Rocky Flats

Environmental Technology Site

3-PRO-112-RSP-02.01

Revision 1

RADIOLOGICAL INSTRUMENTATION

APPROVED BY: / TL Vaughn / 7/28/98
Print Name Date

Responsible Organization: Radiological Engineering Effective Date: 08/24/98

CONCURRENCE BY THE FOLLOWING DISCIPLINES IS DOCUMENTED IN THE PROCEDURE HISTORY FILE:

Radiological Safety Section Manager 371/374
Radiological Safety Section Manager 559/707
Radiological Safety Section Manager 776/777
Radiological Safety Section Manager 771/774
Radiological Safety Section Manager 779/886
Radiological Safety Section Manager DMS/DYNCORP
Subject Technical Expert (Radiological Engineering)

USE CATEGORY 3

This document SHALL be at a known location for reference.

ISR Review Not Required

The following have been incorporated in this document:

~~97-DMR-001215~~ 7-28-98 TLV
DCF #1

Periodic review frequency: 4 years from the effective date.

ELECTRONIC COPY

PADC-98-00361

ADMIN RECORD

1/77

Page 1 of ____

DOCUMENT CHANGE FORM (DCF)

(7) DCF #: _____

(1)
DCF Originator: C. J. Bianconi /s/ 7/28/04
Print Sign Date

Organization: B371 Radiological Engineering

Phone/Pager/Location: X7262/212-5706/T371N

(4)
Ludlum High Range Alpha Ion Chamber, Model 195 Readout
Document Title

ITSS-02.01-22, Revision 0
Existing Document Number and Version

ITSS-02.01-22, Version 1
New Document Number and Version

(2) *(Authorizes processing of request.)*
Responsible Manager: R. J. Sexton 9-8-04
Print Sign

Organization: Radiological Programs Manager

Phone/Pager/Location: 6702/212-0354/T130H

(5)
Type of Document

- ☐ Policy
- ☐ Mgt Directive
- ☐ Manual
- ☐ Procedure (indicate type)
  - ☐ Technical
  - ☐ Alarm
  - ☐ Administrative
  - ☐ Other
- ☐ Instruction
- ☐ Job Aid
- ☒ Other

If "Other" is checked, please specify type: ITSS

(3)
Assigned SME: Gordon Madison
Print Name

Organization: B707/776 Radiological Engineering

Phone/Pager/Location: X4701/212-0375/T707N

(6)
Type of Modification

- ☐ New
  - ☐ One Time Use Only
- ☒ Change
  - ☐ Minor
  - ☒ Major
  - ☐ Cancellation

(8) Proposed Modification	(9) Justification
ITSS-02.01-22 Section I, Part C states: "... increments up to 20 ft in length." Change the statement to read: "... increments up to 300 ft in length."	Testing by the Alpha Group has shown that the instrument functions properly with cable lengths up to 300 ft.
ITSS-02.01-22 Section IV, Part F, 4th bullet states: • Immediately following probe replacement. Change the statement to read: Immediately following probe or cable replacement.	

External (Technical) Review:

(10) Reviewing Organization	(11) Signature or Name of Reviewer	(12) Date	(10) Reviewing Organization	(11) Signature or Name of Reviewer	(12) Date
Subject-Matter Expert	/s/ Gordon Madison	9/7/04			

(13) **Special Reviews:** *(NOTE: Other Special Reviews may be required, See PRO-815-DM-01 for more information.)*

ISR (Number or "Not Required"): N/A

Reviewed for Classification (N/A)
(If Required, "N/A" if not)
By: DANIEL L. MAYFIELD
Date: 09 SEPTEMBER 2004

(14) **Approval** *(Completed to approve new documents and changes. On the cover page, enter the approver's name, "/s/", and the approval date.)*

Approval Authority: R. J. Sexton 9/9/04 **Effective Date:** 9/9/04
Print Name Sign Date

09/03

ADMIN RECORD

DCF (continuation sheet)

DCF#: _____

(4) Document Title	Existing Document Number and Version
Ludlum High Range Alpha Ion Chamber, Model 195	ITSS-02.01-22, Revision 0

(9) Proposed Modification	(10) Justification
ITSS-02.01-22 Section IV, Part I states: Battery change and probe change is allowed. Change the statement to read: Battery change, probe change, and cable length change is allowed. Note: See Part J for changing cable length.	Testing by the Alpha Group has shown that the instrument functions properly with cable lengths up to 300 ft.
ITSS-02.01-22 Section IV, Part J states: • Cables that connect the Model 195 and the Model 43-132 Ion Chamber probe can be assembled in any length or combination of lengths up to 20 feet. • Longer cables [sic] lengths can be used if a special calibration is obtained. Change the statement to read: • Cables that connect the Model 195 and the Model 43-132 Ion Chamber probe can be assembled in any length or combination of lengths up to 300 feet. The NUL knob must be adjusted until the displayed reading on the LO Range readout is 0.00 (the probe must be uncontaminated).	

DOCUMENT CHANGE FORM (DCF)

DCF #: 02.01-1

① DCF Originator: D. J. Davidson (Print) [signature] (Sign) 1/29/03 (Date)

Organization: Radiological Programs

Phone/Pager/Location: 5772/212-5884/MV72

② (Authorizes processing of request.)
Responsible Manager: R. R. Weedon (Print) [signature] (Sign) 1/24/03 (Date)

Organization: Radiological Programs (SE&QP)

Phone/Pager/Location: 6813/212-3827/MV72

③ Assigned SME: Bob Morris (Print Name) Gordon Madison for 1/30/03

Organization: 707/776 Project

Phone/Pager/Location: 6468

④ Radiological Instrumentation
Document Title

3-PRO-112-RSP-02.01
Existing Document Number and Revision

New Document Number and Revision (if Applicable)

⑤ Type of Document

- ☐ Policy
- ☐ Mgt Directive
- ☐ Manual
- ☒ Procedure (indicate type)
  - ☐ Technical
  - ☐ Alarm
  - ☒ Administrative
  - ☐ Other
- ☐ Instruction
- ☐ Job Aid
- ☐ Other

If "Other" is checked, please specify type:

⑥ Type of Modification

- ☐ New
  - ☐ One Time Use Only
- ☐ Revision
- ☐ Change
  - ☒ Minor
  - ☒ Major
- ☐ Cancellation

[illegible] 2/5/03

⑧ Proposed Modification	⑨ Justification
Page 4, paragraph 3, delete purpose of operator aids statement.	Operator aids no longer exist in this procedure.
	Reviewing Organization Changes
	Review organizations updated to reflect current org structure.

External (Technical) Review:

⑩ Reviewing Organization	⑪ Signature or Name of Reviewer	⑫ Date	⑩ Reviewing Organization	⑪ Signature or Name of Reviewer	⑫ Date
Subject-Matter Expert	Robert Morris /S/ Gordon Madison	1/30/03	771 Closure Proj.	Calvin Morgan /S/	1/29/03
RISS Project	Phyllis Thomas /S/	1/30/03	707/776 Closure Proj.	Harry Smith /S/	1/29/03
Material Stewardship	Bev Grant /S/	1/29/03	SEQP	Becky Middleton /S/	1/28/03
371/374 Closure Prj.	Calvin Morgan /S/	1/29/03			

⑬ Special Reviews: (NOTE: Other Special Reviews may be required. See PRO-815-DM-01 for more information.)

ISR (Number or "Not Required"): Not Required

TI Alignment (signature or N/A): [signature] for Becky Middleton (Sign) 1/30/03 (Date)

Reviewed for Classification
(If Required, "N/A" if not)
By: ERIC SWANSON
Date: 1/30/03 (4/NRL)

⑭ Approval (Completed to approve changes and cancellations only. New documents and revisions are approved by signature on the document cover page.)

Approval Authority: R. Sexton (Print Name) [signature] (Sign) Effective Date: 1/30/03

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DOCUMENT CHANGE FORM (DCF)

(7) DCF #: 99-RMRS-DCF-027

(1) DCF Originator: W. E. Dick (Print) W E Dick (Sign) 7/6/99 (Date)

Organization: RMRS Rad Eng Sup Services

Phone/Pager/Location: 8407/2124407/T130B

(2) Responsible Manager: H. B. Estabrooks (Print) (Sign) 7/7/99 (Date)

Organization: Rad Eng Sup Services RMRS

Phone/Pager/Location: 3769/2126469/T130B

(3) Assigned SME: Elliott D. Lesses (Print) (Sign) 7/6/99 (Date)

Phone/Pager/Location: 5726/2123231/T130B

(8) Prescreen/SES/USQD Number: n/a

Independent Safety Review: n/a

(4) Radiological Instrumentation
Document Title

3-PRO-112-RSP-02.01, Revision 1
Existing Document Number and Revision

N/A
New Document Number and Revision (if Applicable)

(5) Type of Document

- ☐ Policy
- ☐ Directive
- ☐ Manual
- ☐ Technical Standard
- ■ Procedure
- ☐ Instruction
- ☐ Job Aid
- ☐ Other

(6) Type of Modification

- ☐ New
  - ○ One Time Use Only
- ☐ Revision
- ☐ Cancellation
- ■ Change
  - ○ Editorial
  - ○ Intent
  - ● Non-Intent

(9) Effective Date: 7/22/99 ~~7/19/99~~ wed per HBE 7/20/99 Expiration Date: N/A

(10) Item	(11) Page	(12) Step	(13) Proposed Modification
1	2	LOEP	Modify list of effective pages (LOEP) to match attached affected pages.
2	6	4.[2]	Add the following text to include the equation and representation of symbols used in the equation. *The time that a survey should stop and wait until the probability of getting another count is at least 90% is calculated as follows: t = 13,800 / CAE ; Where t = time period for static count(s); C = release criteria (dpm/100 cm²); A= physical probe area (cm²); and E = detector efficiency (4π).
3	4	Header	Change effective date to 8/24/98.
4	6-7	All	Make format consistent on both pages
5	7	6.	Change 3-I27-RP-2001 and the word "Control" in the title to 3-PRO-212-RSP-18.01 and "Safety".

(10) Item	(14) Justification
1) per Site Document Requirements Manual (SRDM)	
2) The change is necessary for determining a length of a static count once you detect by alpha scan and is based on MARSSIM technique.	
3) Editorial correction.	
4) Editorial correction.	
5) Updated to reflect current nomenclature (title and designation).	

(15) Reviewing Organization	(16) Name of Reviewer	(17) Date	(15) Reviewing Organization	(16) Name of Reviewer	(17) Date
RMRS RE	[illegible]	7/6/99			
RMRS RO	/S/ G. Carosso	7/9/99			
~~SSOC RS~~	per email dated 7/22/99 wel				
KH-RP	/S/ W. C. Zurlisle	7/21/99			

(18) Approval Authority: T. L. Vaughn (Print) (Sign) 7/22/99 (Date)

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LIST OF EFFECTIVE PAGES

Pages	Effective Date	Pages	Effective Date
1	08/24/98		
2	02/7/03		
3	08/24/98		
4	02/07/03		
5	08/24/98		
6-7	07/22/99		

Total Number pages 7 AB 2-5-03

The following DCFs are active for this procedure:

99-RMRS-DCF-277

DCF-02.01-1

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1. PURPOSE

This procedure contains the requirements of Title 10 Code of Federal Regulations Part 835 (10 CFR 835) and the Rocky Flats Environmental Technology Site Radiological Control Manual (Site RCM) regarding the use of radiological instrumentation.

The Instrument Technical Specification Sheets are based on information compiled from instrument manufacturer technical data, Site RCM, technical basis documents, and/or test data.

DCF-02.01-1

RESPONSIBILITIES

2.1 Instrument User

Trained and qualified to operate radiological instrumentation in accordance with Site RCM Article 551.2.

Performs monitoring with appropriate radiological instrumentation.

Completes proper survey forms.

3. INSTRUCTIONS

Instrument User

[1] Ensure that the instrument being used meets the following:

- Appropriate for the types, levels, and energies of the radiations encountered and the existing environmental conditions.
- Within calibration.
- Meets the performance test and operational check requirements in accordance with the Site RCM Article 562.9 and as stated on the Instrument Technical Specification Sheets.

[2] Return instrument to the Instrument Repair and Calibration Facility if any of the following conditions exist:

- Instrument is due for calibration.
- Instrument is physically damaged.
- Instrument fails performance test or operational check.
- Instrument is malfunctioning or responding abnormally.
- Instrument requires maintenance beyond what is specified on the Instrument Technical Specification Sheet.

[3] Report to the Instrument Repair and Calibration Facility, any change in an instruments status, **in writing**, such as:

- Instrument is disposed of, declared surplus or declared excess.
- Instrument is lost or destroyed.

4. MINIMUM DETECTABLE ACTIVITY AND DECISION LEVELS

Instrument User

[1] For contamination detection instruments, in a stationary mode (e.g. Eberline BC-4, SAC-4, NE Electra, etc.) use the following equation to determine the minimum detectable concentration:

$$MDC = \frac{2.71 + 3.29\sqrt{R_b \cdot t_g\left[1 + \left(\frac{t_g}{t_b}\right)\right]}}{eff \cdot t_g \cdot K}$$

Where: MDC - minimum detectable concentration
R_b - background count rate (cpm)
t_g - gross count time (minutes)
t_b - background count time (minutes)
eff - efficiency (counts/disintegration)
K - correction and conversion factors

[2] For contamination detection instruments, in a scanning mode (e.g. NE Electra, etc.) use the following equation to determine the minimum detectable concentration:

For Alpha Activity, using an instrument with a near-zero (BKG < 3 cpm) background count rate, the probability of observing a single count is determined by:

$$P(n \geq 1) = 1 - e^{-\frac{GEd}{60V}}$$

Where: $P(n \geq 1)$ = probability of observing a single count
G = contamination activity, release limit (dpm)
E = detector efficiency (4π)
d = width of detector in direction of scan (cm)
V = velocity, scanning speed (cm/s)

When a count is detected, then stationary measurements are performed, and the MDC in [1] above applies. The time that a survey should stop and wait until the probability of getting another count is at least 90% is calculated as follows:

$$t = \frac{13{,}800}{CAE}$$

Where: t = time period for static count (s)
C = release criteria (dpm/100 cm^2)
A = physical probe area (cm^2)
E = detector efficiency (4π)

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For Beta Activity: Beta Scan MDC $= \dfrac{\text{MDCR}}{\sqrt{E_{hf}} \cdot E \cdot \left(\dfrac{A}{100}\right) \cdot C}$

Where: MDCR = minimum detectable count rate (cpm)
E_{hf} = human factors efficiency (default value = 0.65)
E = efficiency
A = probe area
C = other conversion factors

The MDCR (cpm) is defined as: MDCR $= d' \cdot \sqrt{b_i} \cdot \left(\dfrac{60}{i}\right)$

Where: d' = detectability value, assumed to be 2.65 for a correct detection rate of 90% and a false positive probability of 10%
b_i = background count in counting interval *i*
i = count interval where the probe is near the source

[3] For dose rate instruments (e.g. Eberline RO-20, Victoreen 450B, Eberline ESP-1, etc.) the Minimum Detectable Dose Rate (MDDR) is defined as 20% of the top end of lowest calibrated scale.

5. DISPOSITION OF RECORDS

Maintain and disposition records in accordance with established requirements, procedures, and policies.

6. REFERENCES

Title 10 Code of Federal Regulations Part 835, Occupational Radiation Protection
Rocky Flats Environmental Technology Site Radiological Control Manual
1-V41-RM-001, Records Management Guidance for Records Sources
3-PRO-212-RSP-18.01, Guidance for Management of Records in Radiological Safety
Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), 12/97

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LAST PAGE

PORTABLE CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG

RSFORMS-02.01-02

INST. TYPE/SERIAL #: ____________ CAL. DUE DATE: ____________ INSTRUMENT EFFICIENCY: ____________ BLDG. ____________

This form is used to record parameters noted during daily performance checks. Instruments that require additional repair or service are returned to Instrumentation Repair Facility.

TIME/DATE	RCT NAME EMP #	BATT STAT Yes No	COUNT TYPE Alpha Beta	BKG (cpm)	INSTRUMENT READING (Net cpm) X1 Range	X10 Range	X100 Range	X1K Range	PROBE S/N	% ERROR ≤ 20% IN TOL (Initials)	RCT SIGNATURE

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* Guidance for use of this form is located on the back of the form

Note: The width of the columns and the number of rows can be adjusted provided all of the information requested on the form is retained.

