be setup to "tie" to a benchmark and log positional data in this coordinate system. If one does not exist, it is necessary to create a Local coordinate system in the field for the positional information to be understandable to a reviewer.

Origin of the B771 Stack Local Coordinate system created for this survey was established at the center of the stack floor and "relative north", i.e. the Y-coordinate line, was a pointing up the center of the stack tunnel. All distances were obtained in Standard feet.

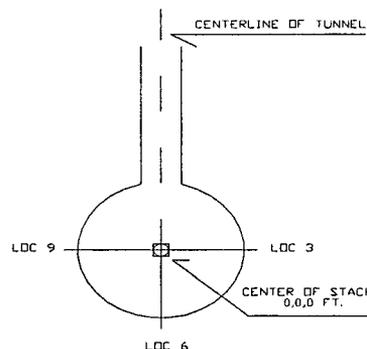
The electronic files submitted with this report contain the actual X-coordinate (XCOORD), Y-coordinate (YCOORD), and elevations (ZCOORD) of where the static scaler readings were taken.

For ease of understanding, two additional fields were added to the electronic databases during data processing, "ELEV" and "LOC".

The elevations (ZCOORDs) were rounded to the nearest foot and included in the files as "ELEV".

Treating a top view of the stack as a watch dial, the "LOC" field gives relative position, i.e. a 12 in the LOC field and 26 in the ELEV field is the data point located $\sim 26'$ above the stack bottom and over the center of the stack tunnel.

Top View of B771 Stack - Coordinate System



VI. Survey Data Discussion

All field data was collected in Counts Per Minute (CPM) of alpha radiation. Two detectors, # 1551 and # 1697 were used to collect of survey data.

Electronic files of all the survey data discussed below are included as ESI deliverables for this survey project and are submitted with the Compact Disk that accompanies this report. Attachment III contains a list of these files as well as a description of the information contained within the database fields of these files.

A. Radiological Background Determination

Background information for each detector is listed in Table 1.

Table 1
Background Information Summary

DETECTOR ID #	NUMBER OF 90-SECOND COUNTS TAKEN	AVG. BKG (90-SEC) CPM	ONE-HOUR BKG CPM
1551	98	8.59	6.46
1697	76	12.33	5.88

Differences were noted between the average of the 90-second background measurements made at each one foot elevations within the stack and the single one hour background measurement made at the three foot elevation point (~15 feet below grade in the bottom of the stack). This difference is most notable for detector # 1697 background results.

ESI believes the most likely explanation for this difference is that the radon levels inside the stack were at lower levels at the single time and location of the one-hour measurement.

Several storms moved through the area during the period of time that the 90-second background measurements were taken. Our experience has been that when low-pressure weather centers pass over an area, radon levels tend to rise while high-pressure centers cause these levels to fall. This pumping action can cause wide swings in radon levels and hence alpha backgrounds over time.

While ESI has never conducted a radiological contamination survey of an operating stack in this manner we do offer the following hypothesis for the differences in background counts:

Static charging on the Mylar of the detector due to the high air speed. The stack tapers from a diameter of ~18 feet at the bottom to 11 feet at the top. Stack air velocity should increase roughly two and one half times from bottom to top. Review of the background data taken at height does not show a correlation of increased background with height that one would expect if:

- a) There is indeed charge occurring and-
- b) The charge level is directly proportional to stack air velocity and-
- c) This charge, regardless of radon levels, would cause an increase in detector background numbers reported.

However, the charging of the detector face coupled with increased radon would cause an increase in count rates reported due to charged particles of radon daughter products collecting upon the detector face and being counted by the CRM.

B. Radiological Survey Results

Conversion factors of 6.58 for Detector # 1551 and 6.49 for Detector # 1697 were used to report activity in Disintegrations Per Minute (DPM).

DPM conversion formula was applied as follows:

$$((\text{Gross cpm}) - (\text{background cpm})) * (\text{detector's conversion factor})$$

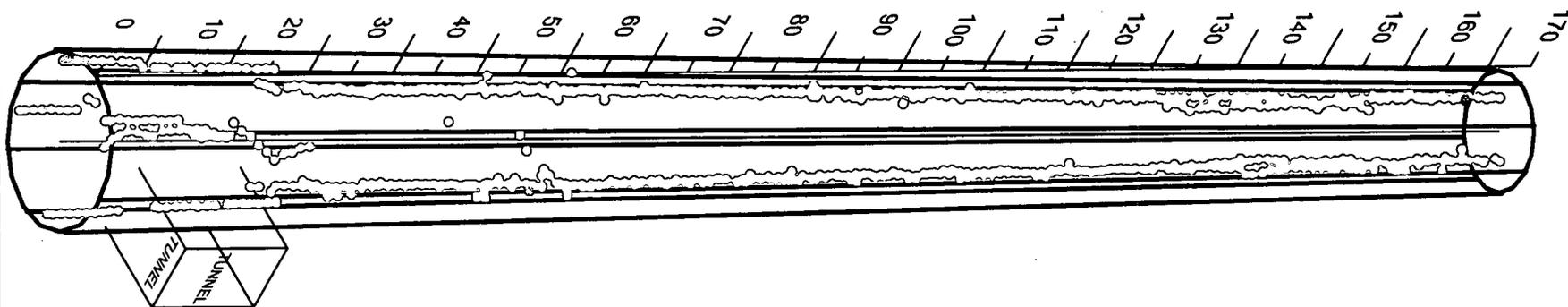
All Figures in this report were based on use of the one-hour background results to calculate dpm activity.

All cpm and dpm values listed in this report and within the electronic files are per 100cm² unit area. The 380AB detector has 100cm² of active area so no probe area calculations were necessary.

1. Initial Survey Results

A total of 701 data points were collected in the initial survey of the stack area. Of these, 68 data points were selected for follow-up surveys.

Figures 1 through 4 contain color-coded data sets of the initial survey results.



dpm/100 cm²

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- > 250

Coverage File: RFSRV

Number of Data Pnts: 701

Type of Survey: 'Alpha'

