



BWXT Y-12, L.L.C.
RADIOLOGICAL CONTROL ORGANIZATION
TECHNICAL BASIS DOCUMENT

TECHNICAL BASIS
FOR
RADIOLOGICAL INSTRUMENTS
USED AT THE Y-12 NATIONAL SECURITY COMPLEX

February 19, 2001

This document has been reviewed by an Authorized Derivative Classifier and UCNI Reviewing Official and has been determined to be UNCLASSIFIED and contains no UCNI. This review does not constitute clearance for public release.

Name: C. A. (Tina) Smith Date: 02-19-01

Technical Basis
for
Radiological Instruments
Used at the Y-12 National Security Complex

Original signatures and dates are on file

February 19, 2001

Prepared by: P. D. Pruitt /s/ 02/19/01
P. D. Pruitt Date

Approved by: D. P. Rowan /s/ 02/19/01
D. P. Rowan, Instrumentation and Technical Programs Department Manager Date

Prepared by the
Radiological Control Organization
Y-12 National Security Complex
operated by
BWXT Y-12, L.L.C.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-ACO5-00OR22800

Table of Contents

1.0 Scope 6

2.0 Requirements 6

 2.1 Applications 6

 2.2 Compliance Criteria 6

3.0 Configuration Control 7

 3.1 Responsibility 7

 3.2 Procedure Guidance 7

 3.3 Training 7

 3.4 Inventory Control 7

 3.5 Performance Test Requirement 7

 3.6 Calibration Requirement 7

 3.7 Conclusion 7

 3.8 References 8

 3.9 Instrument Qualifications 8

 A. Contamination Instruments 11

 1. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-65 Alpha
 Scintillator Detector 12

 2. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-5 Alpha Scintillator
 Detector 15

 3. Ludlum Model 3 Survey Meter with a Ludlum Model 44-9
 Alpha-Beta-Gamma Detector 18

 4. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 43-65 Alpha
 Scintillator Detector 21

 5. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 44-9
 Alpha-Beta-Gamma Detector 23

 6. Ludlum Model 239-1F Floor Monitor 26

 7. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model
 43-89 100 cm² Alpha-Beta-Gamma Scintillator Detector 29

 8. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model
 43-2-2 Alpha-Beta-Gamma Scintillator Detector 31

 9. Bicron Model Electra Scaler Ratemeter with a Model DP6A 100 cm²
 Alpha-Beta-Gamma Scintillator Detector 33

 10. Ludlum Model 3 Survey Meter with a Ludlum Model 44-10 Gamma
 Sodium Iodide (NAI) Detector 35

 11. Eberline Model RM-14SA Radiation Monitor with a Ludlum Model
 44-2 NaI Gamma Scintillator Detector 36

Table of Contents (cont.)

B.	Dose Rate Instruments	37
1.	Eberline Model RO-2 Ion Chamber	38
2.	Eberline Model RO-20 Ion Chamber	40
3.	Bicron Model Micro Rem Tissue Equivalent Survey Meter	42
4.	Ludlum Model 12-4 Count Rate Meter Neutron Counter	44
5.	Automess Model 6112B Teletector	46
6.	Bicron Model Radiographer Dose Rate Meter	48
7.	Keithley Model 36100 Survey Meter	50
8.	Xetex Model Telescan Teletector	52
9.	Ludlum Model 12 Scaler Rate Meter with Ludlum Model 15 Neutron Detector	54
10.	Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Wall Mount Proportional Neutron Counter	55
11.	Eberline Model RO-7 Ion Chamber	56
12.	MGP Model DMC 90/100 Electronic Pocket Dosimeter	58
C.	Air Sampling/Monitoring Instruments	60
1.	F & J Specialty Products Inc. (F & J) Model HV-1/HV-1ST/HV-1SRT High Volume Air Sampler	61
2.	Science Applications International Corporation (SAIC) Model HD-29A Low Volume Air Sampler	62
3.	Eberline Model ALPHA-6S Continuous Air Monitor (CAM)	63
4.	MSA Model Escort Elf Personal Air Monitor (PAM)	64
5.	Overhoff Model 400SBDäC Tritium Monitor	65
6.	Johnston Laboratories, Inc. (JLI) Model Triton 111 Tritium Air Monitor	67
7.	F & J Specialty Products Inc. (F&J) Model LV-1 Low Volume Air Sampler	68
8.	Science Applications International Corporation (SAIC) Model AVS-28A Low Volume Air Sampler	69
9.	Science Applications International Corporation (SAIC) Model H-810 Air Volume Totalizer	70
10.	Science Applications International Corporation (SAIC) Model HD-66A Low Volume Air Sampler	71
D.	Personnel Monitoring Instruments	72
1.	Eberline Model RM-14S Radiation Monitor with an Eberline Model HP-100A Gas Proportional Detector	73
2.	Ludlum Model 177-45 Alarm Rate Meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector	76
3.	Ludlum Model 177-45 Alarm Rate Meter with a Ludlum Model 43-65 Alpha Scintillator Detector	79
4.	Eberline Model PCM-1B Personnel Contamination Monitor	82
5.	Eberline Model PCM-2 Personnel Contamination Monitor	84
6.	Ludlum Model 2200 Scaler Rate Meter with a Ludlum Model 43-65 Alpha Scintillator Detector	86

Table of Contents (cont.)

E. Counters (Field and Laboratory)	87
1. Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-1 Alpha Scintillator Detector	88
2. Ludlum Model 2929 Dual Channel Scaler with a Ludlum Model 43-10-1 Alpha-Beta Sample Counter	91
3. Science Applications International Corporation (SAIC) Model AP-2 Alpha Analyzer	93
4. IN/US Systems B-RAM Model 2B Radioactivity HPLC Detector	95
5. Tennelec Model Eclipse 5XLB Low Background Proportional Counter	96

1.0 Scope

The BWXT Y-12 National Security Complex (Y-12 Complex) Radiological Control (RADCON) Organization shall monitor for uranium and other radionuclides. Instruments used shall be appropriate for detection or measurement of radiation types (alpha, beta, gamma, x-ray or neutron) and energies that may be encountered.

2.0 Requirements

2.1 Applications

Instrument applications shall include personnel contamination monitoring, contamination monitoring, dose rate monitoring, and air monitoring. Instrument applications may be subject to variable environmental conditions and fields of interfering radiation such as radio frequencies.

- o Instruments shall be capable of monitoring alpha radiation in the presence of beta-gamma and neutron radiation; beta-gamma radiation in the presence of alpha and neutron radiation; and neutron radiation in the presence of alpha and beta-gamma radiation. Specific instruments shall be able to monitor airborne, personnel and fixed/removable contamination.
- o Environmental Conditions may vary from 0^o F to 110^o F; 0 to 100% humidity; and 28 to 31 inch Hg barometric pressure. These conditions may be external to the facilities while the operating environment is stable and controlled inside of facilities. Radio frequencies and interfering radiations may be in the environment due to the use of radios, x-ray machines, radioactive sources and materials at the Y-12 Complex.

2.2 Compliance Criteria

- o Title 10, Code of Federal Regulations, Part 835; Occupational Radiation Protection; Instrument Calibration for Portable Survey Instruments is a coded federal regulation that shall govern Department of Energy (DOE) sites.
- o Y-12 Complex procedures/instructions shall govern sites under the contract of DOE and Y-12. This contract shall include DOE orders and guidance such as the Radiological Control Manual.
- o Y-12 Complex Health and Safety procedures shall govern radiological work performed at the Y-12 Complex. RADCON Operating procedures/instructions shall govern the work practices of the RADCON Organization.

3.0 Configuration Control

3.1 Responsibility

Y-12 Complex RADCON Instrumentation Section is responsible for calibrations, performance tests, functional tests, recall/inventory instrument program, and selection of radiological control instruments to be used at the Y-12 Complex.

3.2 Procedure Guidance

Procedures and instructions are in place for the calibration and performance testing of radiological control instruments at the Y-12 Complex.

3.3 Training

DOE/EH-0262T-4; RADIOLOGICAL CONTROL TECHNICIAN (RCT) TRAINING PROGRAM is in place at the Y-12 Complex. The RADCON Organization training section shall train all RCTs to properly use instrumentation available at the Y-12 Complex.

3.4 Inventory Control

The Fluke METTRAK inventory management system is in place at the Y-12 Complex to assist the RADCON Organization with inventory control.

3.5 Performance Test Requirement

Instrument performance testing shall be performed according to written RADCON Organization operating procedures and instructions that meet the requirements of the ANSI N323A standard.

3.6 Calibration Requirement

Instrument calibrations shall be performed according to written RADCON Organization operating procedures and instructions that meet the requirements of the ANSI N323A standard.

3.7 Conclusion

This document is the technical basis for selection and qualification of radiological instruments used at the Y-12 Complex. Additional documentation shall be included in the appendices for each instrument used at the Y-12 Complex.

3.8 References

- o 10 CFR PART 835; Occupational Radiation Protection; Final Rule
- o DOE /EH -0256T, Revision 1; U.S. DEPARTMENT OF ENERGY RADIOLOGICAL CONTROL MANUAL; APRIL 1994
- o ANSIN323A - 1997; AMERICAN NATIONAL STANDARD RADIATION PROTECTION INSTRUMENTATION TEST AND CALIBRATION, PORTABLE SURVEY INSTRUMENTS
- o ANSIN42.17A-1989; AMERICAN NATIONAL STANDARD; Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions
- o RCO/TBD-023; Technical Basis for Scanning and Static Alpha Surveys Using a Scintillator Probe
- o RCO/TBD-042; Technical Basis for Using the Portable Ludlum Model 15 Cylindrical Probe Neutron Counter As a Screening Instrument
- o RCO/TBD-043; Technical Basis for the Use of the Ludlum Model 2929 Calibrated with U-235 to Count Samples Containing Transuranics
- o RCO/TBD-047; Technical Basis for The Y-12 National Security Complex Radiation Protection Instrument Program
- o Y/DQ-63; Selection and Justification of Y-12 Plant Continuous Air Monitor (CAM) Alarm Settings

3.9 Instrument Qualifications

A. Contamination Instruments

1. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector
2. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-5 Alpha Scintillator Detector
3. Ludlum Model 3 Survey Meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector
4. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector
5. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector
6. Ludlum Model 239-1F Floor Monitor
7. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-89 100 cm² Alpha-Beta-Gamma Scintillator Detector
8. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-2-2 Alpha-Beta-Gamma Scintillator Detector
9. N.E. Model Electra with a N.E. Model DP6 Dual Scintillator Alpha-Beta-Gamma 100 cm² Detector
10. Ludlum Model 3 Survey Meter with a Ludlum Model 44-10 GAMMA Sodium Iodide (NAI) Detector
11. Eberline Model RM-14SA Radiation Monitor with a Ludlum Model 44-2 NaI Gamma Scintillator Detector

B. Dose Rate Instruments

1. Eberline Model RO-2 Ion Chamber
2. Eberline Model RO-20 Ion Chamber
3. Bicron Model Micro Rem Tissue Equivalent Survey Meter
4. Ludlum Model 12-4 Count Rate Meter Neutron Counter
5. Automess Model 6112B Teletector
6. Bicron Model Radiographer Survey Meter
7. Keithley Model 36100 Survey Meter
8. Xetex Model Telescan Teletector
9. Ludlum Model 12 Scaler Rate Meter with Model 15 Neutron Detector
10. Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Wall Mount Proportional Neutron Counter
11. Eberline Model RO-7 Ion Chamber
12. MGP Model DMC 90/100 Electronic Pocket Dosimeter

C. Air Sampling/Monitoring Instruments

1. F & J Specialty Products Inc. (F & J) Model HV-1S/HV-1ST/HV-1SRT High Volume Air Sampler
2. Science Applications International Corporation (SAIC) Model HD-29A Low Volume Air Sampler
3. Eberline Model ALPHA-6S Continuous Air Monitor (CAM)
4. MSA Model Escort Elf Personal Air Monitor (PAM)
5. Overhoff Model 400SBDäC Tritium Monitor
6. Johnston Laboratories, Inc. (JLI) Model Triton 111 Tritium Air Monitor
7. F & J Specialty Products Inc. (F&J) Model LV-1 Low Volume Air Sampler
8. Science Applications International Corporation (SAIC) Model AVS-28A Low Volume Air Sampler
9. Science Applications International Corporation (SAIC) Model H-810 Air Volume Totalizer
10. Science Applications International Corporation (SAIC) Model HD-66A Low Volume Air Sampler

D. Personnel Monitoring Instruments

1. Eberline Model RM-14S Radiation Monitor with an Eberline Model HP-100A Gas Proportional Detector
2. Ludlum Model 177-45 Alarm Rate Meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector
3. Ludlum Model 177-45 Alarm Rate Meter with a Ludlum Model 43-65 Alpha Scintillator Detector
4. Eberline Model PCM-1B Personnel Contamination Monitor
5. Eberline Model PCM-2 Personnel Contamination Monitor
6. Ludlum Model 2200 Scaler Rate Meter with a Ludlum Model 43-65 Alpha Scintillator Detector

- E. Counters (Field and Laboratory)
 - 1. Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-1 Alpha Scintillator Detector
 - 2. Ludlum Model 2929 Dual Channel Scaler with a Ludlum Model 43-10-1 Alpha-Beta Sample Counter
 - 3. Science Applications International Corporation (SAIC) Model AP-2 Alpha Analyzer
 - 4. IN/US Systems B-Ram Model 2B Radioactivity HPLC Detector
 - 5. Tennelec Model Eclipse 5XLB Low Background Proportional Counter

A. Contamination Instruments

1. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector

General Information

The Ludlum Model 12 is a portable, battery operated, count ratemeter. The Ludlum Model 12 has a scale of 0-500 cpm with four range multipliers; X1, X10, X100, and X1000. The Ludlum Model 43-65 is a 50 cm² zinc sulfide scintillator detector with a 0.8 mg/cm² aluminized mylar window that detects alpha radiation.