PORTABLE CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG

RSFORMS-02.01-02

SOURCE BOARD CERTIFICATION DUE DATE (Alpha/Beta): _____ SOURCE ISOTOPE (Alpha/Beta): _____

ALPHA SOURCE/ SOURCE BOARD

	S/N	Source (dpm)	Range (cpm) ± 20%
X1/CLS			
X10/CLS			
X100/CLS			
X1K/CLS			

BETA SOURCE/SOURCE BOARD

	S/N	Source (dpm)	Range (cpm) ± 20%
X1/CLS			
X10/CLS			
X100/CLS			
X1K/CLS			

Approved by:
RS Supervision:

Name (print)	Signature	Employee #	Date

$$\%Error = \frac{(Net\ cpm + eff) - Source\ dpm}{Source\ dpm} \times (100)$$

Where (Net cpm = Source cpm - Background cpm)

GUIDANCE:

- The appropriate instrument data and building location is recorded on RSFORMS-02.01-02.
- Obtain an appropriate certified source or source block for the instrument being tested.
- A general inspection is performed on the instrument for the following:
  - Physical condition of the detector, cables, and instrument
  - Instrument battery/power supply check is satisfactory
  - Instrument audio check is satisfactory, as applicable
  - Instrument light leak check is satisfactory, as applicable
  - Instrument background response check is within tolerances of expected values
  - Instrument corrected source count reading (15 second average reading) falls within an acceptable range (± 20% of source value)
- Performance test data is recorded (as applicable) to each portable contamination survey instrument with signature upon completion
- For Ludlum 12-1A use the following guidelines when setting the selector switch.
  - For X1000, press HV Test button, ensure reading is between 1.7 and 1.9 on the bottom scale (or as specified on the calibration tag).
  - For X1000 and Fast Response mode, place detector on highest value source on source board.
  - For X100 and Fast Response mode, place detector on 2nd highest value source on source board.
  - For X10 and Slow Response mode, place detector on 3rd highest value source on source board. (X10 & X10 scales are averaged over 30 seconds)
  - For X1 and Slow Response mode, place detector on lowest value source on source board.
- For Ludlum Model 31 use the following guidelines:
  - Ensure background is < 100 cpm with the range selector switch set to X1 and Fast/Slow Response Mode set to "S" for slow. Record background on RSFORMS-02.01-02.
  - High Voltage (HV) test with instrument on the X1000 scale (Acceptable is between 1.7 and 1.9 on the bottom scales, or as specified on the calibration tag).
  - Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired
  - Select X1000 on instrument and Fast response. Source check on highest value source.
  - Select X100 on instrument and Fast response. Source check on next lower value source
  - Select X10 on instrument and Slow response. Source check on next lower value source.
  - Select X1 on instrument and Slow response. Source check on the lowest value source
  - Verify instrument readings on all scales are ±20% of source standard values.

 * Guidance for use of this form is located on the back of the form

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

SWIPE COUNTER PERFORMANCE LOG

INSTRUMENT MODEL: (Circle One) ALPHA ☐ BETA ☐
SAC-4 / BC-4 / LUDLUM 2929 Counter Serial No._____ Calibration Due Date: _____
Start Date:_____ End Date:_____ Building :_____ Location:_____
Source: S/N _____ D. P. M.: _____ Certification Due Date: _____

Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
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Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. Cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)
Date/Shift:_____ Gross Source cpm:_____ Time:_____ Bkg. cpm:_____ RCT Emp. #_____ Net Source cpm:_____ %Error:_____ (Print Name / Signature)	$\% \text{ ERROR} = \frac{(\text{Net cpm/E})-\text{Source dpm}}{\text{Source dpm}} \times 100$ Net cpm = gross – background cpm

Approved by :_____ / _____ / _____ / _____
RS Supervision **Print Name** **Signature** **Emp. #** **Date**

Note: The number of performance test blocks may be adjusted provided all information within the blocks remains unchanged.

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Rev. 08/04

SWIPE COUNTER PERFORMANCE LOG

GUIDANCE:

- The appropriate instrument / source data, shift / date, and building location is recorded on RSFORMS-02.01-03.

- A background (Bkg) determination is performed as defined below:
  - * SAC-4, BC-4, Ludlum 2929: Perform a ten minute count to determine background
    1) SAC-4 and Ludlum 2929 alpha background must be less than 0.63 cpm for SAC-4 and .8 cpm for Ludlum 2929 (if not, perform a second background count. If background is still 0.63 cpm or greater for SAC-4 and .8 cpm for Ludlum 2929, tag instrument out-of-service and notify RCT Supervision).
    2) BC-4 beta background must be less than 94.9 cpm (if not, perform a second background count. If background is still 94.9 cpm or greater, tag instrument out-of-service and notify RCT Supervision).
    3) Ludlum 2929 beta background must be between 50 cpm and 195 cpm (if not, perform a second background count. If background is still not between 50 cpm and 195 cpm, tag instrument out-of-service and notify RCT Supervision).

- The background cpm is recorded on RSFORMS-02.01-03 in the appropriate space.

- Perform and record source count results in cpm on RSFORMS-02.01-03:
  - * SAC-4, BC-4, Ludlum 2929: Perform a one minute source count.
    1) SAC-4 requires the use of a National Institute of Standards and Technology (NIST) Pu-239 source.
    2) BC-4 requires the use of a NIST certified Sr/Y-90 source.
    3) Ludlum 2929 requires the use of a NIST certified Th-230 or Pu-239 source with a value greater than 1500 dpm.
    4) Ludlum 2929 beta count requires the use of a NIST certified Sr/Y-90 source.

- The percent error (%Error) is determined for the SAC-4, and Ludlum 2929 (alpha and beta) and record on RSFORMS-02.01.03 (%Error formula is located on RSFORMS-02.01.03)

- The % Error is verified within ± 20% for the SAC-4, BC-4 and Ludlum 2929 (alpha and beta).
  - * If the %Error falls outside the ± 20% range, notify the RCT Supervisor and tag the instrument out-of-service.

- Fill out Shift, Time, Employee Number, Print Name, and Sign RSFORMS-02.01.03.

- Ensure a separate form is used for each instrument and type of count performed (i.e. Alpha or Beta).

NOTE: The efficiencies for the SAC-4, Ludlum 2929 and BC-4 are as follows:

- SAC-4 and Ludlum 2929 alpha efficiency is 33%
- BC-4 performance test efficiency using a Sr/Y-90 source is 25% and swipe efficiency for DU is 14%.
- Ludlum 2929 performance test and swipe efficiency is 25%.

PORTABLE SCALER CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG

RSFORMS-02.01-04

Alpha Beta

INST. TYPE/SERIAL #: _____ CAL. DUE DATE: _____ INSTRUMENT EFFICIENCY: _____ : _____

PROBE S/N: _____ BLDG _____

This form is used to record parameters noted during daily performance checks on NE Electra, Bicron Frisk-Tech, Portable instruments with gas proportional detector. Instruments that require additional repair or service are returned to Instrumentation Repair Facility.

TIME/ DATE	RCT NAME/EMP #	IN CAL Yes No	BATT SAT Yes No	COUNT TYPE	BKG (cpm)	INSTRUMENT READING (Net cpm)	FLUSH/RE-CHARGE (N/A if not gas prop. det.) (Initials)	% ERROR ±20% IN TOL (Initials)	RCT SIGNATURE
				Alpha					
				Beta					
				Alpha					
				Beta					
				Alpha					
				Beta					
				Alpha					
				Beta					
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Rev 04/01

* Guidance for use of this form is located on the back of the form

PADC-2000-03527

PORTABLE SCALER CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG RSFORMS-02.01-04

SOURCE ISOTOPE (Alpha): _____ (CSL)(S/N)(Registry No.): _____ Certification/Decay Chart Date: _____
(Circle One) (Circle One)

Source (dpm): _____ Range (cpm) ± 20%: _____

SOURCE ISOTOPE (Beta): _____ (CSL)(S/N)(Registry No.) _____ Certification/Decay Chart Date: _____
(Circle One)

Source (cpm): _____ Range (cpm) ± 20%: _____

Approved by: RS Supervision			
Name (print)	Signature	Employee #	Date

$$\%\,Error = \frac{(Net\ cpm + eff) - Source\ dpm}{Source\ dpm} \times (100)$$

Where Net cpm = Source cpm - Background cpm

GUIDANCE

- The appropriate instrument data and building location is recorded on RSFORMS-02.01-04.
- Obtain an appropriate certified source or decay chart source for the instrument being tested.
- A general inspection is performed on the instrument for the following:
  - Physical condition of the detector, cases, and instrument
  - Instrument battery/power supply check is satisfactory
  - Instrument audio check is satisfactory, as applicable
  - Instrument light leak check is satisfactory, as applicable
  - Instrument background response check is within tolerances of expected values (typically 1 minute count)
  - Instrument corrected source count reading falls within an acceptable range (± 20% of source value typically using a 1 minute count)
- Performance test data is recorded (as applicable) to each portable contamination survey instrument with signature upon completion.

Reviewed For Classification/UCNI
By: [illegible]
Date: 20 MAR 01 (Mark)

EBERLINE BC-4
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

A one-piece Beta detecting unit containing a Geiger-Mueller (GM) detector (shielded on the top and sides by a minimum of 7/8-inch thick lead), Corona tube regulated at 900 V, and direct coupled amplifier with approximately 400 mV input sensitivity.

B. Features

One piece unit, six decade light emitting diode (LED) readouts.
Slide out sample holder.
Preset count times (1, 2, and 5 minutes) with multipliers of X.1, X1, and X10.

C. Scaler/Meter/Detector Configurations

The BC-4 is a complete system consisting of a two-inch GM detector, high voltage power supply, pulse amplifier, timer, and six decade LED readouts.

II. Instrument Specifications

A. MDA

The MDA is 346 dpm, based on a background of 94.9 cpm and an efficiency of 14%.

B. Types of Radiation Measured

Beta

C. Ranges

The scaling range is between 0 and 999,999.

D. Energies

16 keV to 3.27 MeV.

E. Efficiencies

Overall Efficiency is 14% ± 1%. Use 14% for the swipe counter performance log.

F. Types of Batteries and Life

Operates on 115 or 230 ± 10% V AC switch selectable.

G. Sensitivity

Low level sensitivity is 400 mV.

H. Audio

This instrument has no audible outputs.

I. Linearity

The scaling range is between 0 and 999,999.

J. Modes of Operation

Manual continuous count mode, or Timed count mode with various multiplication factors.

K. Voltage Range

High voltage operating point is 900 VDC.

L. Alarm Range

No alarm capabilities.

REVIEWED FOR CLASSIFICATION/UCNI
By Daniel L. Mayfield
Date 07 July 2004

M. Calibration Stability

Reproducibility Check: ± 20% and a Time Base Test (Input 1200 cpm)

X.1 minute:	Tolerance = 118 to 120 counts
X.2 minute:	Tolerance = 238 to 242 counts
X.5 minute:	Tolerance = 594 to 606 counts
X1 minute:	Tolerance = 1188 to 1212 counts
X10 minutes:	Tolerance = 11880 to 12120 counts

N. Response Times

Not applicable.

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair.

III. Limiting Conditions of Operation

A. Temperature

0°C to 60°C (32°F to 140°F).

B. Barometric Pressure/Altitude

No observed effects.

C. Humidity

No observed effects.

D. Chemical Interference

No observed effects.

E. Radio Interference

No observed effects.

IV. General Operations

A. Switch Configuration/Function

Count Mode:	Manual (continuous), Stop, and Timed (from .1 to 50 minutes).
Start/Reset Button:	Resets the scaler output to zero and begins a new count.
Timer Multiplier Switch:	Multiplies the minutes selected for counting by 0.1, 1.0, or 10.
Minutes Switch:	Selects a count time of one, two, or five minutes.
Power Switch:	Switch to supply power to the instrument (Rear Panel).

B. Background Counting

A 10 minute background count is performed each shift. Ensure instrument control switches are set as follows: "ON", Multiplier "X10" (for background determination), Count Mode "TIMED", Minutes "1".

C. Scan Rates

Not applicable for this instrument.

D. Scan Distance

Not applicable for this instrument.

E. Performance Test Requirements

Required to be performed prior to first use of the instrument on each shift.

F. Operational Test Requirements

Ensure that a background determination and performance test has been performed on the current shift. If background after a 10 minute count is ≥ 94.9 cpm, the instrument shall be submitted for repair (after planchet has been cleaned).
Ensure instrument control switches are set as follows: Power "ON", Multiplier "X1" (for counting), Count Mode "TIMED", Minutes "1".

G. Good Practices

Ensure that the planchet is decontaminated prior to use, to ensure a low background.
Ensure there are no smears remaining in the detector (stuck on the detector window) prior to use.
When using tweezers to handle samples, care must be exercised to avoid scratching the swipe counter sample holder.

H. Maintenance Allowed by User

Cleaning of sample holder planchets.

EBERLINE SAC-4
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

Scintillation phosphor on a plastic light pipe with photomultiplier tube, in conjunction with high voltage power supply, charge-sensitive input amplifier, timer, and six decade light emitting diode (LED) readout. This instrument is used for alpha detection.

B. Features

One piece unit, six decade LED readouts.
Preset count times (1, 2, and 5 minutes) with multipliers of X.1, X1, and X10.

C. Scaler/Meter/Detector Configurations

The SAC-4 is a complete system consisting of a two inch scintillation detector, high voltage power supply, charge-sensitive input amplifier, timer, and six decade LED readouts.

II. Instrument Specifications

A. Minimum Detectable Concentration (MDC)

Based on a maximum background of 0.63 cpm and an efficiency of 32%, (lower limit of acceptable efficiency), the MDC for the SAC-4 is 20 dpm.

B. Types of Radiation Measured

Alpha

C. Ranges

Six decade readout in cpm. The scaling range is between 0 and 999,999.

D. Energies

3.83 MeV to 8.78 MeV.

E. Efficiencies

Efficiency is 33%.

F. Types of Batteries and Life

Operates on 115 or 230 ± 10% Volts AC switch selectable.

G. Sensitivity

Discrimination is internally biased at 1.25 V.

H. Audio

This instrument has no audible outputs.

I. Linearity

The scaling range is between 0 and 999,999.

J. Modes of Operation

Manual continuous count mode, or Timed count mode with various multiplication factors.

K. Voltage Range

Regulated variable by a rear panel control to approximately 1500 V.

L. Alarm Range

No alarm capabilities.

M. Calibration Stability

The mean instrument response at constant temperature and pressure is assumed not to vary by more than 6% from the mean of a set of reference readings over a period of 24 hours for AC-powered units after a warm-up period of not less than 10 minutes.

PADC-98-00384

N. Response Times

Not applicable.

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair.

III. Limiting Conditions of Operation

A. Temperature

0°C to 60°C (32°F to 140°F).

B. Barometric Pressure/Altitude

Not measured.

C. Humidity

Not measured.

D. Chemical Interference

Not measured.

E. Radio Interference

Not measured.

IV. General Operations

A. Switch Configuration/Function

Count Mode:	Manual (continuous), Stop, and Timed (from 0.1 to 50 minutes).
Start/Reset Button:	Resets the scaler output to zero and begins a new count.
Timer Multiplier Switch:	Multiplies the minutes selected for counting by X.1, X1, and X10.
Minutes Switch:	Selects a count time of one, two, or five minutes.
Power Switch:	Switch to supply power to the instrument (rear panel).

B. Background Counting

A 10 minute background count is performed each shift. Ensure instrument control switches are set as follows: Power "ON". Multiplier "X10" (for background determination), Count Mode "TIMED", Minutes "1".

C. Scan Rates

Not applicable.

D. Scan Distance

Not applicable.

E. Performance Test Requirements

Required to be performed prior to first use of the instrument on each shift. If background count is ≥ 0.63 cpm, the instrument shall be submitted for repair (after attempting to decontaminate the planchet and sample holder).

F. Operational Test Requirements

Ensure that a background determination and performance test has been performed on the current shift. Ensure instrument control switches are set as follows: Power "ON", Multiplier "X1" (for counting), Count Mode "TIMED", Minutes "1".

G. Good Practices

Pre-screen samples prior to counting.
Ensure that the planchet is decontaminated prior to use, to ensure a low background.
Ensure there are no swipes (smears) remaining in the detector (stuck on the detector window) prior to use.
When using tweezers to handle samples, care must be exercised to avoid scratching the swipe (smear) counter sample holder.

H. Maintenance Allowed by User

Radiological Control Technicians are allowed to perform a decontamination on the instrument planchet sample holder.

EBERLINE RO-20
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

Portable air ion chamber instrument used to detect beta, gamma, and x-ray radiation. It measures 4.2" wide, 7.9" long, 7.7" high (including handle), and weighs 3.6 lb. (including batteries). The instrument casing and sliding "beta" window are 1000 mg/cm^2.