Survey Date: 7/23-8/6 2001

CRM Used: 1244, 1623

Detector 1551, Bkg: 6.46 c/m

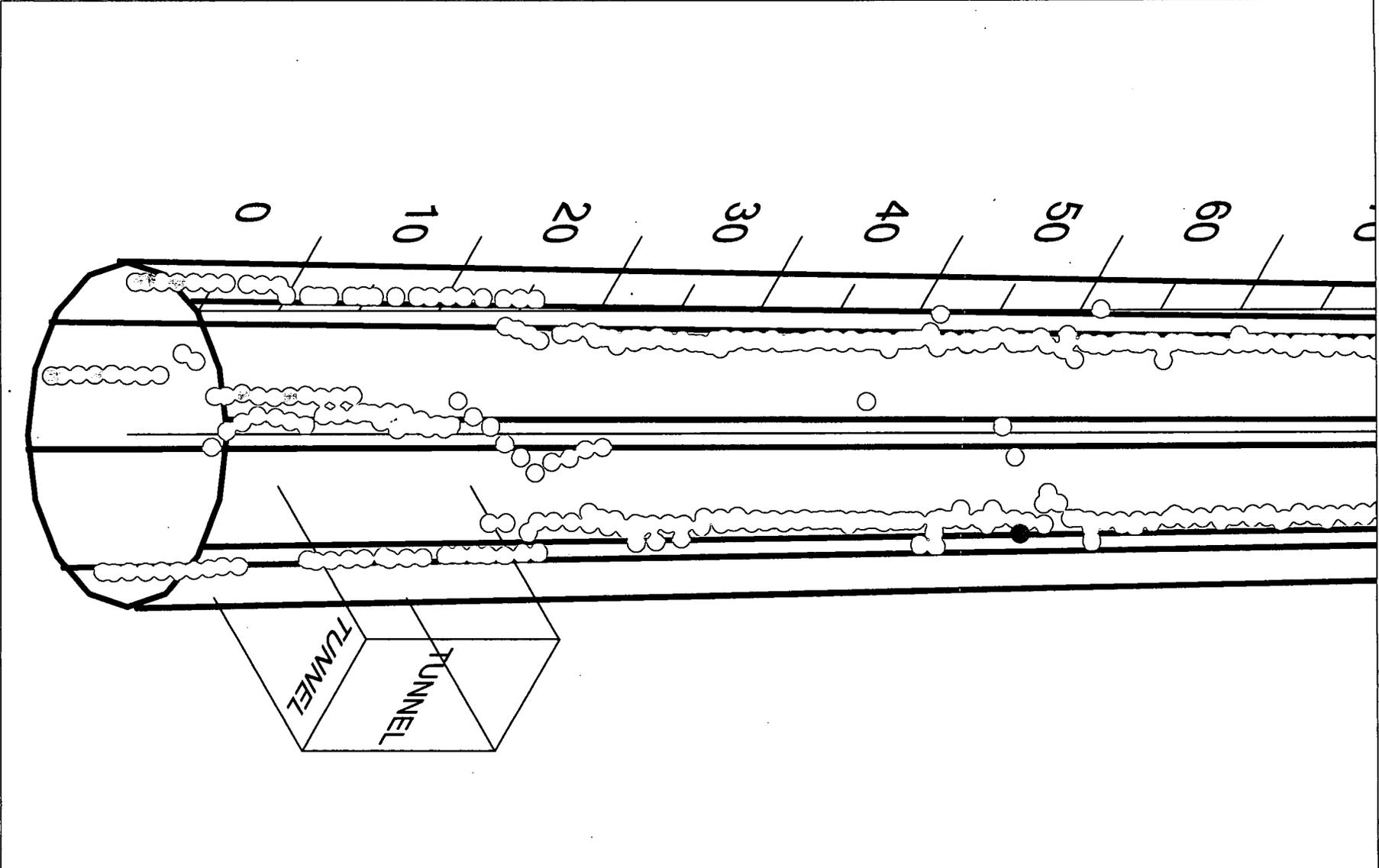
Detector 1697, Bkg: 5.88 c/m

Max DPM: 352

FIGURE 1

RFETS B771 Ventilation Stack LARADS Radiological Survey Initial Survey Data



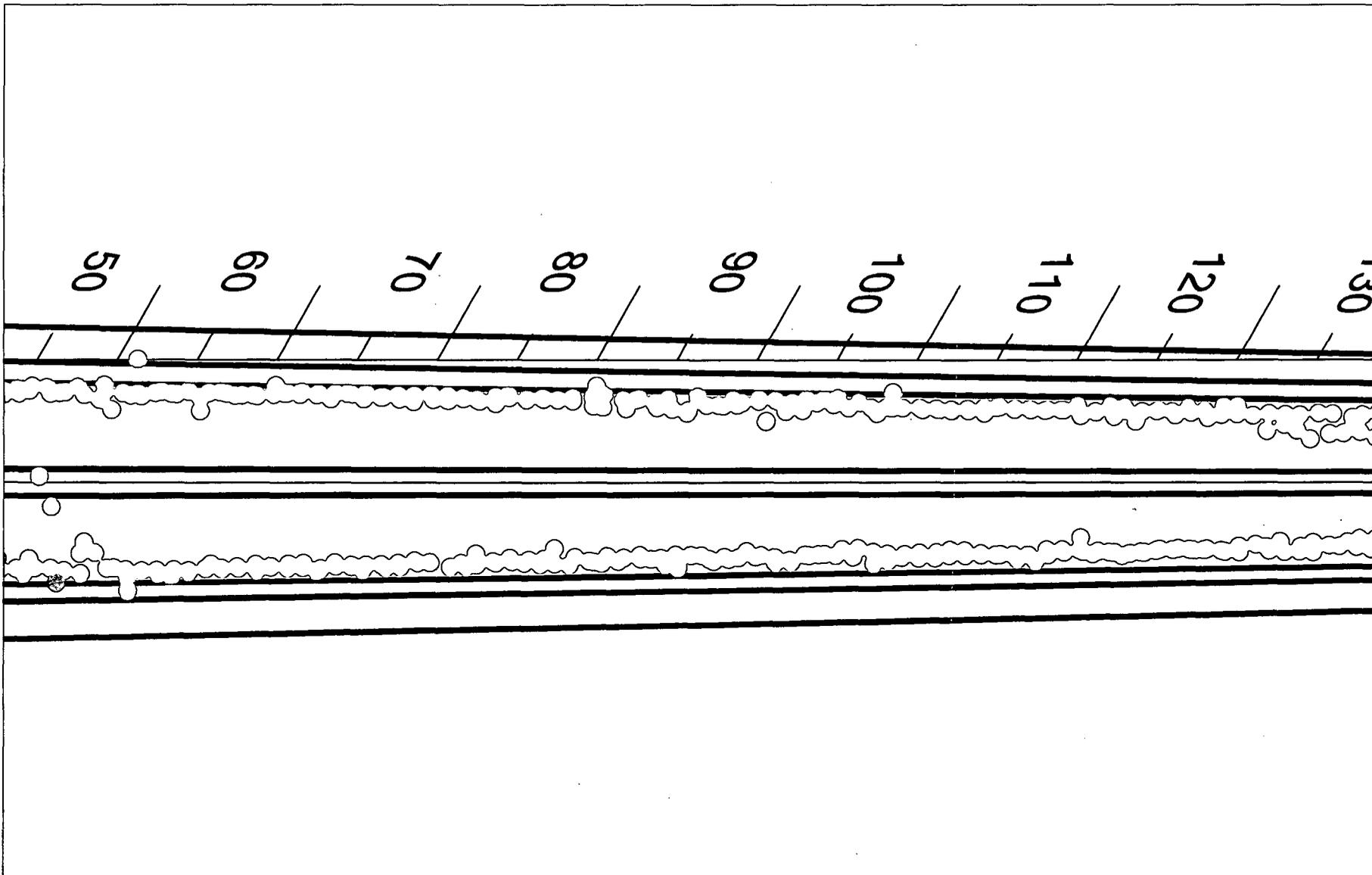


- dpm/100 cm2
- < 100
 - 100 - 150
 - 150 - 200
 - 200 - 250
 - > 250

Coverage File: RFSRV
 Number of Data Pnts: 701
 Type of Survey: 'Alpha'
 Survey Date: 7/23-8/6 2001
 CRM Used: 1244, 1623
 Detector 1551, Bkg: 6.46 c/m
 Detector 1697, Bkg: 5.88 c/m
 Max DPM: 352
 FIGURE 2

RFETS B771 Ventilation Stack LARADS Radiological Survey Initial Survey Data - Bottom Section





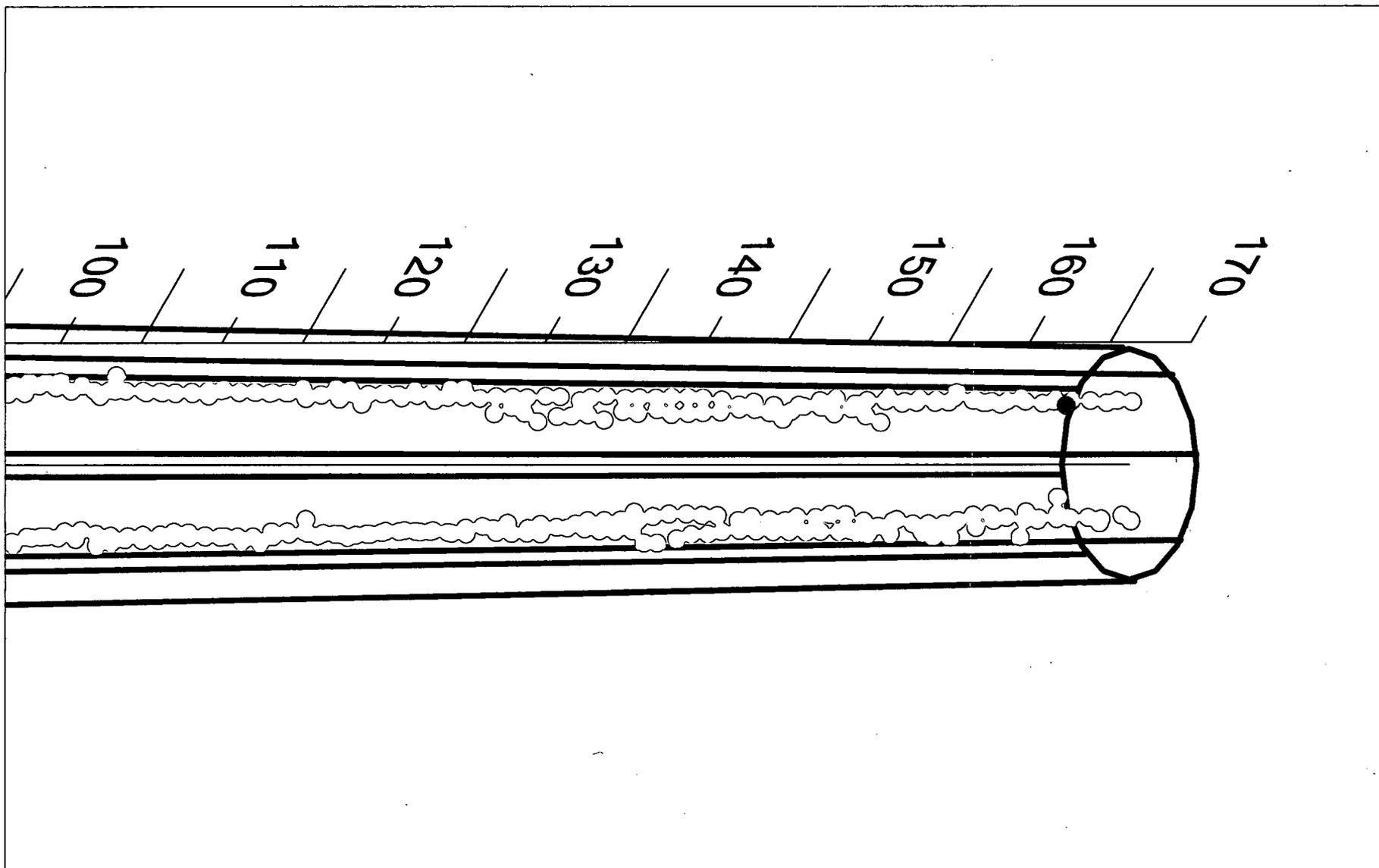
dpm/100 cm²

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- > 250

Coverage File: RFSRV
 Number of Data Pnts: 701
 Type of Survey: 'Alpha'
 Survey Date: 7/23-8/6 2001
 CRM Used: 1244, 1623
 Detector 1551, Bkg: 6.46 c/m
 Detector 1697, Bkg: 5.88 c/m
 Max DPM: 352
 FIGURE 3

RFETS B771 Ventilation Stack LARADS Radiological Survey Initial Survey Data - Middle Section





dpm/100 cm2
 ○ < 100
 ○ 100 - 150
 ○ 150 - 200
 ○ 200 - 250
 ○ > 250

Coverage File: RFSRV
 Number of Data Pnts: 701
 Type of Survey: 'Alpha'
 Survey Date: 7/23-8/6 2001
 CRM Used: 1244, 1623
 Detector 1551, Bkg: 6.46 c/m
 Detector 1697, Bkg: 5.88 c/m
 Max DPM: 352
 FIGURE 4

**RFETS B771 Ventilation Stack
 LARADS Radiological Survey
 Initial Survey Data - Top Section**



Re-Investigation Survey Results

Sixty-eight data points were reinvestigated initially using the longer 180-second scaler count time. Of these, seven exceeded the 75 dpm/100cm² and 100 dpm/cm² requirement. These data points are summarized in Table 2.

