

6.2.5 Determine the "AS FOUND" reading for the high scale as follows:

- 6.2.5.1 Ensure that the selector switch is at the desired scale position.
- 6.2.5.2 Expose the properly centered detector to each selected exposure rate.
- 6.2.5.3 Record the reading in the "AS FOUND" column on ATGF-008.

6.2.6 Determine the "AS FOUND" reading for the lower scales, which are calibrated by pulse generator, as follows:

- 6.2.6.1 Disconnect the detector jacks from the circuit board.
- 6.2.6.2 Connect the pulse generator to the detector jacks on the circuit board.
- 6.2.6.3 Set the pulse height to between 60 and 100 milli-volts negative.
- 6.2.6.4 Set the selector switch to the high scale.
- 6.2.6.5 Adjust the pulse rate until the required value for 20% of the high scale is indicated.
- 6.2.6.6 For each lower scale, reduce the pulse rate by the appropriate factor (i.e. reduce by a factor of 10 when going from 5000 scale to the 500 scale).

NOTE: On the Model 19 when switching from the 500 scale to the 250 scale or the 50 scale to the 25 scale, decreasing the pulse rate by 50% is accomplished by decreasing the mini-pulser base switch setting by 50%.

- 6.2.6.7 Record the readings in the "AS FOUND" column on ATGF-008.
- 6.2.6.8 Repeat steps 6.2.6.4 through 6.2.6.7 for approximately 80% of the scale.
- 6.2.6.9 Remove the pulse generator and connect the detector to the circuit board.

6.2.7 Place the selector switch to the high scale.

6.2.7.1 Connect an electrostatic voltmeter or equivalent to the connections on the circuit board.

6.2.7.2 Measure the high voltage at the detector connection and record the high voltage in the "AS FOUND" column on ATGF-008.

6.2.8 With the selector switch in the "OFF" position, determine if the meter movement is on zero (0).

6.2.8.1 If the meter movement reads zero proceed to Section 6.2.9.

6.2.8.2 If the meter movement is not on zero, turn the mechanical zero screw on the meter face until the meter movement reaches zero.

6.2.9 If the "AS FOUND" readings observed in Section 6.2.6 fall within the $\pm 10\%$ tolerance limit and the mechanical zero was not adjusted, record the readings in the "AS LEFT" column on ATGF-008. If better accuracy is desired, Steps 6.2.11, 6.2.12, and 6.2.13 may be performed.

6.2.10 If any of the "AS FOUND" readings observed in Sections 6.2.5 and 6.2.6 do not fall within the $\pm 10\%$ tolerance limit or if the mechanical zero was adjusted, proceed to Step 6.2.11.

6.2.11 Determine the detector operating voltage as follows:

6.2.11.1 Expose the instrument to an approximately 1 mr/hr field.

6.2.11.2 Decrease the high voltage until there is a marked decrease in the exposure rate indicated on the meter.

6.2.11.3 Increase high voltage in approximately 50 volt increments and plot a voltage vs. indicated exposure rate plateau until there is a significant increase in exposure rate as indicated on the meter. Do not increase the voltage more than 1200 volts.

6.2.11.4 Set the voltage in the middle of the plateau.

6.2.11.5 Measure the high voltage and record as the "AS LEFT" voltage on ATGF-008.

6.2.12 Calibrate the high scale to the required value as follows:

- 6.2.12.1 Position the instrument so that the effective center of the detector will be in the source beam when the source is exposed.
- 6.2.12.2 Expose the detector to the selected exposure rate to give 80% of full scale response, (4000 μ R/hr).
- 6.2.12.3 Adjust calibration control until the reading is within \pm 10% of the required value.
- 6.2.12.4 Expose the detector to the selected exposure rate to give 20% of full scale response, (1000 μ R/hr).
- 6.2.12.5 Adjust the calibration control, if necessary to obtain the reading to within \pm 10% of the required value.
- 6.2.12.6 Record the observed value for each selected position in the "AS LEFT" column on ATGF-008.
- 6.2.12.7 If the instrument cannot be adjusted to \pm 10% of the required value, remove the instrument from service, notify Health Physics Supervision, and arrange for repair of the instrument.

6.2.13 Adjust each scale that is to be calibrated to the pulse generator as follows:

- 6.2.13.1 Set the selector switch to the high scale.
- 6.2.13.2 Adjust the pulse generator until the required value selected for approximately 80% of full scale.
- 6.2.13.3 Set the selector switch to the next range to be checked and reduce the pulse rate by the appropriate factor.
- 6.2.13.4 Adjust the calibration control until the reading is within \pm 10% of the tolerance limit.
- 6.2.13.5 Repeat Steps 6.2.13.3 and 6.2.13.4 for each lower scale.
- 6.2.13.6 Repeat Steps 6.2.13.1 through 6.2.13.3 for approximately 20% of the full scale.
- 6.2.13.7 Record the final observed value for each selected position in the "AS LEFT" position on ATGF-008.
- 6.2.13.8 If the instrument cannot be adjusted to read within \pm 10% of the required value, then remove the instrument from service,

notify Health Physics Supervision and arrange for instrument repair.

6.2.13.9 Disconnect the pulse generator and reconnect the detector.

6.2.13.10 Reassemble the unit.

6.2.14 Determine Performance Test Data

6.2.14.1 Obtain a 5 μ Ci Cs-137 button source and record the serial number on ATGF-008.

6.2.14.2 Switch the instrument to the appropriate range and obtain a source reading on contact. Record the observed reading on ATGF-008.

6.2.14.3 Calculate the performance test range, $\pm 10\%$ of the source reading, and record the results on ATGF-008.

6.2.15 If the above calibration steps are completed satisfactory, attached a completed Calibration Data Sticker and Performance Test Daily Check Sticker to the instrument. Complete form ATGF-008 as appropriate.

6.3 Performance Test

6.3.1 Perform a performance test on the instrument and record all data form ATGF-003, Performance Test Log Sheet.

6.3.2 Obtain the performance test source designated by the Performance Test source designated by the Performance Test Daily Check Sticker on the instrument.

6.3.3 Record the information for each section of form ATGF-003.

6.3.4 Examine the instrument for any obvious physical damage which could interfere with its proper operation.

6.3.5 Verify that the instrument has a current Calibration Data Sticker and Performance Test Daily Check Sticker.

6.3.6 Perform a battery check by turning the selector switch to the 5000 μ R/hr scale and depressing the "BATT" button, if the unit does not read in the "BATTERY" area, replace the batteries.

6.3.7 Expose the center of the detector to the designated source. If the reading is within the designated range for the source, proceed to Step 6.3.9. If the instrument fails record "F" for "FAIL" on ATGF-003 and remove the instrument from service for repair or calibration.

- 6.3.8 If the instrument fails any portion of the performance test, log the instrument as failing on the Performance Test Log Sheet, remove from service, and notify Health Physics Supervision.
- 6.3.9 If the instrument passes the performance test, record "P" for "PASS" on form ATGF-003, then initial the Performance Test Daily Check Sticker on the instrument and initial Performance Test Log Sheet.

NOTE: Due to the extremely low ranges incorporated in the instrument, only the high scales may be performance tested to an actual source reading.

6.4 Maintenance

- 6.4.1 No special storage requirements.
- 6.4.2 Electronic maintenance shall be performed by an Health Physics Instrumentation Technician or by the manufacturer or a approved vendor.
- 6.4.3 All maintenance shall be performed in accordance with the manufacturers' specifications.
- 6.4.4 If recalibration is not required, performance test the instrument as per Step 6.3 prior to returning the instrument to service.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 Form ATGF-008 Instrument Service Record- Ludlum Model 19
- 7.2 Form ATGF-003 Daily Instrument Performance Test Log Sheet
- 7.3 Calibration Data Sticker
- 7.4 Performance Test Daily Check Sticker

8.0 FORMS AND EXHIBITS

8.1 Forms

8.1.1 ATGF-008, Instrument Service Record- Ludlum Model 19

8.1.2 ATGF-003, Daily Instrument Performance Test Log Sheet

8.2 Exhibits

8.2.1 Performance Test Daily Check Sticker

8.2.2 Calibration Data Sticker

EXHIBIT 8.2.1 Performance Test Daily Check Sticker

ATG, Inc.