B. Features

- Measures gamma or x-ray exposure rate.
- Temperature compensated measurements.
- Large backlit display.
- Long battery life.
- Non-mechanical ranging switch.

C. Scaler/Meter/Detector Configurations

One piece meter and air vented ion chamber contained in a metal casing.

II. Instrument Specifications

A. MDDR

1 milliroentgen per hour, 1 mR/hr (based on site guidance, using 20% of the top end of the lowest calibrated scale of 0-5 mR/hr).

B. Types of Radiation Measured

Beta, gamma, and x-ray.

C. Ranges

5 linear ranges: 0-5, 0-50, 0-500 mR/hr and 0-5, 0-50 R/hr.

D. Energies

0.57 keV to 2.73 MeV photons.

E. Efficiencies

Photon Energy Response:	± 30% from 8 keV to 1.3 MeV with the open slide facing the source. ± 15% from 33 keV to 1.3 MeV with the closed slide facing the source. ± 15% from 55 keV to 1.3 MeV through the side of the instrument.
Beta Response:	Uranium slab: 30% of true mrad/hr field behind 7 mg/cm^2 window with RO-20 resting on slab, slide open. A correction factor of 4 is applied to the net reading (open window reading minus closed window reading) when measuring depleted uranium. Sr/Y-90: Approximately 93% of true mrad/hr field at 30 cm with slide open.

F. Types of Batteries and Life

Main power: Five "C" cells.

Chamber bias: Ten, 3 V lithium coin cells, 30 V

- Typical ZnC: mR/hr ranges, 2900 hours. All other ranges, 150 hours.
- Typical Alkaline: mR/hr ranges, 6900 hours. All other positions, 350 hours.

G. Sensitivity

- If the instrument is over ranged by exposure to gamma radiation, it will indicate off scale and shall remain so until the radiation field is reduced to below full scale (When the radiation field is removed, the instrument reading shall return to the expected value within 2 minutes).
- Showed no response to alpha activity.
- Manufacturer's specifications state a response of up to 8% for fast neutron fields.

H. Audio

No audible response for this instrument.

PADC-98-00385

I. Linearity

Within ± 5 percent of full scale.

J. Modes of Operation

Gamma/x-ray radiation detection.
Beta radiation detection (for depleted uranium a correction factor of 4 is applied to the net reading).

K. Voltage Range

The ion chamber structure is maintained at chassis potential (ground), the center electrode is maintained at -30 V by the 30 V bias battery.

L. Alarm Range

No alarm capabilities.

M. Calibration Stability

Performance Test (As found): ± 20% on 0-50 mR/hr range, with known source.
Reproducibility Test (As found): ± 10% on 0-50 mR/hr range, with known source.

N. Response Times

5 seconds, 10 to 90 percent of final reading for each scale.

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair.
± 10% Reproducibility, Linear Range Adjustment, and Linear Range Check.

III. Limiting Conditions of Operation

A. Temperature

Operable from -40°F to 140°F (-40°C to 60°C). For operation below 0°F (18°C), alkaline or nickel cadmium "C" cells should be used.

B. Barometric Pressure/Altitude

The instrument is sensitive to changes in atmospheric pressure. The Technical Basis Document gives correction factors to be used if the RO-20 is used at an elevation other than that when calibrated. Normal atmospheric pressure variations on plantsite have minimal effect.

C. Humidity

Usable at 0-95 percent relative humidity.

D. Chemical Interference

None

E. Radio Interference

When operated on the 0 - 5 mR/hr range, susceptibilities were indicated at various frequencies.

IV. General Operations

A. Switch Configuration/Function

Rotary switch for Off, Battery 1 check, Battery 2 check, Zero, 5, 50, 500, mR/hr; 5-50 R/hr, light switch, and zero adjust knob.

B. Scan Rates

Limited by 5 second response times referenced in II.N.

C. Scan Distance

Contact or general area readings may be taken.

EBERLINE RO-20
INSTRUMENT TECHNICAL SPECIFICATION SHEET

D. Performance Test Requirements

Daily performance test to include: Check *Battery 1* ("C" cells) and *Battery 2* (lithium cells). Do not leave the switch in the *Battery 2* position for more than 5 seconds.
Check *Zero* adjust position.
Check for proper operation of meter light.
Check for proper meter response against a known source.

E. Operational Test Requirements

Performed daily by Health Physics Instrumentation.

F. Good Practices

- Ensure proper response time is allowed.
- When down ranging the instrument from 0-5 or 0-50 R/hr, stop at the 0-500 mR/hr range and allow the meter indication to stabilize before down ranging further (This minimizes the meter spike due to electronic noise).
- Ensure that the sliding window is closed (for gamma measurements)
- Enter area on range selection greater than anticipated, then downscale as appropriate.

G. Maintenance Allowed by User

User is not allowed to perform <u>any</u> maintenance on the instrument (NO battery changing allowed).

LUDLUM MODEL 12-1A WITH AIR PROPORTIONAL PROBE
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

A lightweight, portable, battery operated, handheld instrument, with an air proportional probe for alpha detection. For surface-contaminated-objects (SCO) measurements, a specially modified Ludlum 12-1A with an attached attenuator plate to the face of the air proportional probe and a ten foot cable is used. The attenuator plate is 0.038 inches thick with an 8-segment dual row hole pattern.

B. Features

Portable instrument capable of interfacing with several types of radiation detectors (air proportional used at RFETS).
Linear analog scale indicating values from 0-1000 cpm when used without an attenuator plate (i.e., standard mylar screen).
For SCO measurements, a linear analog scale from 0-500 cpm when used with attenuator plate.
Operates with four ranges: X1, X10, X100, and X1K.
Fast and slow response modes of operation.
Connector for interfacing with a pair of headphones for audible indication of response.

C. Scaler/Meter/Detector Configurations

Ludlum Model 12-1A count ratemeter configured with 0-1000 cpm full scale meter with non attenuated air proportional probe or 12-1A configured with 0-500 cpm full scale meter with an attenuated plate to the face of the air proportional probe.

II. Instrument Specifications

A. MDA

Not applicable to rate meters; however, assuming smallest observable deflection of meter needle is 30 cpm, a justifiable level of detection while stationary would be approximately 500 dpm/100 cm^2 for fast response and 200 dpm/100 cm^2 for slow response.

B. Maximum Operating Range

For SCO measurements, the maximum operating range is 0-250,000 cpm for a metal screen (attenuator plate).

C. Types of Radiation Measured

Alpha surface contamination.

D. Ranges

0-1000, 10,000, 100,000, and 1,000,000 cpm for standard mylar screen probe.

0-500, 5,000, 50,000, and 500,000* cpm for a metal screen probe used in SCO measurements.

*Note (250K is the upper limit allowed)

E. Energies

3.83 MeV to 8.78 MeV.

F. Efficiencies

7% for the air proportional probe, electronically adjusted to 50% (Correction Factor = 2) with standard mylar screen.

For SCO measurements using a metal screen (attenuator), efficiency is typically less than 0.1%.

G. Types of Batteries and Life

Two standard "D" cells.
Minimum continuous operation of 100 hours, the response of the instrument does not vary more than 10% during this time.

H. Sensitivity

Adjustable from 2 to 60 mV.

II. Instrument Specifications (continued)

I. Audio

The instrument has a connector for interfacing with a pair of headphones or ear plugs for audible indication of response.

J. Linearity

± 10% of the equivalent source value and ranges from 0 to 1,000,000 counts per minute (cpm) for standard mylar screen.

± 10% of the source value and ranges from 0 to 250,000 counts per minute (cpm) for SCO measurements using attenuator plate (metal screen).

K. Modes of Operation

"Fast" and "Slow" response modes.
Functions with an alpha air proportional probe.

L. Voltage Range

Variable from 200 - 2500 V.

M. Alarm Range

No alarm capabilities.

N. Calibration Stability

Less than 5% variance to battery endpoint.

O. Response Times

Fast response time of 4 ± 1 seconds for 90% of final meter reading in the Fast Response Mode.
Slow response time of 22 ± 4 seconds for 90% of final meter reading in the Slow Response Mode.

P. Calibration Limitations

Ludlum Model 12-1A configured with an air proportional probe must be calibrated in a temperature controlled environment at annual intervals. For SCO measurements, the modified Ludlum Model 12-1A configured with an attenuated metal screen over the face of the air proportional probe must be calibrated in a temperature controlled environment at six month intervals.

III. Limiting Conditions of Operation

A. Temperature

This instrument should not be used below 64°F (18°C), it can be used up to 122°F (50°C). Air proportional probe is very sensitive to temperature changes and is mainly used indoors. Use of the Model 12-1A with an air proportional probe is allowed outside this operating range if the specific instrument is stored for at least one hour at the temperature at which it will be used and if the instrument passes a pre- and post use performance test at that temperature.

B. Barometric Pressure/Altitude

This instrument over responds when subjected to ambient pressures above normal and under responds when subjected to ambient pressures below normal. Do not operate this instrument in areas other than normal atmospheric pressure.

C. Humidity

Instrument's response shall not vary by ± 15% over the relative humidity (RH) range of 40% to 95% at 71°F (22°C) when compared to the reference response at 40% RH and 71°F (22°C).

D. Chemical Interference

Carbontetrachloride (CCl_4) fumes will cause the air proportional probe to not respond.

E. Radio Interference

Instrument is susceptible to radio frequency interference and should not be operated within six feet of two-way radios that are in use.

LUDLUM MODEL 12-1A WITH AIR PROPORTIONAL PROBE
INSTRUMENT TECHNICAL SPECIFICATION SHEET

IV. General Operations

A. Switch Configuration/Function

"Fast" or "Slow" response toggle switch.
6 position rotary switch to battery test, turn off, and change ranges.
Depressing the RES switch will zero the meter.
Depress the HV switch, the meter should read detector high voltage.

B. Scan Rates

i. 12-1A with Standard Mylar Screen Air Proportional Probe

Stationary:	Fast response ≈ 500 dpm/100 cm^2
	Slow response ≈ 200 dpm/100 cm^2
Scan:	@ 2"/sec (MDA ≈ 20,100 dpm/100 cm^2)

ii. 12-1A with Attenuated Air Proportional Probe for SCO Measurements

Stationary	In either fast or slow response ≈ 500,000,000 dpm/100 cm^2 (roughly 250,000 cpm max reading)

SCO measurements are based on the count rate, divide by the efficiency (results will be in dpm/50 cm^2) and then multiply results by 2 to get 100 cm^2 [i.e., (c/m ÷ eff.) x 2]. The upper range limit for the assembly of Ludlum 12-1A with attenuated Air Proportional Probe is 250,000 cpm. Linearity for readings above 250,000 cpm has not been established. Do not exceed 250,000 cpm when making SCO measurements. The efficiency for the probe/cable pair provided is entered on the efficiency tag for the probe.

Scan:	Limits not established for scan measurements

C. Scan Distance

¼ inch from surface being surveyed.

D. Performance Test Requirements

i. 12-1A with Standard Mylar Screen Air Proportional Probe

Daily performance test to include:

Battery test prior to use.
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1.7 and 1.9 on the bottom scales, or as specified on the calibration tag).
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired.

Select X1000 on instrument and Fast response. Source check on highest value source.
Select X100 on instrument and Fast response. Source check on next lower value source.
Select X10 on instrument and Slow response. Source check on next lower value source.
Select X1 on instrument and Slow response. Source check on the lowest value source.
Verify instrument readings on all scales are ± 20% of source standard values.

ii. 12-1A Attenuated Air Proportional Probe for SCO Measurements

Performance Test prior to use only:

Battery test prior to use.
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1.7 and 1.9 on the bottom scales, or as specified on the calibration tag).
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired.

Select X10 on instrument and Slow response. Source check on the highest source.

IV. General Operations (continued)

E. Operational Test Requirements

i. 12-1A with Standard Mylar Screen Air Proportional Probe

Routine operational checks are performed
at the following minimum periods:
- After each personnel monitoring.
- Every 15 minutes when the instrument is in continuous use.
- Prior to each intermittent use.
- After probe replacement.

Verify proper audible response, needle deflection, and ± 20% readings when checked with the appropriate check source.

ii. 12-1A Attenuated Air Proportional Probe for SCO Measurements

Operation tests are not feasible while applying SCO measurements.

F. Good Practices

Do not contact the probe surface with the contaminated surface.
Protect instrument from temperature and humidity extremes.
Do not puncture thin detector window.
Shall not be used for survey for unrestricted release of any type, to include personnel.

G. Maintenance Allowed by User

i. 12-1A with Standard Mylar Screen Air Proportional Probe

Air proportional probes may be changed as long as the performance test and operational check requirements are met.
User may change batteries.

ii. 12-1A Attenuated Air Proportional Probe for SCO Measurements

No other maintenance is allowed except battery changes.

LUDLUM MODEL 31 WITH LUDLUM MODEL 44-9 PANCAKE GM DETECTOR INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Model 31 is a portable beta-gamma contamination survey instrument that operates on two standard "D" cell batteries. The instrument features a regulated high-voltage power supply, adjustable from 400 to 1500 V and provides four linear ranges from 0 - 1,000,000 cpm.

B. Features

Fast and slow response modes of operation.
Audible external speaker and headphones.
Lightweight, portable, durable, and battery operated.

C. Scaler/Meter/Detector Configurations

Ludlum Model 31 survey instrument with Ludlum Model 44-9 Pancake Geiger-Mueller (GM) Detector.

II. Instrument Specifications

A. MDA

Stationary (Pat Method) response.
Based on a background of 100 cpm and an efficiency of 17.3% for depleted uranium.
Static MDA is 1897 dpm/100 cm^2.

B. Types of Radiation Measured

Beta-gamma.

C. Ranges

0-1000, 10,000, 100,000, 1,000,000 cpm

D. Energies

Isotopic Beta Energy Range:	16 keV to 3.54 MeV (max.)

E. Efficiencies

Beta:	17.3% ± 1% (Correction Factor = 6)
Gamma:	2100 cpm/mR/hr for Cs-137

F. Types of Batteries and Life

Two standard "D" cells with a typical battery life of 200 hours.

G. Sensitivity

40 mV

H. Audio

Instrument has external speaker and headphone jack.

I. Linearity

± 5% full scale.

J. Modes of Operation

Instrument can operate in the "Fast" or "Slow" response mode for detection of surface contamination.

K. Voltage Range

Externally adjustable from 400 to 1500 V, the instrument is set for 900 V, G-M tube operation.

L. Alarm Range

No alarm capabilities.

U/NU
REVIEWED FOR CLASSIFICATION/UCNI
By Daniel L. Mayfield
Date 09 July 2004

PADC-1998-00387

M. Calibration Stability

Reproducibility Test (As found): ± 10%
Performance Test (As found): ± 20%

N. Response Times

Fast Response Mode: 4 seconds ± 1 second for 90% of final meter reading.
Slow Response Mode: 22 seconds for 90% of final meter reading.

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair.

III. Limiting Conditions of Operation

A. Temperature

Do not operate outside of 32°F to 150°F (0°C to 65°C) unless the following conditions are met:
Install new batteries
Limit operations to 10 hours.

B. Barometric Pressure/Altitude

No observed effects.

C. Humidity

No observed effects.

D. Chemical Interference

No observed effects.

E. Radio Interference

No observed effects.

IV. General Operations

A. Switch Configuration/Function

Meter reset switch: Resets the meter to zero when depressed.
Fast-slow meter response switch: Speeds up or slows down the response/display of the meter.
Six position, multifunction switch: Used for Off, Battery Check, X1, X10, X100, and X1000 scale multiples.

B. Scan Rates

1 to 2 inches/second for general use when used with audible response.

C. Scan Distance

Within ½ inch of surface.

D. Performance Test Requirements

Daily performance test to include: Battery test prior to use.
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1.7 and 1.9 on the bottom scales, or as specified on the calibration tag).
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired.
Select X1000 on instrument and Fast response. Source check on highest value source.

Select X100 on instrument and Fast response. Source check on next lower value source.
Select X10 on instrument and Slow response. Source check on next lower value source.
Select X1 on instrument and Slow response. Source check on the lowest value source.
Verify instrument readings on all scales are ± 20% of source standard values.

E. Operational Test Requirements

Routine operational checks are performed at the following minimum periods:

After each personnel monitoring.
Every 15 minutes when the instrument is in continuous use.
Prior to each intermittent use.
After probe replacement.

Verify proper audible response, needle deflection, and ± 20% readings when checked with the appropriate check source.

F. Good Practices

Ensure Performance Test and Operational Requirements are met.
Do not contact the probe surface with the contaminated surface.