Table 2
180-Second Re-Investigation Summary

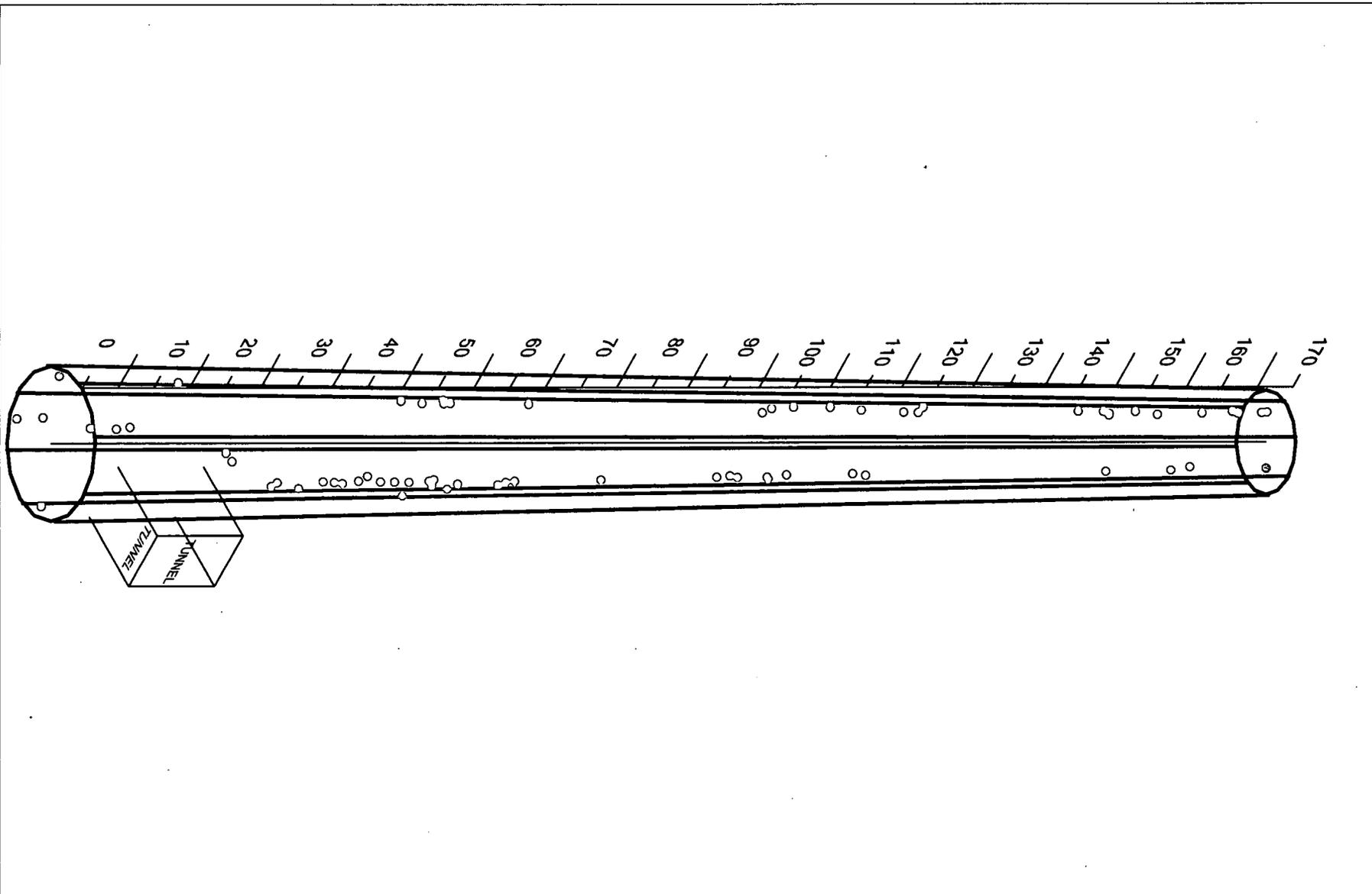
ELEVATION	LOCATION	CPM	BKG CPM 90 SEC.	DPM USING 90 SEC AVG. BKG.	BKG 1- HOUR	DPM USING 1- HR. BKG	DETECTOR ID#
0	8	30	12.33	114.7	5.88	156.6	1697
4	4	27	8.59	121.1	6.46	135.1	1551
4	10	25	12.33	82.3	5.88	124.2	1697
6	10	24.3	12.33	77.7	5.88	119.6	1697
68	3	21.6	12.33	60.2	5.88	102.1	1697
103	3	21.3	8.59	83.6	6.46	97.6	1551
169	12	33.3	12.33	136.2	5.88	178.1	1697

The precision of LARADS coordinate information is < 0.25". However, due to the high air velocity within the stack area, ESI has difficulties repositioning the MAPS platform to the precise location of where the initial reading was taken in a timely and hence, cost effective manner. Most of the reinvestigations occurred within 2" of the original location with some exceeding 3". Table 3 summarizes the locational errors between the reinvestigative points and the target original locations.

Table 3
Reinvestigation Positional Error

Distance from Original Reading Location	<1"	<2"
Percent of Total Reinvestigation Data Points	16.7 %	51.5%

Figures 5 through 8 show color-coded data sets of the re-investigative survey results.



dpm/100 cm2

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- > 250

Coverage File: RESRV

Number of Data Pnts: 68

Type of Survey: 'Alpha'

Survey Date: 8/3-8/2001

CRM Used: 1623

Detector 1551, Bkg: 6.46 c/m

Detector 1697, Bkg: 5.88 c/m

Max DPM: 178.1

FIGURE 5

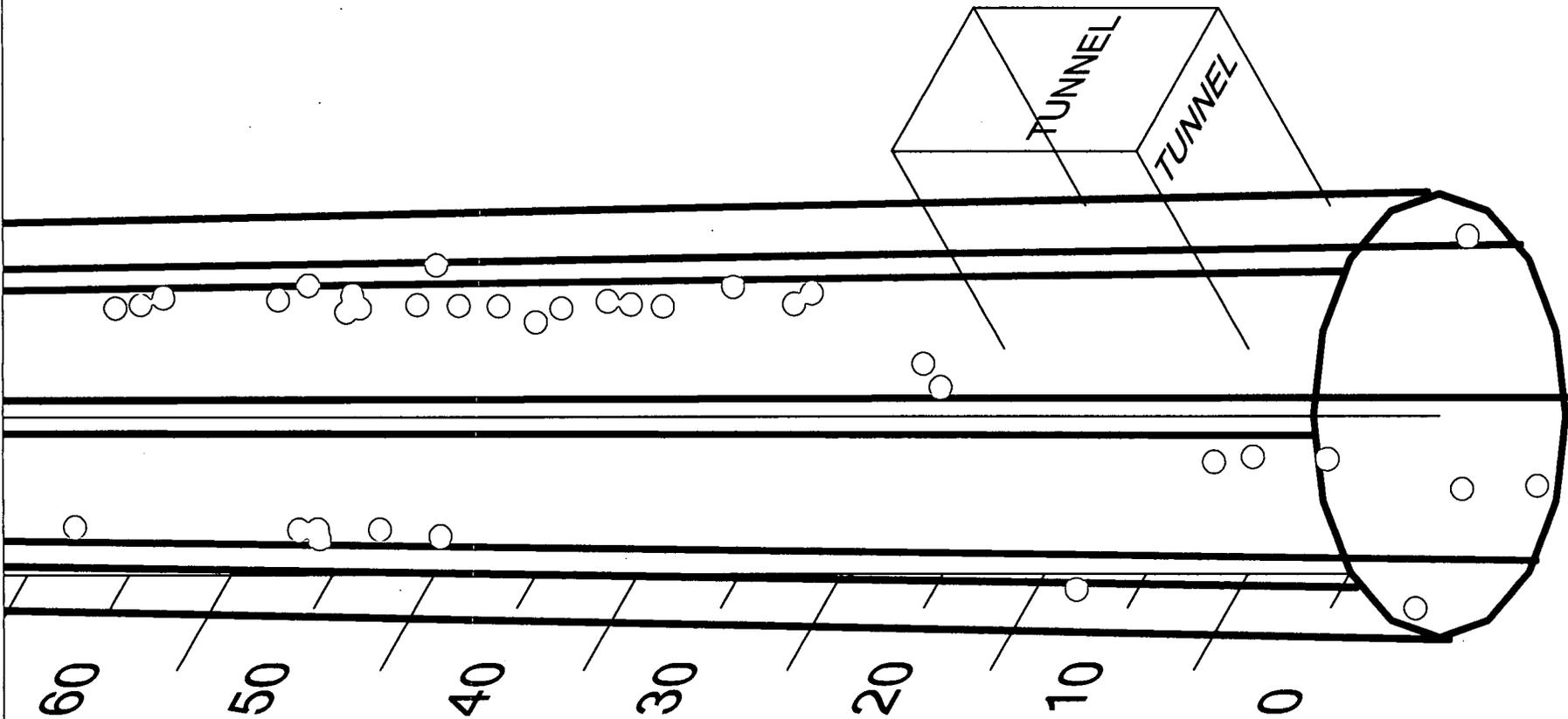
**RFETS B771 Ventilation Stack
LARADS Radiological Survey
Reinvestigation Survey Data**