DAILY INSTRUMENT CHECK

INSTRUMENT	SERIAL NUMBER
------------	---------------

CHECK MONTH

J	F	M	A	M	J	J	A	S	O	N	D

DAY	INITIALS	DAY	INITIALS	DAY	INITIALS
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	
TECHNICIAN INITIALS INDICATE BATTERY & SOURCE CHECKS OK				31	

EXHIBIT 8.2.2 Calibration Data Sticker

ATG Inc. Form ATGF-00D Survey Meter Calibration

Model _____ Serial No. _____

Range +/- 10% CF within +/- 20%

X _____ _____

Dedicated Check Source S/N _____

Activity _____ Date _____ Reading _____

Calibration Date _____

Next Calibration Due _____

Calibrated by _____

INSTRUMENT SERVICE RECORD - LUDLUM MODEL 19

SECTION 1: INSTRUMENT DATA		
Description	Serial No.	Calibration Date
Model 19		
Voltmeter		
Mini Pulser		
Shepherd 28-S or Equivalent		

SECTION 2: CALIBRATION DATA		
Physical Condition	SAT	UNSAT
Battery Test		
Audio Check		
Reset Switch		
F/S Response		

HIGH VOLTAGE

 As Found

 As Left

RADIATION SOURCE CALIBRATION

SCALE	ACTUAL	AS FOUND	AS LEFT	ACCEPTANCE CRITERIA
5000	4000 μ R/hr			3600 - 4000
5000	1000 μ R/hr			900 - 1100

PULSE CALIBRATION

SCALE	ACTUAL	AS FOUND	AS LEFT	ACCEPTANCE CRITERIA
500	400			360 - 440
500	100			90 - 110
250	200			180 - 220
250	50			45 - 55
50	40			36 - 44
50	10			9 - 11
25	20			18 - 22
25	5			4.5 - 5.5

PERFORMANCE TEST DATA

5 μ Ci Cs ¹³⁷ Button Source Serial #	Meter Reading with Source	Performance Test Range \pm 10% of Meter Reading

SECTION 3

 REMARKS:

Calibrated by:

Calibration Due Date:

Reviewed by:

Date:

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

OPERATION AND CALIBRATIONS
OF THE
LUDLUM MODEL 2929 DUAL CHANNEL SCALER

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Allied Technology Group, Inc.

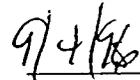
PROCEDURE/PLAN APPROVAL PAGE

This procedure: OPERATION AND CALIBRATIONS OF THE LUDLUM MODEL 2929 DUAL CHANNEL SCALER, has been reviewed and approved by the following:

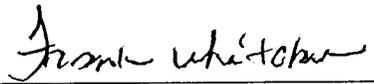
APPROVAL SIGNATURES:



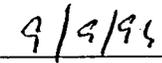
William G. Haney, Project Director



Date



Health Physics Manager/Technical Support



Date

REVISION RECORD INDICATING
LATEST DOCUMENT REVISION

Procedure Number: HP-IP-003

Title: Operation and Calibration of the Ludlum Model 2929 Dual Channel
Scaler

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1	12/13/94
2	3/13/95
3	5/01/96

REVISION RECORD	
Rev. No.	Date

CURRENT REVISION	
Rev. No.	3
Date	5/01/96
Approval	9/4/96

**OPERATION AND CALIBRATIONS
OF THE
LUDLUM MODEL 2929 DUAL CHANNEL SCALER**

1.0 SCOPE

This procedure sets forth the specific requirements to be used for the operation and calibration of the Ludlum Model 2929 Dual Channel Scaler and the Ludlum Model 43-10-1 Alpha-Beta-Gamma Detector for use on ATG, Inc. field projects.

2.0 PURPOSE

The purpose of this procedure is to provide instructions for the operation and calibration of the Ludlum Model 299 Dual Channel Scaler and the Ludlum Model 43-10-1 Alpha-Beta-Gamma Detector in accordance with the requirements specified in Reference 3.1.1.

3.0 REFERENCES

3.1 References

- 3.1.1 Regulatory Guide 10.8, Rev.2-1987, Guide for the Preparation of Applications for Medical Use Programs
- 3.1.2 ANSI N3.1-1987, Selection, Qualifications and Training of Personnel For Nuclear Power Plants
- 3.1.3 Manufacturer's instruction manual(s) for the Ludlum Model 2929 Dual Channel Scaler and Ludlum Model 43-10-1 Alpha-Beta-Gamma Sample Probe
- 3.1.4 ANSI N323-1978, Instrument Test and Calibration
- 3.1.5 HP-OP-001, Radiation and Contamination Surveys
- 3.1.6 HP-OP-005, Control of Radioactive Material

4.0 PRECAUTIONS, LIMITATIONS

4.1 Precautions

- 4.1.1 In the event of loss of power to the instrument, the Ludlum Model 2929 shall require a performance test.

- 4.1.2 The user should verify that the sample activity does not cause a count rate in excess of 1,000 cpm with a pancake probe GM detector prior to inserting the sample into the counter to prevent contaminating the probe surface area.
- 4.1.3 Unless the sample tray drawer is locked closed, the probe will receive no high voltage and the instrument will register no counts. The scaler will cycle through the counting process regardless of the sample tray drawer position.
- 4.1.4 All sources and samples shall be controlled in accordance with Reference 3.1.6.

4.2 Limitations

- 4.2.1 The Ludlum Model 2929 is semi-portable and requires 110 volt line current to operate.
- 4.2.2 Only thin samples of diameter no larger than 2" (5cm) may be counted on the instrument.
- 4.2.3 Calibration shall be performed semi-annually, after maintenance is performed, if the instrument fails the performance test or if its proper operation is in question.
- 4.2.4 The instrument shall be performance tested daily when in use per Section 6.4.

5.0 RESPONSIBILITIES AND QUALIFICATIONS

5.1 Responsibilities

5.1.1 ATG Radiological Field Operations Manager

- 5.1.1.1 Implementation of this procedure.
- 5.1.1.2 Periodic reviews of the adherence of personnel to the requirements of this procedure.
- 5.1.1.3 Ensures by training and experience Health Physics Technicians are qualified to perform the requirements of this procedure.

5.1.2 Health Physics Supervisors

- 5.1.2.1 Performs periodic surveillance of the use and maintenance of the instrument.
- 5.1.2.2 Ensures the instrument is calibrated at specified intervals.

5.1.2.3 Ensures that records pertaining to the instrument are maintained on file throughout the duration of the project and copies retained in the permanent project file.

5.1.3 Health Physics Technicians

5.1.3.1 Performance of the requirements in Section 6.1, and 6.4 of this procedure.

5.1.3.2 Documentation of all records in this procedure.

5.1.3.3 Notification to Health Physics Supervision of any unsafe or unusual conditions observed during operation of the instrument.

5.1.4 Health Physics Instrument Personnel

5.1.4.1 Perform the requirements of Sections 6.2, 6.3, and 6.4 of this procedure.

5.2 Qualifications

5.2.1 Health Physics technicians shall be qualified in accordance with the requirements of ANSI 3.1 - 1987 to operate this instrument for any of the following: Surveys, radiation work permits and job coverage.

5.2.2 Junior Health Physics and Decontamination Technicians may operate this instrument under supervision of a Health Physics Technician meeting the requirements of section 5.2.1.

6.0 PROCEDURE

6.1 Operation

6.1.1 Verify that the instrument has a valid Calibration Data Sticker Label ATGL-DCK and is not out of calibration, and the performance test has been completed and initialed on the Performance Test Daily Check Sticker. If the performance test has not been completed, have a Health Physics Technician perform the test (Section 6.4).

6.1.2 Inspect the instrument for any obvious physical damage which could interfere with its proper operation. It should include inspecting for loose, damaged knobs, buttons, broken or damaged meter movements/displays, dented or corroded instrument cases, punctured/deformed probe/probe window(s). Particular attention should be given to cables and connectors, since these components frequently become damaged or worn. Any instrument or detector having a questionable physical condition shall not be used until properly corrected.

6.1.3 Perform counting of smears and air samples by:

- 6.1.3.1 Place the sample in a clean planchet with the suspected radioactive material up.
- 6.1.3.2 Place the planchet in the sample drawer and push the drawer fully into the detector unit.
- 6.1.3.3 Lock the drawer in place by using the lever on the side of the detector housing.
- 6.1.3.4 Activate the count for the preselected period by pressing the "count" button.
- 6.1.3.5 Air samples should be counted for a minimum of 5 minutes.
- 6.1.3.6 Smears should be counted for a minimum of 1 minute, depending on the desired sensitivity for the count.
- 6.1.3.7 Upon completion of the count period, obtain the total counts in the alpha and beta-gamma channel displays and record this data on the ATGF-006 form.
- 6.1.3.8 Remove the sample from the detector unit by unlocking and pulling out the drawer.
- 6.1.3.9 Repeat Steps 6.1.3.1 through 6.1.3.8 for the remaining samples to be counted.
- 6.1.3.10 MDA shall be calculated and recorded in accordance with Section 6.4.4.