G. Maintenance Allowed by User

User is allowed to change only the coaxial cord and batteries.

BICRON FIDLER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Harshaw / Bicron FIDLER is a light-weight, portable count-rate instrument that utilizes a five-inch Sodium Iodide (NaI[Tl]) scintillator combined with an Analyst counter/scaler (single channel analyzer) to directly read low level/energy gamma and x-rays on large surfaces. The detector is wide and thin and therefore highly directional.

B. Features

Light-weight, battery operated (portable).
Large scintillation detector.

C. Scaler/Meter/Detector Configurations

Analyst counter/scaler with the G5 FIDLER Probe.

II. Instrument Specifications

A. MDA

Stationary: 1053.3 dpm (This is an ideal MDA calculation assuming an optimum static source geometry. Motion, distance, etc. will dramatically increase this value.)

B. Background Decision Levels

If survey is in a known radiological area: 2 times background (RFETS assumed Background is 2,000 cpm). 4,000 cpm indicates activity above background.

If survey is not in known radiological area: Area not expected to contain activity = Background $+ 2x \sqrt{BKG}$

C. Types of Radiation Measured

Low level/low energy gamma and x-ray emitters.

D. Ranges

0-500, 0-5000, 0-50,000, and 0-500,0000 cpm.

E. Energies

15 keV to 1 MeV (Peak centered at 17 keV utilizing Am -241).

F. Efficiencies

20% (Average) (Correction Factor = 5).

G. Types of Batteries and Life

One 9-V battery (MN1604 or equivalent) which lasts 50 hours typically. The additional battery holder may be used for storage of spare or parallel-wired (100 hour life with parallel option).

H. Sensitivity

Low-level discriminator adjustable from <0.1 to 1V with internal potentiometer.

I. Audio

A built-in speaker provides audible "click" for each detector pulse.

J. Linearity

± 5% from 400 to 1600 V.

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K. Modes of Operation

The Analyst counter/scaler has a single channel analyzer with three modes of operation:

Channel 1 (Window Mode):	This mode provides energy discrimination by accepting only those detector pulses within a certain range or window. Channel 1 counts all pulses between the lower and upper level discriminators.
Channel 2:	Counts all pulses above the upper level discriminator.
Out (Gross Counting Mode):	Accepts all signals above the lower-level discriminator.

L. Voltage Range

Electronically stabilized and adjustable, 400 to 1600 V with readout on the meter.

M. Alarm Range

Over range alarm may be selected to respond to 30% of full scale.

N. Calibration Stability

Source Response (As Found):	± 20%
Source Reproducibility Test (As Found):	± 10%

O. Response Times

Response time is switch selectable, optimized for each range, 10-90% of final reading as follows:

X1	12 sec. (Fast)	20 sec. (Slow)
X10	1 sec. (Fast)	8 sec. (Slow)
X100	<1 sec. (Fast)	2 sec. (Slow)
X1000	<1 sec. (Fast)	1 sec. (Slow)

P. Calibration Limitations

Calibration required yearly or after maintenance and/or repair.

III. Limiting Conditions of Operation

A. Temperature

Below 39°F, this instrument is limited to a 30 minute field operating use. A minimum one hour warm-up period at indoor room temperature is required between each half-hour of use.

B. Barometric Pressure/Altitude

No observed effects.

C. Humidity

No observed effects.

D. Chemical Interference

No observed effects.

E. Radio Interference

No observed effects.

F. Hydroscopic

Detector is hermetically sealed and if the seal is compromised, then the performance/response will degrade.

IV. General Operations

A. Switch Configuration/Function

Seven position rotary switch: Off, bat., HV, X1000, X100, X10, X1
Fast/Slow Response, Channel Switch, audio ON/OFF switch.

B. Scan Rates

Scan as slowly as possible to give the instrument time to respond. Scan rates above two inches per second drastically reduce the probability of detection.

Perform a one minute stationary count if readings above background are detected.

C. Scan Distance

At least 12 inches from the item being surveyed if the item is much larger than the detector.
Hold the detector on contact if the item is the same size or smaller than the detector.
For soil surveys performed in SITU place detector on the ground surface.

D. Performance Test Requirements

Required to be performed every 24 hours of operational use by Health Physics Instrumentation.

E. Operational Test Requirements

Prior to using the instrument perform the following checks:
- Ensure calibration is current.
- Inspect instrument for physical damage.
- Ensure Performance Test requirements are met.
- Perform a battery check and ensure that the needle reads in the BAT. OK region.

F. Good Practices

Listen to audible response closely since it responds faster than the instrument meter reading.
Use proper care not to damage the extremely thin and fragile window on the scintillation detector.

G. Maintenance Allowed by User

None (except for battery replacement)

NE ELECTRA/ELECTRA PLUS
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

NE Technology Electra/Electra Plus Model with DP6BD/DP8A Dual Scintillation Probe or AP6 Alpha Probe, portable ratemeter/scaler, used for the detection of alpha and beta radiation fields. The alpha probe uses a ZnS phosphor. The dual scintillation probe uses a ZnS phosphor (alpha detection) painted on a 1 mm thick plastic scintillator (alpha/beta detector). The relatively high signal output from interactions of alpha particles in the ZnS layer and the relatively low output from beta particles in the plastic scintillator provide corresponding electronic pulse amplitude distributions that can be used to differentiate between alpha and beta contamination during the same measurement process. These instruments can also operate in the "Rate" mode or the "Integrate" mode and the Electra Plus offers the capability of data logging.

B. Features

- Real-time digital analysis
- Background subtraction
- Integrated count rate and upper threshold adjustable from the keypad
- Autoranging bargraph display for ease of reading
- Display and control capabilities can be configured to suite individual circumstances
- Peak Hold and Sampler modes*
- I-Button™ or Barcode compatible *
- Data logging of up to 1000 data points (two channels) *
- Serial communication mode*
- Ratemeter with reset function*

* indicates available on Electra Plus model only

C. Scaler/Meter/Detector Configurations

NE Electra Plus Ratemeter with Model DP8A or Model AP6. NE Electra with DP6BD dual scintillation alpha/beta probe. Note: The DP8A and AP6 are identical in appearance – differentiated by the Restricted Use Tags applies to the detector case.

II. Instrument Specifications

A. The following are typical examples of PAT MDCs.

Source	Probe	t_s (s)	t_g (s)	Bkg. (cpm)	Efficiency	MDC (dpm/100 cm²)
Alpha (Pu-239)	DP6BD	60	60	0.8	20%	34
Alpha (Pu-239)	DP6BD	60	60	8	17%	94
Beta (DU)	DP6BD	60	60	513	22%	491
Alpha (Pu-239)	DP8A	4	4	15	14%	131
Alpha (Pu-239)	DP8A	8	8	15	16%	73

The following are typical examples of scan MDCs.

Source	Probe	Scan Speed (in/s)	Bkg. (cpm)	Efficiency	MDC (dpm/100 cm²)
Alpha (Pu-239)	DP6BD	0.65	0.8	20%	485
Alpha (Pu-239)	DP6BD	2	0.8	20%	1699
Beta (DU)	DP6BD	2	1000	22%	2938
Beta (DU)	DP6BD	4	1000	22%	4155
Beta (DU)	DP8	2	4100	16.3%	4806
Beta (DU)	DP8	4	5000	16.3%	7447

Note 1: the assumed surface to detector distance for scanning is ¼ of an inch for alpha; 1/2 of an inch for beta.

Note 2: If either background, surface to detector distance, or scan speed increases or efficiency decreases, then the corresponding MDCs will increase in magnitude.

Note 3: See RSP 02.01 for derivation of MDCs. The alpha scan rate should be determined based on the acceptable probability of detection and regulatory criteria.

Note 4: PAT and Scan MDC's for the AP6 are yet to be determined at Rocky Flats.

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B. Types of Radiation Measured

Alpha or Beta; incidental gamma and neutron

- The AP6 is configured only to detect alpha.

C. Ranges

- 0.1 cps to 100,000 cps
- 1 cpm to 1,000,000 cpm

D. Energies

- Alpha: 3.83 MeV - 8.78 MeV
- Beta: 16 KeV - 3.27 MeV (max) [dual phosphor probes only]

E. Efficiencies

- AP6 Alpha: (Pu-239) Minimum 14%
- DP6BD Alpha: (Pu-239) Minimum 17% (typically 18-20%)
- DP6BD Beta: (DU) Minimum 22%
- DP8A Alpha: (Pu-239) Minimum 14% (typically 14-16%)
- DP8A Beta: (DU) Minimum 16%

F. Types of Batteries and Life

- "3" C-cells with a typical life of greater than 90 hours

G. Sensitivity

- AP6 probe surface sensitivity yet to be determined at Rocky Flats.
- DP6BD probe surface sensitivity tolerance is ± 15%.
- DP8A probe surface sensitivity yet to be determined at Rocky Flats.

H. Audio

- External audible loudspeaker indication and a headphone/earpiece connector. One click for each detected particle, different sounds for alpha and beta, alarm condition, or change of display

I. Linearity

± 10% (Electra/Electra Plus)

J. Modes of Operation

- Rate Mode: Each second, the latest 1-second count is compared with the 16-second rolling average. If the difference is significant the 1-second value is displayed, otherwise a new 16-second rolling average is displayed. The NE Electra/Electra Plus can also display rolling averages calculated over periods of between 1 and 25 seconds.
- Integrate Mode: Integrate Mode offers precise digital readout without the need for averaging techniques required by conventional ratemeters. The Electra plus allows the user to specify the degree of precision (0.1-20%).
- Peak Hold: Electra Plus only, updates the display only with new maximum readings and beeps for each new maximum.
- Sampler Mode: Electra Plus only, allows multiple integrations to be performed with fixed pause times between each integration.

Recommended that the 5 second response time setting be used to keep readout fluctuations minimized.

K. Voltage Range

- High Voltage: 400 -1400 volts for load resistance

L. Alarm Range

- 0.1 to 50,000 cps
- 1 to 300,000 cpm

Independent values can be set for alpha and beta (generally set to 500 cpm alpha and 5000 cpm beta).

M. Calibration Stability

As found value must be within ±10% of the previous calibration reference reading.

N. Response Times

- 16 second rolling average in steady fields with FAST one second reaction time to significant changes.
- Rolling average, adjustable average period 1 to 25 seconds. - (recommended response period is 5 seconds)
- INTEGRATE mode, 10 to 5000 seconds in 10-second steps. Integrate mode, 1-10 sec in 1-sec steps, 15-30 sec in 5-sec steps, 40 to 5000 seconds in 10-second steps.

O. Calibration Limitations

- The Electra/Electra Plus will be calibrated by qualified HPI personnel every six months, or after maintenance/repair.

III. Limiting Conditions of Operation

A. Beta Radiation

- The DP8A has not been qualified for beta radiation surveys at this time.

B. Temperature

- The AP6 should not be operated below 25°F (-4°C) or above 104°F (40°C).
- The DP6BD should not be operated below -40°F (-40°C) or above 104°F (40°C) for detection of alpha radiation. (up to 9% deviation of meter readings between these temperature ranges)
- The DP6BD should not be operated below -5°F (-30°C) or above 86°F (30°C) for detection of beta radiation. (up to 15% deviation of meter readings between these temperature ranges)
- The DP8A should not be operated below 32°F (0°C) or above 104°F (40°C) for detection of alpha or beta radiation (Manufacturer spec.)

C. Barometric Pressure/Altitude

- No observed effects.

D. Humidity

- Up to 95%, non-condensing.

E. Chemical Interference

- No observed effects.

F. Radio Interference

- The DP6BD experienced no interference at frequencies in use at Rocky Flats.
- The Electra Plus/DP8A should not be operated within 1m of any portable radio transmitter at Rocky Flats.
- The Electra Plus/AP6 should not be operated within 1m of any portable radio transmitter at Rocky Flats.

G. Gamma/Neutron Radiation Interference

- The DP6DB/DP8A will respond to gamma radiation fields, when monitoring for beta radiation move to an area with lower gamma levels if possible.
- The DP6DB/DP8A will respond to neutron radiation fields, when monitoring for alpha radiation move to an area with lower neutron levels if possible.
- The AP6 has not been evaluated for neutron interference.

IV. General Operations

A. Switch Configuration/Functions

- On/Off Button: Depress to turn instrument on or off.
- Rate/Integrate Mode Button: Depress to switch between the integrate and rate counting modes.
- Alpha/Beta Button: Depress to switch between alpha, beta, and alpha plus beta displays. [Not enabled for the AP6].
- Audible Loudspeaker Button: Depress to toggle the audible loudspeaker on and off.
- Light Button: Depress to toggle the liquid crystal display light on and off.
- Set Up Button: distinguishes between settings which can be varied by the user and settings which are inhibited to the user but adjustable under supervision.
- Enter Button: Used for storage of display setting or display background.
- Ø Button: Depress to prevent adjustment of particular settings in use or on the Electra Plus allows access to the data logging functions.

- Increase/Decrease Buttons: Allows all settings (observed by pressing the "Set Up" button) to be adjusted up or down when the internal User/Supervisor switch is set to Supervisor. On the Electra Plus, allows access to the Peak Hold mode functions.
- Internal User/Supervisor Switch: When set to "Supervisor", allows settings to be adjusted by supervisor and locked in by depressing the "Ø" button and then switching back to the "User" position.
- Internal Show/Hide Switch: When set to "Hide" all settings distinguished by the Ø symbol are hidden, in the "User" switch setting.

B. Scan Rates

See Section II. A

C. Scan Distance

See Section II. A

D. Performance Test Requirements

Required to be performance tested daily and prior to use. The instrument shall be performance tested by a qualified RCT Technician in accordance with approved Radiological Protection procedures. Performance test requirements cover the following items:

- Instrument battery/power supply is satisfactory.
- Instrument audio check is satisfactory, as applicable.
- Instrument light leak check is satisfactory, as applicable.
- Instrument background response check is within tolerances of expected values.
- Instrument reading falls within ±20% of the reference performance test reading.
- The sources used for instrument performance checks shall at least meet the minimum criteria specified below:

	Nominal Value	Minimum Value
Alpha (Pu-239)	20,000 dpm	10,000 dpm
Beta (Sr/Y-90)	20,000 dpm	10,000 dpm

E. Operational Test Requirements

No additional operational test requirements beyond the performance test requirements.

F. Good Practices/Precautionary Measures

- Be very, very careful not to puncture thin mylar coating on scintillation probes (0.5 mm).
- Do not drop or bang probe due to sensitive photomultiplier tubes.
- Do not disconnect probe with power to instrument left on - turn power off first or instrument damage could occur.

G. Maintenance Allowed by User

Battery change out is allowed.

VICTOREEN 450 B/G
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Victoreen Model 450B is a hand-held, battery operated, microprocessor based, air ionization chamber instrument calibrated in exposure rate units of roentgens/hour. It is designed to measure alpha radiation above 4 MeV, beta radiation above 100 KeV and gamma radiation and X-ray radiation above 7 KeV. A 400 mg/cm^2 sliding Bakelite shield is provided as a beta shield. This shield also serves as an equilibrium thickness for photon measurements and protects the mylar window. The 450B contains a LCD digital readout and a 100 segment analog bargraph . The unit is auto-ranging and auto-zeroing.

The Model 450G is a hand-held, battery operated, ionization chamber designed to measure gamma radiation above 7 KeV. It contains the same features as the 450B minus the beta window slide and has no beta detection capability.

B. Features

- 200 cc volume air ionization chamber
- Bakelite chamber wall is 200 mg/cm^2 thick
- Beta chamber window is 1.7 mg/cm^2 mylar
- Microprocessor based for data collection, averaging, multiplication by stored calibration factors, range changing, and battery check functions.
- Digital and analog displays
- Auto-ranging and auto-zeroing
- Light contained in handle for display

C. Scaler/Meter/Detector Configurations

Mode button allows configuration to either display exposure rate values or display integrated exposure

II. Instrument Specifications

A. MDDR

1 mR/hr based on "ideal" counting statistics, background of 0.01 mR/hr, and optimal static source geometry. (Actual field measurements and the variables therein will dramatically affect this value).

B. Types of Radiation Measured

- Alpha above 4 MeV with model 450B (450G is not sensitive to alpha)
- Beta above 100 keV with model 450B (450G is not sensitive to beta)
- Gamma and X-ray lower energy threshold: 7 keV with model 450B and at least 60 keV with model 450G

C. Ranges

- 0-5 mR/hr
- 0-50 mR/hr
- 0-500 mR/hr
- 0-5 R/hr
- 0-50 R/hr

D. Energies

20 keV to 1.3 MeV (Energy ranges of concern at RFETS are 57 keV to 2.73 MeV for Cs-137, fission fragments, decay products of Pu, U, and Am isotopes)

E. Efficiencies

Not applicable (non-quantifiable) for dose rate instruments

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F. Types of Batteries and Life

- Two 9-volt transistor batteries (main power) & 2 AAA batteries (for backlight)
- Battery life is approx. 200 hrs. on continuous operation for the main batteries. Each battery will operate the instrument for approx. 100 hours and will run independent of each other allowing continuous operation during battery change.
- LOW BAT message will appear on the display approx. 1.5 hours prior to the instrument becoming inoperable.