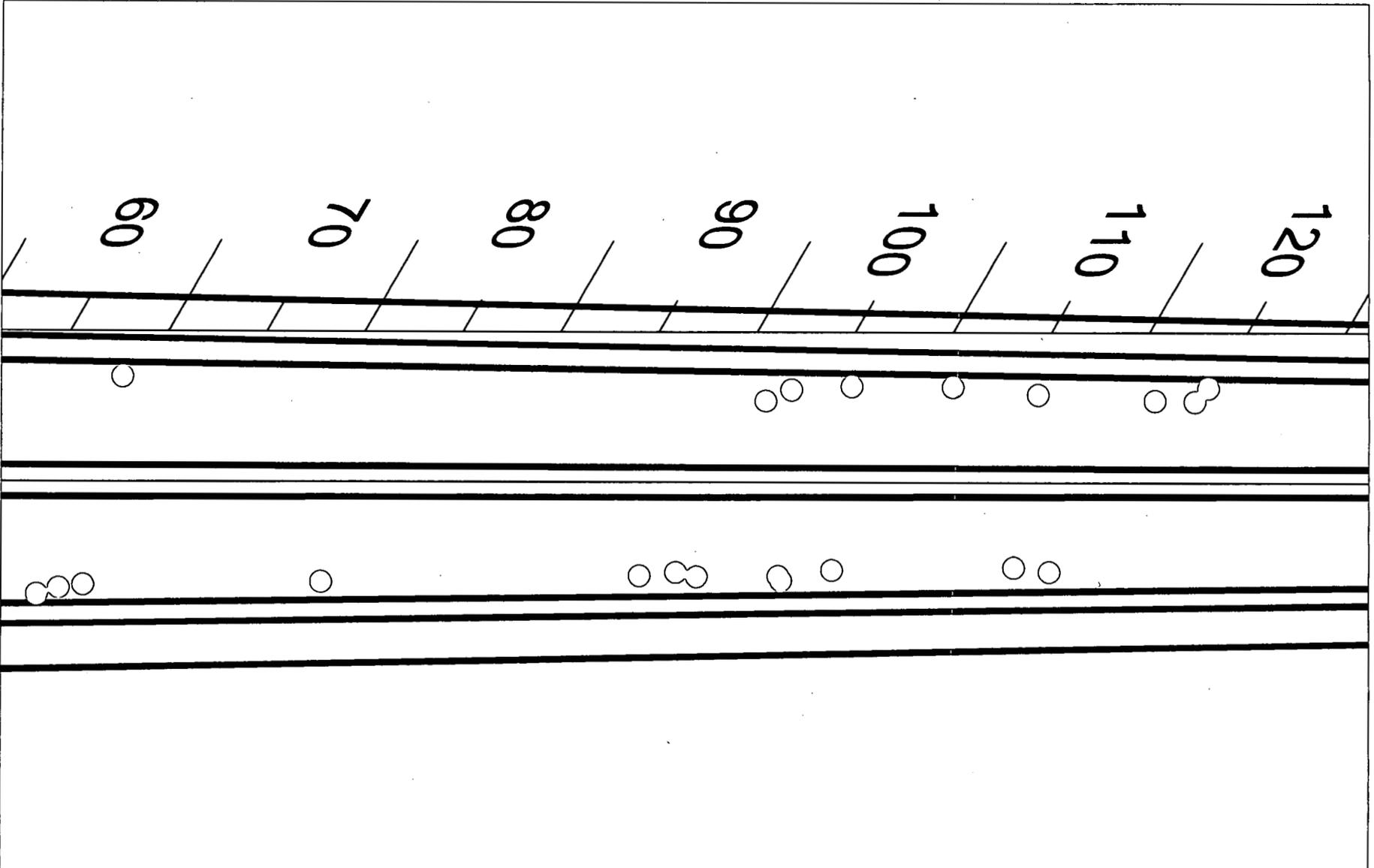




RFETS B771 Ventilation Stack LARADS Radiological Survey Reinvestigation Data - Bottom Sec.

Coverage File: RESRV
Number of Data Pnts: 68
Type of Survey: 'Alpha'
Survey Date: 8/3-8/2001
CRM Used: 1623
Detector 1551, Bkg: 6.46 c/m
Detector 1697, Bkg: 5.88 c/m
Max DPM: 178.1
FIGURE 6



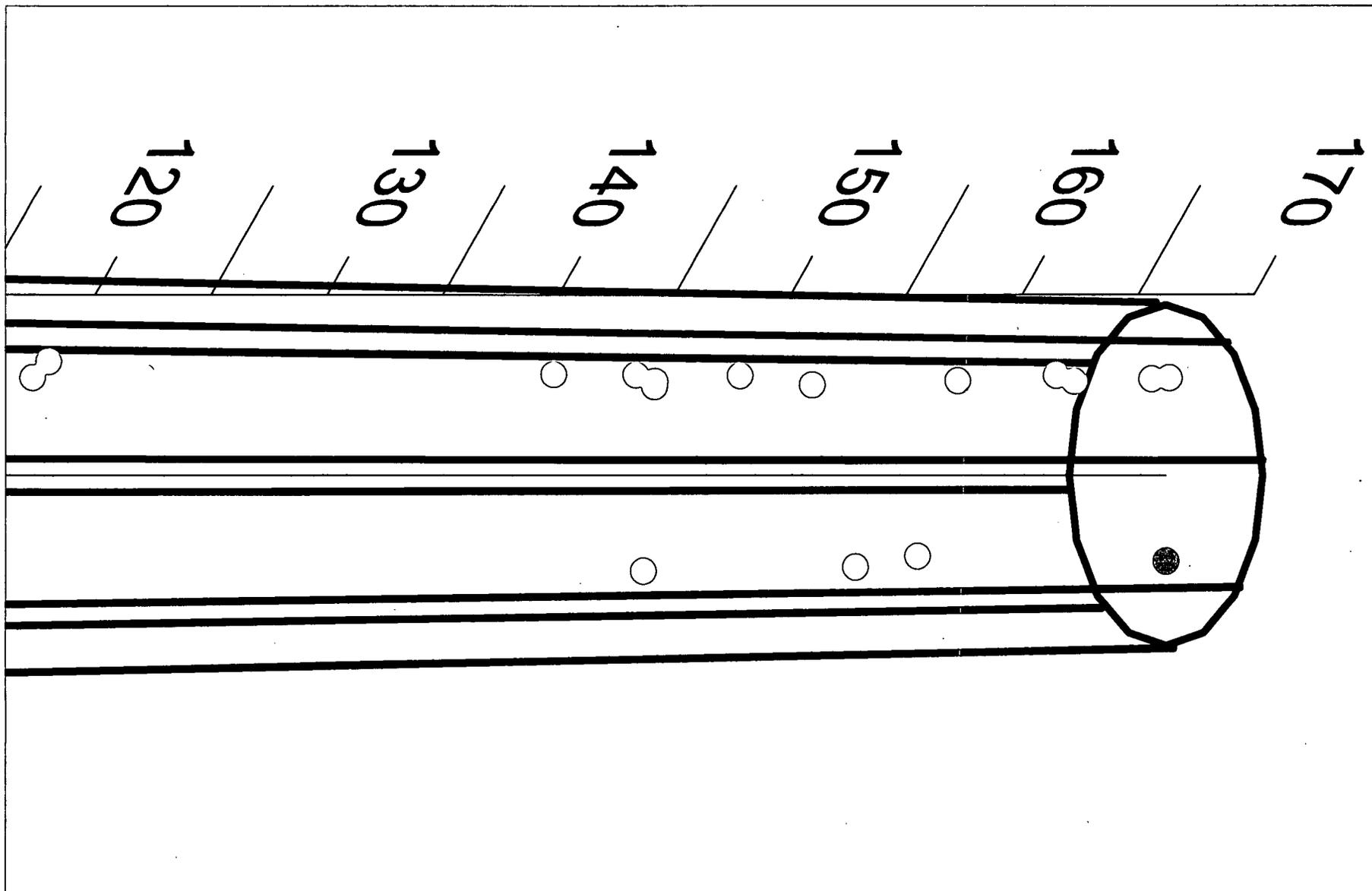


- dpm/100 cm2
- < 100
 - 100 - 150
 - 150 - 200
 - 200 - 250
 - > 250

Coverage File: RESRV
 Number of Data Pnts: 68
 Type of Survey: 'Alpha'
 Survey Date: 8/3-8/2001
 CRM Used: 1623
 Detector 1551, Bkg: 6.46 c/m
 Detector 1697, Bkg: 5.88 c/m
 Max DPM: 178.1
 FIGURE 7

**RFETS B771 Ventilation Stack
 LARADS Radiological Survey
 Reinvestigation Data - Middle Section**





dpm/100 cm2

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- > 250

Coverage File: RESRV

Number of Data Pnts: 68

Type of Survey: 'Alpha'

Survey Date: 8/3-8/2001

CRM Used: 1623

Detector 1551, Bkg: 6.46 c/m

Detector 1697, Bkg: 5.88 c/m

Max DPM: 178.1

FIGURE 8

RFETS B771 Ventilation Stack LARADS Radiological Survey Reinvestigation Data - Top Section



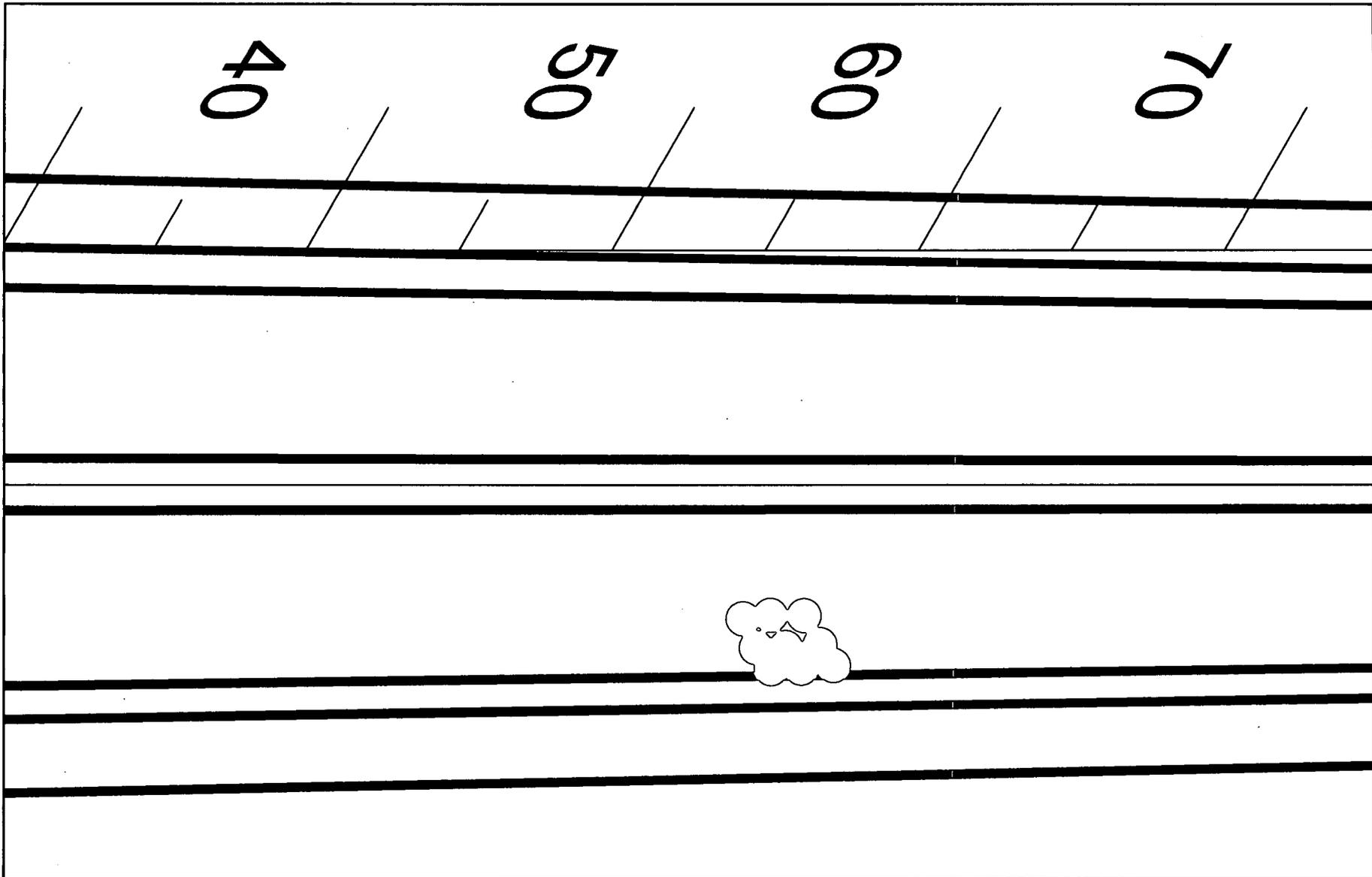
2. Square Meter Re-Investigation Results