6.2 Calibration

6.2.1 Equipment needed:

- 6.2.1.1 Calibrated electrostatic voltmeter or equivalent traceable to N.I.S.T.
 - 6.2.1.2 Calibrated Eberline minipulser or equivalent traceable to N.I.S.T.
 - 6.2.1.3 Th-230 reference source greater than 10,000 dpm traceable to N.I.S.T.
 - 6.2.1.4 Tc-99 reference source greater than 10,000 dpm traceable to N.I.S.T.
- 6.2.2 Initiate the Instrument Service Record Ludlum Model 2929/43-10-1 (ATGF-009) by completing Section 1. Attach the old Calibration Data Sticker to the new ATGF-009 form.

- 6.2.3 Check the physical condition of the instrument for defects that could affect instrument operation. If necessary, complete the "AS FOUND DATA" and arrange for repair before proceeding to record your findings on ATGF-009.
- 6.2.4 Steps 6.2.4.1, 6.2.4.2, and 6.2.4.3 should be performed only upon initial calibration or repair which may affect the scaler or proper operation of the scaler in question.

6.2.4.1 Amp/Disc Board Calibration

- (a) Apply a negative pulse of 10mV amplitude to the DETECTOR input of the Model 2929. A count rate greater than 25,000 CPM should be used.
- (b) Connect an oscilloscope probe to the AMP OUT connector located on the back panel of the Model 2929.
- (c) Adjust the GAIN control located internally to and on the righthand side of the instrument for a positive pulse amplitude of 250mV (at the AMP OUT connector). This amplitude has been decreased from the initial value of 400mV.
- (d) This completes the amplifier gain calibration. The optimum amplifier gain should be 25 V/V.

6.2.4.2 B-G Threshold and Width Calibration

- (a) Apply a negative pulse of 200mV amplitude.
- (b) Attach an oscilloscope probe to pin 7, U5 (CD4098) and adjust B-G THS WIDTH (R6) for a 5 micro-second wide negative 5 volt pulse.
- (c) Move the oscilloscope probe to pin 9, U5 (CD4098) and adjust B-G WIN WIDTH (R5) for a 10 micro-second wide positive 5 volt pulse.
- (d) Now move the oscilloscope to pin 9, U6 (CD4098) and apply a negative pulse of 4mV amplitude.
- (e) Adjust B-G THS (R3) until negative 5 volt pulses just appear.
- (f) Apply a negative pulse of 50mV amplitude and adjust B-G WIN (R2) until negative 5 volt pulses just disappear.
- (g) Apply a negative pulse of 175mV amplitude and adjust ALPHA THS (R4) until a 5 volt positive pulse appears at pin 6 of U6 (CD4098).

NOTE: Steps (a), (b), and (c) above do not normally require re-adjustment. These steps may be accomplished without the use of an oscilloscope by using the audio speakers.

Beta-Gamma audio should only be present for any applied pulse amplitude from 4mV to 50mV. Alpha audio should only be present for pulse amplitudes of 175mV and above.

6.2.4.3 High Voltage Power Supply Calibration

- (a) Using a high voltage meter of at least 100 megohm input impedance adjust the front panel HV control for 1000 VDC at the DETECTOR connector.
- (b) Adjust R5 (brd 5170-011-00) for a front panel meter reading of 1 Kilovolt (Note: if adjustment is necessary, a 10-pin extender board will be required).
- (c) With no detector attached, turn the HV dial to maximum (fully clockwise) and adjust R13 for 1500 Volts (higher limits may be necessary depending upon the type of detector being used).

6.2.5 Counter Verification

6.2.5.1 Connect an Eberline minipulser or equivalent to the input connector of the Model 2929. Increase the minipulser amplitude enough to make the Model 2929 count and use the pulse inputs signified on ATGF-009 as the inputs. Record your findings on ATGF-009.

6.2.5.2 If the readings are within the acceptance ranges record the "AS FOUND" readings as the "AS LEFT" readings. If the readings are out of specification, then disposition the unit for repair. Note accordingly, in the remarks section of ATGF-009, your findings.

6.3 Counter Quality Control Checks

Quality control testing and evaluation shall be performed semi-annually (\pm 15 days). The routine frequency may be extended by up to one additional month with written approval of the ATG Radiation Safety Officer. In addition to the routine frequency of performance, quality control testing and evaluation shall be performed under the following conditions:

- a. Prior to placing a new counting system into service.
- b. After any major repair or alteration to the counting system or detectors.

6.3.1 Detector Voltage Plateau

- 6.3.1.1 Obtain a radiation source with a known counting rate in the region of 1000 to 20,000 counts per minute (cpm).
- 6.3.1.2 Record the following information on the Plateau Data Sheet, Form ATGF-HPQA01:
 - a. Scaler/counter ID Number
 - b. Detector ID Number, if external/separate
 - c. Source ID Number
- 6.3.1.3 Place the source in the detector chamber.
- 6.3.1.4 Set the high voltage adjustment of the counting system to the lowest possible setting.

NOTE

DO NOT exceed the manufacturer's limitations or restrictions on voltage for either the detector or the power supply.

- 6.3.1.5 Gradually increase the high voltage until a rapid increase in count rate is obtained. Note the high voltage setting.
- 6.3.1.6 Reduce the high voltage to approximately 100 volts below the noted increase point.
- 6.3.1.7 Obtain, and record on the Plateau Data Sheet, a series of one minute counts at appropriate voltage increments, usually equal increments of 20 to 50 volts are convenient, until EITHER no further voltage increase is possible, OR a second sharp increase in count rate is noted.
- 6.3.1.8 Using the Voltage Plateau Graph, plot a curve of count rate (vertical axis) versus voltage (horizontal axis).
- 6.3.1.9 Record the following on the Voltage Plateau Graph, Form ATGF-HPQA02.
 - a. Scaler/counter ID Number
 - b. Detector ID Number, if external/separate
 - c. Source ID Number

6.3.1.10 The relatively flat portion of the plot is the plateau. The correct operating voltage is located one-third to one-half the distance up the plotted plateau. Pick a point within this range with a convenient value of high voltage. Use whole numbers, if possible a multiple of 10, only.

6.3.1.11 Record this operating voltage on the Voltage Plateau Graph.

6.3.1.12 Perform the following:

- a. Enter the date, time and printed name of the individual performing the test on both the data sheet and the graph sheet.
- b. Sign both the data sheet and the graph sheet.

6.3.1.13 The plateau data and graph MAY be submitted to the ATG Project Manager or Health Physics Supervisor at this time for review. Review should be performed at this time if:

- a. Any of the data were anomalous, or
- b. The entire Quality Control evaluation is not being performed at this time.

6.3.2 Determination of System Background

6.3.2.1 Prerequisites

A valid voltage plateau or operating voltage has been determined and documented.

6.3.2.2 Record the following information on the Background Data Sheet, Form ATGF-HPQA03:

- a. Scaler/counter ID Number
- b. Detector ID Number, if external/separate
- c. Source ID Number

6.3.2.3 Data Accumulation

- a. Place a clean, empty planchet in the sample holder.
- b. Insert the sample holder in the detector chamber.
- c. Set the instrument for a timed count of 2 minutes.
- d. Count the empty planchet.
- e. Divide the total counts by two (2) and record the total counts on the Background Data Sheet. Form ATGF-HPQA03.

NOTE

The instrument/system may remain in service, using the "old" background during the accumulation of data for the new determination of background. The repetitive counts may be accumulated over several days, however all counts shall be completed within 10 days of the initial count.

6.3.2.4 Repeat Section 6.3.2.3 nine additional times.

6.3.2.5 Remove the empty planchet from the detector chamber.

6.3.3 Calculations:

- a. Total the values of the individual counts. Enter the value in the Total box on the data sheet.
- b. Divide the total by the number, 10, of determinations and enter this value in the Mean Count, \bar{x} , box on the data sheet.
- c. Subtract the mean count, \bar{x} , from each of the individual counts. Enter the values found in the column labeled $(x - \bar{x})$ on the data sheet.
- d. Square each of the deviations, $(x - \bar{x})$, and enter the values found in the column labeled $(x - \bar{x})^2$ on the data sheet.
- e. Total the values of the squared deviations column, and enter this value in the Sum of Squares, box on the data sheet.
- f. Divide the Sum of Squares, by nine (9). Enter this value in the Variance, box on the data sheet.
- g. Extract the square root of the Variance, and enter the value in the Standard Deviation (σ) (Counts), box on the data sheet.
- h. The Background Count Rate $\pm 2\sigma$ is the acceptable background range.
- i. Enter the background range in the appropriate blocks of Form ATGF-013.
- j. Perform the following:
 1. Enter the date, time, and (printed) name (of the individual performing the test) on the Background Data Sheet.