Operational Use

The Ludlum Model 12 with a Ludlum Model 43-65 alpha scintillator detector is one of two primary instruments used at the Y-12 Complex to measure alpha surface contamination.

Detection Limits

The static detection limit is 200 dpm/100 cm² (100 cpm times 2) and the scanning detection limit is 1,000 dpm/100 cm² (250 cpm times 4). The correction factors are 2 for an area less than the size of the detector (~50 cm²), 2 for efficiency correction (calibrated to 50% efficiency with ²³⁵U plated sources) and 4 for an area larger than the size of the detector.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).
Operating voltage of 500-1200 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Ludlum Model 12 with a Ludlum Model 43-65 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 12 with a Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was acceptable on the X10 range. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was acceptable on the X1 range for temperatures from 10°C to 40°C. **The Ludlum Model 12 with a Ludlum Model 43-65 should not be used on the X1 range when the temperatures are < 10°C (50° F) or > 40°C (104° F).**

1. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector (cont.)

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was unacceptable for the temperature shock test. **The Ludlum Model 12 with a Ludlum Model 43-65 should not be used for one hour after being subjected to a temperature change of $\geq 10^\circ\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 12 with a Ludlum Model 43-65 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 12 with a Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was unacceptably low on the X1 and X10 ranges. **The Ludlum Model 12 with a Ludlum Model 43-65 should not be used in magnetic fields.**

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 12 with a Ludlum Model 43-65 was unacceptably low when subjected to the microwave field on the X1 range. **Therefore, the Ludlum Model 12 with a Ludlum Model 43-65 should not be operated in microwave fields on the X1 range.**

The radio frequency field tests were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. Response abnormalities were observed at frequencies to 35 MHz on the X1 range. The response of the Ludlum Model 12 with a Ludlum Model 43-65 decreased at 140 MHz on the X1 range. **The Ludlum Model 12 with a Ludlum Model 43-65 should not be operated in radio frequency fields on the X1 range.**

Interfering Ionizing Radiations

The interfering ionizing neutron radiation test was an exposure to a 1 rem/hr ²⁵²Cf neutron field. The response of the Ludlum Model 12 with a Ludlum Model 43-65 was 2000 to 4000 cpm when exposed to the 1 rem/h ²⁵²Cf neutron field. The interfering ionizing gamma radiation test was an exposure to 11.7 rad/hr ¹³⁷Cs gamma field. The Ludlum Model 12 with a Ludlum Model 43-65 did not respond when exposed to the gamma field.

1. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector (cont.)

Performance Criteria

The Ludlum Model 12 with a Ludlum Model 43-65 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ^{230}Th check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-600INS: *Operation of Ludlum 12 Count Ratemeter w/43-65 or 43-5 Alpha Scintillator Probe.*

2. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-5 Alpha Scintillator Detector

General Information

The Ludlum Model 12 is a portable, battery operated, count ratemeter. The Ludlum Model 12 has a scale of 0-500 cpm with four range multipliers; X1, X10, X100, and X1000. The Ludlum Model 43- 5 is a 50 cm² zinc sulfide scintillator detector with a 0.8 mg/cm² aluminized mylar window that detects alpha radiation.

Operational Use

The Ludlum Model 12 with a Ludlum Model 43-5 alpha scintillator detector is one of two primary instruments used at the Y-12 Complex to measure alpha surface contamination.

Detection Limits

The static detection limit is 200 dpm/100 cm² (100 cpm times 2) and the scanning detection limit is 1,000 dpm/100 cm² (250 cpm times 4). The correction factors are 2 for an area less than the size of the detector (~50 cm²), 2 for efficiency correction (calibrated to 50% efficiency with ²³⁵U plated sources) and 4 for an area larger than the size of the detector.

Manufacturers Specifications

Operating temperature range should be -40° C to 50° C (-40° F to 122° F).
Operating voltage of 500-1200 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Ludlum Model 12 with a Ludlum Model 43-5 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 12 with an Ludlum Model 43-5 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was acceptable for \geq 690 in. Hg. **Use of the Ludlum Model 12 with a Ludlum Model 43-5 below 690 in. Hg ambient pressure requires a performance test under those conditions.**

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was acceptable for the humidity tests.

2. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-5 Alpha Scintillator Detector (cont.)

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was acceptable on the X10 range for temperatures 0°C to 40°C. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was acceptable on the X1 range for temperatures from 0°C to 30°C. . **The Ludlum Model 12 with a Ludlum Model 43-5 should not be used when the temperatures are < 0°C (32°F) or > 30° C (86° F).**

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was unacceptable for the temperature shock test. **The Ludlum Model 12 with a Ludlum Model 43-5 should not be used for 1 hour after being subjected to a temperature change of $\geq 10^\circ\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 12 with a Ludlum Model 43-5 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 12 with an Ludlum Model 43-5 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 12 with a Ludlum Model 43-5 was unacceptable for the magnetic field test. **The Ludlum Model 12 with a Ludlum Model 43-5 should not be used in magnetic fields.**

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 12 with a Ludlum Model 43-5 was unacceptably low when subjected to the 2.45 GHz microwave field. **The Ludlum Model 12 with a Ludlum Model 43-5 should not be operated in microwave fields of ≥ 2.45 GHz.**

The radio frequency field tests were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. Response abnormalities were observed at frequencies to 35 MHz on the X1 range. The response of the Ludlum Model 12 with a Ludlum Model 43-5 decreased at 140 MHz on the X1 range. **The Ludlum Model 12 with a Ludlum Model 43-5 should not be operated in radio frequency fields on the X1 range.**

2. Ludlum Model 12 Count Ratemeter with a Ludlum Model 43-5 Alpha Scintillator Detector (cont.)

Interfering Ionizing Radiations

The interfering ionizing neutron radiation test was an exposure to a 1 rem/hr ²⁵²Cf neutron field. The response of the Ludlum Model 12 with a Ludlum Model 43- 5 was 2000 to 4000 cpm when exposed to the 1 rem/h ²⁵²Cf neutron field. The interfering ionizing gamma radiation test was an exposure to 11.7 rad/hr ¹³⁷Cs gamma field. The Ludlum Model 12 with a Ludlum Model 43- 5 did not respond when exposed to the gamma field.

Performance Criteria

The Ludlum Model 12 with a Ludlum Model 43-5 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ²³⁰Th check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-600INS: *Operation of Ludlum 12 Count Ratemeter w/43-65 or 43-5 Alpha Scintillator Probe.*

3. Ludlum Model 3 Survey meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector

General Information

The Ludlum Model 3 is a portable battery operated survey meter. The Ludlum Model 44-9 detects alpha and beta-gamma radiations. The Ludlum Model 3 has a scale of 0-5000 counts per minute with four range multipliers; X0.1, X1, X10 and X100. The Ludlum Model 44-9 is an approximately 20 cm² GM pancake detector.

Operational Use

The Ludlum Model 3 with a Ludlum Model 44-9 detector is the primary instrument used at the Y-12 Complex to measure beta/gamma surface contamination. The Ludlum Model 44-9 has a plastic cover installed to attenuate alpha particles.

Detection Limits

The static detection limit is 600 dpm/100 cm² (100 cpm above background times 6) and the scanning detection limit is 3,000 dpm/100 cm² (100 cpm above background times 30). The correction factors are 6 (correction factor for ²³⁸U efficiency) for efficiency, area of contamination less than the size of the detector, and 30 (correction factor for ²³⁸U efficiency and detector size) for an area larger than the size of the detector.

Manufacturers Specifications

Battery seal failure may occur at 100° F.

Limitations

The Ludlum Model 3 with a Ludlum Model 44-9 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 3 with an Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable for ambient pressures ≥ 690 in. Hg. **Use of the Ludlum Model 3 with a Ludlum Model 44-9 below 630 in. Hg ambient pressure requires a performance test under those conditions.**

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable for the humidity tests.

3. Ludlum Model 3 Survey meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

The temperature test range was -10°C to 50°C . The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable on the X1 range. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was erratic on the X0.1 range. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable on the X0.1 range for temperatures $\leq 40^{\circ}\text{C}$. **The Ludlum Model 3 with a Ludlum Model 44-9 should not be used on the X0.1 range in an environment of $> 40^{\circ}\text{C}$ (122°F).**

The temperature shock test ranges were 22° to 50°C , 50° to 22°C , 22° to -10°C , and -10° to 22°C . The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable on the X1 range. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was unacceptable on the X0.1 range. **The Ludlum Model 3 with a Ludlum Model 44-9 should not be used on the X0.1 range for 1 hour after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 3 with Ludlum Model 44-9 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 3 with an Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 3 with a Ludlum Model 44-9 produced acceptable readings on the X1 range. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was unacceptably low on the X0.1 range. **The Ludlum Model 3 with a Ludlum Model 44-9 should not be used in magnetic fields on the X0.1 range.**

The microwave field test points were 915 MHz at $0.4 \text{ Watts/meter}^2$ and 2.45 GHz at $2.0 \text{ Watts/meter}^2$. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 3 with a Ludlum Model 44-9 was acceptable for the range of the radio frequency field test.

3. Ludlum Model 3 Survey meter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

Interfering Ionizing Radiations

The plastic cover installed to attenuate alpha particles shields out all alphas and some low energy beta particles below 50 Kev.

Performance Criteria

The Ludlum Model 3 with a Ludlum Model 44-9 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ¹³⁷Cs check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-515INS; *Operation of Ludlum 3 Survey Meter with a 44-9 Alpha-Beta-Gamma Detector*.

4. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector

General Information

The Ludlum Model 2221 is a portable battery operated scaler ratemeter. The Ludlum Model 2221 has a dual scale of 0-500 and 50-500K counts per minute with five range multipliers; X1, X10, X100, X1K and LOG. The Ludlum Model 43-65 is a 50 cm² zinc sulfide scintillator detector with a 0.8 mg/cm² aluminized mylar window that detects alpha radiation.

Operational Use

The Ludlum Model 2221 with a Ludlum Model 43-65 detector is the primary instrument used at the Y-12 Complex to measure transuranic alpha surface contamination.

Detection Limits

The alpha scanning detection limit is 300 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 1 inch per second. The static alpha detection limit is 125 dpm/100cm². The correction factors are 5 for a point source and 10 for a plane source.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).
Operating voltage of 500-1200 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Ludlum Model 2221 with a Ludlum Model 43-65 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2221 with an Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the temperature test.

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the temperature shock test.

4. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector (cont.)

The Ludlum Model 2221 with a Ludlum Model 43-65 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2221 with an Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-65 was acceptable for the radio frequency test.

Interfering Ionizing Radiations

The interfering ionizing radiation test was not performed.

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Ludlum Model 2221 with a Ludlum Model 43-65 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ²³⁰Th check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-511INS: *Operation of the Ludlum Model 2221 with a Ludlum Model 43-65 Alpha Scintillator Probe for TRU Limit Surveys.*

5. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector

General Information

The Ludlum Model 2221 is a portable battery operated scaler ratemeter. The Ludlum Model 2221 has a dual scale of 0-500 and 50-500K counts per minute with five range multipliers; X1, X10, X100, X1K and LOG. The Ludlum Model 44-9 detects alpha and beta-gamma radiation.

Operational Use

The Ludlum Model 2221 with a Ludlum Model 44-9 detector is the primary instrument used at the Y-12 Complex to measure the presence of ^{14}C , ^{137}Cs , ^{99}Tc , and ^{90}Sr surface contamination.

Detection Limits

The beta scanning detection limit is 14,900 dpm/100 cm² for ^{14}C , 2,750 dpm/100 cm² for ^{137}Cs , 4,300 dpm/100 cm² for ^{99}Tc and 2,400 dpm/100 cm² for ^{90}Sr . at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 1 inch per second. The static beta detection limit is 4,900 dpm/100 cm² for ^{14}C , 900 dpm/100 cm² for ^{137}Cs , 1,000 dpm/100 cm² for ^{99}Tc and 200 dpm/100 cm² for ^{90}Sr . The correction factors for a point source are 29 for ^{14}C , 6 for ^{137}Cs 7 for ^{99}Tc and 4 for ^{90}Sr . The correction factors for a plane source are 145 for ^{14}C , 30 for ^{137}Cs , 35 for ^{99}Tc and 20 for ^{90}Sr .

Manufacturers Specifications

Operating temperature range should be -40°C to 65°C (-40°F to 150°F).
Operating voltage of 900 volts (set at calibration).

Limitations

The Ludlum Model 2221 with a Ludlum Model 44-9 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2221 with an Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the humidity test.

5. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was erratic on the X1 range. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the temperature test.

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the temperature shock test.

The Ludlum Model 2221 with a Ludlum Model 44-9 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2221 with an Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 2221 with a Ludlum Model 44-9 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. One of four instruments indicated some susceptibility to frequencies of 1.9, 13.6 and 32.8 MHz. Each abnormality lasted approximately one second. All other responses were acceptable for the 0.3 to 35 MHz frequency scan test and at 140 Mhz. Field intensity was 50 volts/meter. Each instrument tested had acceptable results when exposed to 140, 915, and 2450 MHz at 20 (+10,-0) volts/meter. One instrument, when exposed to 2450 MHz, had inconclusive results due to the low value of the 95% confidence interval being slightly less than the low limit of the acceptance range. Response abnormalities were observed during the frequency scan of 0.1 to 1000 MHz at frequencies from 60 to 67.5 MHz. Abnormalities included low, zero, and off-scale responses, and blank display.

Interfering Ionizing Radiations

The interfering ionizing radiation test was not performed.