The 68' and 169' anomalies were further investigated by taking nine additional readings for each in a rectangular pattern approximating a 1-meter by 1-meter grid block containing each specific anomalous location. These readings were taken using Detector # 1551. Results of this investigation are summarized in Table 4.

Table 4
Additional Re-Investigation of Anomalous Areas

GROSS CPM	XCOORD	YCOORD	ELEVATION	DPM USING 90 SEC AVG. BKG.	DPM USING 1-HOUR BKG.
24.6	-1.19	3.52	168.71	105.3	119.3
32.0	0.36	3.62	168.73	154.0	168.0
26.0	1.39	3.30	168.71	114.5	128.6
22.0	1.14	3.47	167.87	88.2	102.2
18.3	0.35	3.67	167.90	63.9	77.9
18.6	-0.58	3.71	167.87	65.9	79.9
13.0	-0.74	3.79	166.89	29.0	43.0
13.6	0.43	3.79	166.84	33.0	47.0
16.3	1.36	3.53	166.85	50.7	64.7
Average dpm:				78.3	92.3
27.3	5.98	0.12	67.99	123.1	137.1
7.6	5.86	1.00	68.00	-6.5	7.5
19.0	5.89	-1.00	68.01	68.5	82.5
16.0	5.82	-0.92	69.03	48.8	62.8
14.3	5.86	0.12	69.05	37.6	51.6
13.0	5.81	0.95	69.05	29.0	43.0
15.0	5.85	1.03	67.00	42.2	56.2
11.6	5.95	0.15	67.00	19.8	33.8
16.0	5.90	-0.88	67.06	48.8	62.8
Average dpm:				45.7	59.7

Figure 9 (68') and Figure 10 (169') show close up views of these results.



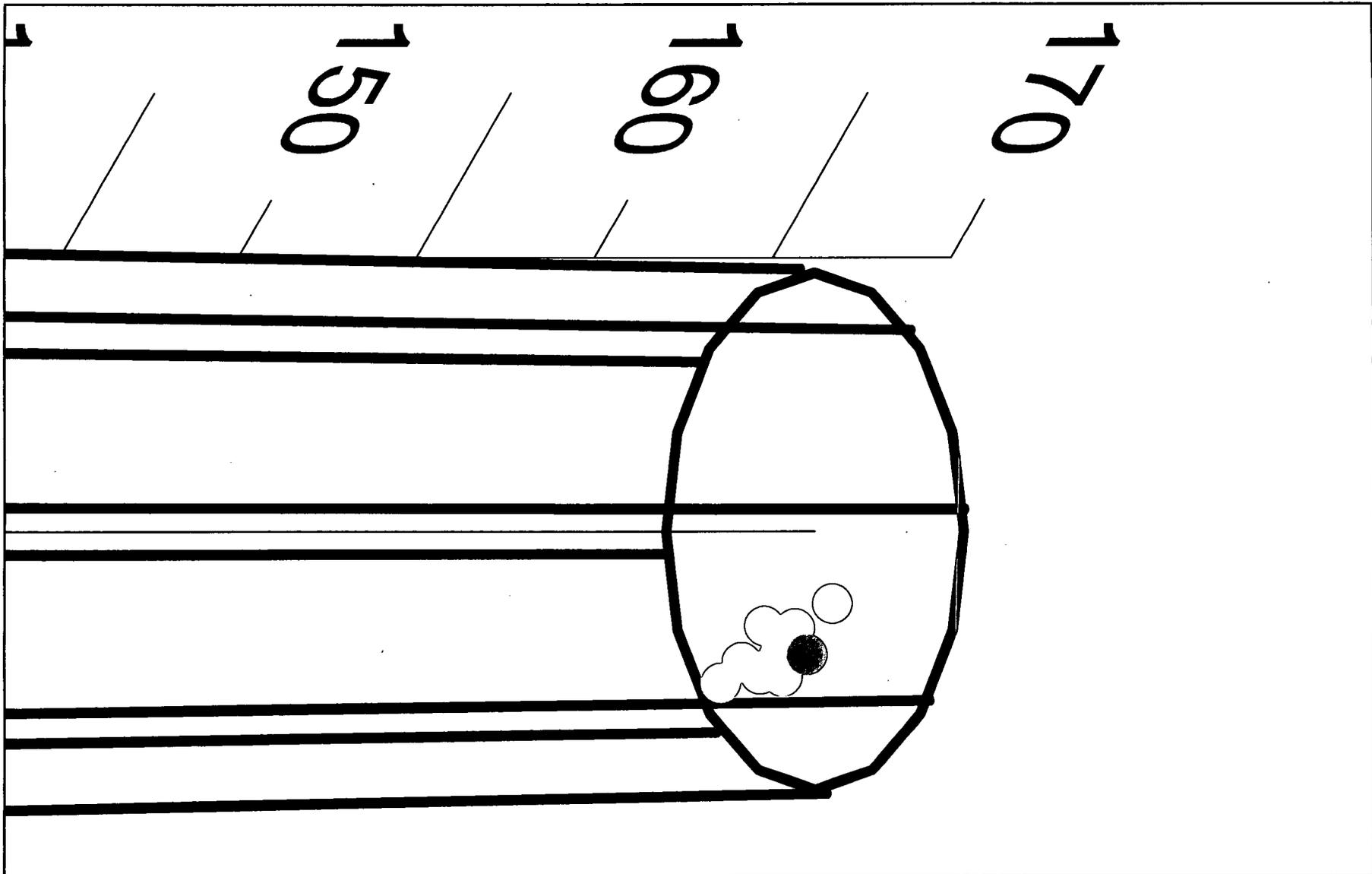
- dpm/100 cm2
- < 100
 - 100 - 150
 - 150 - 200

Coverage File: RESRV2
 (68' Subset Only)
 Number of Data Pnts: 9
 Type of Survey: 'Alpha'
 Survey Date: 8/7/2001
 CRM Used: 1623
 Detector 1551, Bkg: 6.46 c/m
 Max DPM: 137.1
 Sq. Meter Avg. DPM: 59.7

RFETS B771 Ventilation Stack LARADS Radiological Survey 68' Square Meter Reinvestigation



FIGURE 9



- dpm/100 cm2
- < 100
 - 100 - 150
 - 150 - 200

Coverage File: RESRV2
 (169' Subset Only)
 Number of Data Pnts: 9
 Type of Survey: 'Alpha'
 Survey Date: 8/7/2001
 CRM Used: 1623
 Detector 1551, Bkg: 6.46 c/m
 Max DPM: 168
 Sq. Meter Avg. DPM: 92.3

**RFETS B771 Ventilation Stack
 LARADS Radiological Survey
 169' Sq. Meter Reinvestigation**



FIGURE 10

Eberline Services
Rocky Flats Environmental Test Site
Building 771 Stack
LARADS Radiological Survey Report

Attachment I

Instrument Calibration Reports

Eberline Services
3200 George Washington Way
Richland, WA 99352
(509) 371-1506

EBERLINE E-600 CALIBRATION DATA SHEET
RADIOLOGICAL CALIBRATION PROCEDURES, MANUAL MA-563

Project # 98106:06 File Class: T6.5

Procedure: 3.9.5 Current Procedure Issued: 05/01 Supersedes: 03/00 Page 1 of 1

Eberline Model E-600

SN 1295

Barcode: <u>CMEBD-1247</u>
Barcode: <u>N/A</u>

Conventional Channel Calibrated With: Pancake GM Other

If other is checked, Model N/A SN N/A
M&TE

Pulsar Mfr/Model Eberline MP2 Barcode: RCEB1-0004 Cal. Expires 11/01

DMM: Model Fluke 77 Barcode: MMFLS-0001 Cal. Expires 11-8-01

Pancake GM Detector S/N 1202 Barcode: DTEB9-0283 Cal. Expires 8-8-01 N/A

Pulsar C/m	As-Found c/m			As-Left c/m			Acceptable Range c/m			
	Channel 1	Channel 2	Channel 3	Channel 1	Channel 2	Channel 3				
200 X 1	S	S	S	200	200		190 to 210			
400 X 1 ¹	S	S	S	400			300 to 420 450 to 550			
800 X 1				800			760 to 840			
200 X 10				1.998K			1.9 K to 2.1K			
800 X 10				8K			7.6K to 8.4K			
200 X 100				19.91K			19K to 21K			
800 X 100				79.9K			76K to 84K			
200 X 1K				199.7K			190K to 210K			
800 X 1K				799K	799K	799K	760K to 840K			
SCALER CHECK (counts/1 minute)										
800 X 100							79.8K			78400 to 81600

¹ Midpoint of most commonly used scale: ANSI N323-1978

NOTES: An "S" in the as-found column indicates no as-found readings available due to instrument repairs. All radiation standards used in this calibration are traceable to NIST. Calibration of M&TE is traceable to NIST. The acceptable tolerance for as-left readings is ±5% or ±20% if a correction factor chart is provided.