2. Sign the data sheet.
- k. The Background data MAY be submitted to the cognizant Health Physics Supervisor at this time for review. Review should be performed at this time if:
 1. Any of the data were anomalous, or
 2. The entire Quality Control evaluation is not being performed at this time.

6.3.4 Chi-Squared Test of Reliability

6.3.4.1 Prerequisites

- a. A valid voltage plateau, or operating voltage, has been determined and documented.
- b. A well determined background value has been obtained and documented.

6.3.4.2 Ensure that the counting system is set up for operation according to the applicable Instrument Calibration and Use Procedure and/or the manufacturer's technical literature.

6.3.4.3 Obtain a NIST Traceable Standard Source with isotopic content appropriate to the detector being evaluated.

- a. The source should be of sufficient activity to yield a counting rate of 1000 to 20,000 counts per minute.
- b. The source should not exceed 20,000 cpm.

6.3.4.4 Record the following information on the Chi-squared Data Sheet, Form ATGF-HPQA04:

- a. Scaler/Counter ID Number.
- b. Detector ID Number, if external/separate.
- c. Source ID Number.

6.3.4.5 Place the source in the detector chamber.

6.3.4.6 Collect ten (10) counts of two (2) minutes duration each. Divide Gross CPM by two (2) and record the results, in counts per minute, in the column labeled "Gross cpm, C_G ".

6.3.4.7 Subtract the background count rate, C_B , from each count to obtain the net count rate. Record the results in the column labeled "Net cpm, C_i ".

6.3.4.8 Calculations:

- a. Sum the ten C_i values and record the result in the box labeled:

$$\sum_{i=1}^{10} C_i = \text{Total} = \underline{\hspace{2cm}}$$

- b. Divide the total by 10 and record the result obtained in the box labeled:

$$\frac{\text{Total}}{10} = \bar{c} = \underline{\hspace{2cm}}$$

- c. Subtract the mean count rate, \bar{c} from each of the C_i values, recording the results in the column, " $(C_i - \bar{c})$ ".
- d. Square each of the $(C_i - \bar{c})$ values obtained, record the results in the column labeled, " $(C_i - \bar{c})^2$ ".
- e. Sum the " $(C_i - \bar{c})^2$ " values and record the results in the box labeled:

$$\underline{\sum_{i=1}^{10} (C_i - \bar{c})^2}$$

- f. Calculate the Observed Standard Deviation by extracting the square root of the Sum of Squares divided by 9 $\{(C_i - \bar{c})^2/9$.

$$\text{Standard Deviation } \bar{\sigma} = \text{SQRT } \sum (C_i - \bar{c})^2/9$$

- 6.3.4.9 Calculate the Theoretical Standard Deviation (σ_t) by: $\sigma_t = \sqrt{\bar{c}}$

- 6.3.4.10 Calculate the resulting Reliability Factor (R.F.) by:

$$\text{R.F.} = \frac{\bar{\sigma}}{\sigma_t}$$

- a. Record the Reliability Factor (R.F.) in the box labeled: (R.F.)
- b. R.F. should be between 0.64 and 1.22 when calculated. This indicates the instrument/detector is operating reliably. An R.F. that falls between 0.50 and 0.64 or 1.22 and 1.40 shall be investigated by the ATG Project Manager or Health Physics Supervisor. An R.F. less than 0.50 or greater than 1.40 is unsatisfactory.

6.3.4.11 Perform the following:

- a. Enter the date, time, and (printed) name (of the individual performing the test) on the Chi-squared Data Sheet.
- b. Sign the data sheet.
- c. The Chi-squared data MAY be submitted to the ATG Project Manager or Health Physics Supervisor at this time for review. Review should be performed at this time if:
 1. Any of the data were anomalous, or
 2. The entire Quality Control evaluation is not being performed at this time.

6.3.5 Counting System Efficiency

6.3.5.1 Prerequisites

- a. A valid voltage plateau, or operating voltage, has been determined and documented.
- b. A well determined background value has been obtained and documented.
- c. A successful Chi-squared test has been performed and documented.

6.3.5.2 Non-routine isotopes

- a. In addition to the routine frequency of determination, counting system efficiencies SHOULD be determined when isotopes with energies significantly different from the calibration energy must be analyzed.

6.3.5.3 Enter the following information on the Efficiency Data Sheet:

- a. Scaler/Counter ID Number.
- b. Detector ID Number, if external/separate.
- c. Source ID Number.
- d. Source Present Activity ($\mu\text{Ci/dpm}$)
- e. The mean counting rate, c , of the source.

6.3.5.4 Calculation:

- a. Complete the following calculation on the Efficiency Data Sheet:

$$E = \frac{(\text{NET CPM}) (4.5E-7)}{(\text{Source } \mu\text{Ci})} = \underline{\hspace{2cm}}$$

NOTE

Non-routine sources and/or geometries should be calculated only at the direction of the Health Physics Technical Supervisor or designee.

6.3.5.5 Alpha Channel

- a. Obtain a 1 7/8" dia Th-230 reference source greater than 1,000 dpm.
- b. Place the source in the detector chamber and count for a period of one minute.
- c. Determine the net count rate from the source.
- d. Determine the specific efficiency, E_i

NOTE

Detection efficiencies for different sample types (i.e., geometry, mass, etc.) must be calculated separately.

- e. Calculation:

$$E = \frac{(\text{NET CPM}) 4.5E-7}{(\text{Source } \mu\text{Ci})}$$

Note: 4.5E-7 is conversion from μCi to dpm. It is not needed if source activity is expressed in dpm.

- f. Record the result on the data sheet.

6.3.5.6 Perform the following:

- a. Enter the date, time, and (printed) name (of the individual performing the test) on the Efficiency Data Sheet.
- b. Sign the data sheet.
- c. The Efficiency data MAY be submitted to the ATG Radiation Safety Officer at this time for review. Review SHOULD be performed at this time if:
 1. Any of the data were anomalous, or
 2. The entire Quality Control evaluation is not being performed at this time.

6.3.5.7 Beta Channel

- a. Obtain a 1 $\frac{7}{8}$ " dia Tc-99 reference source greater than 1,000 dpm.
- b. Perform Steps 6.3.5.5 (b) through (f).

6.4 Performance Test

6.4.1 Background Check

- 6.4.1.1 Remove any source or sample from the detector tray.
- 6.4.1.2 Place the appropriate clean blank in clean counting planchet.
- 6.4.1.3 Lock the drawer closed.
- 6.4.1.4 Perform a 20 minute timed background count.
- 6.4.1.5 Divide the total counts for the alpha and beta-gamma channels by twenty (20) to obtain results in CPM.
- 6.4.1.6 Record the Alpha and Beta-Gamma results in cpm, in the respective columns on the Daily Background and Efficiency Form ATGF-013.
- 6.4.1.7 Compare each background to its background and & range.
- 6.4.1.8 If either background rate exceeds its limits, clean the sample drawer and recheck background.
- 6.4.1.9 If either background remains out of range, remove the instrument from service and arrange for repair. Notify Health Physics Supervision.

6.4.2 Alpha Source Check (Th-230)

- 6.4.2.1 Retrieve from storage the check source identified in the 'SOURCE ID#' space at the top of form ATGF-013.
- 6.4.2.2 Place the source in an empty counting planchet.
- 6.4.2.3 Open the sample drawer and place the source/planchet in the sample tray.
- 6.4.2.4 Close and lock the drawer in the count position, and perform a 1-minute timed count, record the results on Form ATGF-013.
- 6.4.2.5 Record the result of the source count in the "SOURCE COUNTS" (CPM) column of the form.
- 6.4.2.6 If the net response is within +/- 10% of the source activity multiplied by the efficiency of the instrument, initial the "Initials" column of Form ATGF-013.

6.4.3 Beta Source Check (Tc-99)

- 6.4.3.1 Repeat the steps of Section 6.4.2 using the beta check source specified in the "SOURCE ID#" space at the top of form ATGF-013.
- 6.4.3.2 Record the data in the applicable columns of form ATGF-003 and complete the entry on form ATGF-013.
- 6.4.3.3 Initial ATGF-003 and ATGF-013 in the appropriate columns. Initial the Performance Test Daily Check Sticker.
- 6.4.3.4 Return the check sources to their designated storage locations.

6.4.4 Determination of MDA

6.4.4.1 Prerequisites

- a. A valid voltage plateau has been performed and documented for those instruments or systems with a variable high voltage capability.
- b. A well determined background is available, unless an exception is made in the specific instrument procedure.
- c. A successful Chi-squared test has been performed and documented.
- d. Counting efficiency for the appropriate emission has been determined and documented.