5. Ludlum Model 2221 Scaler Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Ludlum Model 2221 with a Ludlum Model 44-9 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ¹³⁷Cs check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-523INS: *Operation of a Ludlum Model 2221 with a Ludlum Model 44-9 Alpha-Beta-Gamma (GM) Probe for Technetium 99 or Strontium-Yttrium 90 Surveys.*

6. Ludlum Model 239-1F Floor Monitor

General Information

The Ludlum Model 2221 is a portable battery operated scaler ratemeter. The Ludlum Model 43-37 detects alpha and beta-gamma radiation. The Ludlum Model 2221 has a dual scale of 0-500 and 50-500K counts per minute with five range multipliers; X1, X10, X100, X1K and LOG.

Operational Use

The Ludlum Model 2221 with a Ludlum Model 43-37 detector mounted on a cart as the Ludlum Model 239-1F is the primary instrument used at the Y-12 Complex as a radiation detection floor monitor to determine the presence of surface contamination. The Ludlum Model 239-1F can not discriminate between alpha and beta-gamma surface contamination. The Ludlum Model 239-1F must be set up at calibration for alpha or alpha-beta-gamma.

Detection Limits

The alpha scanning detection limit is $<1,000$ dpm/100 cm² (14 cpm alpha) and the beta scanning detection limit is $<2,600$ dpm/100 cm² (693 cpm beta/gamma). The calibrated efficiencies are approximately 15% for alpha and 27% for beta/gamma.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).
Operating voltage of 1000-1800 volts (set at calibration according to counts versus high voltage plateau).
OPEN window area of approximately 425 cm².
Cart mounted detector, instrument and bottle rack with a total weight of approximately 25 lbs.

Limitations

The Ludlum Model 2221 with a Ludlum Model 43-37 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2221 with an Ludlum Model 43-37 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. This test was not performed.

6. Ludlum Model 239-1F Floor Monitor (cont.)

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was unacceptably low for the humidity tests. **The Ludlum Model 2221 with a Ludlum Model 43-37 shall not be used after a humidity change from $\geq 95\%$ to $\leq 40\%$ until sufficient time for detector to adjust to such change.**

The temperature test range was -10°C to 50°C . The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was erratic on the X1 range. The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was unacceptable for the temperature test. **The Ludlum Model 2221 with a Ludlum Model 43-37 should only be used to quantify activity in temperatures $\geq 10^{\circ}\text{C}$ (50°F) and $\leq 30^{\circ}\text{C}$ (86°F).**

The temperature shock test ranges were 22° to 50°C , 50° to 22°C , 22° to -10°C , and -10° to 22°C . The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was unacceptable for the temperature shock test. **The Ludlum Model 2221 with a Ludlum Model 43-37 shall not be used after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) until detector has stabilized.**

The Ludlum Model 2221 with a Ludlum Model 43-37 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2221 with an Ludlum Model 43-37 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter^2 and 2.45 GHz at 2.0 Watts/meter^2 . The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 2221 with a Ludlum Model 43-37 was acceptable for the radio frequency test.

6. Ludlum Model 239-1F Floor Monitor (cont.)

Interfering Ionizing Radiations

The interfering ionizing radiation test was an exposure to a 1 mrem/hr ^{252}Cf neutron field. The response of the Ludlum Model 2221 with a Model 43-37 gas proportional detector was 3155 to 5032 counts per minute when exposed to the 1 mrem/hr neutron field.

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Ludlum Model 2221 with a Ludlum Model 43-37 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ^{230}Th check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-503INS: *Operation of the Ludlum Model 2221 with a Ludlum Model 43-37-1 Gas Proportional Detector (Floor Monitor)*

7. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-89 100 cm² Alpha-Beta-Gamma Scintillator Detector

General Information

The Ludlum Model 2224/2224-1 is a portable battery operated dual channel (alpha-beta) scaler ratemeter. The Ludlum Model 2224/2224-1 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, X1000. The Ludlum Model 2224/2224-1 has a selector switch for alpha-beta, alpha only or beta only. The major difference between the Ludlum Model 2224 and the Ludlum Model 2224-1 is that the Ludlum Model 2224-1 has a user adjustable scaler count time selector switch. The Ludlum Model 2224 scaler count time must be set at calibration. The Ludlum Model 43-89 detects alpha and beta-gamma radiations.

Operational Use

The Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 detector is the primary instrument used at the Y-12 Complex to measure the presence of alpha and beta contaminants where a 100 cm² detector proves most efficient and costly.

Detection Limits

The alpha scanning detection limit is 100 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static alpha detection limit is 85 dpm/100cm². The beta scanning detection limit is 2,500 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static beta detection limit is 800 dpm/100cm².

Manufacturers Specifications

Operating temperature range should be -20°C to 50°C (-4°F to 122°F).
Operating voltage of 200-2000 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2224 with an Ludlum Model 43-89 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was acceptable to 0°C.

7. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-89 100 cm² Alpha-Beta-Gamma Scintillator Detector (cont.)

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the temperature shock test due to susceptibilities to temperature change.

The Ludlum Model 2224/2224-1/ with a Ludlum Model 43-89 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2224 with an Ludlum Model 43-89 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the radio frequency test.

Interfering Ionizing Radiations

The interfering ionizing radiation test was an exposure to a 7 mrem/hr Cf-252 neutron field. The response of the Ludlum Model 2224/2224-1 with a Model 43-89 scintillator detector was 20 to 50 counts per minute alpha, 15000 to 18000 counts per minute alpha + beta, and 14000 to 19000 counts per minute beta when exposed to the 7 mrem/hr neutron field.

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ²³⁰Th and ¹³⁷Cs check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-531INS: *Operation of the Ludlum Model 2224 or 2224-1 with a Ludlum Model 43-89 Alpha/Beta Detector.*

8. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-2-2 Alpha-Beta-Gamma Scintillator Detector

General Information

The Ludlum Model 2224/2224-1 is a portable battery operated dual channel (alpha-beta) scaler ratemeter. The Ludlum Model 2224/2224-1 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, X1000. The Ludlum Model 2224/2224-1 has a selector switch for alpha-beta, alpha only or beta only. The major difference between the Ludlum Model 2224 and the Ludlum Model 2224-1 is that the Ludlum Model 2224-1 has a user adjustable scaler count time selector switch. The Ludlum Model 2224 scaler count time must be set at calibration. The Ludlum Model 43-2-2 detects alpha and beta-gamma radiations.

Operational Use

The Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 detector is the primary instrument used at the Y-12 Complex to measure the presence of alpha and beta contamination in drums.

Detection Limits

The alpha scanning detection limit is 1000 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static alpha detection limit is 430 dpm/100cm². The beta scanning detection limit is 4000 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static beta detection limit is 1300 dpm/100cm².

Manufacturers Specifications

Operating temperature range should be -20°C to 50°C (-4°F to 122°F).
Operating voltage of 200-2000 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2224 with an Ludlum Model 43-89 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 was acceptable for the humidity tests.

8. Ludlum Model 2224/2224-1 Scaler Ratemeter with a Ludlum Model 43-2-2 Alpha-Beta-Gamma Scintillator Detector (cont.)

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 was acceptable to 0°C.

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 was unacceptable for the temperature shock test due to susceptibilities to temperature change.

The Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2224 with an Ludlum Model 43-89 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-89 was unacceptable for the radio frequency test.

Interfering Ionizing Radiations

The interfering ionizing radiation test was an exposure to a 7 mrem/hr ²⁵²Cf neutron field. The response of the Ludlum Model 2224/2224-1 with a Model 43-89 scintillator detector was 0 to 10 counts per minute alpha, 2900 to 3000 counts per minute alpha + beta, and 2800 to 2900 counts per minute beta when exposed to the 7 mrem/hr neutron field.

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ²³⁰Th and ¹³⁷Cs check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-509INS: *Operation of the Ludlum Model 2224/2224-1 with a Ludlum Model 43-2-2 Alpha/Beta Detector.*

9. Bicron Model Electra Scaler Ratemeter with a Model DP6A 100 cm² Alpha-Beta-Gamma Scintillator Detector

General Information

The Bicron Model Electra is a portable battery operated dual channel (alpha-beta) scaler ratemeter. The Bicron Model Electra has an autoranging digital readout in 1 count per minute to 1000 kilocounts per minute. The Bicron Model Electra has a pushbutton for alpha-beta, alpha only or beta only. The Bicron Model DP6A is 100 cm² and detects alpha and beta-gamma radiations.

Operational Use

The Bicron Model Electra with a Bicron Model DP6A detector is the primary instrument used at the Y-12 Complex to measure the presence of alpha and beta contamination in inert atmospheres.

Detection Limits

The alpha scanning detection limit is 100 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static alpha detection limit is <100 dpm/100cm². The beta scanning detection limit is 1000 dpm/100 cm² at a distance of $\leq \frac{1}{4}$ inch and a rate of ≤ 0.5 inch per second. The static beta detection limit is <1000 dpm/100cm².

Manufacturers Specifications

Operating voltage of 400-1400 volts (set at calibration according to counts versus high voltage plateau).

Limitations

The Bicron Model Electra with a Bicron Model DP6A should only be used within the ranges of the following environmental conditions. If operation of the Bicron Model Electra with a Bicron Model DP6A outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Bicron Model Electra with a Bicron Model DP6A was acceptable for the humidity tests up to 95%.

The temperature test range was -10°C to 50°C. The response of the Bicron Model Electra with a Bicron Model DP6A was acceptable.

9. Bicron Model Electra Scaler Ratemeter with a Model DP6A 100 cm² Alpha-Beta-Gamma Scintillator Detector (cont.)

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Bicron Model Electra with a Bicron Model DP6A was unacceptable for the temperature shock test due to susceptibilities to temperature change.

The Bicron Model Electra with a Bicron Model DP6A should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Bicron Model Electra with a Bicron Model DP6A outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Bicron Model Electra with a Bicron Model DP6A was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Bicron Model Electra with a Bicron Model DP6A was acceptable for the magnetic field.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Bicron Model Electra with a Bicron Model DP6A was unacceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Bicron Model Electra with a Bicron Model DP6A was unacceptable for the radio frequency test.

Interfering Ionizing Radiations

The interfering ionizing radiation test was an exposure to a 11 mrem/hr ²⁵²Cf neutron field. The response of the Bicron Model Electra with a Model DP6A scintillator detector was 59 kcpm to 104 kcpm alpha, when operated in the beta-gamma mode, readings were off-scale high. The response of the Bicron Model Electra with a Model DP6A scintillator detector was 22 to 52 cpm alpha when exposed to the 1 R/hr ¹³⁷Cs gamma field.

Performance Criteria

Perform surveys to document results from any areas of detectable contamination greater than background with portable survey instruments. The Bicron Model Electra with a Bicron Model DP6A shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ²³⁰Th and ¹³⁷Cs check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-524INS: *Operation of an N. E. Electra with a Dual Scintillator Alpha-Beta Detector.*

10. Ludlum Model 3 Survey meter with a Ludlum Model 44-10 Gamma Sodium Iodide (NaI) Detector

General Information

The Ludlum Model 3 is a portable battery operated survey meter. The Ludlum Model 3 has a scale of 0-5000 counts per minute with four range multipliers; X0.1, X1, X10 and X100. The Ludlum Model 44-10 is an approximately 20 cm² NaI detector.

Operational Use

The Ludlum Model 3 with a Ludlum Model 44-10 detector is the primary instrument used at the Y-12 Complex to detect gamma contamination.

Detection Limits

The scanning detection limit is 1 μ Ci. This unit is not used to measure contamination.

Manufacturers Specifications

Battery seal failure may occur at 100° F.

Limitations

The Ludlum Model 3 with a Ludlum Model 44-10 should only be used within the ranges of the manufacturers environmental conditions. If operation of the Ludlum Model 3 with an Ludlum Model 44-10 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

Interfering Ionizing Radiations

The interfering ionizing radiations test was not performed.

Performance Criteria

The Ludlum Model 3 with a Ludlum Model 44-10 shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ¹³⁷Cs check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-534INS; *Operation of a Ludlum Model 3 with a Ludlum Model 44-10 Sodium Iodide (NaI) Gamma Detector.*

11. Eberline Model RM-14SA Radiation Monitor with Ludlum Model 44-2 NaI Gamma Scintillator Detector

General Information

The Eberline Model RM-14SA is a line operated alarm ratemeter. The Eberline Model RM-14SA has a scale of 0-5 counts per minute with six range multipliers; X10, X100, X1K, X10K and X1M. The Ludlum Model 44-2 NaI Gamma Scintillator Detector responds to gamma, and x-ray radiations.

Operational Use

The Eberline Model RM-14SA Radiation Monitor with Ludlum Model 44-2 NaI Gamma Scintillator Detector is the primary instrument used at the Y-12 Complex to detect gamma/x-ray contamination that may enter a low background area.

Detection Limits

The scanning alarm limit is 12.5 μ rem/hr. gamma/x-ray.

Manufacturers Specifications

Operating temperature range should be -30°C to 60°C (-22°F to 140°F).

Limitations

The Eberline Model RM-14SA Radiation Monitor with Ludlum Model 44-2 NaI Gamma Scintillator Detector should only be used within the ranges of the manufacturers environmental conditions. If operation of the Eberline Model RM-14SA Radiation Monitor with Ludlum Model 44-2 NaI Gamma Scintillator Detector outside the ranges of the following conditions is necessary, a performance test shall be passed before use. To satisfy a performance test in an environment outside the manufacturers conditions, ensures the instrument is operating properly.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

Eberline Model RM-14SA Radiation Monitor with Ludlum Model 44-2 NaI Gamma Scintillator Detector used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RADCON Instrumentation Section.