G. Sensitivity

Not applicable to Ionization chamber type instruments

H. Audio

Audio alarm set points are set using a PC and the Model 450A-1 communicator.

I. Linearity

Within ± 6% of reference readings

J. Modes of Operation

- Can be configured so that MODE button alternately toggles display of exposure rate values and display of integrated exposure.
- FREEZE Mode operation gives the operator a constant reference of the highest exposure rate obtained from the time the freeze function is initialized.

K. Voltage Range

-90V collection voltage

L. Alarm Range

Audio alarm can be set in increments of 1% up to full scale (100%)

M. Calibration Stability

Within ± 6% of reference readings

N. Response Times

- 0-5 mR/hr = 9.3 seconds
- 0-50 mR/hr = 3 to 5 seconds
- 0-500 mR/hr = 2 to 2.3 seconds
- 0-5 R/hr = 1.5 to 2.5 seconds
- 0-50 R/hr = 1 to 2.5 seconds

O. Calibration Limitations

A Model 450A-1 communicator (infrared signal) is used in conjunction with a PC for calibration of the instrument. The survey meter will communicate via the Model 450A-1 communicator and send test signals/data to the PC. Calibration adjustments can also be entered via the PC to the Model 450 B/G.

III. Limiting Conditions of Operation

A. Temperature

Operating range of -4° F to 104° F (-20° C to 40° C)

B. Barometric Pressure/Altitude

No testing done

C. Humidity

- Effective for 0-98% relative humidity for Model 450G (non-condensing @ 60° C)
- Effective for 0-100% relative humidity for Model 450B (non-condensing @ 60° C)

D. Chemical Interference

None known

E. Radio Interference

No abnormalities noted when exposed to 140, 915, and 2450 MHz fields at 20 V/m. Substantially reduced responses were noted when exposed to a frequency scan from 100 kHz to 1000 MHz at 20 V/m compared to the instruments response when the field was not present.

Site radios may interfere, past experience has shown meter deflection.

IV. General Operations

A. Switch Configuration/Function

- Auto-on light : automatically turns on when ambient light drops below a pre-determined level
- Overrange rate: if the instantaneous dose rate exceeds 50 R/hr the "R" in mR/hr will blink
- Low battery indicator: Approximately 1.5 hours of operation are remaining when the LOW BATTERY indicator blinks
- INTEGRATE Mode: operational 30 seconds after instrument is turned on
- FREEZE Mode: places a "tick" mark on the bargraph display to hold on the peak displayed value and lock on the maximum range.

B. Background Counting

Not applicable

C. Scan Rates

Not applicable

D. Scan Distance

Not applicable

E. Performance Test Requirements

- The Model 450B/G shall be performance tested as a minimum once every 24 hours during each operational use period.
- The instrument shall be performance tested by a qualified HPI Technician in accordance with approved Radiological Protection procedures.
- Performance check response shall be ± 20% of mean reference reading.

F. Operational Test Requirements

- Ensure that calibration due date has not expired
- Verify that instrument has been Performance tested within the last 24 hours prior to use
- Verify battery power is satisfactory
- Ensure that the instrument is not damaged or otherwise impaired.

G. Good Practices

- On the Model 450B use caution to not damage mylar beta window.

H. Maintenance Allowed by User

- Batteries (located in handle) may be changed by instrument user.
- All other maintenance shall be performed by qualified HPI personnel.

BICRON FRISKTECH WITH A-100 (ALPHA) AND B-50 (BETA) PROBES
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description:

The Bicron Frisktech is an alarming ratemeter designed to use GM or scintillation detectors in a wide variety of "frisking" or monitoring applications. Additionally it has an optional built in scaler and mR/h meter scale that add to its versatility. The Frisktech is used with the Bicron A-100 probe which is a ZnS scintillation, 100 cm^2 alpha detector, and the B50 probe which is an organic scintillation, 50 cm^2 beta detector. Both probes are designed to be used with the Frisktech ratemeter or scaler function.

B. Features:

- Built in digital Scaler & recorder outputs
- Can be used with GM or scintillation detectors
- Regulated battery recharge
- Adjustable response times
- Audible/visual alarms (audible is adjustable)
- Can be used as a portable or stationary monitor
- High efficiency organic scintillation detector (B-50 probe)

C. Scaler/Meter/Detector Configurations

The Frisktech is used with the A-100, and the B-50 scintillation probes. The A-100 probe has a 100 cm^2 sensitive area designed for alpha detection . The B-50 probe has a 50 cm^2 sensitive area and is used for beta or alpha detection. Both probes are used to provide scaler measurements. Probes are calibrated to the specific Frisktech instrument and should not be interchanged.

II. Instrument Specifications

A. MDA

A-100 Probe MDA for alpha (Pu-239):

- 1 minute count = 55 dpm/100 cm^2 with a stationary count in the scaler mode; Assuming a 17% probe efficiency, 0.25 inch surface to probe distance, and 2 cpm or less background.
- 6 second count = 282 dpm/100 cm^2 with a stationary count in the scaler mode; Assuming 17% probe efficiency, 0.25 inch surface to probe distance, and 2 cpm background or less.

B-50 Probe MDA for beta (U-238):

- 1 minute Count = 848 dpm/100 cm^2 with a stationary count in the scaler mode; Assuming a 18% probe efficiency ,0.5 inch surface to probe distance, and a 250 cpm background or less.
- 6 second count = 2218 dpm/100 cm^2 with a stationary count in scaler mode; Assuming a 18% probe efficiency, 0.5 inch surface to probe distance, and 250 cpm background or less.

B. Types of Radiation Measured

Alpha, beta, incidental gamma
(Note: The B-50 probe has a gamma sensitivity of 3,600 cpm/mR/hr. The A-100 probe has minimal gamma sensitivity in fields up to 1 R/h when appropriate HV settings are used.)

C. Ranges

Standard: 0-500k cpm

D. Energies

- Alpha - A-100 Probe : Typical 35% for Po-210 (5.3 MeV)
- Beta - B-50 Probe: Typical 15% for C-14 (155 KeV) to 35% for Cl-36 (709 KeV)

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By Daniel T. Mayfield
Date 09 July 2004

E. Efficiencies

- A-100 probe: 17-23% for Pu-239 ; 50% for Th-230

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- B-50 Probe: 18% for DU (U-238)

F. Types of Batteries and Life

- Dual 6 volt, rechargeable gelled cells
- >50 hours between charges; battery indicator indicates low battery.
- < 10% change in reading through "bat.ok" check band
- Regulated battery recharge operates whenever unit is connected to AC power

G. Sensitivity: (Uniformity)

- A-100: + or - 10% over the probes surface
- B-50 : Within 10% for alphas & high energy betas: within 25% for low energy betas

H. Audio

- Provides an audible click for each detector pulse plus an audible alarm, or just an audible alarm alone.
- Adjustable when in the "pulse/alarm" mode; does not affect volume when the "alarm mode".
- Rate alarm is non-latching with front panel adjustment

I. Linearity

Within 5% of full scale: within 10% of reading above 20% of full scale.

J. Modes of Operation

- Rate Mode: Response times are adjustable from 2 to 20 seconds Rate mode should be used for personnel self monitoring and contamination surveys.
- Scaler Mode: Uses 6 second or 1 minute count times ; used for counting smears, etc.

K. Voltage Range

- Adjustable from 400 to 2000 V w/meter readout (factory set to 900 VDC)
- Maximum voltage is 1500 V
- 115 VAC but convertible to 210-250 VAC

L. Alarm Range

- From 10% to 130% of full scale and meter readout
- Red LED indicator on front panel

M. Calibration Stability

"As-found" values must be within 10% of the previous calibration reference value.

N. Response Times

- Continuously adjustable from 2 to 20 seconds on all 4 count rate ranges.
- The response control has no effect on the "alarm set" , "bat" or "HV" positions of the ratemeter control switch. These response times for these modes are preset to be < 1 sec.

O. Calibration Limitations

- Must be calibrated every 6 months by qualified HPI personnel.
- Calibrated electronically using a variable frequency pulse generator.

III. Limiting Conditions of Operation

A. Temperature

- Frisktech meter/scaler: Operational from -20 C to + 50 C
- A-100 Probe : No limiting factors for use
- B-50 Probe : -10 C to +30 C (14 to 86 F) and maximum of 50% relative humidity to stay within 20% of calibration reference values.

B. Barometric Pressure/Altitude

No observed effects

C. Humidity

Limiting condition for B-50 probe is < 50% relative humidity to stay within 20% of calibration reference values.

D. Chemical Interference

No observed effects

E. Radio Interference

None observed at frequencies used at RFETS

IV. General Operations

A. Switch Configuration/Function

- Power on/off knob
- Reset alarm knob provides rapid meter zeroing. When depressed the meter will remain at zero for all 4 count rate ranges , "HV", "alarm set" , and "bat".
- Ratemeter mode has 7 settings (Alarm set; Battery check; HV check; and x1 to x1000 scales)
- "Alarm Set" - alarm level is set from 10-130% of full scale via the alarm set potentiometer located immediately to the left of the control knob. A small flat bladed screwdriver is required for adjustment.
- "Bat." setting - the strength of the internal batteries is indicated on the meter.
- Slow/fast response adjustment
- Audible alarm volume controls the internal speaker. In the "pulse" position the speaker provides an audible "click" for each detector event.
- Speaker adjustment for : off; pulse/alarm; & alarm
- Scaler count time; adjustable via 3 position switch on rear panel to 0.1, 1, and 10 minutes
- Recorder output is located on rear panel of unit to provide remote analog meter readout
- Scaler output is located on rear panel of the unit to provide logic type pulse for each detector event. The pulse width is approx. 15 microseconds.
- Headphone output is located on rear of unit and provides a pulse output for each event to headphones.

B. Background Counting

Typically 6 second and 1 minute count times are used in scaler mode. No background subtraction on count rate mode.

C. Scan Rates

- Ratemeter Mode: A-100 (alpha) and B-50 Probes: 2 inches/second @ 2 cpm bkgd. or less for the A-100 and 250 cpm bkgd. or less for the B-50 - probes to be within 1/4 inch surface to probe distance.
- Scaler Mode: 6 second or 1 minute stationary counts within ¼ inch of surface to probe distance.

D. Scan Distance

- Within ¼ inch distance for scan mode.
- Within ¼ inch for stationary count in scaler mode.

E. Performance Test Requirements

Required to be performance tested daily prior to use. The instrument shall be performance tested by qualified RCTs in accordance with approved Radiological Protection procedures. Performance check reading shall ensure that the instrument reading is within 20% of performance check values.

F. Operational Test Requirements

Operational Checks shall be performed prior to each use and shall include the following items:

- Instrument battery power is satisfactory. If low "bat" meter reading reconnect instrument into AC power to recharge the internal batteries.
- Instrument audio check is satisfactory
- Instrument is not damaged or unsuitable for use
- Instrument calibration period is not expired
- Instrument has been performance checked within 24 hours.

G. Good Practices/Precautions

- Use caution to not puncture mylar over detector probe face.
- Do not drop due to sensitive photomultiplier tubes
- Do not interchange probes; they are calibrated to a specific Frisktech meter.
- The detector should always be stored with its protective cover in place to prevent window damage.
- The power switch should always be turned "off" prior to connecting or disconnecting the detector cable.
- When "bat" meter band reading is low and unit is disconnected from AC power it should be reconnected to the AC power to prevent full discharge of the internal rechargeable gel cell batteries.

H. Maintenance Allowed by User

Any required instrument maintenance (including battery replacement) shall be referred to HPI personnel.

BICRON MICROREM METER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description:

The Harshaw-Bicron Micro-Rem/Micro-Sievert Meter is a light weight, portable survey instrument that utilizes a tissue-equivalent organic scintillator to directly read deep dose equivalent from gamma and X-ray at the 1 cm deep dose equivalent index. The instrument gives tissue-equivalent photon response for gamma and X-ray radiation at energies from 40 keV to 1.3 MeV from environmental levels of 0-20 µRem/hr (0-0.2 µSv/hr) to survey levels of 200 mrem/hr (2 mSv/hr). A low energy response option allows the same detection ranges down to a photon energy of 17 keV.

The instrument is a small hand held meter designed for direct monitoring of personnel deep dose equivalent without the necessity of conversion from mrad/hr.

B. Features:

- Internal Tissue-equivalent scintillator
- Flat energy response
- HV Check
- Wide View meter
- Gamma and X-ray detection
- Five decade range
- Splash-proof, shock proof all metal case

C. Scaler/Meter/Detector Configurations:

One internally mounted tissue-equivalent organic detector
Extended detector option is available and is mounted so that its sensitive area extends out from the front of the instrument case bottom, making it easier to survey certain hard-to-reach locations.

II. Instrument Specifications

A. MDDR:

17 µrem/hr (using site guidance, assuming a background of 10 µrem/hr).

B. Types of Radiation Measured:

Gamma & X-ray

C. Ranges:

- 0 - 20 µrem/hr.
- 0 - 200 µrem/hr
- 0 - 2,000 µrem/hr
- 0 - 20,000 µrem/hr
- 0 - 200,000 µrem/hr

D. Energies:

40 keV to 1.3 MeV
Energy sensitive down to 17 keV with the Low Energy response option.

E. Efficiencies:

Not Applicable

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F. Types of Batteries and Life:

- Two 9-volt batteries
- >100 hours battery life under normal use

G. Sensitivity:

See "MDDR" above

H. Audio:

No alarm capabilities

I. Linearity:

Within 10% of reading between 20% and 100% of full scale on any range

J. Modes of Operation:

Single mode - dose rate meter surveys

K. Voltage Range:

HV is electronically stabilized with factory set HV during calibration with check band on the meter.

L. Alarm Range:

No alarm capabilities

M. Calibration Stability:

Instrument response is within 10% for Cs-137 between 20% and 100% of full scale on any range
Dose equivalency is within 1% across the entire range of instrument energy

N. Response Times:

Optimized for each range, 0-90% of final reading as follows:

- x 0.1 = < 15 sec.
- x1 = < 15 sec.
- x 10 = < 5 sec.
- x100 = < 2 sec.
- x1000 = < 2 sec.

O. Calibration Limitations:

None known at present time

III. Limiting Conditions of Operation

A. Temperature:

- Operable from -4° F (-20° C) to 122° F (50° C)
- DO NOT USE BELOW - 4° F (-20° C)

B. Barometric Pressure/Altitude:

No observed effects

C. Humidity:

< 5% change in reading from 10-95% relative humidity.

D. Chemical Interference:

None known

E. Radio Interference:

No test data available

IV. General Operations

A. Switch Configuration/Function:

- On/Off switch
- "bat" switch - provides meter band indication of battery strength
- "HV" switch - provides meter band indication of HV factory settings

B. Background Counting:

Not Applicable

C. Scan Rates:

Not applicable

D. Scan Distance:

Not applicable

E. Performance Test Requirements:

- HPI Technician performs Daily Performance check using an Am-241 source.
- Performance check values must be within 20% of established reference values

F. Operational Test Requirements:

- Ensure that the instrument calibration due date has not expired
- Verify that the instrument has been Performance checked within the last 24 hours
- Verify battery power is satisfactory
- Verify that HV setting is satisfactory
- Ensure that the instrument is not damaged or otherwise impaired.

G. Good Practices/Precautions:

Use caution to prevent damage to the thin mylar window opening on the extended and low energy probe option

H. Maintenance Allowed by User:

Batteries can be changed by user

LUDLUM MODEL 2929 WITH MODEL 43-10-1 SAMPLE COUNTER INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

Dual Channel Scaler designed for use with "phoswich" and/or proportional detectors. At RFETS the Model 2929 Scaler is used with a dual scintillation detector (model 43-10-1) composed of ZnS (for alpha detection) adhered to plastic scintillation material (for beta detection). A pulse height analyzer is employed to provide information to two independent counters. The sample holder when fully closed activates a micro switch that allows HV to be applied to the Photomultiplier tube. The sample drawer is locked in position by rotation of the slide lever mounted on the side of the instrument.