- e. The daily checks have demonstrated that the instrument is in statistical control; OR; where directed by specific procedure, a daily working background has been determined.

6.4.4.2 Calculation

- a. Calculate MDA by performing a count of a paired blank for counting time equal to the sample counting time. A paired blank means a sample which is identical, chemically and physically, to the samples to be counted, except that no isotope is present (e.g., for smear samples a smear of a clean surface could be used as a paired blank for smears of potentially contaminated surfaces).

6.4.4.3 MDA may be calculated from the following formula:

$$\text{MDA (dpm)} = \frac{2.71 + 4.65\sqrt{C_B/T_B}}{E}$$

where:

- C_B = Background Counts for the paired blank (CPM)
- T_B = Sample Count Time for the paired blank (Minutes)
- E = Instrument Efficiency for the isotope expected, expressed as a decimal

6.4.4.4 Record the MDA value for each channel (beta-gamma and alpha) on form ATGF-006.

6.5 Maintenance

6.5.1 No special storage requirements.

6.5.2 Electronic maintenance (except external adjustments and cable replacements) shall be performed by a Health Physics Instrumentation Technician or by the manufacturer or an approved vendor.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 Form ATGF-009 Instrument Service Record-Ludlum Model 2929/43-10-1
- 7.2 Form ATGF-013 Ludlum Model 2929 Daily Background and Efficiency
- 7.3 Form ATGF-003 Daily Instrument Performance Test Log Sheet

7.4 Calibration Data Sticker

7.5 Performance Test Daily Check Sticker

8.0 FORMS AND EXHIBITS

8.1 Forms

8.1.1 Form ATGF-009 Instrument Service Record- Ludlum Model 2929/43-10-1

8.1.2 Form ATGF-013 Ludlum Model 2929 Daily Background and Efficiency

8.1.3 Form ATGF-003 Daily Instrument Performance Test Log Sheet

8.1.4 Form ATGF-006 Smear Counting Analysis Report

8.1.5 Form ATGF-HPQA01 Plateau Data Sheet

8.1.6 Form ATGF-HPQA02 Voltage Plateau Graph

8.1.7 Form ATGF-HPQA03 Background Data Sheet

8.1.8 Form ATGF-HPQA04 Chi-Squared Data Sheet

8.1.9 Form ATGF HPQA05 Efficiency Data Sheet

8.2 Exhibits

8.2.1 Performance Test Daily Check Sticker

8.2.2 Calibration Data Sticker

EXHIBIT 8.2.1

PERFORMANCE TEST DAILY CHECK STICKER

ATGL-DCK

DAILY INSTRUMENT CHECK

INSTRUMENT	SERIAL NUMBER
------------	---------------

CHECK MONTH

J	F	M	A	M	J	J	A	S	O	N	D

DAY	INITIALS	DAY	INITIALS	DAY	INITIALS
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	
				31	

TECHNICIAN INITIALS INDICATE
BATTERY & SOURCE CHECKS OK

EXHIBIT 8.2.2
CALIBRATION DATA STICKER

ATG Inc. Form ATGF-00D
Survey Meter Calibration

Model _____ Serial Number _____

Range +/- 10% CF within +/- 20%

X _____ _____

Dedicated Check Source S/N _____

Activity _____ Date _____ Reading _____

Calibration Date _____

Next Calibration Due _____

Calibrated By _____

INSTRUMENT SERVICE RECORD - LUDLUM MODEL 2929/43-10-1

SECTION 1 - INSTRUMENT DATA:

2929 Serial No.	Calibration Due Date:	
43-10-1 Serial No.	Calibration Due Date:	
Minipulser M&TE No.	Calibration Due Date:	
Voltmeter M&TE No.	Calibration Due Date:	
Th ²³⁰ Reference Source ID No.	Th ²³⁰ Activity:	Assay Date:
Tc ⁹⁹ Reference Source ID No.	Tc ⁹⁹ Activity:	Assay Date:

SECTION 2 - CALIBRATION DATA:

HIGH VOLTAGE	As Found :	As Left:
---------------------	------------	----------

PULSE GENERATOR	SURVEY METER		ACCEPTANCE
	AS FOUND	AS LEFT	
100			90 - 110
400			360 - 440
1,000			900 - 1,000
4,000			3,600 - 4,400
10,000			9,000 - 11,000
40,000			36,000 - 44,000
100,000			90,000 - 110,000
400,000			360,000 - 440,000

**ALLIED TECHNOLOGY GROUP, INC.
VOLTAGE PLATEAU DATA SHEET**

Instrument Model:		Instrument Serial No.	
Last Calibration Date:	Detector Model	Detector Serial No.	
Today's Date		Source ID No.	
Data Collected By:			
Count Number	Voltage (Volts)	Count	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

ALLIED TECHNOLOGY GROUP
VOLTAGE PLATEAU GRAPH FORM

Instrument Model: _____

Instrument Serial No. _____

Detector Model: _____

Detector Serial No. _____

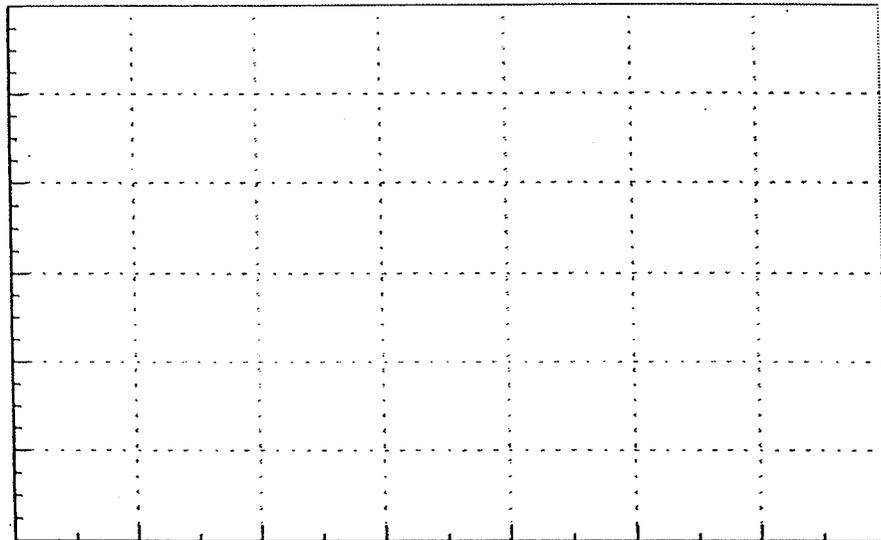
Today's Date: _____

Source ID No. _____

Data Plotted by: _____

Voltage Plateau

Counts



Voltage (Volts)

Record the count and voltage scales as needed based on the data from the plateau data sheet. Plot the curve of counts v.s. voltage as you increase the voltage 50 volts per data point. A rapid increase in response indicates a voltage beyond the detector's design voltage - do not allow operation at a voltage in this continuous discharge range as it will damage the detector.

Follow instructions in the QA procedure to determine the optimum range for operating voltage of the detector. Record the optimum voltage below.

Optimum operating voltage: _____ volts

Technician: _____ Date: _____

**ALLIED TECHNOLOGY GROUP, INC.
BACKGROUND DETERMINATION DATA SHEET**

Instrument Model:		Instrument Serial No.	
Last Calibration Date:	Detector Model	Detector Serial No.	
Today's Date:			
Data Collected By:			
Alpha		Beta-Gamma	
		(Circle One)	
Count Number	Count (X)	$(X - \bar{x})$	$(X - \bar{x})^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total		= $\Sigma (X)$	
Mean Count (\bar{x})		= $\Sigma (X) / 10$	
		Sum of Squares = $\Sigma (X - \bar{x})^2 =$	
		Variance = $\Sigma (X - \bar{x})^2 / 9 =$	
		Standard Deviation (σ) = $\text{SQRT} (\Sigma (X_i - \bar{x})^2 / 9) =$	
Background Count Rate = Mean (x)		CPM $\pm 2\sigma$:	
Calculations Completed By:			Date:
Data and Calculations Reviewed By:			Date:

**ALLIED TECHNOLOGY GROUP, INC.
CHI-SQUARED TEST OF RELIABILITY DATA SHEET**

Instrument Model:		Instrument Serial No.	Background Count Rate C_B :	
Last Calibration Date:		Detector Model		Detector Serial No.
Today's Date:		Data Collected By:		Source ID No.
Count Number	CPM Gross (C_G)	CPM Net (C_i)	$(C_i - \bar{c})$	$(C_i - \bar{c})^2$
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
Sum		$\Sigma (C_i)$		
Mean (\bar{c})		$\Sigma (C_i)/10$		
Sum of Squares = $\Sigma (C_i - \bar{c})^2$				
Standard Deviation (σ) = SQRT $\Sigma (C_i - \bar{c})^2/9$				
Theoretical Standard Deviation (σ_i) = \sqrt{c}				
Reliability Factor (R.F.) = σ/σ_i				
Calculations Completed By:				Date:
Data and Calculations Reviewed By:				Date:

**ALLIED TECHNOLOGY GROUP, INC.
COUNTING SYSTEM EFFICIENCY DATA SHEET**

Instrument Model		Instrument Serial No.	
Last Calibration Date	Detector Model	Detector Serial No.	
Today's Date		Data Collected By	
Alpha		Beta-Gamma Channel	
(Circle One)			
Source number:			
Source activity ($\mu\text{Ci/dpm}$) =		on	(A_0)
Source decay time to today		days (t)	
Source radionuclide half life		days ($t_{1/2}$)	
Source radionuclide decay constant = $\ln(2)/(t_{1/2}) =$		/day (λ)	
$A(\text{today}) = A_0 * e^{-\lambda t} =$		($\mu\text{Ci/dpm}$)	
Net count rate = source count rate (CPM) - background count (CPM)			
Efficiency =	$\frac{\text{Net Count rate} * 4.5E-7}{A(\text{today} - \mu\text{Ci/dpm})}$		counts/disintegration
Efficiency =	counts/disintegration		
Calculations Completed By:		Date:	
Data and Calculations Reviewed By:		Date:	

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

OPERATION AND CALIBRATION
OF THE
LUDLUM MODEL 9 ION CHAMBER

Allied Technology Group, Inc.
47375 Fremont Blvd.
Fremont, California 94538

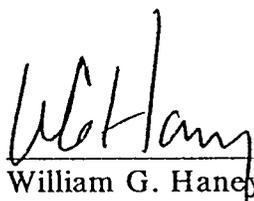
Prepared by:
D. Spicuzza

Allied Technology Group, Inc.

PROCEDURE/PLAN APPROVAL PAGE

This procedure: HP-IP-004, OPERATION AND CALIBRATION OF THE LUDLUM MODEL 9 ION CHAMBER, has been reviewed and approved by the following:

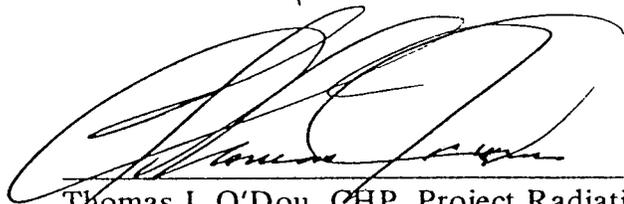
APPROVAL SIGNATURES:



William G. Haney, Project Director

4/10/95

Date



Thomas J. O'Dou, CHP, Project Radiation Safety
Officer, HP Technical Support

4/12/95

Date

**REVISION RECORD INDICATING
LATEST DOCUMENT REVISION**

Procedure Number: HP-IP-004

Title: OPERATION AND CALIBRATION OF THE LUDLUM MODEL 9 ION CHAMBER

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1	11/11/94

REVISION RECORD	
Rev. No.	Date

CURRENT REVISION	
Rev. No.	1
Date	11/11/94
Approval	

1.0 SCOPE

This procedure sets forth the specific requirements to be used for the operation and calibration of the Ludlum Model 9 Ionization Chamber Radiation Detector for use on Allied Technology Group, Inc. field projects.

2.0 PURPOSE

The purpose of this procedure is to provide instructions for the operation and calibration of the Ludlum Model 9 Ion Chamber in accordance with the requirements specified in Reference 3.1.1.

3.0 REFERENCES

3.1 References

- 3.1.1 Regulatory Guide 10.8, Rev.2-1987, Guide for the Preparations of Applications for Medical Use Programs.
- 3.1.2 ANSI N3.1-1987, Selection, Qualifications and Training of Personnel For Nuclear Power Plants.
- 3.1.3 Manufacturer's instruction manual for the Ludlum Model 9 Ion Chamber.
- 3.1.4 ANSI N323-1978, Instrument Test and Calibration.
- 3.1.5 HP-OP-001, Radiation and Contamination Survey Techniques.
- 3.1.6 HP-OP-002, Radiological Area Posting and Access Control.

4.0 PRECAUTIONS, LIMITATIONS

4.1 Precautions

- 4.1.1 The ion chamber is vented to atmosphere, it is sensitive to changes in atmospheric pressure and ambient temperature.
- 4.1.2 When the shield is open, protect the thin face against puncture damage.
- 4.1.3 When using this instrument in a known, or suspected contaminated area, seal the instrument in a protective media (i.e., plastic, poly) to prevent contamination of the instrument.

- 4.1.4 Check the zero setting during use on the low range. Adjust as necessary. Readjustment is not required on the higher ranges.

4.2 Limitations

- 4.2.1 The operation of the Model 9 depends on the condition of the battery. Therefore, the battery check should be performed before each use and periodically during use to ensure proper operation.
- 4.2.2 Calibration shall be performed semi-annually, after maintenance is performed, if the instrument fails the performance test or if proper operation is in question.
- 4.2.3 A daily performance test is required when the instrument is in use.

5.0 Responsibilities and Qualifications

5.1 Responsibilities

- 5.1.1 ATG Radiological Field Operations Manager shall be responsible to:

- 5.1.1.1 Implement this procedure.
- 5.1.1.2 Periodically review adherence to the requirements of this procedure.
- 5.1.1.3 Ensure Health Physics Technicians are qualified by training and experience to perform the requirements of this procedure.

- 5.1.2 Health Physics Supervisors shall:

- 5.1.2.1 Perform periodic surveillance of the use and maintenance of the instrument.
- 5.1.2.2 Ensure instruments in use are calibrated at specified intervals.
- 5.1.2.3 Ensure that records pertaining to the instrument are maintained on file throughout the duration of the project and copies retained in the permanent project file.

- 5.1.3 Health Physics Technicians shall be responsible to:

- 5.1.3.1 Perform the requirements in Section 6.1, 6.2, 6.3 and 6.4 of this procedure.

5.1.3.2 Document all records in this procedure.

5.1.3.3 Notify Health Physics Supervision of any unsafe or unusual conditions observed during operation of the instrument.

5.1.4 Health Physics Instrument Personnel shall be responsible to:

5.1.4.1 Perform the requirements of Sections 6.2, 6.3, and 6.4 of this procedure.

5.2 Qualifications

5.2.1 Health Physics Technicians shall be qualified in accordance with the requirements of ANSI 3.1 - 1987 to operate this instrument for any of the following: Surveys, radiation work permits and job coverage.

5.2.2 Junior Health Physics and Decontamination Technicians may operate this instrument under supervision of a Health Physics Technician meeting the requirements of section 5.2.1.

6.0 PROCEDURE

6.1 Operation

6.1.1 Verify that the instrument has a valid Calibration Data Sticker Label # ATGL-DCK and is not out of calibration, and the daily performance test has been completed and initialled on the Performance Test Daily Check Sticker. If the performance test has not been completed, have a Health Physics Technician perform the test (Section 6.3).

6.1.2 Inspect the instrument for any obvious physical damage which could interfere with its proper operation. Include inspection for loose, damaged knobs, buttons, broken or damaged meter movements/displays, dented or corroded instrument cases, punctured/deformed probe/probe window(s). Particular attention should be given to cables and connectors, since these components frequently become damaged or worn. Any instrument or detector having a questionable physical condition shall not be used until properly corrected.

6.1.3 Perform a battery check on the instrument by turning the range selector switch on the meter face to the "BAT" position. Observe the meter needle position on the meter face. Ensure the needle position is above the "BAT TEST" area on the meter face scale. If not, replace the batteries in accordance with Reference 3.3.1. and repeat the above test.

- 6.1.4 Turn the range selector switch on the meter face to the X1 range setting and wait approximately 5 minutes. Re-zero the meter in a low background radiation area by turning the zero adjust knob on the meter face to obtain a reading on the meter of zero, if necessary.
- 6.1.5 If the instrument fails any of the above checks, remove it from service, notify Health Physics Supervision, and arrange for repair of the meter.
- 6.1.6 Turn the audio switch switch on the meter face to the "ON" position.
- 6.1.7 For gamma exposure rates proceed as follows:
 - 6.1.7.1 Ensure the β shield is covering the mylar window.
 - 6.1.7.2 When entering a radiation area of unknown radiation levels turn the range selector switch on the meter face to the highest scale X100 range (1 Rem/hr to 5 Rem/hr range) and scale down until a upscale meter needle deflection is observed on the meter scale face.
 - 6.1.7.3 If possible, place the entire chamber volume in and perpendicular to the radiation field of interest.