B. Dose Rate Instruments

1. Eberline Model RO-2 Ion Chamber

General Information

The Eberline Model RO-2 is a portable battery operated air ion chamber instrument. The Eberline Model RO-2 detects beta, gamma, and x-ray radiations on four linear ranges of 0-5, 0-50, 0-500, and 0-5000 mR/h.

Operational Use

The Eberline Model RO-2 is the primary instrument used at the Y-12 Complex to measure Beta/Gamma/X-ray dose rates. The Eberline Model RO-2 is the primary instrument used at the Y-12 Complex to detect the presence of pulsed x-rays but shall not be used to quantify pulses.

Detection Limits

The lowest reliable dose rate reading is 0.1 mRem/hr. The detectable beta dose rate limit is 0.1 times the Beta Response Factor (approximately 3.5) and the detectable beta/gamma dose rate limit is times the Beta Response Factor plus 0.1 gamma. The bottom of the case has a 400 mg/cm² sliding phenolic beta shield covering the mylar window of the detector that is opened to detect beta.

Manufacturers Specifications

Operating temperature range should be -40°C to 60°C (-40°F to 140°F). Eberline also states the Model RO-2 photon energy response of nominal ±15% from 12 keV to greater than 1.3 MeV. Also, Eberline states a RO-2 fast neutron response reads approximately 10% in mR/h of a true neutron field in mrem/h. Over response to photon energies > 2 MeV may vary by 50%.

Limitations

The Eberline Model RO-2 should only be used within the ranges of the following environmental conditions. If operation of the Eberline Model RO-2 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Eberline Model RO-2 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Eberline Model RO-2 was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the Eberline Model RO-2 was acceptable for the temperature test.

1. Eberline Model RO-2 Ion Chamber (cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Eberline Model RO-2 was unacceptable when subjected to quick temperature changes of 10° C (50° F) on the 0 to 5 mR/hr range. **After being subjected to a temperature change of $\geq 10^\circ$ C (50° F), the Eberline Model RO-2 should be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Eberline Model RO-2 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Eberline Model RO-2 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Eberline Model RO-2 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Eberline Model RO-2 was acceptable for the magnetic test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The Eberline Model RO-2 response was acceptable for the microwave test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Eberline Model RO-2 was acceptable for the radio frequency test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 rem/hr Pu-Be neutron field. The response of the Eberline Model RO-2 was 8% of the 1 rem/hr neutron field.

Performance Criteria

Eberline Model RO-2s used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Health Physics, Oak Ridge National Lab. Eberline Model RO-2s used at the Y-12 Complex have a beta response factor determined and labeled on each instrument at the time of calibration.

Eberline Model RO-2s shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ⁹⁰SrY source testing each range with the beta shield open. A range has been calculated for each of four test points coinciding with the four ranges on the Eberline Model RO-2. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-506INS; *Performance Test and*

Operation of an Eberline Model RO-2 Ion Chamber.

2. Eberline Model RO-20 Ion Chamber

General Information

The Eberline Model RO-20 is a portable battery operated air ion chamber instrument. The Eberline Model RO-20 detects beta, gamma, and x-ray radiations on five linear ranges of 0-5, 0-50, 0-500 mR/hr and 0-5, 0-50 R/h.

Operational Use

The Eberline Model RO-20 is the primary instrument used at the Y-12 Complex to measure Beta/Gamma/X-ray dose rates from emitters with energies of > 2 MeV.

Detection Limits

The lowest reliable dose rate reading is 0.1 mRem/hr. The detectable beta dose rate limit is 0.1 times the Beta Response Factor (approximately 3.5) and the detectable beta/gamma dose rate limit is times the Beta Response Factor plus 0.1 gamma. The bottom of the case has a 1,000 mg/cm² sliding phenolic beta shield covering the mylar window of the detector that is opened to detect beta.

Manufacturers Specifications

Operating temperature range should be -40°C to 60°C (-40°F to 140°F). Eberline states the Model RO-20 should be used with alkaline or Nicad batteries in temperatures < 0°F. Over response to photon energies > 2 MeV may vary by 30%.

Limitations

The Eberline Model RO-20 should only be used within the ranges of the following environmental conditions. If operation of the Eberline Model RO-20 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Eberline Model RO-20 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Eberline Model RO-20 was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the Eberline Model RO-20 was acceptable for the temperature test.

2. Eberline Model RO-20 Ion Chamber (cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Eberline Model RO-20 was unacceptable when subjected to quick temperature changes from 22° C to -10° F on the 0 to 5 mR/hr range. **After being subjected to a temperature change of $\geq 10^{\circ}$ C (50° F), the Eberline Model RO-20 should be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Eberline Model RO-20 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Eberline Model RO-20 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The Eberline Model RO-20 response was acceptable for the microwave test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Eberline Model RO-20 was acceptable for the radio frequency test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 rem/hr Pu-Be neutron field. The response of the Eberline Model RO-20 was 8% of the 1 rem/hr neutron field.

Performance Criteria

Eberline Model RO-20s used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab. Eberline Model RO-20s used at the Y-12 Complex have a beta response factor determined and labeled on each instrument at the time of calibration.

Eberline Model RO-20s shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test will be completed with a ⁹⁰SrY source testing each range with the beta shield open. A range has been calculated for each of five test points coinciding with the five ranges on the Eberline Model RO-20. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-506INS; *Performance Test and Operation of an Eberline Model RO-2 Ion Chamber.*

3. Bicron Model Micro Rem Tissue Equivalent Survey Meter

General Information

The Bicron Model Micro Rem is a portable battery operated tissue equivalent organic scintillator instrument. The Bicron Model Micro Rem detects low gamma, and x-ray radiations on five linear ranges of 0-20, 0-200, 0-2000, 0-20,000 and 0-200,000 mrem/h.

Operational Use

The Bicron Model Micro Rem instrument is the primary instrument used at the Y-12 Complex to measure low level Gamma/X-ray dose rates.

Detection Limits

The Bicron Model Micro Rem detects low gamma, and x-ray radiations from 17 keV to 1.3 Mev.

Manufacturers Specifications

Operating temperature range should be -20° C to 50° C (-4° F to 122° F). Bicron states a 5% change in readings from 10 - 95% relative humidity (RH). Response times stated are < 15 seconds for X0.1 and X1, < 5 seconds for X10, and < 2 seconds for X100 and X1000 ranges.

Limitations

The Bicron Model Micro Rem should only be used within the ranges of the following environmental conditions. If operation of the Bicron Model Micro Rem outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Bicron Model Micro Rem was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Bicron Model Micro Rem was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the Bicron Model Micro Rem was acceptable for the temperature test.

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Bicron Model Micro Rem was unacceptable when subjected to quick temperature changes of 10° C (50° F). **After being subjected to a temperature change of $\geq 10^{\circ}$ C (50° F), the Bicron Model Micro Rem should be allowed to stabilize for 1 hour before use or until passing a performance test in the changed**

environment.

3. Bicron Model Micro Rem Tissue Equivalent Survey Meter (cont.)

The Bicron Model Micro Rem should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Bicron Model Micro Rem outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Bicron Model Micro Rem was acceptable for electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Bicron Model Micro Rem was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Bicron Model Micro Rem was unacceptable for the 915 MHz microwave field. **The Bicron Model Micro Rem should not be used in a microwave field.**

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The Bicron Model Micro Rem response was unacceptable for the frequency scan range of the radio frequency field test. **The Bicron Model Micro Rem should not be used in radio frequency fields.**

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 rem/hr Pu-Be neutron field. The response of the Bicron Model Micro Rem was 4% to 4.5% of the 1 rem/hr neutron field.

Performance Criteria

Bicron Model Micro Rem used at the Y-12 Complex are calibrated to 200 mrem/h of ¹³⁷Cs by the RASCAL facility, Health Physics, Oak Ridge National Lab.

Bicron Model Micro Rem shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. A performance test range will be calculated for the Bicron Model Micro Rem when it is returned from RASCAL using a ¹³⁷Cs source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instructions Y75-56-FO-532INS; *Performance Test and Operation of the Bicron Model Micro Rem Tissue Equivalent Survey Meter.*

4. Ludlum Model 12-4 Count Ratemeter Neutron Counter

General Information

The Ludlum Model 12-4 is a portable battery operated neutron dose rate instrument. The Ludlum Model 12-4 detects neutron radiations on a scale of 0-10 mrem/h or 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1000. The 12-4 utilizes a Ludlum Model 42-31 boron trifluoride (Bf³) proportional detector surrounded by a polyethylene sphere moderator.

Operational Use

The Ludlum Model 12-4 is the primary instrument used at the Y-12 Complex to measure neutron dose rates.

Detection Limits

The Minimum Detectable Activity (MDA) of the Ludlum Model 12-4 is 0.2 mrem/hr. Ludlum Model 12-4 instruments equipped with a scalar option will have a cpm meter face and a specific MDA for that instrument.

Manufacturers Specifications

Ludlum states battery seal may fail at 100° F.

Limitations

The Ludlum Model 12-4 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 12-4 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test was not performed on the Ludlum Model 12-4.

The humidity test range was 40% relative humidity (RH) to 95% RH. The Ludlum Model 12-4 response was unacceptable for the humidity test. **The Ludlum Model 12-4 may respond high at \geq 95% RH on the X1 range.**

The temperature test range was -10° C to 50° C. The response of the Ludlum Model 12-4 was unacceptable for the range of this test. The response of the Ludlum Model 12-4 was low for temperatures < 0° C on the X 1 range and at 10° C on the X 10 range. **The Ludlum Model 12-4 should not be used on the X1 range when temperatures are < 0° C (32° F) or on the X10 range when temperatures are < 10° C (50° F).**

4. Ludlum Model 12-4 Count Ratemeter Neutron Counter (REMBALL)(cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The Ludlum Model 12-4 response was unacceptable when subjected to quick temperature changes of 10° C (50° F) on the X1 range. **After being subjected to a temperature change of 10° C (50° F), the Ludlum Model 12-4 shall be allowed to stabilize for 1 hour before use.**

The Ludlum Model 12-4 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 12-4 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 12-4 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 12-4 was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45GHz at 2.0 Watts/meter². The response of the Ludlum Model 12-4 was acceptable for the microwave field test.

The radio frequency field test ranges were frequency scans of 0.3 MHz to 35 MHz at 50 volts/meter and 140 MHz at 50 volts/meter. The response of the Ludlum Model 12-4 was acceptable for the radio frequency test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Operational Criteria

Ludlum Model 12-4 used at the Y-12 Complex are calibrated to a 200 mrem/h PuBe neutron field by the RASCAL facility, Oak Ridge National Lab.

Ludlum Model 12-4 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a AmBe source testing one range. A range has been calculated for the test point coinciding with the range on the Ludlum Model 12-4. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction 75-56-FO-522INS; *Operation of the Ludlum Model 12-4 Count Ratemeter Neutron Counter (Rem Ball)*.

5. Automess Model 6112B Teletector

General Information

The Automess Model 6112B is a portable battery operated telescopic dual Geiger Mueller (GM) tube instrument. The Automess Model 6112B detects beta, gamma, and x-ray radiations on five linear ranges of 2 mR/h, 50 mR/h, 2 R/h, 50 R/h, and 1000 R/h.

Operational Use

The Automess Model 6112B is used at the Y-12 Complex to detect high range gamma/x-ray dose rates. The Automess Model 6112B is used for indication purposes only.

Detection Limits

No detection limits.

Manufacturers Specifications

Operating temperature range should be -30°C to 50°C .

Class 1.5 vibration and shock resistant.

Response of $\pm 15\%$ for energy from 80 keV to 200 keV; response of $\pm 10\%$ for energy from .2 MeV to 2 MeV.

Limitations

The Automess Model 6112B should only be used within the ranges of the following environmental conditions.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Automess Model 6112B was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Automess Model 6112B was acceptable for the humidity test.

The temperature test range was -10°C to 50°C . The response of the Automess Model 6112B was acceptable at temperatures $\geq 0^{\circ}\text{C}$ (32°F) on the 50 mR/hr range and $< 40^{\circ}\text{C}$ (104°F) on the 2 R/hr range. **The Automess Model 6112B should not be used in temperatures $< 0^{\circ}\text{C}$ (32°F) on the 50 mR/hr range or $\geq 40^{\circ}\text{C}$ (104°F) on the 2 R/hr range.**

The temperature shock test ranges were 22° to 50°C , 50° to 22°C , 22° to -10°C , and -10° to 22°C . The response of the Automess Model 6112B was unacceptable when subjected to quick temperature changes of 10°C (50°F) on the 0 to 5 mR/hr range. **After being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F), the Automess Model 6112B shall be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

5. Automess Model 6112B Teletector (cont.)

The Automess Model 6112B should only be used within the ranges of the following conditions provided by interfering radiations.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Automess Model 6112B was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Automess Model 6112B was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Automess Model 6112B was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Automess Model 6112B was acceptable for the radio frequency field test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 rem/hr Pu-Be neutron field. The response of the Automess Model 6112B was 50 mR/hr when exposed to the 1 Rem/hr neutron field.

Performance Criteria

Automess Model 6112Bs used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

Automess Model 6112Bs shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ⁶⁰Co source testing the 2R/h and 50 mR/h ranges. An acceptance range has been calculated for each test point coinciding with the ranges on the Automess Model 6112B. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instructions RCO/Y-IN-656INS; *Performance Testing an Automess Model 6112-B Teletector and Y75-56-FO-519INS; Operation of Automess Model 6112-B Teletector.*

6. Bicron Model Radiographer Dose Rate Meter

General Information

The Bicron Model Radiographer is a portable battery operated internal Geiger Mueller tube instrument. The Bicron Model Radiographer detects gamma, and x-ray radiations on three linear ranges of 0-10, 0-100, and 0-1,000, mR/h.