B. Features

- Simultaneous alpha/beta counting
- Micro switch activated sample drawer w/lock to ensure constant reproducible counting geometry
- Magnetically shielded PMT
- Separate audio for alpha and beta channels
- Separate digital scaler readout windows for alpha and beta
- Two 15 PIN connectors to allow for recorder, printer, or software interface
- Adjustable count time periods from 0.1 - 990 minutes

C. Scaler/Meter/Detector Configurations

- Used with the M43-10-1 Alpha-Beta Sample Counter assembly consisting of sample drawer w/micro switch positioning and drawer lock, and a 2.25" diameter end window dual scintillation detector composed of ZnS (Ag) coated on a 0.01" thick plastic scintillation detector.
- Detector window is 0.4 mg/cm^2 aluminized mylar

II. Instrument Specifications

A. Minimum Detectable Concentration (MDC):

- Alpha: 18 dpm/100 cm^2 - based on 0.8 cpm background, and 33% efficiency
- Beta: 205 dpm/100 cm^2 - based on 195 cpm background, and 25% efficiency
- Above MDC values are only valid for removable alpha/beta swipes.

B. Types of Radiation Measured

Alpha, Beta

C. Ranges

0 - 999,999 counts on two separate LED displays

D. Energies

Adequate for all isotopes of concern at RFETS
See "Efficiencies" below for energy dependence

E. Efficiencies

- Alpha: 37% Th-230; 39% U-238; 37% Pu-239
- Beta: 8% C-14; 22% Tc-99; 29% Cs-137; 26% Sr-90/Y-90
- Above values are typical efficiencies from a range of efficiencies and are based on a 4 pi geometry

F. Types of Batteries and Life

95-135 VAC (178-240 VAC available) 50-60 Hz single phase (less than 100 mA)

G. Sensitivity

- Assume uniform sensitivity across 2.25" detector face
- < 10 % alpha cross talk in beta channel ; <1% beta cross talk in alpha channel

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H. Audio

Built in unimorph type speakers with volume controls to provide a dual tone (1 per channel) click-per-event audio.

I. Linearity

Read outs within 2% of true value

J. Modes of Operation

Scaler mode as a swipe (smear) counter to measure removable alpha-beta surface contamination

K. Voltage Range

- HV is adjustable from 200-2500 volts
- Will support 60 megaohm scintillation loads

L. Alarm Range

No alarm capabilities (Not applicable to scalers)

M. Calibration Stability

Within 10% of previous calibration reference values

N. Response Times

Not applicable to scalers/swipe (smear) counters

O. Calibration Limitations

At RFETS the alpha efficiency is set to 33% using a Pu-239 source by adjusting HV settings (administrative setting). The Model 2929 is calibrated for use with a specific detector and cable. Changing the detector or cable will invalidate the current calibration.

III. Limiting Conditions of Operation

A. Temperature

- Acceptable operating range is -4°F to 85°F (-20°C to 25°C)
- Instrument will read >20% over calibration values at temperatures >85° F. DO NOT USE ABOVE THIS TEMPERATURE.

B. Barometric Pressure/Altitude

No observed effects

C. Humidity

Acceptable in relative humidity of 95% (non-condensing) for up to 8 hours.

D. Chemical Interference

None known

E. Radio/Microwave Interference

- Tested and acceptable from frequencies of 0.3-35 MHz and 140 MHz at 50 volts/meter.
- Tested and acceptable when exposed to 915 MHz and 2.45 GHz at 0.4 watts/meter^2 and 2.0 watts/meter^2

IV. General Operations

A. Switch Configuration/Function

- HV readout analog meter - displays HV settings continuously.
- HV dial - 10 turn dial used to adjust detector HV.
- On/Off switch - used to turn power on or off.
- Minutes wheel dial - two digit thumb-wheel switch used to dial in the count time. Used in conjunction with the Multiplier switch located to the right.
- Count button - initiates a count cycle when depressed and will also reset both counters.

- LED Lamp - indicates that a counting cycle is in progress.
- Hold button - push button used to stop a count cycle. The counters will hold the value present at the time this button is pressed.
- Beta-Gamma Volume knob. - rotary control used to vary audio output of the B-G channel.
- Alpha Volume knob - rotary control used to vary audio output of the alpha channel.
- Alpha Count LED Display - indicates counts received in the alpha channel.
- Beta -Gamma Count LED Display - indicates counts received in the beta channel.
- AMP OUT - a BNC connector providing access to amplifier.
- ALPHA OUT - 15 PIN type "D" connector used as data output for the alpha channel.
- BETA-GAMMA OUT - 15 PIN type "D" connector used as a data output for the beta-gamma channel.

B. Background Counting

- Ambient background of 35 μR/hr = 60 cpm Beta-Gamma, 0.25 cpm Alpha.
- Typical background of 1 cpm alpha and 200 cpm beta based on 1 minute count from averaged 10 minute background count.
- 10 minute background counts for alpha and beta channels required by RFETS procedure.

C. Scan Rates

Not applicable

D. Scan Distance

Not applicable

E. Performance Test Requirements

The Model 2929 shall be performance tested by an RCT prior to use each shift, and the average background count rate determined.

F. Operational Test Requirements

Prior to use each shift:

- Verify the calibration due date on the calibration sticker has not expired
- Ensure that all required performance checks have been performed
- The 10 minute equipment initial warm up time has been met
- Verify the instrument is not damaged or otherwise impaired

G. Good Practices/Precautions

- Use caution to not contaminate the slide drawer when placing swipes (smears) into the counter. Use of planchets or petri dishes are strongly recommended.
- Do not tip sample counter over with sample holder in sample slide. The sample holder will tear the thin mylar window creating a light leak and excessive counts.
- Do not interchange sample counter assembly, detector, or cable. They have been calibrated to a specific instrument and interchanging will invalidate the current calibration.
- Only paper swipes (smears) and appropriate check sources should be placed in the sample holder. Do not place any foreign objects into the sample holder as they may damage the detector.

H. Maintenance Allowed by User

- User should clean sample holder as required using cotton swabs or Kimwipes® moistened with alcohol.
- All other maintenance on the Model 2929 shall be performed by qualified HPI personnel.

LUDLUM 12-4 WITH MODEL 42-31 NEUTRON DETECTOR
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description:

The Ludlum Model 12-4 is a count ratemeter connected to the Ludlum Model 42-31 Neutron Rem Detector for the detection of neutron radiation. The Model 42-31 Neutron Rem detector is a 9-inch diameter, cadmium loaded, polyethylene sphere with a BF_3 proportional detector tube in the center. This detector measures the dose from neutrons over the energy range from 0.025 eV (thermal) to about 10 MeV.

B. Features

- Splash proof shields for outdoor use
- Removable detector
- Weighs 21 lbs.
- Meter re-zero function

C. Scaler/Meter/Detector Configurations

Used with the Model 42-31 Neutron Rem Detector only

II. Instrument Specifications

A. Minimum Detectable Dose Rate (MDDR):

The MDDR is 1 mrem/hr based on empirical data and testing. Note: This MDDR applies to model 12-4 meters with the 0-10 mrem/hr scale face plate.

B. Types of Radiation Measured

Neutron

C. Ranges)

0-10 mrem/hr
0-100 mrem/hr
0-1,000 mrem/hr
0-10,000 mrem/hr

D. Energies

Thermal (0.025 eV) to approximately 10 MeV

E. Efficiencies

Approximately 30 cpm/mrem/hr (AmBe neutrons)
Approximately 20 cpm/mrem/hr (bare Cf neutrons)

F. Types of Batteries and Life

- 2 "D" cell alkaline batteries
- Approximately 600 hr. life

G. Sensitivity

Adjustable from 2 to 60 millivolts.

H. Audio

- Built in unimorph speaker with ON/OFF switch
- > 60 dB at 2 feet

Reviewed For Classification/UCNI
By [illegible]
Date 20 MAR 01 (UNU)

I. Linearity

Reading within 10 % of true values

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J. Modes of Operation

Dose Ratemeter for Neutron detection only.

K. Voltage Range

Adjustable from 200 - 2500 volts

L. Alarm Range

Not applicable

M. Calibration Stability

Satisfactory to within 10% of calibration source values

N. Response Times

- 90% of full scale can be reached in 22 seconds on "S", Slow setting; 4 seconds on "F" fast setting.
- At < 50 mrem/hr max response time is 30 seconds
- At 50 mrem/hr to 1 rem/hr response time is 10 seconds
- At > 1 rem/hr response time is 5 seconds

O. Calibration Limitations

- Calibration requires a pulser and voltmeter
- Approximate calibration time is 1 hour
- The 9" Rem ball is calibrated to Cf-252 neutron energies and will meet response requirements.
- Calibrated every 6 months

III. Limiting Conditions of Operation

A. Temperature

5°F (-15° C) to 122°F (50° C)

B. Barometric Pressure/Altitude

No discernible effects

C. Humidity

- No noted effects but no testing completed
- O-ring seal on case to prevent moisture penetration

D. Chemical Interference

None known

E. Radio Interference

No testing data available

IV. General Operations

A. Switch Configuration/Function

- Speaker Switch: has ON/OFF capability
- Meter Dial: 0-10 mrem/hr scale selection; BAT TEST
- Response Switch: toggle switch for "F", FAST (4 seconds) or "S", SLOW (22 seconds)
- Reset button: push-button to re-zero meter reading

B. Background Counting

Background will vary by location on-site.

C. Scan Rates

Not Applicable

D. Scan Distance

Not Applicable

LUDLUM 12-4 WITH MODEL 42-31 NEUTRON DETECTOR INSTRUMENT TECHNICAL SPECIFICATION SHEET

E. Performance Test Requirements

- Must be performance checked daily by an HPI Technician.
- Performance check results must be within 20% of reference values.

F. Operational Test Requirements

- Verify that calibration due date has not expired
- Verify that a Performance check has been performed within the last 24 hours prior to use
- Inspect the instrument for physical damage or other impairments that would cause its inoperability
- Check battery power

G. Good Practices/Precautions

- Use caution not to drop the instrument. It is heavy and can cause physical injury and instrument damage
- When measuring general area readings at one-foot (30 cm.), the unit should be positioned such that the CENTER (not the edge) of the rem ball is located at 30 centimeters or 12 inches from the source.
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source. All measurements must be made with the detector at 90 degrees from the active area of the source. For example, if the source is in the floor below or the overhead above, the rem ball must be rotated 90 degrees from the upright position in order to obtain an accurate measurement.
- Only qualified HPI personnel are allowed to access instrument internals.

H. Maintenance Allowed by User

- Change out of batteries is allowed by user.
- All other maintenance shall be performed by qualified HPI personnel

LUDLUM 2
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Model 2 is a portable radiation survey instrument that is used in conjunction with the Ludlum Model 44-6 stainless steel wall G-M probe. The Model 2 has 3 linear ranges from 0 to 50 mR/hr and operates on 2 "D" cell batteries. The Model 44-6 detector is a Beta-gamma survey detector that incorporates a rotary shield, which when open allows for beta detection for energies > 200 keV. The beta and gamma contribution can be determined by subtracting the reading with the closed shield from the open shield reading. The dose range of the Model 44-5 is nominally linear (within 10%) up to 50 mR/hr without instrument dead time correction, and up to 500 mR/hr with dead time correction.

B. Features

- Can operate with GM or Scintillation detectors
- 3 linear ranges
- HV is externally adjustable
- Audio ON/OFF switch
- External battery access
- Meter reset button

C. Scaler/Meter/Detector Configurations

- Used at RFETS with the Ludlum Model 44-6 G-M stainless steel wall G-M probe.
- Detector has a 30-45 mg/cm^2 stainless steel wall (halogen quenched).

II. Instrument Specifications

A. MDDR

MDDR: 0.4 mR/hr (using site guidance, assuming a background of 0.02 mR/hr)

B. Types of Radiation Measured

Beta, Gamma

C. Ranges

- 0-0.5 mR/hr
- 0-5 mR/hr
- 0-50 mR/hr

D. Energies

- Beta: 200 keV - 3.27 MeV_{max}(based on the probe)
- Gamma : 10 keV - 2.73 MeV

E. Efficiencies

1,200 cpm/mR/hr for Cs^{137} gamma energy

F. Types of Batteries and Life

- two "D" cell batteries
- Typically 200 hr. battery life

G. Sensitivity

Input sensitivity of 30 mV (±10 mV)

H. Audio

Built in unimorph speaker with ON/OFF switch

I. Linearity

Within 5% of full scale reading

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J. Modes of Operation

Portable radiation dose rate meter

K. Voltage Range

850-1000 Volts

L. Alarm Range

No alarm functions

M. Calibration Stability

- Less than 15% variance to battery end point
- Less than ± 6% variance from the mean reference readings over a period of 3 hours

N. Response Times

4 seconds (± 1 second) on FAST setting ; 22 seconds (± 4 seconds) on SLOW setting from 10% to 90% of final meter reading.

O. Calibration Limitations

- Calibration shall be performed every 6 months
- Calibration time is approx. 2-3 hours
- Calibration is performed using a pulser, stopwatch, and voltmeter

III. Limiting Conditions of Operation

A. Temperature

-67°F to 167°F (-55° C to 75°C)

B. Barometric Pressure/Altitude

Not tested but no noticeable effects

C. Humidity

Testing not performed

D. Chemical Interference

No known effects

E. Radio Interference

No testing performed

IV. General Operations

A. Switch Configuration/Function

- Range multiplier switch: 5 position switch marked OFF, BAT, x10, x1, x0.1
- Audio ON/OFF switch
- FAST/SLOW toggle switch: provides meter response from 4 seconds (FAST) to 22 seconds (SLOW)
- RES button: when depressed re-zeros the meter reading

B. Background Counting

Not Applicable

C. Scan Rates

Not applicable

D. Scan Distance

Not applicable

E. Performance Test Requirements

- Must be performance checked daily when in use (by an HPI Technician).
- Performance check values must be within 20% of reference values.

F. Operational Test Requirements

- Verify calibration due date has not expired.
- Verify that the instrument has been performance checked prior to use (required daily).
- Check to see if battery power is satisfactory.
- Inspect instrument for damage or other condition that could impair its performance.

G. Good Practices

- Do not interchange probes with other meters. They are calibrated to a specific meter/probe configuration.
- Only qualified HPI personnel are allowed access to instrument internals.

H. Maintenance Allowed by User

- Batteries may be changed out by user.
- All other maintenance shall be performed by qualified HPI personnel.

EBERLINE ESP-1
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The ESP-1 is a microcomputer based potable radiation survey instrument designed to operate with a variety of Eberline radiation detectors. For neutron detection it is utilized with a Neutron Rem Detector (NRD) polyethylene ball. The ESP-1/NRD combination reads out neutron dose rate from 0.001 to 60 Rem/hr. and weighs 17.5 lbs. The ESP-1 has 3 operating modes (Rate meter, Scaler, and Inquiry/Calibration) and has an LCD read-out which can read-out radiation units as selected and calibrated by the user. The ESP-1 has an earphone output capability and internal speakers with audio alarm features.

The NRD is a 9-inch diameter cadmium loaded polyethylene sphere with a BF_3 tube in the center. This detector has been shown to have an energy response which closely follows the theoretical dose from neutrons over the energy range from 0.025 eV (thermal) to about 10 MeV. The BF_3 tube allows excellent gamma rejection and is identical to that of the Eberline PNR-4 portable neutron rem counter.

B. Features

- Can be used with a variety of detectors
- Can be operated as count rate instrument or scaler
- Can be operated with cable lengths up to 100 feet
- LCD display with digital bar graph
- Excellent linear response with the NRD sphere due to programmable Dead Time corrections

C. Scaler/Meter/Detector Configurations

- The ESP-1 can be operated in 3 modes ; Rate meter, Scaler, or Inquiry/Calibration mode.
- The ESP-1 is used at RFETs as a ratemeter attached to a neutron dose equivalent detector (NRD 9" ball)

II. Instrument Specifications

A. MDA

- 0.05 mR/hr (this is an "ideal" MDA based on a background of 0 mRem/hr and assuming a static source geometry - actual field measurements and the variables inherent therein will dramatically effect this value)
- RFETS neutron background activity is typically less than the instrument lower detection threshold of 1 mRem/hr (the instrument's minimum readout) and will usually result in a zero or "less than detectable" reading in normal survey conditions.

B. Types of Radiation Measured

Neutron (ESP-1 w/NRD)

C. Ranges

0.001 to 60 rem/hr for the NRD detector

D. Energies

0.025 eV (thermal) to approximately 10 MeV

E. Efficiencies

Gamma rejection up to 500 R/hr. (begins to fail at 50 R/hr) dependent on HV setting.