NOTE: If the entire detector volume is not in the radiation field, detector response will be low by the fraction of the volume exposed.
 - 6.1.7.4 Allow sufficient time for the meter to respond. The Ludlum Model-9 instrument has a response time of approximately 3 seconds to achieve 90% of full scale.
 - 6.1.7.5 Proceed with use of the instrument.
- 6.1.8 Determine the presence of β radiation as follows:
 - 6.1.8.1 Obtain a γ exposure rate measurement in accordance with Step 6.1.7 of this procedure. β shield closed {closed window (CW)}.
 - 6.1.8.2 Slide the β shield back exposing the mylar window.
 - 6.1.8.3 Take an open window (OW) reading.
 - 6.1.8.4 A higher reading with the β shield open indicates the presence of β radiation.

NOTE: In situations where very low photons are encountered, the phenolic shield may attenuate these photons. In such cases, the low energy photons may appear to be beta radiation.

6.1.9 Determine the approximate β dose rate for contact/surface exposure rates as follows:

6.1.9.1 Take a γ exposure rate reading (CW) with approximately 1/2" from the surface of interest.

6.1.9.2 Slide back the β shield and take a reading with the mylar window open (OW) at the same location.

6.1.9.3 Using the β correction (BCF), calculate the approximate β exposure rate as follows:

$$\beta \text{ exposure rate} = \text{BCF} \times (\text{OW} - \text{CW})$$

6.1.10 For 30cm β exposure rates:

6.1.10.1 Take a γ reading (CW) approximately 30cm from the source.

6.1.10.2 Slide back the β shield and take a reading with the mylar window open (OW) at the same location.

6.1.10.3 Using a BCF of 1.5, calculate the approximate β exposure rate as follows:

$$\beta \text{ exposure rate} = \text{BCF}(1.5) \times (\text{OW} - \text{CW})$$

6.1.11 Surveys under unusual atmospheric conditions:

6.1.11.1 These ion chambers are vented to atmospheric pressure and are sensitive to changes in pressure and temperature. The error, however, is approximately < 10% for temperatures between 40°F to 120°F and 10% for altitude changes of 2,000 feet.

6.1.11.2 If the instrument is to be used outside these ranges, refer to Reference 3.1.3 for correction factors.

6.1.12 Return of the instrument after surveys.

- 6.1.12.1 After completion of a survey, perform a battery check, (Section 6.1.3 of this procedure) and decontaminate as applicable, and return the instrument to its proper storage location.
- 6.1.12.2 If the battery check indicates an unsatisfactory condition, survey results should be evaluated by Health Physics Supervision.

6.2 Calibration

6.2.1 Calibration shall be performed by the manufacturer or a qualified vendor.

NOTE: The Health Physics Technician or Health Physics Instrument Technician shall perform steps 6.2.2 through 6.2.7 of this procedure.

6.2.2 Upon receipt from the manufacturer or qualified vendor, perform a physical inspection of the instrument. Record as satisfactory or unsatisfactory on ATGF-015.

6.2.3 Perform a battery check; replace if necessary. Record as satisfactory or unsatisfactory on ATGF-015.

6.2.4 Determine contact beta correction factor as follows:

6.2.4.1 Obtain the depleted uranium slab. Utilizing fixed geometry, perform a Closed Window Source Reading. Record results on ATGF-015.

6.2.4.2 Perform an Open Window Source Reading. Record results on ATGF-015.

6.2.4.3 Record the actual beta dose rate from the depleted uranium slab as indicated on the source assay certificate on ATGF-015.

6.2.4.4 Calculate the Beta Correction Factor (BCF) as follows:

$$\text{BCF} = \frac{\text{Actual Beta Dose Rate}}{\text{OPEN Window} - \text{CLOSED Window}}$$

NOTE: Calculated BCF is to be used for contact readings only. BCF for 30cm readings is 1.5.

6.2.4.5 Record the BCF on ATGF-015.

6.2.5 Determine performance test reference data.

6.2.5.1 Record the Cs-137 source serial number on ATGF-015.

6.2.5.2 Perform an Open Window Source Reading with the Cs-137 source in contact with the mylar window. Record results on ATGF-015.

6.2.5.3 Calculate the reference value range $\pm 10\%$ of the source reading and record results on ATGF-015.

6.2.6 Attach the manufacturer or qualified vendor's Calibration Data Sheet to ATGF-015.

6.2.7 If the above calibration steps are completed satisfactorily, attach a completed Calibration Data Sticker Label # ATGL-DCK and a Performance Test Daily Check Sticker to the instrument. Complete Section 3 of ATGF-015.

6.3 Performance Test

6.3.1 Do a performance test on the instrument and record all data on ATGF-003, Daily Instrument Performance Test Log.

6.3.2 Obtain the performance test source designated by the ATGF-015, and Label # ATGL-DCK on the instrument.

6.3.3 Record the information for each section of ATGF-003.

6.3.4 Examine the instrument for any obvious physical damage which could interfere with its proper operation.

6.3.5 Verify that the instrument has a current Calibration Data Sticker Label # ATGL-DCK, and a Performance Test Daily Check Sticker.

6.3.6 Turn the range selector switch to the "BAT" position and check that the battery is within the "BAT TEST" range on the meter scale face.

6.3.7 Turn the range selector switch to the X1 position and perform a zero check on the instrument. Adjust the "ZERO ADJUST" knob on the meter face to obtain a reading of zero if necessary.

6.3.8 Expose the detector to the designated source. If the response is within the designated range for the source, record "P" for pass on the Daily Instrument Performance Test Log. If the instrument fails, record "F" for fail and remove the

instrument from service for repair or calibration.

- 6.3.9 If the instrument passes the performance test, initial the Performance Test Daily Check Sticker on the instrument and initial the Daily Instrument Performance Test Log (ATGF-003).

6.4 Maintenance

- 6.4.1 Instruments shall be stored in areas which prevent damage by movement, accumulation of moisture or dust. Detector covers shall be used for storage when practical.
- 6.4.2 Electronic maintenance shall be performed by an Health Physics Instrumentation Technician or by the manufacturer or an approved vendor.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 ATGF-003, Daily Instrument Performance Test Log
- 7.2 ATGF-015, Instrument Service Record - Ludlum Model 9

8.0 FORMS

- 8.1 ATGF-003, Daily Instrument Performance Test Log
- 8.2 ATGF-015, Instrument Service Record - Ludlum Model 9

INSTRUMENT SERVICE RECORD- LUDLUM MODEL 9

SECTION 1: INSTRUMENT DATA

Model 9 Serial Number:	Calibration Date:
Depleted Uranium Source Serial Number:	Assay Date:

SECTION 2: CALIBRATION DATA

Note: See Attached Calibration Data Sheet for the Dose Rate Calibration

Physical Condition	<input type="checkbox"/> Satisfactory	<input type="checkbox"/> Unsatisfactory
Battery Test	<input type="checkbox"/> Satisfactory	<input type="checkbox"/> Unsatisfactory
Beta Correction Factor:	$\frac{\text{Actual Beta Dose Rate}}{\text{OPEN Window} \text{ _____ } - \text{CLOSED Window} \text{ _____ }} = \text{BCF}$	

Cs-137 Source Serial Number	Source Reading	Range 10% of Source Reading

SECTION 3: REMARKS

Checked By:	Date:
Calibration Due Date:	Date:
Reviewed By:	Date:

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

CONTROL AND ISSUANCE OF
POCKET IONIZATION CHAMBERS (PICs)

Allied Technology Group, Inc.
47375 Fremont Blvd.
Fremont, California 94538

Prepared by

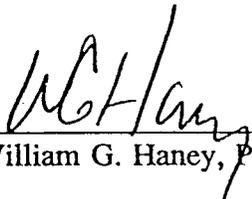
D. Spicuzza

Allied Technology Group, Inc.