Operational Use

The Bicron Model Radiographer is the primary instrument used at the Y-12 Complex to detect and measure gamma/x-ray dose rates at assembly stations. The Bicron Model Radiographer is used for indication purposes only.

Detection Limits

The Bicron Model Radiographer is used to measure and detect photon/x-rays from 40 keV to 1.2 MeV.

Manufacturers Specifications

Operating temperature range should be -40°C to 60°C (-40°F to 140°F).
Bicron states a 5% change in readings from 10 - 95% relative humidity (RH).
Response times stated are < 5 seconds for 10 mR/h, < 2 seconds for 100 mR/h, and < 1 second for 1 R/h ranges.
Shock resistant to 100g per lightweight machine of MIL-STD 202C, method 202B.
Vibration resistant to 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33Hz.

Limitations

The Bicron Model Radiographer should only be used within the ranges of the following environmental conditions. If operation of the Bicron Model Radiographer outside the ranges of the following conditions is necessary, a performance test shall be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Bicron Model Radiographer was acceptable for the ambient pressure test.

The humidity test range was 40% RH to 95% RH. The response of the Bicron Model Radiographer was acceptable for the humidity test.

The temperature test range was -10°C to 50°C . The response of the Bicron Model radiographer was acceptable for the temperature test.

6. Bicron Model Radiographer Dose Rate Meter (cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Bicron Model Radiographer was acceptable when subjected to quick temperature changes of 10° C (50° F).

The Bicron Model Radiographer should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Bicron Model Radiographer outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Bicron Model Radiographer was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Bicron Model Radiographer was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Bicron Model Radiographer was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and 140 MHz at 50 volts/meter. The response of the Bicron Model Radiographer was unacceptable for the radio frequency field test. **The Bicron Model Radiographer should not be used in radio frequency fields to measure or detect dose rates.**

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 rem/hr Pu-Be neutron field. The response of the Bicron Model Radiographer was 60 mR/hr when exposed to the 1 rem/hr neutron field.

Performance Criteria

Bicron Model Radiographers used at the Y-12 Complex are calibrated to ⁶⁰Co by RADCON Instrumentation Section personnel.

The Bicron Model Radiographer is used as an emergency instrument at the Y-12 Complex assembly stations. Bicron Model Radiographers shall be performance tested each day prior to use. The performance test shall follow Y-12 Complex emergency procedures Y40-100; Management of a Nuclear Criticality Accident (11/01/2000) - Effective Date 11/01/2000, Appendix B.1.D-E.

7. Keithley Model 36100 Survey Meter

General Information

The Keithley Model 36100 Survey Meter is a portable battery operated air ion chamber instrument.

Operational Use

The Keithley Model 36100 is the primary instrument used in the Y-12 Complex by radiographers to check for the presence of a radiation field.

Detection Limits

The Keithley Model 36100 may only be used to detect photon/x-ray radiation with energies from 7.5 keV to 2 MeV.

Manufacturers Specifications

Operating temperature range should be 0°C to 50°C (32°F to 122°F).

Moisture resistance is provided by gaskets, seals, and replaceable desiccant cartridges.

Limitations

The Keithley Model 36100 should only be used within the ranges of the following environmental conditions. If operation of the Keithley Model 36100 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Keithley Model 36100 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Keithley Model 36100 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C. The response of the Keithley Model 36100 was acceptable from 10°C to 30°C. **The Keithley Model 36100 must pass a performance test if used in temperatures < 10°C (32°F) or > 30°C (86°F).**

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Keithley Model 36100 was acceptable in the range of 22° to -10°C. **After being subjected to a temperature change of ≥ 10°C (50°F), the Keithley Model 36100 should be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

7. Keithley Model 36100 Survey Meter (cont.)

The Keithley Model 36100 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Keithley Model 36100 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Keithley Model 36100 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Keithley Model 36100 was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Keithley Model 36100 was unacceptably low when subjected to the 915 MHz microwave field. **The Keithley Model 36100s should not be operated in microwave fields.**

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. Response abnormalities were observed at frequencies to 35 MHz with some responses increasing and some decreasing. All responses decreased at 140 MHz. **The Keithley Model 36100s should not be operated in radio frequency fields.**

Interfering Ionizing Radiations

The interfering ionizing radiation test was not performed.

Performance Criteria

Keithley Model 36100s used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

The Keithley Model 36100 is not used to perform quantifying radiological measurements but to detect the presence of photon/x-ray radiations.

8. Xetex Model Telescan Teletector

General Information

The Xetex Model Telescan Teletector is a portable battery operated telescopic dual Geiger Mueller (GM) tube instrument. The Xetex Model Telescan Teletector detects beta, gamma, and x-ray radiations on seven linear ranges of X0.1, X1, X10, X100 mR/h; and X1, X10, X100 R/hr.

Operational Use

The Xetex Model Telescan Teletector is used at the Y-12 Complex to detect high range gamma/x-ray dose rates. The Xetex Model Telescan Teletector is used for indication purposes only.

Detection Limits

No detection limits.

Manufacturers Specifications

Operating temperature range should be -10° C to 50° C.
Extendable from 3.6 to 14 feet. Weighs 6.5 lbs.

Limitations

The Xetex Model Telescan Teletector should only be used within the ranges of the following environmental conditions.

The ambient pressure test range was not performed.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Xetex Model Telescan Teletector was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the Xetex Model Telescan Teletector was acceptable to the temperature test.

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Xetex Model Telescan Teletector was unacceptable when subjected to quick temperature changes of 10° C (50° F). **After being subjected to a temperature change of $\geq 10^{\circ}$ C (50° F), the Xetex Model Telescan Teletector shall be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Xetex Model Telescan Teletector should only be used within the ranges of the following conditions provided by interfering radiations.

8. Xetex Model Telescan Teletector (cont.)

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Xetex Model Telescan Teletector was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Xetex Model Telescan Teletector was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Xetex Model Telescan Teletector was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Xetex Model Telescan Teletector was acceptable for the radio frequency field test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

Xetex Model Telescan Teletectors used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

Xetex Model Telescan Teletectors shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ⁶⁰Co source testing the 1R/h and X10 mR/h ranges. An acceptance range has been calculated for each test point coinciding with the ranges on the Xetex Model Telescan Teletector. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instructions (In leu of Telescan instructions due to similarity) RCO/Y-IN-656INS; *Performance Testing an Automess Model 6112-B Teletector* and Y75-56-FO-519INS; *Operation of Automess Model 6112-B Teletector*.

9. Ludlum Model 12 Count Ratemeter with a Ludlum Model 15 Neutron Detector

General Information

The Ludlum Model 12 is a portable, battery operated, count ratemeter with an optional digital scaler. The Ludlum Model 12 has a scale of 0-500 cpm with four range multipliers; X1, X10, X100, and X1000. The Ludlum Model 15 is a boron trifluoride BF³ proportional detector with a 3" diameter cadmium lined moderator that detects neutron radiation.

Operational Use

The Ludlum Model 12 Count Ratemeter with a Ludlum Model 15 Neutron Detector is the primary instrument used at the Y-12 Complex to detect neutron radiation above 0.1 mrem/hr.

Detection Limits

The scanning detection limit is 0.1mrem/hr which is equivalent to 7 cpm. Detected levels above this limit will require a measurement with a rem equivalent neutron instrument such as the Ludlum Model 12-4.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).

Limitations

The Ludlum Model 12 Count Ratemeter with a Ludlum Model 15 Neutron Detector should only be used within the ranges of the manufacturers environmental conditions. If operation of the Ludlum Model 12 Count Ratemeter with a Ludlum Model 15 Neutron Detector outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

Interfering Ionizing Radiations

The interfering ionizing radiation is quoted from Ludlum as <10 cpm through 10 R/hr.

Performance Criteria

The Ludlum Model 12 Count Ratemeter with a Ludlum Model 15 Neutron Detector shall be performance tested each day prior to use. The performance test shall follow ANSI N323A guidelines. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-IN-537INS: *Performance Test of the Ludlum Model 12-4 Count Ratemeter Neutron Counter (Rem Ball)* and Y75-56-FO-522INS; *Operation of the Ludlum Model 12-4 Count Ratemeter Neutron Counter (Rem Ball)*.

10. Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Wall Mount Neutron Detector

General Information

The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector is a digital AC/DC operated area monitor. The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector detects neutron radiations with a display range of 0 to 9999 mR/hr. The Model 42-30 Neutron detector is a boron trifluoride BF₃ proportional detector surrounded by a polyethylene sphere moderator.

Operational Use

The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector is used at the Y-12 Complex to measure neutron dose rates. The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detectors primary use is in areas near a Cf neutron source.

Detection Limits

No detection limits.

Manufacturers Specifications

Operating temperature range should be -20° C to 50° C.
Operating voltage of 1600 to 1900 volts.

Limitations

The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector should only be used within the ranges of the manufacturers environmental conditions.

Interfering Ionizing Radiation

The Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector has a gamma rejection of 10 cpm up to 10 R/hr.

Performance Criteria

Ludlum Model 375 Digital Area Monitor with a Ludlum Model 42-30 Neutron Detector used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

11. Eberline Model RO-7 Ion Chamber

General Information

The Eberline Model RO-7 Ion Chamber is a portable battery operated ion chamber high range gamma meter. The Eberline Model RO-7 Ion Chamber detects beta, gamma, and x-ray radiations on a digital readout up to 20,000 R/hr. The Eberline Model RO-7 Ion Chamber may be equipped with an waterproof detector housing and underwater cable, a rigid extension or a 60 ft. cable.

Operational Use

The Eberline Model RO-7 Ion Chamber is used at the Y-12 Complex to detect high range gamma/x-ray dose rates. The Eberline Model RO-7 Ion Chamber is used for special purposes only that require its specified capabilities.

Detection Limits

No detection limits.

Manufacturers Specifications

Operating temperature range should be -10° C to 50° C.
Extendable from to 6.5 feet. Weighs 2.7 lbs. plus cable and detector.

Limitations

The Eberline Model RO-7 Ion Chamber should only be used within the ranges of the following environmental conditions.

The ambient pressure test range was not performed.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Eberline Model RO-7 Ion Chamber was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the Eberline Model RO-7 Ion Chamber was acceptable to the temperature test.

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Eberline Model RO-7 Ion Chamber was unacceptable when subjected to quick temperature changes of 10° C (50° F). **After being subjected to a temperature change of $\geq 10^{\circ}$ C (50° F), the Xetex Model Telescan Teletector shall be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Eberline Model RO-7 Ion Chamber should only be used within the ranges of the following conditions provided by interfering radiations.

11. Eberline Model RO-7 Ion Chamber (cont.)

The electric field test was not performed.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Eberline Model RO-7 Ion Chamber was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Eberline Model RO-7 Ion Chamber was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 100 MHz to 1000 MHz at 20 volts/meter and frequencies from 45-430 MHz. The response of the Eberline Model RO-7 Ion Chamber was unacceptable for the radio frequency field test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

Eberline Model RO-7 Ion Chamber used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

Eberline Model RO-7 Ion Chamber shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ⁶⁰Co source. An acceptance range has been calculated for each test point coinciding with the ranges on Eberline Model RO-7 Ion Chamber. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instructions Y75-56-FO-520INS; *Operation of the Eberline Model RO-7 with a Eberline Model RO-7-LD Low Range Detector, RO-7-BM Mid Range Detector, RO-7-BH High Range Detector or a RO-7-UWH Underwater Housing.*

12. MGP Model DMC 90/100 Electronic Pocket Dosimeter

General Information

The MGP Model DMC 90/100 Electronic Pocket Dosimeter is a portable battery operated ion chamber high range gamma meter. The MGP Model DMC 90/100 Electronic Pocket Dosimeter detects beta, gamma, and x-ray radiations on a digital readout up to 20,000 R/hr.

Operational Use

The MGP Model DMC 90/100 Electronic Pocket Dosimeter is used at the Y-12 Complex to detect and measure gamma/x-ray dose rates. The MGP Model DMC 90/100 Electronic Pocket Dosimeter is used as a general indicator of dose and no dose will be assigned to the user from this dosimeter.

Detection Limits

No detection limits.

Manufacturers Specifications

Operating temperature range should be -10° C to 50° C.

Limitations

The MGP Model DMC 90/100 Electronic Pocket Dosimeter should only be used within the ranges of the following environmental conditions.

The ambient pressure test range was not performed.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable to the temperature test.

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable when subjected to quick temperature changes.

The MGP Model DMC 90/100 Electronic Pocket Dosimeter should only be used within the ranges of the following conditions provided by interfering radiations.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable for the electric field test.

12. MGP Model DMC 90/100 Electronic Pocket Dosimeter (cont.)

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 100 MHz to 1000 MHz at 20 volts/meter and frequencies from 45-430 MHz. The response of the MGP Model DMC 90/100 Electronic Pocket Dosimeter was acceptable for the radio frequency field test.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

MGP Model DMC 90/100 Electronic Pocket Dosimeter used at the Y-12 Complex are calibrated to ¹³⁷Cs by the RASCAL facility, Oak Ridge National Lab.

C. Air Sampling/Monitoring Instruments

1. **F & J Specialty Products Inc. (F&J) Model HV-1S/HV-1ST/HV-1SRT High Volume Air Sampler**

General Information

The F&J Model HV-1S is an ac line operated high volume vacuum pump.

Operational Use

The F&J Model HV-1S and variants of this model is the primary instrument used at the Y-12 Complex as a high volume air sampler to collect airborne contamination.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

F&J states maximum capacity of 94 cubic feet per minute (cfm) at 29.92 in Hg and 68°F. F&J states an ultimate vacuum of 80 in H₂O at standard temperature and pressure.

Limitations

The F&J Model HV shall only be used in conditions stated by the manufacturer. The operating temperatures, humidity, and ambient pressures should be environmentally controlled for human occupation.