HIGH VOLTAGE CALIBRATION

High Voltage Setting (E-600)	As-Found	As-Left	Acceptable Range (DMM)
1246 ±5V	S V	1246 V	1246 ± 10V
2250 ±5V	S V	2253 V	2250 ± 10V

Comments: Done For Marc Wendling

Calibrated By [Signature] Calibration Date 6-8-01 Due for Recalibration 6-8-01

Reviewed and Approved By/Date
m Johnson
JUN 12 2001

Signatures indicate acceptability of calibration data as recorded above.

06/08/01 09:54:54

Serial Number : 1295
 Program Version : E600 V4.01
 Calibration Date/Due Date : 06/08/01 to 06/08/02
 Scaler Precision : 10%
 Lower Threshold Cal. Points : 1.80 mV and 6.00 mV
 Upper Threshold Cal. Points : 6.00 mV and 60.0 mV
 Lower Threshold Slope : 0.8810
 Lower Threshold Intercept : -0.1238 mV
 Lower Threshold Span : 0.1405 mV (<=0.5) to 5.10 mV (>=5.0)
 Upper Threshold Slope : 0.9444
 Upper Threshold Intercept : -0.8444 mV
 Upper Threshold Span : 0.8941 mV (<=1.5) to 60.0 mV (>=50.0)
 Alarm Editing : Enabled
 Latching Alarms : Enabled
 Auto Ranging : Enabled
 Beep on Auto-Range : No
 Ignore E-600 Cal. Date : No
 Ignore Probe Cal. Date : No
 Ratemeter Mode Support : Enabled
 Integrate Mode Support : Enabled
 Scaler Mode Support : Enabled
 Peak Hold Mode Support : Enabled
 Background Update Mode Support : Enabled
 Log ID Source : Internal/Aux.
 Star Key Ratemeter Function : Start Scaler
 Star Key Integrate Function : Zero Display
 Scaler Display Units : Rate
 Scaler Counting Mode : Fixed Time

COPY

Conventional Probe Serial Number : 0
 Type : HP 360
 Calibration Date/Due Date : 06/08/01 to 06/08/02
 Dead Time : 100 usec
 Surface Area : 15.0 cm²
 Max High Voltage : 900 Vdc
 Overrange : 58000 cps

COPY

Probe HP 360 0 continued...

Channel 2

Channel Type : Beta
Rate Units : cpm
Response Times : 20, 20, 20 secs
High Voltage : 898 Vdc
Lower Threshold : 5.00 mV
Upper Threshold : 10.1 mV
Selected Window : Upper
Upper Cal. Constant : 1.00 counts/count
Scaler Time : 120 secs
Lower to Upper Crossover : 0.0
Upper to Lower Crossover : 0.0

Cable Length: 60 inches

Signature: *Jeff B...*

Date: 6-8-01

COPY

COPY

EBERLINE E-600 CALIBRATION DATA SHEET
RADIOLOGICAL CALIBRATION PROCEDURES, MANUAL MA-563

Project # 98106:06 File Class: T6.5

Procedure: 3.9.5 Current Procedure Issued: 05/01 Supersedes: 03/00 Page 1 of 1

Eberline Model E-600

SN 1711

Barcode: <u>CMEBD-1623</u>
Barcode: <u>N/A</u>

Conventional Channel Calibrated With: Pancake GM Other

If other is checked, Model N/A SN N/A
M&TE

Pulser Mfr/Model Eberline MP2 Barcode: PGEB1-0004 Cal. Expires 11/01
DMM: Model Fluke 77 Barcode: MMFL5-0001 Cal. Expires 11-8-01
Pancake GM Detector S/N 120L Barcode: DTE59-0283 Cal. Expires 8-8-01 N/A

Pulser C/m	As-Found c/m			As-Left c/m			Acceptable Range c/m		
	Channel 1	Channel 2	Channel 3	Channel 1	Channel 2	Channel 3			
200 X 1	S	S	S	200	200	200	190 to 210		
⁴⁰⁰ 500 X 1 ¹	S	S	S	400	S	S	380 to 420 ⁹² 450 to 550		
800 X 1				800			760 to 840		
200 X 10				2K			1.9 K to 2.1K		
800 X 10				7.99K			7.6K to 8.4K		
200 X 100				19.98K			19K to 21K		
800 X 100				79.8K			76K to 84K		
200 X 1K				199.7K			190K to 210K		
800 X 1K				799K			799K	799K	760K to 840K
SCALER CHECK (counts/1 minute)									
800 X 100	S	S	S	79.8K	S	S	78400 to 81600		

¹ Midpoint of most commonly used scale: ANSI N323-1978

NOTES: An "S" in the as-found column indicates no as-found readings available due to instrument repairs. All radiation standards used in this calibration are traceable to NIST. Calibration of M&TE is traceable to NIST. The acceptable tolerance for as-left readings is ±5% or ±20% if a correction factor chart is provided.

HIGH VOLTAGE CALIBRATION

High Voltage Setting (E-600)	As-Found	As-Left	Acceptable Range (DMM)
1246 ±5V	S V	1248 V	1246 ± 10V
2250 ±5V	S V	2251 V	2250 ± 10V

Comments: None For Marc Wendling

Calibrated By: [Signature] Calibration Date: 6-8-01 Due for Recalibration: 6-8-02

Reviewed and Approved By/Date: [Signature]
JUN 12 2001

Signatures indicate acceptability of calibration data as recorded above.

CMEED-1623

06/08/01 08:14:19

```

E-600 Serial Number      : 1711
Program Version          : E600 V4.01
Calibration Date/Due Date : 06/08/01 to 06/08/02
Scaler Precision         : 10%
Lower Threshold Cal. Points : 1.80 mV and 6.00 mV
Upper Threshold Cal. Points : 6.00 mV and 60.0 mV
Lower Threshold Slope     : 0.8333
Lower Threshold Intercept : -0.1333 mV
Lower Threshold Span      : 0.1600 mV (<=0.5) to 5.10 mV (>=5.0)
Upper Threshold Slope     : 0.9889
Upper Threshold Intercept : -0.7556 mV
Upper Threshold Span      : 0.7641 mV (<=1.5) to 60.0 mV (>=50.0)
Alarm Editing             : Enabled
Latching Alarms          : Enabled
Auto Ranging              : Enabled
Beep on Auto-Range       : No
Ignore E-600 Cal. Date   : No
Ignore Probe Cal. Date   : No
Ratemeter Mode Support   : Enabled
Integrate Mode Support   : Enabled
Scaler Mode Support       : Enabled
Peak Hold Mode Support   : Enabled
Background Update Mode Support : Enabled
Log ID Source             : Internal/Aux.
Star Key Ratemeter Function : Start Scaler
Star Key Integrate Function : Zero Display
Scaler Display Units      : Rate
Scaler Counting Mode      : Fixed Time

```

```

Conventional Probe Serial Number : 0
Type                              : HP 360
Calibration Date/Due Date         : 06/08/01 to 06/08/02
Dead Time                          : 100 usec
Surface Area                       : 15.0 cm2
Max High Voltage                   : 900 Vdc
Overrange                          : 58000 cps

```

COPY

COPY

COPY

probe HP 360 0 continued...
channel 2

Channel Type	: Beta
Rate Units	: cpm
Response Times	: 20, 20, 20 secs
High Voltage	: 898 Vdc
Lower Threshold	: 5.00 mV
Upper Threshold	: 10.1 mV
Selected Window	: Upper
Upper Cal. Constant	: 1.00 counts/count
Scaler Time	: 120 secs
Lower to Upper Crossover	: 0.0
Upper to Lower Crossover	: 0.0

Cable Length: 60 inches

Signature: Jeff Bault Date: 6-8-01

COPY

EBERLINE SHP-380A(B) DATA SHEET
RADIOLOGICAL CALIBRATION PROCEDURES, MANUAL MA-563

Project # 98106.06/98107.06 File Class: T6.5

Procedure: 3.9.6

Issued: 06/00

Supersedes: 04/99

Rev. 1, Page 1 of 1

(Circle One)

SHP380AB or SHP380A

SN 435

Barcode MEBY-1551

M&TE Eberline E-600

SN 1603

Cal. Expires 8/01

Isotope

SN

Cert. Date

Activity

239Pu

G4790

4-26-01

54.7K dpm

N/A

dpm

N/A

dpm

AS-FOUND

Isotope

Background (Channel)

Gross, cpm

Efficiency

HV

90Sr(Y)

N/A

β

N/A

N/A

N/A

239Pu

N/A

α

N/A

N/A

N/A

RADIOLOGICAL CALIBRATION

Source/Detector Distance 1/4"

HV 566

Isotope	Activity (dpm)	Gross count rate (cpm)		Efficiency 100*(cpm/dpm)	Acceptance Criteria	
		α Ch.	β Ch.		Rugged Window*	Regular Window
Background		<u>2</u>	<u>N/A</u>		150 to 350 cpm β , \leq 3 cpm α	
90Sr(Y)				β	\geq 15% β	\geq 20% β, \leq 0.2% α
137Cs				β	\geq 10% β	\geq 15% β
<u>239Pu</u>	<u>54.7K</u>	<u>8.3K</u>	<u>N/A</u>	<u>15.2%</u>	<u>α</u>	<u>\geq 8% α</u>
				α or β		

Disabled Channels: 1 2 3 None

NOTES: An "S" in the as-found column indicates no as-found readings available due to instrument repairs. All radiation standards used in this calibration are traceable to NIST. Calibration of M&TE is traceable to NIST. The acceptable tolerance for as-left readings is $\pm 10\%$ or $\pm 20\%$ if a correction factor chart is provided.

Comments: Alpha Only per Marc Wendling

*Minimum efficiency for beta-only probes with rugged windows have tyvek, extra screen or other material to protect window.

Calibrated By Jeff Bealt

Calibration Date 6-12-01

Due for Recalibration 6-12-02

Reviewed and Approved By m johnson
 Date JUN 11 2001

Signatures indicate acceptability of calibration data as recorded above.