REVIEWED FOR CLASSIFICATION/UCNI
By B. M. Hoffman
Date 1-30-01 U/NU

F. Types of Batteries and Life

- The ESP-1 uses six "C" cell batteries.
- Carbon-zinc batteries last 250 hours during continuous use
- Alkaline batteries last approximately 300 hours during continuous operation
- Low battery alarm (first character blinking on display) signals at least 4 hours of operation remain before end of battery life.

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- The ESP-1 will turn itself off after it has operated for 2 hours under the "low voltage" condition (first character blinking). The instrument can be turned on by the operator and will operate for another 2 hours after which it will turn itself off again.
- Internal capacitor allows battery change (within 20 minutes) without memory loss.

G. Sensitivity

Approximately 50 cpm/mrem/hr (3000 counts/mrem)

H. Audio

- 2000 Hz audio tone from the internal speaker
- The speaker/alarm provides an audible "click rate" which is proportional to the output of the amplifier/discriminator. This rate can be scaled down when the high count rate detectors are employed.

I. Linearity

Within 10% of mean reference reading

J. Modes of Operation

The ESP-1 w/NRD combination is used in the Rate Meter mode and calibrated to read out in mrem/hr.

K. Voltage Range

- Low voltage: 5 Vdc
- High Voltage (detector bias voltage) : 350 to 2300 Vdc. NRD operating voltage is typically 1600 to 2000 V

L. Alarm Range

Programmable from the Inquiry/Calibration Mode to alarm at values from 1 mrem/hr to 60 Rem/hr.

M. Calibration Stability

Within 10% of mean reference values on all scales

N. Response Times

No testing performed

O. Calibration Limitations

- Separate calibration constants must be entered via the Inquiry/Calibration Mode for each type of detector used with the ESP-1. Failure to enter the correct parameters for the NRD sphere may result in erroneous display values on the ESP-1 read-out.
- A specific dead time (DT) must also be set for each type of detector used with the ESP-1 and each NRD sphere is calibrated to a specific ESP-1.
- Pulse generator calibration is recommended

III. Limiting Conditions of Operation

A. Temperature

-4°F to 122° F (-20° C to 50° C)

B. Barometric Pressure/Altitude

No known detrimental effects

C. Humidity

Within 15% of mean reference values at 40% to 95% relative humidity (non-condensing). No testing performed at <40% relative humidity.

D. Chemical Interference

No testing done, but no detrimental effects expected

E. Radio Interference

No testing performed

IV. General Operations

A. Switch Configuration/Function

- The ESP-1 has a 7 push button array located on the instrument face.
- ON/OFF: Powers the instrument on and off. A 1 minute warm up time is recommended prior to use.
- MODE: Used to enter one of 3 operating modes - Ratemeter, Scaler, or Inquiry/Calibration Modes
- RESET: The functions of this switch depend on the operating mode selected for the instrument. In the Rate Meter Mode the RESET is used to maintain the bar graph. In the Scaler Mode the switch resets the ESP-1 to a new count interval. In the Inquiry/Calibration Mode the RESET switch allows the user to select or change parameters and when used with the "+" or "-" keys will increase or decrease the value set for that parameter.
- LIGHT: When pressed the display is illuminated
- "+" & "-" keys: Use is dependent on the operating mode selected but generally used to increase or decrease parameters
- SPKR: Pressing the switch turns the speaker on and off. It also turns the alarm off when it activates. When SPKR is used to silence the alarm the speaker remains on until the operator presses SPKR again.

B. Background Counting

Not applicable when used with the NRD sphere

C. Scan Rates

Not applicable when used with the NRD sphere.

D. Scan Distance

Not applicable when used with the NRD sphere

E. Performance Test Requirements

Daily during use (by an HPI Technician).

F. Operational Test Requirements

- Verify that calibration due date has not expired.
- Verify that instrument has been performance checked daily during use.
- Check LIGHT and SPKR switches to ensure the light and alarm/ratemeter speaker are working.
- Inspect the instrument for damage or other impairments to its operation.

G. Good Practices

- The NRD sphere is relatively heavy -use caution not to drop it to prevent damage or personal injury
- The NRD is calibrated to a specific ESP-1 and should not be interchanged with other ESP-1s .
- When measuring general area readings at one-foot (30 cm.), the unit should be positioned such that the CENTER (not the edge) of the rem ball is located at 30 centimeters or 12 inches from the source.
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source. All measurements must be made with the detector at 90 degrees from the active area of the source. For example, if the source is in the floor below or the overhead above, the rem ball must be rotated 90 degrees from the upright position in order to obtain an accurate measurement.

H. Maintenance Allowed by User

All maintenance including battery change out shall be performed by qualified HPI personnel.

EBERLINE XETEX TELESCAN 330A
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description:

The Xetex Telescan 330A is a portable gamma radiation survey instrument designed to measure gamma radiation levels from 0.35 mrem/hr to 1,000 rem/hr. The instrument is microcomputer based and reads out on an analog meter. The telescoping probe can be extended to approximately 13 feet. This allows the measurement of high level radiation sources while the user maintains distance and reduces exposure. It also allows measurements in hard to reach places. The Telescan has two energy compensated G-M tubes in a remote head and have different sensitivities to cover a broad range of gamma radiation measurements. Data from the remote head is transmitted to the base unit via infrared signal inside the hollow telescoping wand to eliminate the problems associated with wiring within the sliding telescope.

B. Features

- High range and low range energy compensated detectors
- Optional plastic sheaths available for making underwater measurements
- Microprocessor based
- Carrying strap and carrying case provided to transport instrument
- Telescoping probe to 13 feet

C. Scaler/Meter/Detector Configurations

For use as a high range detector with an extendible probe to reduce personnel exposure and to monitor hard to reach areas.

II. Instrument Specifications

A. MDDR

0.35 mR/hr on Low range detector (based on site guidance, using a background of 0.02 mR/hr)

B. Types of Radiation Measured

Gamma, X-ray

C. Ranges

- x100 = high range 0 - 1,000 R/hr.
- x10 = high range 0 - 100 R/hr
- x1 = high range 0 - 10 R/hr.
- x100 = low range 0 - 1,000 mR/hr
- x10 = low range 0 - 100 mR/hr
- x1 = low range 0 - 10 mR/hr
- x0.1 = low range 0 - 1 mR/hr.

See **CAUTION** statement on Page 3

D. Energies

70 keV to about 1.3 MeV (± 15%)

E. Efficiencies

Not applicable

F. Types of Batteries and Life

- Four alkaline "C" cell batteries in the base unit (approx. 400 hours life)
- Two 3.6 Volt lithium AA batteries in the remote probe (approx. 350 hours life normal operation- 80 hours when in a 100 Rem/hr field)

G. Sensitivity

- High range probe: 21 cpm/mR/hr
- Low range probe: 1040 cpm/mR/hr.

H. Audio

Internal speaker puts out 70 dB at 30 cm

PADC-98-00399

I. Linearity

10 % of reading (calibrated to Cs^{137})

J. Modes of Operation

- High range scale (0-1,000 R/hr)
- Low range scale (0-1,000 mR/hr)
- Can be used for monitoring high radiation areas without excessive personnel exposure
- With optional sheathing, can be used to take underwater measurements

K. Voltage Range

Operating voltage is 525 VDC for both detectors

L. Alarm Range

No alarm capabilities

M. Calibration Stability

<10% variance over the calibration reference values

N. Response Times

Varies from 1 second to a maximum of 4 seconds depending on range and response pot setting.

O. Calibration Limitations

- Requires approximately 6-8 hours to calibrate
- High level gamma source required to calibrate highest scale ranges

II. Limiting Conditions of Operation

A. Temperature

0° C to 40° C (32° F to 104° F) ± 10%

B. Barometric Pressure/Altitude

No detrimental effects

C. Humidity

Operable within 0-95% relative non-condensing humidity.

D. Chemical Interference

None known

E. Radio Interference

Results acceptable for both ranges tested during frequency scan (0.3 to 35 Mhz) and 140 Mhz at 50 volts/meter.

IV. General Operations

A. Switch Configuration/Function

- Analog meter - Scale from 0-10 with 10 divisions and 50 subdivisions
- Light - membrane push button ON/OFF
- Speaker - membrane push button - ON/OFF
- Reset - Push button resets meter reading to zero
- 9 position rotary switch - OFF, BATTERY, 7 decade scale
- LED light on base unit lights to indicate any of several failures in the remote detector and base unit The number of "beeps" corresponds to the meter reading for a particular malfunction as follows; (1= remote probe battery low; 2 = remote probe voltage low, 3 = infrared communications failure, 5 = over range on highest low range, and 8 = over range on highest high range)

B. Background Counting

Not Applicable

C. Scan Rates

Not Applicable

D. Scan Distance

Not Applicable

E. Performance Test Requirements

- The Telescan shall be performance checked at least every 24 hours when in use by an HPI Technician.
- Performance check results shall be within 10% of reference values.

F. Operational Test Requirements

Prior to use:

- Verify that battery power is satisfactory
- Verify that instrument has been performance checked within the last 24 hours of use.
- Verify that calibration due date has not expired
- Check LED failure light in detector base for failure indication
- Inspect instrument for damage or other impairment to its operation

G. Good Practices

- Do not immerse probe in water without plastic sheath - it is not watertight.
- Use caution in handling probe to ensure that the end detector or telescoped sheath is not damaged.

H. Maintenance Allowed by User

- User may change batteries in the base unit only by removing the handle and replacing the four "C" cell batteries.
- All other maintenance shall be performed by qualified HPI personnel.

CAUTION:

The instrument will not indicate overrange readings if it is turned on with its detectors in a high intensity overranging radiation field. The detector must be brought into the overranging field after it is turned on in order for the latching overranging condition to be set. Exposure rate saturation is < twice maximum scale reading (Saturation = 1300 R/hr for high range.)

EBERLINE SWENDI (also WENDI-2)
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

Portable high-sensitivity neutron dose equivalent meter equipped with an Eberline E600 rate meter/scaler. The WENDI-2 detector is 9" diameter, 12 1/2" high (including handle), and weighs approximately 30 lb. The E-600 is 9" long, 4.1" inches wide and 6" tall. It weighs 3.4 lbs.

B. Features

- Measures neutron dose equivalent and dose equivalent rate.
- Automatic background subtraction feature available.
- Dose equivalent rates as low as 15 to 100 microrem/hour are readable in the rate meter mode.
- Large backlit display.
- Autoranging display.
- WENDI-2 stores its calibration parameters and can be used with any E600, not just the one initially used in calibration.

C. Scaler/Meter/Detector Configurations

E-600 meter and the WENDI-2 detector are connected by a coaxial cable and operated as a single unit. Detector includes a helium-3 tube surrounded by a moderator designed to produce an approximately tissue equivalent dose response.

II. Instrument Specifications

A. Minimum Detectable Dose Equivalent Rate

15 microrem per hour in the rate meter mode. (Based on slow response setting equal to 60 seconds and linear extrapolation of the signal below cardinal points of calibration.)

B. Types of Radiation Measured

Neutron.

C. Ranges

Autoranging from nanorem per hour to rem per hour.

D. Energies

Emulates a tissue equivalent response over the neutron energy range including thermal to 1000 MeV. The response function is based on a theoretical calculation. Overresponse of up to 40% is known to occur when a highly moderated (low energy) neutron spectrum is measured. Under most conditions at RFETS the response is expected to be within 30% of the conventionally true value and corrections are not normally required for field measurements.

E. Types of Batteries and Life

Powered by three alkaline "C" cells. Typical alkaline battery life: 8 hours. Use of the instrument may be continued until the unit disables itself due to low power.

F. Sensitivity

Nominally 600 cpm per mrem per hour.

G. Audio

User selectable.

H. Linearity

Within ± 5% of the conventionally true value for unmoderated californium-252 neutrons over the dose equivalent range of 2.5 to 4000 mrem per hour. Definitive testing is not available at lower dose equivalent rates, but linearity is expected to be similar down to the limits of detection.

I. Modes of Operation

Normally used in the rate meter mode.

J. Alarm Range

No alarm capabilities are enabled in this application.

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By [illegible]
Date 20 MAR 01 UNR

PADC-1999-02612

K. Calibration Stability

Not available

L. Response Times

The time to reach 90% of the full scale reading varies depending on the position of the response switch.

Fast:	7 seconds
Medium:	25 seconds
Slow:	60 seconds

Use the slow response setting when accurate measurements are required and the dose equivalent rate is less than 0.1 mrem per hour.

M. Calibration Limitations

WENDI-2 and E600 are calibrated as one unit every six months or after maintenance and/or repair.

N. Angular Response

Depending on the orientation of the source to the detector the instrument can underrespond to high energy neutrons by 10% or overrespond by up to 15%. For lower energy neutrons the overresponse can be larger. See the Technical Basis Document 00136 for details. Corrections are not normally required for field measurements.

N. Miscellaneous

Contains non-toxic, highly dispersible, powdered tungsten metal inside the polyethylene moderator. Do not remove fasteners holding the polyethylene moderator together.

III. Limiting Conditions of Operation

A. Temperature

-4°F to 122°F (-20°C to 50°C).

B. Barometric Pressure/Altitude

Insensitive to barometric pressure changes.

C. Humidity

Zero to 95% relative humidity, non-condensing.

D. Chemical Interference

None

E. Radio Interference

Do not use within 1 meter of a radio transmitter.

IV. General Operations

A. Switch Configuration/Function

Rotary switch functions

- Off
- Check
- Ratemeter
- Integrate
- Scaler
- Peak Hold (functions like Ratemeter, trapping the highest reading)
- Background (press star key to lock in background measurement after desired precision is attained).

Gross/Net button

User selectable with status displayed on screen. If net is selected the value locked in using the star key in Background mode is subtracted from all measurements.

Speaker button
User selectable.

Range
User selectable, but autoranging normally eliminates the need for this.

Chnl
Handle-mounted button switches display units if enabled.

Star key
Handle-mounted button has different uses depending on rotary switch position.

Ratemeter:	First press provides instantaneous readout, bypassing normal time constant calculations Second press returns to normal rate meter mode
Integrate:	Provides a view of the rate meter mode as long as the key is pressed. Does not interfere with integrated count.
Scaler:	Initiates a pre-set timed count cycle. The count time is typically set for 6 minutes, but may be different.
Peak-Hold:	Releases the peak hold to begin again.

Log
Handle-mounted button is pressed once to log sequential ID number, and again to record the displayed data.

Light
Handle-mounted button momentarily illuminates the screen when pressed.

B. Scan Rates

Limited by response times referenced in II.L.

C. Performance Test Requirements

Check for proper meter response against a known source. All other tests are automatically performed when the instrument is turned on.

D. Operational Test Requirements

Performed daily by Health Physics Instrumentation. Instrument locks itself out of service when calibration of either component is expired.

E. Good Practices

- Ensure proper response time is allowed, especially when making dose equivalent rate measurements where the reading is less than 0.5 mrem per hour.
- When measuring general area readings at one-foot (30 cm.), the unit should be positioned such that the CENTER (not the edge) of the cylinder is located at 30 centimeters or 12 inches from the source.
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source. All measurements must be made with the detector at 90 degrees from the active area of the source. For example, if the source is in the floor below or the overhead above, the cylinder must be rotated 90 degrees from the upright position in order to obtain an accurate measurement.
- Be aware that the dose rate is measured at the centerline – not at the surface - of the detector. Therefore a contact reading represents the dose equivalent 4 ½ inches from the surface being measured.
- Use with a hand truck whenever possible to avoid carrying or lifting this heavy detector.

F. Maintenance Allowed by User

User is allowed to perform battery replacement only.

LUDLUM HIGH RANGE ALPHA ION CHAMBER, MODEL 195 READOUT WITH MODEL 43-132 ION CHAMBER PROBE INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The instrument consists of a lightweight (2.7 lb.), portable, battery-powered readout unit with a lightweight (1 lb.) hand probe. The probe is a 100 cm^2 air filled ion chamber with a 0.4 mg/cm^2 Mylar window for alpha detection. The readout and probe are collectively known as the Ludlum Model 195. The nickname is "SCOOBY TWO."

B. Features

The instrument reads out directly in units of million dpm, and because the probe measures per 100 cm^2 area, the readout is actually in million dpm per 100 cm^2. The hand probe is equipped with feet on each corner to provide a 1/8-inch spacing between the probe face and the surface being measured. This reduces variability in measurements and minimizes contamination of the probe. Field replacement of the probe can be performed by the RCT.

C. Scaler/Meter/Detector Configurations

The meter is a direct digital readout. The only configuration option available is cable length. The cable can be connected to other Ludlum Model 195 cables to alter cable length in 3, 7, or 10-foot increments up to 300 ft in length.