Performance Criteria

The F&J Model HV shall be used with 10.16 cm Whatman 41 filter paper. The F&J Model HV flow rate shall be documented at calibration and labeled on each pump. The F&J Model HV is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

2. Science Applications International Corporation (SAIC) Model HD-29A Low Volume Air Sampler

General Information

The SAIC Model HD-29A is an AC line operated low volume vacuum pump. The SAIC Model HD-29A has an adjustable air flow rate of 0.5 to 3.0 CFM (20 to 90 lpm).

Operational Use

The SAIC Model HD-29A is the primary instrument used at the Y-12 Complex as a low volume air sampler to collect airborne contamination.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

SAIC states a pressure of 0 to 30 in Hg (vacuum) for reading the Delta P gauge.
SAIC states a pressure of 0 to 30 in Hg (vacuum) for reading the pump head gauge.

Limitations

The SAIC Model HD-29A shall only be used in conditions stated by the manufacturer. The operating temperatures, humidity, and ambient pressures should be environmentally controlled for human occupation.

Performance Criteria

The SAIC Model HD-29A shall be used with Whatman 41 filter paper. The SAIC Model HD-29A flow rate shall be set to 20 lpm during calibration and labeled on each pump. The SAIC Model HV is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

3. Eberline Model ALPHA-6S Continuous Air Monitor (CAM)

General Information

The Eberline Model ALPHA-6S CAM is an AC line operated microprocessor-based alpha continuous air monitor. The Eberline Model ALPHA-6S CAM detects alpha radiation and uses a multi-channel analyzer to calculate activity of particular isotopes. The Eberline Model ALPHA-6S CAM is equipped with an alarm system to alert personnel in the area of air counts over the Derived Air Concentration Limit (DAC).

Operational Use

The Eberline Model ALPHA-6S CAM is the primary instrument used at the Y-12 Complex to measure levels of airborne alpha contamination.

Detection Limits

Uranium limit is 1 DAC averaged over 8 hours in laboratory conditions.

Manufacturers Specifications

Operating temperature range should be 0°C to 40°C (32°F to 104°F).

Limitations

The Eberline Model ALPHA-6S CAM will be used in the buildings at the Y-12 Complex that have environmental conditions within the manufacturers operating specifications.

Radio frequencies at the Y-12 Complex may cause false alarms if portable radios are used in CAM areas.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

The Eberline Model ALPHA-6S CAM shall be functionally checked each day and source checked weekly. The weekly source check will be completed with a ²³⁵U check source. The performance tests shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y50-66-RC-151; *Operation of the Eberline Alpha - 6S Continuous Air Monitor*.

4. MSA Model Escort Elf Personal Air Monitor (PAM)

General Information

The MSA Model Escort Elf PAM is a battery operated microprocessor-based air monitor. The MSA Model Escort Elf PAM measures the flow rate and battery voltage. The MSA Model Escort Elf PAM is equipped with an alarm system to alert personnel of low flow or battery failure.

Operational Use

The MSA Model Escort Elf PAM is the primary instrument used at the Y-12 Complex to collect samples of airborne alpha contamination in the breathing area of the worker.

Detection Limits

No detection limits..

Manufacturers Specifications

Operating temperature range should be 0°C to 40°C (32°F to 104°F).

Limitations

The MSA Model Escort Elf PAM will be used in the environmental conditions of buildings at the Y-12 Complex that are within the manufacturers operating specifications.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

The MSA Model Escort Elf PAM shall be functionally checked each day. The operation of the PAM shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-501INS; *Operation of the MSA Escort Elf Personal Air Monitor (PAM)*.

5. Overhoff Model 400SBDyC Tritium Monitor

General Information

The Overhoff Model 400SBDyC Tritium Monitor is a portable battery (or AC adapter) operated 10 position alarm air monitor. The Overhoff Model 400SBDyC Portable Tritium Monitor uses multiple ion chambers with a port to port air volume of 440 cm³. The response of the Overhoff Model 400SBDyC Portable Tritium Monitor is 30 seconds to reach 90% of final reading. The pump pulls 3-5 volume changes per minute.

Operational Use

The Overhoff Model 400SBDyC Tritium Monitor is the primary instrument used at the Y-12 Complex to detect and measure the airborne concentrations of tritium. Detection of quantities greater than limit set per task are then measured from an air sample.

Detection Limits

No detection limit set for Overhoff Model 400SBDyC Tritium Monitor.

Manufacturer Specifications

Operating temperature range of -20° C to 40° C.
Operating humidity range of 0-98 % R.H.

Limitations

The Overhoff Model 400SBDyC Tritium Monitor should only be used within the ranges of the following environmental conditions. If operation of the Overhoff Model 400SBDyC Tritium Monitor outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test was not performed.

The humidity test range was 40% relative humidity (RH) to 95% RH. **The response of the Overhoff Model 400SBDyC Tritium Monitor was abnormal for the humidity test at 95% RH.**

The temperature test range was -10° C to 50° C. The response of the Overhoff Model 400SBDyC Tritium Monitor was abnormal from -10° C to 20° C. **The Overhoff Model 400SBDyC Tritium Monitor must pass a performance test if used in temperatures < -10° C (14° F) or > 50° C (122° F).**

5. Overhoff Model 400SBDäC Tritium Monitor (cont.)

The temperature shock test was not performed due to the manufacturer stated susceptibility to rapid temperature change. **After being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F), the Overhoff Model 400SBDäC Tritium Monitor should be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Overhoff Model 400SBDäC Tritium Monitor should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Overhoff Model 400SBDäC Tritium Monitor outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were an electrostatic field at 5000 Volts/meter and 60, 400 Hz electric fields at 40 V/meter. The response of the Overhoff Model 400SBDyC Portable Tritium Monitor was acceptable to the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Overhoff Model 400SBDyC Portable Tritium Monitor was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Overhoff Model 400SBDyC Portable Tritium Monitor was acceptably for the microwave field test.

The radio frequency field test were a frequency scan of 0.1 MHz to 1000 MHz at 20 volts/meter and a frequency of 140 MHz at 50 volts/meter. Response abnormalities were observed during frequency scan from 100 kHz to 1000 MHz at 20 volts/meter with some responses increasing and some decreasing.. **The Overhoff Model 400SBDyC Portable Tritium Monitor should not be operated in radio frequency fields.**

Interfering Ionizing Radiations

This interfering ionizing radiations test was not performed.

Performance Criteria

The Overhoff Model 400SBDyC Portable Tritium Monitor shall be functionally checked and performance tested before use each day. The operation of the Overhoff Model 400SBDyC Portable Tritium Monitor shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-505INS; *Operation of the Overhoff Technology Corporation Model 400SBDyC Portable Tritium Monitor.*

6. Johnston Laboratories, Inc. (JLI) Triton Model 111 Tritium Air Monitor

General Information

The JLI Triton Model 111 is an AC/DC microprocessor-based tritium air monitor. The JLI Triton Model 111 detects beta radiation and uses an ion chamber to calculate activity of tritium. The JLI Triton Model 111 is equipped with an alarm system to alert personnel in the area of elevated air counts.

Operational Use

The JLI Triton Model 111 is used at the Y-12 Complex to measure levels of airborne tritium beta contamination.

Detection Limits

Sensitive in the 0-50 $\mu\text{Ci}/\text{M}^3$ linear scale.

Manufacturers Specifications

Operating temperature range should be 0°C to 50°C (32°F to 122°F).
Operating relative humidity (RH) range should be 0 to 95% RH.
Battery operation is <6 hours of continuous use.

Limitations

Operating temperature range is 0 to 50°C.
Operating humidity range is 0 to 90% R.H.

Interfering Ionizing Radiations

The JLI Triton Model 111 is gamma compensated up to 5 mR/hr for a uniform gamma field.

Performance Criteria

The JLI Triton Model 111 will be used in the environmental conditions of buildings at the Y-12 Complex that are within the manufacturers operating specifications.

The JLI Triton Model 111 shall be performance tested each day prior to use. The performance test will be completed with a ^{137}Cs check source. The performance tests shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-512INS; *Operation of the Triton Model 111 Tritium Monitor*.

7. F & J Specialty Products Inc. (F&J) Model LV-1 Low Volume Air Sampler

General Information

The F&J Model LV-1 is an AC line operated low volume carbon vane vacuum pump.

Operational Use

The F&J Model LV-1 is an instrument used at the Y-12 Complex as a low volume air sampler to collect airborne contamination on filter media.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

F&J states maximum capacity of 4 cubic feet per minute (cfm) at 0 in Hg pressure drop.
F&J states an ultimate vacuum of 25 in H₂O at sea level.
Weight of 29 lbs.

Limitations

The weight of this unit may create a hazard if proper lifting techniques are not used due to the total of 29 lbs on a small handle.

Performance Criteria

The F&J Model LV-1 shall be used with Millipore AW-19 or Whatman 41 filter paper. The F&J Model LV-1 flow rate shall be documented at calibration and labeled on each pump. The F&J Model LV-1 is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

8. Science Applications International Corporation (SAIC) Model AVS-28A Low Volume Air Sampler

General Information

The SAIC Model AVS-28A is an AC line operated low volume carbon vane vacuum pump. The SAIC Model AVS-28A has an adjustable air flow rate of 0.5 to 3.5 CFM (20 to 100 lpm).

Operational Use

The SAIC Model AVS-28A is an instrument used at the Y-12 Complex as a low volume air sampler to collect airborne contamination on filter media.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

SAIC states operating range up to 4 CFM and 28" Hg maximum vacuum.
SAIC states a noise level of 70 db at 1 meter.
Weighs 25 lbs.

Limitations

The weight of this unit may create a hazard if proper lifting techniques are not used due to the total of 25 lbs on a small handle.

Performance Criteria

The SAIC Model AVS-28A shall be used with Millipore AW-19 or Whatman 41 filter paper. The SAIC Model AVS-28A flow rate shall be set during calibration and labeled on each pump. The SAIC Model AVS-28A is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

9. Science Applications International Corporation (SAIC) Model H-810 Air Volume Totalizer

General Information

The SAIC Model H-810 Air Volume Totalizer is an AC line operated low volume carbon vane vacuum pump. The SAIC Model H-810 Air Volume Totalizer has an adjustable total air flow to 99999 CFM.

Operational Use

The SAIC Model H-810 Air Volume Totalizer is an instrument used at the Y-12 Complex as a low volume air sampler to collect airborne contamination on filter media.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

SAIC states operating range up to 99999 CFM.
Totalizer accuracy of $\pm 5\%$.

Limitations

The SAIC Model H-810 Air Volume Totalizer shall only be used in conditions stated by the manufacturer.

Performance Criteria

The SAIC Model H-810 Air Volume Totalizer shall be used with Millipore AW-19 or Whatman 41 filter paper. The SAIC Model H-810 Air Volume Totalizer flow rate shall be set during calibration and labeled on each pump. The SAIC Model H-810 Air Volume Totalizer is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

10. Science Applications International Corporation (SAIC) Model HD-66A Low Volume Air Sampler

General Information

The SAIC Model HD-66A is an AC line operated low volume carbon vane vacuum pump. The SAIC Model HD-66A has an adjustable air flow rate of 1.0 to 7.0 CFM.

Operational Use

The SAIC Model HD-66A is an instrument used at the Y-12 Complex as a low volume air sampler to collect airborne contamination on filter media.

Detection Limits

There are no detection limits for this air pump.

Manufacturers Specifications

SAIC states operating range up to 7 CFM and 30" Hg maximum vacuum.
SAIC states air flow regulation of 5%.
Weighs 75 lbs.

Limitations

The SAIC Model HD-66A shall only be used in conditions stated by the manufacturer. The weight of this unit may create a hazard if proper lifting techniques are not used due to the total weight of 75 lbs.

Performance Criteria

The SAIC Model HD-66A shall be used with Millipore AW-19 or Whatman 41 filter paper. The SAIC Model HD-66A flow rate shall be set during calibration and labeled on each pump. The SAIC Model HD-66A is a pump and does not make measurements of contamination. The operation shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-514INS; *Low and High Volume Air Sampling*.

D. Personnel Monitoring Instruments

1. Eberline Model RM-14S Radiation Monitor with Eberline Model HP-100A Gas Proportional Detector

General Information

The Eberline Model RM-14S is AC line operated alarm ratemeter. The Eberline Model RM-14S has a scale of 0-5 counts per minute with six range multipliers; X10, X100, X1K, X10K and X1M. The Eberline Model HP-100A Gas Proportional Detector responds to alpha, beta, gamma, and x-ray radiations.

Operational Use

The Eberline Model RM-14S with the Eberline Model HP-100A is the primary instrument used at the Y-12 Complex to measure alpha-beta-gamma surface contamination on personnel after an alarm in an automated monitor.

Detection Limits

The static detection limit is 100 dpm/100 cm^2 alpha and 300 dpm/100 cm^2 beta/gamma. The scanning detection limit is 350 dpm/100 cm^2 alpha and 1,000 dpm/100 cm^2 beta/gamma. The corrections are for efficiency only because the size of the detector is 100 cm^2 . The efficiency is specific to each instrument calibration.

Manufacturers Specifications

Operating temperature range should be -30°C to 60°C (-22°F to 140°F).

Limitations

The Eberline Model RM-14S with a Eberline Model HP-100A should only be used within the ranges of the following environmental conditions. If operation of the Eberline Model RM-14S with a Eberline Model HP-100A outside the ranges of the following conditions is necessary, a performance test shall be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test was not performed on the Eberline Model RM-14S with the HP-100A gas proportional detector.