EBERLINE E-600 CALIBRATION REPORT - V4.02

DTEBY-1551

06/12/01 14:02:55 Probe Only
 E-600 Serial Number : 1603
 Smart Probe Serial Number : 435
 Type : SHP380AB
 Calibration Date/Due Date : 06/12/01 to 06/12/02
 Dead Time : 8.00 usec
 Surface Area : 100 cm²
 Max High Voltage : 1000 Vdc
 Overrange : 80000 cps

Channel 1
 Channel Type : Alpha
 Rate Units : cpm
 Response Times : 20,20,20 secs
 High Voltage : 566 Vdc
 Lower Threshold : 2.00 mV
 Upper Threshold : 10.1 mV
 Selected Window : Upper
 Upper Cal. Constant : 1.00 counts/count
 Scaler Time : 90 secs
 Lower to Upper Crossover : 0.0
 Upper to Lower Crossover : 0.0

Cable Length: 36 inches

Signature: *Jeff Burt* Date: 6-12-01

EBERLINE SHP-380A(B) DATA SHEET
RADIOLOGICAL CALIBRATION PROCEDURES, MANUAL MA-563

Project # 98106:06/98107:06 File Class: T6.5

Procedure: 3.9.6

Issued: 06/00

Supersedes: 04/99

Rev. 1, Page 1 of 1

(Circle One)

SHP380AB or SHP380A

SN 813

Barcode DTEBY-1697

M&TE Eberline E-600 SN 1603

Cal. Expires 8/01

Isotope	SN	Cert. Date	Activity	
<u>239Pu</u>	<u>G4796</u>	<u>4-26-01</u>	<u>54.7K</u>	dpm
<u>N/A</u>				dpm
<u>N/A</u>				dpm

AS-FOUND

Isotope	Background (Channel)		Gross, cpm	Efficiency	HV
<u>90Sr(Y)</u>	<u>N/A</u>	β	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>
<u>239Pu</u>	<u>N/A</u>	α	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>

RADIOLOGICAL CALIBRATION

Source/Detector Distance 1/4"

HV 557

Isotope	Activity (dpm)	Gross count rate (cpm)		Efficiency 100*(cpm/dpm)	Acceptance Criteria	
		α Ch.	β Ch.		Rugged Window*	Regular Window
Background		<u>1</u>	<u>N/A</u>		150 to 350 cpm β , \leq 3 cpm α	
90Sr(Y)				β	\geq 15% β	\geq 20% β , \leq 0.2% α
137Cs				β	\geq 10% β	\geq 15% β
<u>239Pu</u>	<u>54.7K</u>	<u>8.42K</u>	<u>N/A</u>	<u>15.4%</u>	α	\geq 8% α , \geq 10% α
					α or β	

Disabled Channels: 1 2 3 None

NOTES: An "S" in the as-found column indicates no as-found readings available due to instrument repairs. All radiation standards used in this calibration are traceable to NIST. Calibration of M&TE is traceable to NIST. The acceptable tolerance for as-left readings is $\pm 10\%$ or $\pm 20\%$ if a correction factor chart is provided.

Comments: Alpha Only per Marc Wendling

*Minimum efficiency for beta-only probes with rugged windows have tyvek, extra screen or other material to protect window.

Calibrated By Jeff Breatt

Calibration Date 6-12-01

Due for Recalibration 6-12-02

Reviewed and Approved By m johnson
 Date JUN 11 2001

Signatures indicate acceptability of calibration data as recorded above.

EBERLINE E-600 CALIBRATION REPORT - V4.02

DTEBY-1697

06/12/01 14:03:29 Probe Only
E-600 Serial Number : 1603
Smart Probe Serial Number : 813
Type : SHP380AB
Calibration Date/Due Date : 06/12/01 to 06/12/02
Dead Time : 8.00 usec
Surface Area : 100 cm2
Max High Voltage : 1000 Vdc
Overrange : 80000 cps

Channel 1
Channel Type : Alpha
Rate Units : cpm
Response Times : 20,20,20 secs
High Voltage : 557 Vdc
Lower Threshold : 2.00 mV
Upper Threshold : 10.1 mV
Selected Window : Upper
Upper Cal. Constant : 1.00 counts/count
Scaler Time : 90 secs
Lower to Upper Crossover : 0.0
Upper to Lower Crossover : 0.0

Cable Length: 36 inches

Signature: Jeff Breaht Date: 6-12-01

Eberline Services
Rocky Flats Environmental Test Site
Building 771 Stack
LARADS Radiological Survey Report

Attachment II

Instrument Performance Checks

Eberline Services
3200 George Washington Way
Richland, WA 99352
(509) 371-1506

Eberline Services

Environmental Survey Instrument Data Sheet

Page 1 of 3

Project: B771 STACK SURVEY		Dates Covered From: 7/17/01 To: 8/8/01		ESID Number: RF-001	
Instrument/Probe Information					
Instrument Serial Number: 1244 & 1623	Instrument Type: E600 CRM	Calibration Date: 6/8/01	Calibration Due Date: 6/8/02		
Probe Serial Number: 1697	Probe Type/Model: 380AB	Calibration Date: 6/12/01	Calibration Due Date: 6/12/02	Alpha Eff: 15.4%	Beta/Gamma Eff: N/A
Alpha Source Information					
Source Number: 603600 TS2600	Source Isotope: Pu-239	Source Activity: 19429 ± 970 dpm	Assay Date: 2/01		
Beta/Gamma Source Information					
Source Number: N/A	Source Isotope: N/A	Source Activity: N/A	Assay Date: N/A		
Instrument Response Check					
Date: 7/17/01	Time: 1550	RCT Name/Signature: MARC WENDLING <ORIGINAL SIGNED BY MARC WENDLING>			
Alpha Background (cpm): 4	Alpha Count Time (min.): 1.5	Beta/Gamma Background: N/A	Beta/Gamma Count Time (min): N/A		
Count Number	Alpha Source Count Rate (cpm)		Beta Sources Count Rate ()		
1	4.85k		N/A		
2	4.78k		N/A		
3	4.78k		N/A		
4	4.77k		N/A		
5	4.67k		N/A		
6	4.82k		N/A		
7	4.81k		N/A		
8	4.76k		N/A		
9	4.77k		N/A		
10	4.84k		N/A		
Mean Alpha Source Net Measurement (cpm)	Alpha Upper Bound (average + 20%)		Alpha Lower Bound (average - 20%)		
4.79k	5.74k		3.83k		
Mean Beta Source Net Measurement () N/A	Beta/Gamma Upper Bound (average + 20%) N/A		Beta/Gamma Lower Bound (average - 20%) N/A		
Reviewed By (print and sign) J.D. MORONEY				Date 8/14/01	
<ORIGINAL SIGNED BY MARC WENDLING FOR JOHN MORONEY>					

**Eberline Services
Environmental Survey Instrument Data Sheet**

Project: B771 STACK SURVEY	Dates Covered From: 7/17/01 To: 8/8/01	ESID Number: RF-001	Probe Serial Number: 1697
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Operational Checks

	Date	Time	Alpha			Beta/Gamma			RCT Initials
			Background (cpm)	Source Check (netcpm)	P/F*	Background ()	Source Check ()	P/F*	
Pre	7/18/01	0910	2	4.69k	P	N/A			MW
Post	7/24/01	0705	4	4.62k	P				MW
Pre	7/24/01	0705	7.33	4.62k	P				MW
Post	7/25/01	0630	7	4.77k	P				MW
Pre	7/25/01	0635	6	4.78k	P				MW
Post	7/25/01	1540	7.33	4.71k	P				MW
Pre	7/25/01	1545	10	4.68k	P				MW
Post	7/31/01	0755	4	4.7k	P				MW
Pre	7/31/01	0800	4.66	4.7k	P				MW
Post	8/1/01	1110	28.6	4.78k	P				MW
Pre	8/2/01	1105	7.33	4.65k	P				MW
Post	8/6/01	0730	5.71	4.68k	P				MW
Pre	8/6/01	1300	4.94	4.61k	P				MW
Post	8/7/01	0815	3.33	4.68k	P				MW
Pre	8/7/01	0830	3.33	4.68k	P				MW
Post	8/8/01	1015	4.94	4.67k	P				MW

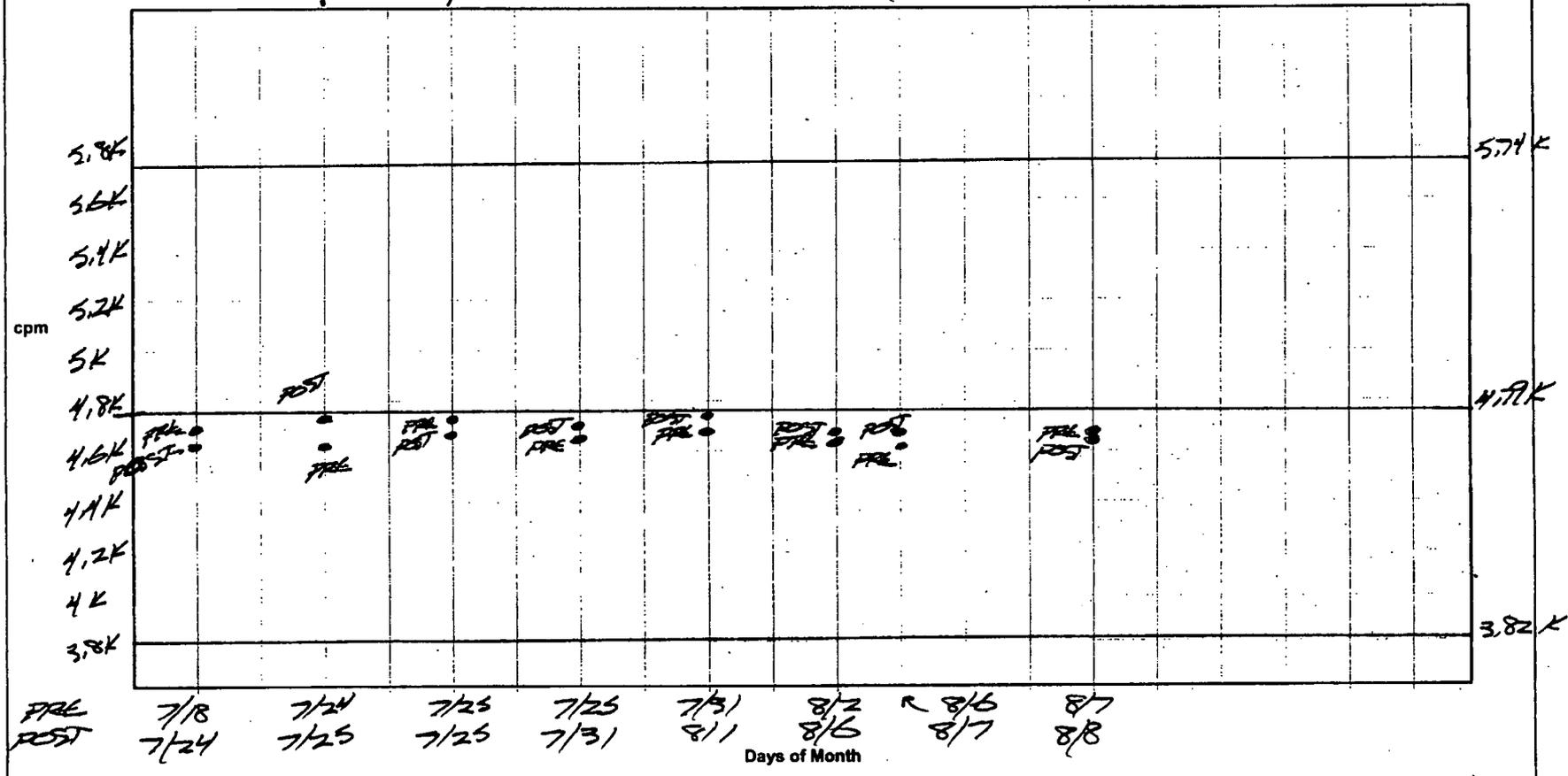
Reviewed By (print and sign) J.D. MORONEY