II. Instrument Specifications

A. MDA

MDA as defined in RSP 02.01 is not applicable to this instrument. However we define a lower limit of detection, which is a similar concept, as the lowest number that can be displayed on the readout. The lower limit of detection is 0.01 million dpm per 100 cm^2, which is the same as 10,000 dpm per 100 cm^2. Put this number in the MDA field when writing survey reports.

B. Maximum Operating Range

The upper limit for this instrument is 1000-million dpm per 100 cm^2. Readings in excess of this value have not been qualified and may or may not be accurate. Readings in excess of this value should not be used as quality assured data for record purposes; however, they may be useful as unofficial indicators of contamination level.

C. Types of Radiation Measured

This instrument is specifically designed to measure alpha surface contamination, but it is also sensitive to beta, gamma and neutron radiation. Testing has shown that dose equivalent rates as high as 100 mrem per hour produce no significant reading.

D. Ranges

- Low range spans from 0.01 to 20.00-million dpm per 100 cm^2. When a reading is off scale on the low range, the display shows the number "1" on the left hand side of the display. The normal display - of 4 digits including a decimal point - is not seen.
- High range spans from 1 to 1000-million dpm per 100 cm^2. Numbers in excess of this may be displayed, and may or may not be accurate, but they should not be recorded on survey report.

RSP 09.05 Rev 3, Section 5 states: *"Specialized instrumentation may be used over the full-specified range in the implementing procedure."* This instrument is specialized instrumentation, and it may be used to the full extent of its qualification for any purpose, including SCO characterization. The 80% limitation does not apply to this instrument.

E. Energies

- All alpha energies are detected.

REVIEWED FOR CLASSIFICATION/UCNI
By Daniel L. Blanfield
Date 09 SEPTEMBER 2004

F. Efficiencies

- Not applicable for this detector

G. Types of Batteries and Life

- The Ludlum Model 195 uses two alkaline D-cell batteries. Batteries may be changed in the field by the RCT. No recalibration is required after battery change.

H. Sensitivity

- Not applicable for this detector

I. Audio

- None

J. Linearity

Response linearity to ±1% over the entire operating range of 0.01 to 1000-million dpm per 100 cm^2 has been demonstrated under laboratory conditions using NIST traceable sources and radiation fields.

K. Modes of Operation

- Operates only in the rate meter mode with a direct readout of million dpm per 100 cm^2.

L. Voltage Range

- The ion chamber operates at 85 V and produces an output signal of 0 to 5 V.

M. Alarm Range

- No alarm capability.

N. Calibration Stability

- No data have been accumulated to define this value. Calibration of the readout unit at six-month intervals is planned. Every probe is acceptance tested and calibrated upon receipt. Probes are expected to be irretrievably contaminated during use, consequently "as found" testing of the probe at the end of the calibration cycle is unlikely to occur. Performance testing is required prior to use and, if possible, at the end of service.

O. Response Times

- Response time is 90% of the final reading within approximately 5 seconds.

P. Calibration Limitations

- None.
- The readout unit calibration due date is stated on the readout unit.
- The probe calibration lasts indefinitely, as long as the performance test criteria (see section IV. F.) are met.

III. Limiting Conditions of Operation

A. Temperature

- Qualified for use over the temperature range of 32° F and 120° F.
- Use outside this temperature range is possible, but special calibrations are required.

B. Barometric Pressure/Altitude

- Not affected by barometric changes associated with changes in the weather or changes in altitude that can occur at RFETS.
- This instrument is calibrated for use at RFETS. If the instrument is operated at altitudes that are different from the RFETS altitude by more than 500 feet, significant measurement bias may exist.

C. Humidity

- Not affected by ordinary changes in humidity.
- Not designed for continuous use in areas where relative humidity is 100%.

D. Chemical Interference

- No data available.

E. Radio Interference

- Affected by hand-held radio transceiver transmissions within 10 feet of the instrument. The effect is transient and is usually obvious.
- No effect from fluorescent lighting has been observed.

F. Mylar Window Damage

- There is no significant effect on instrument readings if limited mylar window damage occurs. The probe can remain in service as long as the hole in the mylar is not larger than ½-inch diameter or an equivalent area (for example two ¼ inch holes would also be acceptable). Any change in instrument response due to damaged mylar is conservative, which means the damage has the effect of overestimating the true contamination level. For example, a ½-inch hole in the mylar produced a 3% over response in laboratory testing.
- The instrument is not affected at all by light leaks that occur when mylar is damaged.

G. Shock and Vibration

- Shock and vibration do not have a significant effect on instrument readings. Any effect is transient and is usually obvious.

IV. General Operations

A. Warm-Up Period

- After the instrument is turned on or the batteries are replaced, allow the detector to warm up for 5 minutes before taking data for survey reports. This allows the ion chamber wall voltage to stabilize.
- Operational and performance tests can be done during the warm up period. If these test fail repeat them after the warm up period is complete.

B. Switch Configuration/Function

- The range selector switch can be set at OFF, BAT, HI and LO.
- A zero adjust knob, called the NUL, can be operated by the user when a probe change occurs. The NUL is protected to prevent inadvertent adjustment.
- Use of the NUL adjustment is limited to probe replacement. Do not use the NUL adjust to remove a persistent background signal.

C. Scan Rates

- Not applicable.

D. Scan Distance

- Fixed at 1/8-inch above the surface by feet on each corner of the probe face.

E. Background Subtraction

- As the probe gets contaminated, or in the unlikely event that beta, gamma or neutron radiation produces an interfering signal, a background reading will appear on the detector readout. In that case the background reading is recorded and subtracted from the gross reading to result in the net contamination level.

F. Performance Test Requirements

Performance tests are required:

- Daily, prior to use, when the instrument is in service
- Daily, at the end of use
- Prior to probe replacement if practical, and
- Immediately following probe or cable replacement.

Performance testing can be performed using the built-in test feature on the Model 43-132 Ion Chamber probe with results documented with the survey.

a) Battery Test
   - Test battery by putting the range selector switch on BAT.
   - Replace if the green battery light does not illuminate

b) Electronic Test
   - Position the Model 43-132 Ion Chamber probe so it is not affected by a contaminated surface.
   - Turn the range selector switch to HI.
   - Note the expected increase during performance testing as shown on the calibration sticker.
   - Note the displayed reading, which is the background.
   - Press and hold the performance test button on the Model 43-132 probe.
   - Note the displayed reading after the readout has stabilized. This may take up to 10 seconds.
   - Release the test button.

The instrument passes the performance test if the displayed reading has been increased by an amount within the acceptable range. (The acceptable increase range is the expected increase, plus or minus 15%).

Figure 1 and 2 are typical examples of the calibration sticker and calculation data.

	RFP CALIBRATION			
S E P	CAL DATE	06/01/02	SERIAL NO.	PR161523
	DUE DATE	NONE	SOURCE	Test button
	BY	21	TOLERANCE	234 -316

Figure 1, Typical Calibration Sticker

Example Parameter	**Example Result,** Million dpm / 100 cm^2
Currently observed background	150
Expected increase when test button is pushed	275
Minimum increase when test button is pushed (- 15%)	234
Maximum increase when test button is pushed (+ 15%)	316
Minimum acceptable reading when test button is pushed (background plus minimum increase)	150 + 234 = 384
Maximum acceptable reading when test button is pushed (background plus minimum increase)	150 + 316 = 466

Figure 2, Example Parameter and Results Calculations

G. Operational Test Requirements

- Perform operational tests every hour when the instrument is in service or prior to intermittent use.

a) Operational Tests:
- Battery
- Readings fluctuate as expected
- Depress electronic test button and observe significant increase in displayed contamination level. (It is not necessary to perform the calculations to demonstrate that performance test has been passed during hourly operational testing.)

H. Good Practices

- Do not unnecessarily allow contact between the face of the probe and highly contaminated surfaces.
- Note the location of a convenient area, called a field reference point, where the contamination level is significantly elevated.
- Periodically during the survey, return to the field reference point to confirm the instrument reading is consistent with prior measurements. If the instrument reading is not consistent with prior measurements, perform an operational or a performance test.

I. Maintenance Allowed by User

Battery change, probe change, and cable length change is allowed. (Note: See Part J for changing cable length).

a) Battery Change

The battery should be changed when the battery indication light fails to illuminate when the BAT position is selected.
- Open the battery compartment lid by twisting the opening the thumbscrew counterclockwise.
- Remove the batteries and discard in an appropriate waste container.
- Replace the batteries with two new alkaline D-cell batteries. Observe the polarity requirements shown on the battery compartment.
- Perform the battery test
- Allow 5 minutes for the chamber voltage to stabilize before recording data.
- Operational and performance tests may be performed during the warm up period.

b) Probe Change

The probe should be changed when 1) contamination of the probe reaches levels that interfere with measurements 2) the mylar is extensively damaged, or 3) other operational conditions indicate a change would be beneficial.

Perform these actions only with a new, unused replacement probe.
- Disconnect the old probe.
- Place the new probe in a location and/or orientation where the expected reading is zero.
- Connect the new probe.
- Select the LO Range readout.
- Adjust the NUL knob until the displayed reading is 0.00
- Conduct operational and performance tests.

J. Cable Length

- Cables that connect the Model 195 and the Model 43-132 Ion Chamber probe can be assembled in any length or combination of lengths up to 300 feet.
- The NUL knob must be adjusted until the displayed reading on the LO Range readout is 0.00 (the probe must be uncontaminated).

LUDLUM MODEL 43-133 SIDE WINDOW GM WITH LUDLUM MODEL 31 READOUT INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Ludlum Model 43-133, also called the "silver poker," is a portable alpha/beta contamination survey instrument that is designed to measure high level alpha contamination on interior surfaces of pipes and conduits and other spaces that would be inaccessible to a larger probe. The probe is normally operated with a battery powered Ludlum Model 31 ratemeter, which provides four linear ranges from 0 to 1,000,000 cpm. (The detector upper-range-limit is 200,000 cpm)

B. Features

Fast and slow response modes of operation.
Audible external speaker and headphones.
Lightweight, portable, durable, and battery operated.
Detector is fitted in a handle with a bicycle grip to define orientation of the detector opening.
The outside diameter of the detector housing is 0.8 inches and fits inside a 1" diameter pipe.
The detector housing is calibrated for use with a replaceable mylar sleeve to prevent contamination of the assembly.
The window of the detector is ½ inch diameter, equivalent to a 1.3 cm^2 area.

C. Scaler/Meter/Detector Configurations

Ludlum Model 31 survey instrument with Ludlum Model 43-133 Side Window Geiger-Mueller (GM) Detector.

II. Instrument Specifications

A. Minimum Detectable Concentration

Stationary (Pat Method) response is based on readability of the analog ratemeter movement using the slow response. The smallest scale division corresponds to 50 cpm. Assuming that a technician can read to within ½ of the minor scale division and the background count rate is 10 cpm or less, and the minimum net count rate in a stationary count is approximately 30 cpm:

<u>MDC for uniformly distributed alpha contamination</u>
The counting efficiency for uniformly distributed alpha contamination, including the area correction factor, is 0.1%. This is the same as an efficiency factor of 1000. The MDC for uniformly distributed alpha contamination is:

$$MDC = 30 \text{ cpm} * 1000 = 30{,}000 \text{ dpm} / 100 \text{ cm}^2.$$

<u>MDA for a point source of alpha contamination</u>
The counting efficiency for a point source of alpha contamination, <u>not</u> including the area correction factor, is 9.2%. This is the same as an efficiency factor of 11. The MDA for a point source of alpha contamination is:

$$MDA = 30 \text{ cpm} * 11 = 400 \text{ dpm (rounded up for only 1 significant figure)}$$

B. Types of Radiation Measured

Alpha contamination.

Beta contamination. The detector is also sensitive to beta contamination, which is some areas might confuse interpretation of results under some conditions. The efficiency for strontium-90 beta radiation is similar to the efficiency for alpha emissions. The instrument is not calibrated for measurement of beta radiation.

Gamma radiation. The detector has a slight sensitivity to gamma radiation, which is some areas might confuse interpretation of results. It is not calibrated for measurement of gamma radiation.

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LUDLUM MODEL 43-133 SIDE WINDOW GM WITH LUDLUM MODEL 31 READOUT INSTRUMENT TECHNICAL SPECIFICATION SHEET

C. Ranges

Ludlum Model 31 Instrument Ranges	Alpha Contamination Level, dpm per 100 cm^2	Comment
0 to 1000 cpm	0 to 1,000,000	MDC is 30,000 dpm per 100 cm^2 based on readability of the meter movement and "nearly zero" background
0 to 10,000 cpm	0 to 10,000,000	
0 to 100,000 cpm	0 to 100,000,000	
0 to 1,000,000 cpm	0 to 1,000,000,000	Calibration is limited to 200,000,000 dpm per 100 cm^2

The Model 43-133 has been demonstrated to be linear up to 200 million dpm / 100 cm^2 which corresponds to 200,000 cpm. Due to source limitations testing has not been performed above this level. The upper detection limit is therefore set at 200 million dpm / 100 cm^2.

Note: It may be possible to use the Model 43-133 to measure higher levels of alpha contamination. If higher contamination levels need to be measured, the detector could be matched with a ratemeter that includes dead-time correction in the circuit. The Ludlum Model 2241 ratemeter includes a dead-time correction circuit.

D. Energy Response

Beta Energy Range: greater than 16 keV
Alpha Energy Range: all alpha energies are detected

E. Efficiency

Alpha efficiency is 0.12%, which has been rounded down to 0.1% to enable simpler field calculations possible and make all probes interchangeable between ratemeters. 0.1% efficiency results in a multiplication factor of 1000. In other words:

Uniformly distributed alpha contamination (dpm / 100 cm^2) = cpm * 1000

If a point source of alpha activity is being measured, the area of the probe can be factored out of the efficiency shown above resulting in the following:

Point source alpha activity (dpm) = cpm * 11

F. Types of Batteries and Life

Two standard "D" cells with a typical battery life of 200 hours.

G. Audio

Instrument has external speaker and headphone jack.

H. Linearity

± 10% full scale.

I. Modes of Operation

Instrument can operate in the "Fast" or "Slow" response mode for detection of surface contamination.

J. Voltage Range

The instrument is set to operate at nominally 900 V.

K. Alarm Range

No alarm capabilities.

L. Response Times

Fast Response Mode:	4 seconds ± 1 second for 90% of final meter reading.
Slow Response Mode:	22 seconds for 90% of final meter reading.

M. Calibration Limitations

Calibrated every six months or after maintenance and/or repair.

III. Limiting Conditions of Operation

A. Temperature

Do not operate outside of 32°F to 150°F (0°C to 65°C)

B. Barometric Pressure/Altitude

No observed effects.

C. Humidity

No observed effects.

D. Chemical Interference

No observed effects.

E. Radio Interference

No observed effects.

IV. General Operations

A. Switch Configuration/Function

- Meter reset switch: Resets the meter to zero when depressed.
- Fast-slow meter response switch: Speeds up or slows down the response/display of the meter.
- Six position, multifunction switch: Used for Off, Battery Check, X1, X10, X100, and X1000 scale multiples.

B. Scan Rates

The small detector size makes it impractical to define a scan MDC and a recommended scan speed is not defined. Scan surveys are useful only in a relative sense.

C. Measurement Distance

Measure within 1/4 inch of surface.

D. Establish Response on a Source Board

When an instrument is first used in a facility, establish the nominal response on the high range Model 12-1A source board assigned to that facility. Select a specific location on the source. Note that the activity on the Model 12-1A source board is not uniformly distributed, so not all locations on the source board have the same surface emission rate. Put the instrument in close contact (< ¼ inch) to the test source. Be careful not to directly touch the source. Establish the acceptable count rate range for comparison in future performance tests.

Here is an example: - 20% value = cpm – (0.2 * cpm)
+ 20% value = 1.2 * cpm

Future performance tests should be done on the same location on the same source board.

LUDLUM MODEL 43-133 SIDE WINDOW GM WITH LUDLUM MODEL 31 READOUT INSTRUMENT TECHNICAL SPECIFICATION SHEET

E. Performance Test Requirements

Daily performance test to include:

- Quantitative source response.
- Battery test prior to use.
- Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired.
- During use, verify audible response, needle deflection, when challenged with a radiation source.

F. Good Practices

- Ensure Performance Test and Operational Requirements are met.
- Use the instrument with a protective mylar sleeve to prevent contamination.
- Ensure the bicycle handle grip is oriented so the sensitive area of the probe points directly downward when the hand grip is held in a normal position.

G. Maintenance Allowed by User

User is allowed to change batteries.

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