The humidity test range was 40% relative humidity (RH) to 95% RH. The Eberline Model RM-14S with the HP-100A response was unacceptable for the humidity test. **After being subjected to a change of 50% RH , the Eberline Model RM-14S with the HP-100A should be allowed to stabilize for 1 hour before use.**

1. **Eberline Model RM-14S Radiation Monitor with Eberline Model HP-100A Gas Proportional Detector** (cont.)

The temperature test range was -10° C to 50° C. The response of the Eberline Model RM-14S with the HP-100A was unacceptable for the range of this test. The Eberline Model RM-14S with the HP-100A responded low for temperatures < 10° C and high for temperatures > 30° C on the X 100 range. The Eberline Model RM-14S with the HP-100A responded low for temperatures < 0° C on the X1K range. **The Eberline Model RM-14S with the HP-100A should not be used when temperatures are < 10° C (50° F) or > 30° C (86° F) on the X 100 range or < 0° C (32° F) on the X1K range.**

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The Eberline Model RM-14S with the HP-100A response was unacceptable when subjected to quick temperature changes of 10° C (50° F) on the 0 to 5 mR/hr range. **After being subjected to a temperature change of 10° C (50° F), the Eberline Model RM-14S with the HP-100A shall be allowed to stabilize for 1 hour before use or until passing a performance test in the changed environment.**

The Eberline Model RM-14S with the HP-100A should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Eberline Model RM-14S with the HP-100A outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Eberline Model RM-14S with the HP-100A was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Eberline Model RM-14S with the HP-100A was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Eberline Model RM-14S with the HP-100A was acceptable for the microwave field test.

The radio frequency field test ranges were frequency scans of 0.3 MHz to 35 MHz at 50 volts/meter and 140 MHz at 50 volts/meter. The response of the Eberline Model RM-14S with the HP-100A was unacceptable for the radio frequency test. **The Eberline Model RM-14S with the HP-100A should not be operated in radio frequency fields.**

The results of the Electronic and Mechanical Requirements and Tests may be limiting factors for the use of the Eberline Model RM-14S with the HP-100A.

The line noise test points were a 100 kHz ring wave at 2.5 kV and 6 kV, and a combination wave at 2.5 kV and 6 kV. The response of the Eberline Model RM-14S with the HP-100A was acceptable for the ring wave test.

1. Eberline Model RM-14S Radiation Monitor with Eberline Model HP-100A Gas Proportional Detector (cont.)

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to a 1 mrem/hr ^{252}Cf neutron field. The response of the Eberline Model RM-14S with the HP-100A was 1330 to 1480 counts per minute of the 1 mRem/hr neutron field with the Alpha/Beta switch in the Beta position. There was no response when exposed to the 1 mrem/hr ^{252}Cf neutron field with the Alpha/Beta switch in the Alpha position.

Performance Criteria

Eberline Model RM-14S with the HP-100A used at the Y-12 Complex are calibrated to ^{241}Am and ^{90}SrY by the RADCON Instrumentation Section.

Eberline Model RM-14S with the HP-100A shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ^{241}Am and ^{90}SrY sources testing one range. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-518INS; *Performance Test and Operation of an Eberline Model RM-14S Radiation Monitor with an Eberline Model HP-100A Gas Proportional Detector*.

2. Ludlum) Model 177-45 Alarm Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector

General Information

The Ludlum Model 177-45 is a portable battery or line operated alarm ratemeter. The Ludlum Model 44-9 detects alpha-beta-gamma radiation. The Ludlum Model 177-45 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1K.

Operational Use

The Ludlum Model 177-45 with a Ludlum Model 44-9 is the primary instrument used at the Y-12 Complex for self-monitoring of personnel for beta-gamma surface contamination. The Ludlum Model 44-9 has a plastic cover installed to attenuate alpha particles.

Detection Limits

The alarm set point is 5,000 dpm/100 cm^2 .

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).

Limitations

The Ludlum Model 177-45 with a Ludlum Model 44-9 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 177-45 with an Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable for the ambient pressure test.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C . The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable on the X10 range. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable on the X1 range for temperatures $> 10^{\circ}\text{C}$. **The Ludlum Model 177-45 with a Ludlum Model 44-9 should not be used on the X1 range when the temperatures are $\leq 10^{\circ}\text{C}$ (50°F).**

2. Ludlum Measurements Inc. (Ludlum) Model 177-45 Alarm Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was unacceptable for the temperature shock test. **The Ludlum Model 177-45 with a Ludlum Model 44-9 should not be used for 1 hour after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 177-45 with a Ludlum Model 44-9 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 177-45 with a Ludlum Model 44-9 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was unacceptably low on the X1 range. **The Ludlum Model 3 with a Ludlum Model 44-9 should not be used in magnetic fields on the X1 range.**

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was unacceptable for the range of the radio frequency scan test. **The Ludlum Model 177-45 with a Ludlum Model 44-9 should not be used in radio frequency fields.**

The results of the Electronic and Mechanical Requirements Tests may be limiting factors for the use of the Ludlum Model 177-45 with a Ludlum Model 44-9.

The line noise test points were a 100 kHz ring wave at 2.5 kV and 6 kV, and a combination wave at 2.5 kV and 6 kV. The response of the Ludlum Model 177-45 with a Ludlum Model 44-9 was acceptable for the ring wave test. The combination wave test was not performed due to the known susceptibility of damage that would result to the Ludlum Model 177-45.

2. Ludlum Model 177-45 Alarm Ratemeter with a Ludlum Model 44-9 Alpha-Beta-Gamma Detector (cont.)

Interfering Ionizing Radiation

The interfering ionizing radiation test was an exposure to 1 rem/hr Pu-Be neutron field. The Ludlum Model 177-45 with a Ludlum Model 44-9 response was 120,000 counts per minute when exposed to the 1 rem/hr neutron field.

Performance Criteria

The Ludlum Model 177-45 with a Ludlum Model 44-9 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ¹³⁷Cs check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-502INS; *Performance Test of a Ludlum Model 177-45 Alarm Ratemeter (PMI)*.

3. Ludlum Model 177-45 Alarm Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector

General Information

The Ludlum Model 177-45 is a portable battery or line operated alarm ratemeter. The Ludlum Model 177-45 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1K. The Ludlum Model 43-65 is a 50 ^{cm}2 zinc sulfide scintillator with a 0.8 mg mylar window that detects alpha radiation.

Operational Use

The Ludlum Model 177-45 with a Ludlum Model 43-65 is the primary instrument used at the Y-12 Complex for self-monitoring of personnel for alpha surface contamination.

Detection Limits

The alarm set point is 5,000 or 1,000 dpm/100 ^{cm}2 depending on the area and nuclide of concern.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).

Limitations

The Ludlum Model 177-45 with a Ludlum Model 43-65 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 177-45 with an Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable for ambient pressures \geq 690 in. Hg. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used when the ambient pressure is <690 in. Hg.**

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable for the humidity test at 40% RH. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was unacceptably low for the humidity test at 95% RH. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used on the X1 range when the relative humidity is > 40%..**

3. Ludlum Model 177-45 Alarm Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector (cont.)

The temperature test range was -10°C to 50°C . The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable on the X10 range. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable on the X1 range for temperatures $> 10^{\circ}\text{C}$ to $< 30^{\circ}\text{C}$. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used on the X1 range when the temperatures are $\leq 10^{\circ}\text{C}$ (50°F) or $\geq 30^{\circ}\text{C}$ (86°F).**

The temperature shock test ranges were 22° to 50°C , 50° to 22°C , 22° to -10°C , and -10° to 22°C . The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was unacceptable for the temperature shock test. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used for 1 hour after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 177-45 with a Ludlum Model 43-65 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 177-45 with a Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was unacceptable for the electric field test. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used in electric fields.**

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was unacceptable on the X1 range for the magnetic field test. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used in magnetic fields.**

The microwave field test points were 915 MHz at 0.4 Watts/meter^2 and 2.45 GHz at 2.0 Watts/meter^2 . The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was unacceptable for the range of the radio frequency scan test. **The Ludlum Model 177-45 with a Ludlum Model 43-65 should not be used in radio frequency fields.**

The results of the Electronic and Mechanical Requirements Tests may be limiting factors for the use of the Ludlum Model 177-45 with a Ludlum Model 43-65.

3. Ludlum Model 177-45 Alarm Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector (cont.)

The line noise test points were a 100 kHz ring wave at 2.5 kV and 6 kV, and a combination wave at 2.5 kV and 6 kV. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was acceptable for the ring wave test. The combination wave test was not performed due to the known susceptibility of damage that would result to the Ludlum Model 177-45.

Interfering Ionizing Radiation

The interfering ionizing neutron radiation test was an exposure to a 100 mrem/hr Pu-Be neutron field. The response of the Ludlum Model 177-45 with a Ludlum Model 43-65 was 9000 to 9300 counts per minute when exposed to the neutron field. The interfering ionizing gamma radiation test was an exposure to 1 R/hr ^{137}Cs gamma field. The Ludlum Model 177-45 with a Ludlum Model 43-65 did not respond when exposed to the gamma field.

Performance Criteria

The Ludlum Model 177-45 with a Ludlum Model 43-65 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ^{235}U check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-502INS; *Performance Test of a Ludlum Model 177-45 Alarm Ratemeter (PMI)*.

4. Eberline Model PCM-1B Personnel Contamination Monitor

General Information

The Eberline Model PCM-1B is a whole body beta/gamma surface contamination personnel monitor. The Eberline Model PCM-1B has an array of fifteen 500 ^{cm}² detectors positioned to monitor one side of a persons body per count time before the user is prompted to insert other side. Minimum Count Time is the primary mode used to operate the Eberline Model PCM-1Bs because of the modes ability to adjust the optimal count time due to background changes and the other set parameters. The Eberline Model PCM-1Bs have been equipped to monitor for alpha surface contamination on the hands, forearms and feet.

Operational Use

The Eberline Model PCM-1Bs are installed inside buildings as the primary automated instrument used at the Y-12 Complex to perform beta/gamma whole body frisking. An optional alpha frisk for hands, feet and forearm (detectors with probability of geometry for alpha particle interaction) is also performed by the Eberline Model PCM-1B.

Detection Limits

The contamination alarms are set to 5,000 dpm/100 ^{cm}² .

Manufacturers Specifications

Operating temperature should be 0^o to 50^o C (32^o F to 122^o F).

Pressure should be ambient atmosphere.

Operating humidity should be 0 to 95% (non-condensing).

Limitations

The operating temperatures at Boundary Control Stations are suitable for routine work for personnel and temperatures shall fall within the specified range. Ambient pressures should be approximately equivalent to atmospheric pressure. The Eberline Model PCM-1B is a 550 lb. fixed location monitor.

Performance Criteria

Daily performance tests of the alarm in the environment of use with sources of approximately Complex release limits should provide sufficient qualification for the intended use. The Eberline Model PCM-1B continuously diagnoses the background updates using statistical routines to provide users information about the status of the monitors ability to detect the activity specified in the instrument parameters. Diagnostic routines built into the monitor alert RADCON technicians to the presence of interfering radiations. The RADCON technician may take corrective actions for continued operation of the monitor or discontinue use of the monitor until the interfering radiations no longer present a problem.

4. Eberline Model PCM-1B Personnel Contamination Monitor (cont.)

The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-IN-503INS; *Performance Test of an Eberline Model PCM-1B Personnel Contamination Monitor*.

5. Eberline Model PCM-2 Personnel Contamination Monitor

General Information

The Eberline Model PCM-2 is a whole body alpha/beta/gamma surface contamination personnel monitor. The Eberline Model PCM-2 has an array of sixteen detectors divided into thirty-four counting zones. The detectors are positioned to monitor one side (front or back) of a persons body per count time before the user is prompted to insert other side. Minimum Count Time is the primary mode used to operate the Eberline Model PCM-2s because of the modes ability to adjust to the optimal count time due to background changes and the other set parameters.

Operational Use

The Eberline Model PCM-2s are installed inside buildings as the primary automated instrument used at the Y-12 Complex to perform for alpha/beta/gamma whole body frisking. The design allows geometry for personnel to monitor surface contamination.

Detection Limits

The contamination alarms are set to 5,000 dpm/100 cm² or less depending on area and nuclide of concern.

Manufacturers Specifications

Operating temperature should be 0^o to 45^o C (32^o to 113^o F).
Pressure should be ambient atmosphere.
Operating humidity should be 0 to 95% (non-condensing).

Limitations

The operating temperatures at Boundary Control Stations are suitable for routine work for personnel and temperature/humidity shall fall within the specified range. Ambient pressures should be approximately equivalent to atmospheric pressure. The Eberline Model PCM-2 is a 660 lb. fixed location monitor.

Performance Criteria

Daily performance tests of the alarm in the environment of use with sources of approximately Complex release limits should provide sufficient qualification for the intended use. The PCM-2 continuously diagnoses the background updates using statistical routines to provide user information about the status of the monitors ability to detect the activity specified in the instrument parameters. Diagnostic routines built into the monitor alert RADCON technicians to the presence of interfering radiations. The RADCON technician may take corrective actions for continued operation of the monitor or discontinue use of the monitor until the interfering radiations no longer present a problem.

5. Eberline Model PCM-2 Personnel Contamination Monitor (cont.)

The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-IN-502INS; *Performance Test of an Eberline Model PCM-2 Personnel Contamination Monitor.*

6. Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-65 Alpha Scintillator Detector

General Information

The Ludlum Model 2200 is a portable battery or line operated scaler ratemeter. The Ludlum Model 2200 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1000. The Ludlum Model 43-65 is a 50 ^{cm²} zinc sulfide scintillator with a 0.8 mg mylar window that detects alpha radiation.

Operational Use

The Ludlum Model 2200 with a Ludlum Model 43-65 Alpha scintillator detector is the primary instrument used at the Y-12 Complex as a special hand monitor in areas prior to performing an exit survey from alpha contamination areas.