Date 8/14/01

<ORIGINAL SIGNED BY MARC WENDLING FOR JOHN MORONEY>

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Eberline Services			Instrument Control Chart		Radiation Type: <input checked="" type="checkbox"/> Alpha <input type="checkbox"/> Beta/Gamma	
Project: <i>LARSEN'S 771 STACK SURVEY</i>	Dates Covered From: <i>7/10/01</i> To: <i>8/8/01</i>	ESID Number: <i>15/</i>	Probe Serial Number: <i>1784-1697</i>	Probe Type: <i>380A/B</i>		
Source Number: <i>603600 752600 4429</i>	Source Isotope: <i>242A</i>	Source Activity: <i>19429 PM</i>	Assay Date: <i>2/01</i>	Calibration Date: <i>6-12-01</i>	Calibration Due Date: <i>6-12-02</i>	



RadCon Supervision Review

Name: *J.P. MORSEY* Signature: *[Handwritten Signature]* Date: *8/14/01*

Page 3 of 3

Eberline Services
Environmental Survey Instrument Data Sheet

Project: B771 STACK SURVEY		Dates Covered From: 7/17/01 To: 8/8/01		ESID Number: RF-002	
Instrument/Probe Information					
Instrument Serial Number: 1244 & 1623	Instrument Type: E600 CRM	Calibration Date: 6/8/01	Calibration Due Date: 6/8/02		
Probe Serial Number: 1551	Probe Type/Model: 380AB	Calibration Date: 6/12/01	Calibration Due Date: 6/12/02	Alpha Eff: 15.2%	Beta/Gamma Eff: N/A
Alpha Source Information					
Source Number: 603600 TS2600	Source Isotope: Pu-239	Source Activity: 19429 ± 970 dpm	Assay Date: 2/01		
Beta/Gamma Source Information					
Source Number: N/A	Source Isotope: N/A	Source Activity: N/A	Assay Date: N/A		
Instrument Response Check					
Date: 7/17/01	Time: 1620	RCT Name/Signature: MARC WENDLING <ORIGINAL SIGNED BY MARC WENDLING>			
Alpha Background (cpm): 2	Alpha Count Time (min.): 1.5	Beta/Gamma Background: N/A	Beta/Gamma Count Time (min): N/A		
Count Data					
Count Number	Alpha Source Count Rate (cpm)		Beta Sources Count Rate ()		
1	4.43k		N/A		
2	4.64k		N/A		
3	4.54k		N/A		
4	4.58k		N/A		
5	4.47k		N/A		
6	4.53k		N/A		
7	4.51k		N/A		
8	4.47k		N/A		
9	4.56k		N/A		
10	4.58k		N/A		
Summary					
Mean Alpha Source Net Measurement (cpm)		Alpha Upper Bound (average + 20%)		Alpha Lower Bound (average - 20%)	
Mean Beta Source Net Measurement () N/A		Beta/Gamma Upper Bound (average + 20%) N/A		Beta/Gamma Lower Bound (average - 20%) N/A	
Reviewed By (print and sign) J.D. MORONEY <ORIGINAL SIGNED BY MARC WENDLING FOR JOHN MORONEY>				Date 8/14/01	

**Eberline Services
Environmental Survey Instrument Data Sheet**

Page 2 of 3

Project: B771 STACK SURVEY	Dates Covered From: 7/17/01 To: 8/8/01	ESID Number: RF-002	Probe Serial Number: 1551
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Operational Checks

	Date	Time	Alpha			Beta/Gamma			RCT Initials
			Background (cpm)	Source Check (netcpm)	P/F*	Background ()	Source Check ()	P/F*	
Pre	7/18/01	0910	3.33	4.47k	P	N/A			MW
Post	7/24/01	0720	2	4.37k	P				MW
Pre	7/24/01	0724	3.33	4.46k	P				MW
Post	7/26/01	0720	5.33	4.49k	P				MW
Pre	7/26/01	0725	4	4.41k	P				MW
Post	7/30/01	1440	4	4.43k	P				MW
Pre	7/30/01	1445	4	4.36k	P				MW
Post	8/1/01	1100	6.66	4.43k	P				MW
Pre	8/1/01	1105	5.33	4.46k	P				MW
Post	8/2/01	0735	2.66	4.39k	P				MW
Pre	8/2/01	0740	4	4.44k	P				MW
Post	8/3/01	1230	4.23	4.34k	P				MW
Pre	8/3/01	1240	4.66	4.36k	P				MW
Post	8/6/01	1000	5.64	4.18k	P				MW
Pre	8/6/01	1010	6	4.22k	P				MW
Post	8/7/01	0815	4.94	4.39k	P				MW
Pre	8/7/01	0825	6.33	4.41k	P				MW
Post	8/8/01	1020	4.23	4.42k	P				MW

Reviewed By (print and sign) J.D. MORONEY

Date 8/14/01

<ORIGINAL SIGNED BY MARC WENDLING FOR JOHN MORONEY>

Eberline Services
Rocky Flats Environmental Test Site
Building 771 Stack
LARADS Radiological Survey Report

Attachment III

Electronic Deliverable Information

Eberline Services
3200 George Washington Way
Richland, WA 99352
(509) 371-1506

Electronic deliverables include the following:

Narrative

ESI-B771 STACK REPORT.DOC - This report in Microsoft Word format.
ESI-B77 STACK REPORT.PDF - This report in Adobe pdf format.

Figures – Figures from this report in Adobe pdf format.

FIG1.PDF
FIG2.PDF
FIG3.PDF
FIG4.PDF
FIG5.PDF
FIG6.PDF
FIG7.PDF
FIG8.PDF
FIG9.PDF
FIG10.PDF

Drawings – All in AutoDesk's AutoCad 2000 format

ESI_B771S_RFSRV.DWG – Base for Figures 1 through 4
ESI_B771S_RESRV.DWG – Base for Figures 5 through 8
ESI_B771S_RESRV2.DWG – Base for Figures 9 and 10

Raw Data Files – All in ASCII text format. Can be opened with any text viewer such as Microsoft's Notepad, Wordpad, or Word.

RF723.ATT	RF802A.ATT
RF724.ATT	RF802.ATT
RF725.ATT	RF803A.ATT
RF726A.ATT	RF803.ATT
RF726.ATT	RF806A.ATT
RF728A.ATT	RF806.ATT
RF728.ATT	RF806B.ATT
RF730A.ATT	RF807A.ATT
RF730.ATT	RF807.ATT
RF731.ATT	RF808.ATT
RF801A.ATT	SMP808.ATT
RF801.ATT	

Data Files – All in Microsoft Excel format.

ESI_B771S_RFBKG.XLS – 90-second background results.
ESI_B771S_RFSRV.XLS – Initial survey results.
ESI_B771S_RESRV.XLS – Re-Investigation survey results.
ESI_B771_RESRV2.XLS – Square meter investigation results.

Information contained in database fields:

CPM1 – Gross counts per minute obtained from the E600 CRM.

TYPE1 – Type of measurement being conducted, in this case all Alpha.

UNITS1 – Units of measure for the CPM1 field result, in this case all CPM.

XCOORD – X-axis positional coordinate in feet from origin at center of stack bottom.

YCOORD – Y-axis positional coordinate in feet from center of stack bottom.

ZCOORD – Z-axis positional coordinate (height or elevation) from center of stack bottom.

DATETIME – Date and time reading obtained.

E600 – CRM meter identification. For example, calibration facility uses CMEBD-1623; this is truncated to 1623 in this field.

DETECT_ID – Specific detector identifier using truncation as discussed for E600 field.

ELEV – Rounded ZCOORD elevation information in feet.

LOC – Relative rotational position of this reading if viewed from top of stack using a watch-dial system with center of stack tunnel being 12 o'clock (12).

BKG_CPM – Mean of 90-second background reading results for specific detector used.

NETCPM – CPM1 field – BKG_CPM field. Net CPM for this specific detector and measurement using the mean 90-second backgrounds result.

DPM – Calculated WGP activity per 100 cm sq. result for this specific reading when using the 90-second background information.

BKG_CPM2 – 1-hour background reading for this specific detector.

NETCPM2 – CPM1 field – BKG_CPM2 field. Net CPM for this specific detector and measurement using the 1-hour background result.

DPM2 – Calculated WGP activity per 100 cm sq. result for this specific reading when using the 1-hour background information.

CNT_TIME – Duration of static reading at this location.