Detection Limits

The detection limit is 100 cpm is approximately 5,000 dpm per 100 ^{cm²}.

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).

Limitations

The Ludlum Model 2200 with a Ludlum Model 43-65 should only be used within the ranges of the manufacturers environmental conditions. If operation of the Ludlum Model 2200 with an Ludlum Model 43-65 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

Interfering Ionizing Radiation

The interfering ionizing radiation test was not performed.

Performance Criteria

The Ludlum Model 2200 with a Ludlum Model 43-65 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ²³⁰Th check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instructions.

E. Counters (Field and Laboratory)

1. Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-1 Alpha Scintillator Detector

General Information

The Ludlum Model 2200 is a portable battery or line operated scaler ratemeter. The Ludlum Model 2200 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1000. The Ludlum Model 43-1 is a 75 cm² zinc sulfide scintillator that detects alpha radiation.

Operational Use

The Ludlum Model 2200 with a Ludlum Model 43-1 Alpha scintillator detector is the primary instrument used at the Y-12 Complex as a quick count air sample counter for large filters to measure airborne alpha contamination.

Detection Limits

The detection limit is 44 dpm per filter for one minute count time with background < 6 cpm. Instruction Y75-56-FO-109, for longer count times and different detection limits, will be used to calculate needed count time to meet limits .

Manufacturers Specifications

Operating temperature range should be -40°C to 50°C (-40°F to 122°F).

Limitations

The Ludlum Model 2200 with a Ludlum Model 43-1 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2200 with an Ludlum Model 43-1 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The ambient pressure test range was 525 in. Hg to 795 in. Hg. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was unacceptable at 795 in. Hg for the ambient pressure test. **The Ludlum Model 2200 with a Ludlum Model 43-1 should not be used in ambient pressures > 758 in. Hg.**

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was erratic on the X1 range. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was acceptable for the temperature test.

1. **Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-1 Alpha Scintillator Detector** (cont.)

The temperature shock test ranges were 22° to 50° C, 50° to 22° C, 22° to -10° C, and -10° to 22° C. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was unacceptable for the temperature shock test. **The Ludlum Model 2200 with a Ludlum Model 43-1 should not be used for 1 hour after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

The Ludlum Model 2200 with a Ludlum Model 43-1 should only be used within the ranges of the following conditions provided by interfering radiations. If operation of the Ludlum Model 2200 with a Ludlum Model 43-1 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The electric field test points were 60 and 400 Hz at 100 volts/meter, and electrostatic at 5000 volts/meter. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was acceptable for the electric field test.

The magnetic field test point was 10 Oersted at 800 amps/meter. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was unacceptably low on the X1 range. **The Ludlum Model 2200 with a Ludlum Model 43-1 should not be used in magnetic fields on the X1 range.**

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was acceptable for the microwave field test.

The radio frequency field test were a frequency scan of 0.3 MHz to 35 MHz at 50 volts/meter and a frequency of 140 MHz at 50 volts/meter. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was unacceptable for the range of the radio frequency scan test. **The Ludlum Model 2200 with a Ludlum Model 43-1 should not be used in radio frequency fields.**

The results of the Electronic and Mechanical Requirements Tests may be limiting factors for the use of the Ludlum Model 2200 with a Ludlum Model 43-1.

The line noise test points were a 100 kHz ring wave at 2.5 kV and 6 kV, and a combination wave at 2.5 kV and 6 kV. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was acceptable for the ring wave test. The combination wave test was not performed due to the known susceptibility of damage that may result to the Ludlum Model 2200.

1. **Ludlum Model 2200 Scaler Ratemeter with a Ludlum Model 43-1 Alpha Scintillator Detector** (cont.)

Interfering Ionizing Radiation

The interfering ionizing neutron radiation test was an exposure to a 1 rem/hr ^{252}Cf neutron field. The response of the Ludlum Model 2200 with a Ludlum Model 43-1 was 120 to 180 counts per minute when exposed to the neutron field. The interfering ionizing gamma radiation test was an exposure to 11.7 R/hr ^{137}Cs gamma field. The Ludlum Model 2200 with a Ludlum Model 43-1 did not respond when exposed to the gamma field.

Performance Criteria

The Ludlum Model 2200 with a Ludlum Model 43-1 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ^{235}U check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-516INS; *Operation of Ludlum 2200 Portable Scaler Ratemeter with a 43-1 Alpha Scintillator Probe*.

2. Ludlum Model 2929 Dual Channel Scaler with a Ludlum Model 43-10-1 Alpha-Beta Sample Counter

General Information

The Ludlum Model 2929 is an AC line operated dual channel scaler. The Ludlum Model 2929 has a simultaneous digital readout for alpha and beta-gamma. The Ludlum Model 43-10-1 detects alpha and beta-gamma radiation.

Operational Use

The Ludlum Model 2929 with a Ludlum Model 43-10-1 is the primary instrument used at the Y-12 Complex as a smear or air sample counter to measure removable or airborne alpha-beta-gamma contamination.

Detection Limits

The detection limits are calculated for and labeled on each instrument. This instrument typically has an alpha detection limit of ≤ 20 dpm. Instruction Y75-56-FO-109, for longer count times and different detection limits, will be used to calculate needed count time to meet desired limits for air samples.

Manufacturers Specifications

Ludlum states alpha cross talk in the beta channel is $\leq 10\%$ and beta cross talk in the alpha channel is $\leq 1\%$.

Limitations

The Ludlum Model 2929 with a Ludlum Model 43-10-1 should only be used within the ranges of the following environmental conditions. If operation of the Ludlum Model 2929 with a Ludlum Model 43-10-1 outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the Ludlum Model 2929 with a Ludlum Model 43-10-1 was acceptable for the humidity test.

The temperature test range was -10°C to 50°C . The response of the Ludlum Model 2929 with a Ludlum Model 43-10-1 was erratic on the X1 range. The response of the Ludlum Model 2929 with a Ludlum Model 43-10-1 was unacceptably low at 0°C and unacceptably high at 30°C for the temperature test. **The Ludlum Model 2929 with a Ludlum Model 43-10-1 should only be used at temperatures $\geq 0^{\circ}\text{C}$ (32°F) and $\leq 30^{\circ}\text{C}$ (86°F).**

2. Ludlum Model 2929 Dual Channel Scaler with a Ludlum Model 43-10-1 Alpha-Beta Sample Counter (cont.)

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the Ludlum Model 2929 with a Ludlum Model 43-10-1 was unacceptable for the temperature shock test. **The Ludlum Model 2929 with a Ludlum Model 43-10-1 should not be used for 1 hour after being subjected to a temperature change of $\geq 10^\circ\text{C}$ (50° F) or until passing a performance test after under going the temperature change.**

The operating temperatures, humidity, and ambient pressures should be environmentally controlled as in an office environment. Limits are placed, on each monitor, for the amount of background allowed for alpha or beta-gamma.

Performance Criteria

The Ludlum Model 2929 with a Ludlum Model 43-10-1 shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with ^{235}U and/or ^{238}U check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-517INS; *Operation of Ludlum 2929 Dual Channel Scaler with a 43-10-1 Alpha and Beta-Gamma Detector.*

3. Science Applications International Corporation (SAIC) Model AP-2 Alpha Analyzer

General Information

The SAIC Model AP-2 Alpha Analyzer is a portable instrument for alpha detection and measurement. The SAIC Model AP-2 Alpha Analyzer has a multichannel analyzer with a solid state 2" detector to determine the energy(s) of alpha particles. Analyzing unknown alpha particles can now be performed outside a laboratory environment.

Operational Use

The SAIC Model AP-2 Alpha Analyzer is the primary instrument used in the Y-12 Complex to identify the nuclide of alpha contamination from smears or air samples.

Detection Limits

Limits are instrument specific and calculated at time of calibration.

Manufacturer Specifications

Operating temperature range is 0° to 50° C
Operating humidity range is 0 to 85% non-condensing.
Energy discrimination adjustable from 1.0 to 9.9 MeV.

Limitations

The SAIC Model AP-2 Alpha Analyzer should only be used within the ranges of the manufacturers environmental conditions. If operation of the SAIC Model AP-2 Alpha Analyzer outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

The humidity test range was 40% relative humidity (RH) to 95% RH. The response of the SAIC Model AP-2 Alpha Analyzer was acceptable for the humidity test.

The temperature test range was -10° C to 50° C. The response of the SAIC Model AP-2 Alpha Analyzer was erratic for the temperature test.

The temperature shock test ranges were 22° to 50°C, 50° to 22°C, 22° to -10°C, and -10° to 22°C. The response of the SAIC Model AP-2 Alpha Analyzer was unacceptable for the temperature shock test. **The SAIC Model AP-2 Alpha Analyzer should not be used for 1 hour after being subjected to a temperature change of $\geq 10^{\circ}\text{C}$ (50°F) or until passing a performance test after under going the temperature change.**

3. Science Applications International Corporation (SAIC) Model AP-2 Alpha Analyzer (cont.)

The magnetic field test point was 10 Oersted (Gauss) DC and 60 Hz (1.26 Gauss) AC. The response of the SAIC Model AP-2 Alpha Analyzer was acceptable for the magnetic field test.

The microwave field test points were 915 MHz at 0.4 Watts/meter² and 2.45 GHz at 2.0 Watts/meter². **The response of the SAIC Model AP-2 Alpha Analyzer was unacceptable for the microwave field test.**

The radio frequency field test were a frequency scan of 0.1 MHz to 1000 MHz at 20 volts/meter and a frequency of 140 MHz at 50 volts/meter. **The response of the SAIC Model AP-2 Alpha Analyzer was unacceptable for the radio frequency field test.**

The operating temperatures, humidity, and ambient pressures should be environmentally controlled as in an office environment. Limits are placed, on each monitor, for the amount of background allowed for alpha or beta-gamma.

Interfering Ionizing Radiations

The interfering ionizing radiation test was an exposure to a 1 mrem/hr ²⁵²Cf neutron field. The response of the SAIC Model AP-2 Alpha Analyzer was 21 to 28 counts per minute alpha. The interfering ionizing radiation test included an exposure to a 1 mrem/hr ¹³⁷Cs gamma field. The response of the SAIC Model AP-2 Alpha Analyzer was 133 to 221 counts per minute alpha + gamma. The interfering ionizing radiation test included an exposure to a 0.5 rad/hr ⁹⁰Sr/Y beta field. The response of the SAIC Model AP-2 Alpha Analyzer was 323 to 511 counts per minute beta.

Performance Criteria

The SAIC Model AP-2 Alpha Analyzer shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with ²³⁵U or ²³⁸U check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-510INS; *Operation of the SAIC AP-2 Alpha Analyzer*.

4. IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B Radioactivity HPLC Detector

General Information

The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B is an AC line operated instrument with a flow through detection system. The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B detects $\hat{\alpha}$ emitting and soft $\hat{\beta}$ emitting isotopes in continuous flow. Based upon scintillation principles, detection takes advantage of processes which generate light as radioactive decay occurs. The actual measurement is made in cells of coiled Teflon tubing positioned between two opposed photomultipliers operating in coincidence; only light pulses seen simultaneously by both detectors are analyzed and recorded. Pulses arising from one, not matched by the other, are assumed to derive from thermal phenomena and other spurious sources within the photomultiplier and are rejected.

Operational Use

The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B is used at the Y-12 Complex as a tritium detector.

Detection Limits

The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B is used for indication only.

Manufacturers Specifications

^3H is detected with 60% efficiency with a background of 4 cpm while ^{14}C is detected with >90% efficiency with a background of about 12 cpm.

Limitations

The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B shall only be used in environmental conditions of buildings at the Y-12 Complex that are suitable for human occupation.

Performance Criteria

The IN/US Systems $\hat{\alpha}$ -RAM[®] Model 2B shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with a ^3H check source. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-FO-504INS; *Operation of a HPLC-2 Tritium Detector*.

5. Tennelec Model Eclipse 5XLB Low Background Proportional Counter

General Information

The Tennelec Model Eclipse 5XLB Low Background Proportional Counter is a laboratory counter that should reside in a controlled environment. The Tennelec Model Eclipse 5XLB Low Background Proportional Counter is an automated counter that may be loaded with up to 100 samples to be counted. The Tennelec Model Eclipse 5XLB Low Background Proportional Counter uses a P-10 counting gas to supply a windowed proportional detector.

Operational Use

The Tennelec Model Eclipse 5XLB Low Background Proportional Counter is the primary instrument used in the Y-12 Complex to perform measurement of alpha/beta contamination on smears or air samples. Fixed Air Samples (FAS) and Personal Air Monitor (PAM) Samples are counted on the Tennelec Model Eclipse 5XLB Low Background Proportional Counters.

Detection Limits

Limits are instrument specific and calculated at time of calibration.

Manufacturer Specifications

Operating temperature range is 0° to 50° C
Operating humidity range is 0 to 80% non-condensing.

Limitations

The Tennelec Model Eclipse 5XLB Low Background Proportional Counter should only be used within the ranges of the manufacturers environmental conditions. If operation of the Tennelec Model Eclipse 5XLB Low Background Proportional Counter outside the ranges of the following conditions is necessary, a performance test should be passed before use. To satisfy a performance test in an environment outside the following conditions, ensures the instrument is operating properly.

Interfering Ionizing Radiations

The interfering ionizing radiations test was not performed.

Performance Criteria

The Tennelec Model Eclipse 5XLB Low Background Proportional Counter shall be performance tested each day prior to use. The performance test shall follow ANSI N323 guidelines. The performance test will be completed with ⁹⁹Tc check sources. The performance test shall be performed and documented by trained RADCON personnel according to RADCON operating instruction Y75-56-IN-536INS; *Operation of a Tennelec Eclipse Low Background Proportional Counter*.