PROCEDURE/PLAN APPROVAL PAGE

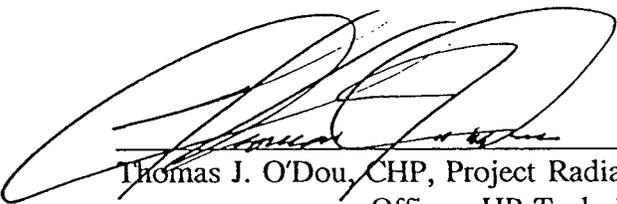
This procedure: Control And Issuance Of Pocket Ionization Chambers (PICs) has been reviewed and approved by the following:

APPROVAL SIGNATURES:



William G. Haney, Project Director

4/12/95
Date



Thomas J. O'Dou, CHP, Project Radiation Safety
Officer, HP Technical Support

4/12/95
Date

**REVISION RECORD INDICATING
LATEST DOCUMENT REVISION**

Procedure Number: HP-IP-006

Title: Control And Issuance Of Pocket Ionization Chambers (PICs)

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Approval	9/19/94

CONTROL AND ISSUANCE OF POCKET IONIZATION CHAMBERS (PICs)

1.0 SCOPE

This procedure shall provide the guidelines for the issuance and control of pocket ionization chamber instruments used on A.T.G. field projects.

2.0 PURPOSE

This procedure ensures that proper issuance and control of Pocket Ionization Chambers (PICs) and is performed in accordance with the provisions of documents in Section 3.1 of this procedure.

3.0 REFERENCES AND DEFINITIONS

3.1 References

- 3.1.1 HP-OP-004, Issue and Use of Radiation Work Permits (RWPs).
- 3.1.2 HP-OP-002, Radiological Area Posting and Access Control.
- 3.1.3 HP-IP-005, Calibration of Pocket Ionization Chambers.
- 3.1.4 Regulatory Guide 8.4, Direct Reading and Indirect Reading Dosimeters.
- 3.1.5 ANSI N322, Inspection and Test Specifications for Direct and Indirect Reading Dosimeters.
- 3.1.6 Manufacturer's technical manual(s).

3.2 Definitions

- 3.2.1 **Pocket Ionization Chamber (PIC)** - A small, portable ion chamber provided with an internal electroscope that can be read on an internal scale. These ion chambers allow the integrated gamma dose to be checked periodically by the user. A PIC may also be known as a self-reading dosimeter (SRD) or direct reading dosimeter (DRD).

4.0 PRECAUTIONS, LIMITATIONS

- 4.1 PICs shall receive a calibration check every six (6) months.

- 4.2 Any PIC lacking a current calibration sticker shall be considered OUT OF SERVICE and returned to the designated A.T.G. location.

5.0 RESPONSIBILITIES

- 5.1 ATG Radiological Field Operations Manager (Project Manager) shall be responsible to:
- 5.1.1 Implement this procedure.
 - 5.1.2 Periodically review adherence of personnel to the requirements of this procedure.
 - 5.1.3 Ensure Health Physics Technicians are qualified by training and experience to perform the requirements of this procedure.
 - 5.1.4 Ensure personnel are qualified to perform the requirements of this procedure and have a working knowledge of PICs.
- 5.2 Health Physics Supervisors shall:
- 5.2.1 Perform periodic surveillance of the use and maintenance of the PICs.
 - 5.2.2 Ensure PICs are calibrated at specified intervals.
 - 5.2.3 Maintain an inventory of PIC locations and users.
- 5.3 Health Physics Technicians shall be responsible for:
- 5.3.1 Collection of PICs requiring calibration and notification of Health Physics Supervisor.
 - 5.3.2 Performing release surveys on the PICs requiring calibration.
 - 5.3.3 Ensuring all personnel issued PICs are using the PIC correctly in accordance with the provisions of the RWP.
- 5.4 Escorts shall:
- 5.4.1 Return PICs issued to any personnel in their group.
- 5.5 Any personnel issued a PIC shall:
- 5.5.1 Make sure the dosimeter issued always has a valid, dated calibration sticker.
 - 5.5.2 Read the PIC and act upon the indication as required by the RWP and the Health Physics Technician.

6.0 PROCEDURE

6.1 Control of PICs

- 6.1.1 The Health Physics Supervisor shall maintain a copy of an updated inventory of all A.T.G. PICs at the job site.
- 6.1.2 When the PICs are due for calibration check, the Health Physics Supervisor shall determine the location of the PICs, collection of the PICs, and arrange for recalibration of the PICs.

6.2 Issuance of PICs

- 6.2.1 Calibrated PICs shall be stored for issue at a designated location at the A.T.G. job site.
- 6.2.2 A PIC charger shall be maintained at the A.T.G. job site. PICs shall be rezeroed prior to issuance and each day before work.
- 6.2.3 Health Physics shall issue PICs to cover 10% of a group of visitors. If visitors intend to separate at any time while in a controlled area, each group will be assigned the required 10%, with a minimum of two visitors in each group having a PIC assigned to them.
- 6.2.4 When issuing a PIC to a visitor, Health Physics personnel shall assign a 0-200 mr PIC, note the serial number, and complete the PIC issue log, ATGF-018, with all pertinent information.
 - 6.2.4.1 Visitors may be required to enter a radiological area and/or an RWP required area, the PIC requirements will be decided by the Health Physics Supervisor and PICs will be issued accordingly.
- 6.2.5 Health Physics Supervisors shall determine the need for PIC issuance in accordance with References 3.1.1 and 3.1.2.
 - 6.2.5.1 PICs shall not be issued to individuals for extended use. PICs shall be issued on an as needed or job duration basis.
 - 6.2.5.2 A.T.G. staff may self issue PICs in accordance with the provisions of this procedure.
- 6.2.6 At the time of issue Health Physics personnel should instruct visitors being issued the PIC:
 - 6.2.6.1 On the proper reading of the PIC and action to be taken upon off-scale indication of the PIC.

- 6.2.6.2 That if the PIC is dropped or mishandled, readings may not be indicative of true exposure. If this happens notify Health Physics personnel immediately.
- 6.2.6.3 PICs shall be worn adjacent to the TLD or film badge during work periods. In all instances, PICs shall be returned to Health Physics, or proper storage location, at the end of the day.

6.3 Return of PICs

- 6.3.1 PICs shall be returned to issue point upon completion of shift or after the completion of RWP requirements.
- 6.3.2 At the completion of the RWP work, or the end of the work day, temporarily assigned PICs shall be returned to the issuance point.
- 6.3.3 Lost and damaged PICs shall be handled in accordance with the provisions of Reference 3.1.1.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 ATGF-018, PIC Issue Log.

8.0 FORMS

- 8.1 ATGF-018, PIC Issue Log.

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

OPERATION AND CALIBRATION OF THE MODEL LV-1
LOW VOLUME AIR SAMPLER

Allied Technology Group, Inc.
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Fremont, CA 94538

Prepared by

D. Spicuzza

Allied Technology Group, Inc.

PROCEDURE/PLAN APPROVAL PAGE

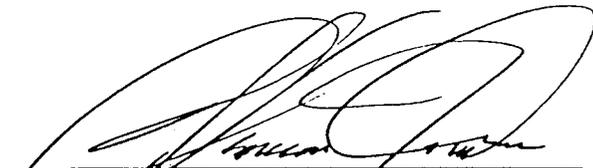
This procedure: HP-IP-007 has been reviewed and approved by the following:

APPROVAL SIGNATURES:



William G. Haney, Project Director

4/12/95
Date



Thomas J. O'Dou, CHP, Project Radiation Safety
Officer, HP Technical Support

4/12/95
Date

**REVISION RECORD INDICATING
LATEST DOCUMENT REVISION**

Procedure Number: HP-IP-007

Title: Operation and Calibration of the Model LV-1 Low Volume Air Sampler

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Approval	12/23/93

OPERATION AND CALIBRATION OF THE MODEL LV-1 LOW VOLUME AIR SAMPLER

1.0 SCOPE

This procedure sets forth the specific requirements to be used for the operation and calibration of the F & J Specialty Products Model LV-1 low volume air samplers used on Allied Technology Group, Inc. field projects.

2.0 PURPOSE

The purpose of this procedure is to provide instructions for the operation, use, and calibration of the F & J Specialty Products Model LV-1 low volume air samplers in accordance with the requirements of Reference 3.1.

3.0 REFERENCES

3.1 References

- 3.1.1 Regulatory Guide 10.8, Rev. 2-1987, Guide for the Preparation of Applications for Medical Use Programs
- 3.1.2 ANSI N3.1-1987, Selection, Qualification and Training of Personnel for Nuclear Power Plants
- 3.1.3 HP-OP-010, Air Sampling and Analysis
- 3.1.4 Technical Manual for the F & J Specialty Products Model LV-1 Regulated Low Volume Air Sampler
- 3.1.5 HP-OP-005, Control of Radioactive Material

4.0 PRECAUTIONS, LIMITATIONS

4.1 Precautions

- 4.1.1 Do not operate air samplers in an explosive environment unless the air sampler is specifically certified and designated for such use.
- 4.1.2 Ensure the power switch is in the "off" position prior to plugging any air sampling devices into electrical outlets.

- 4.1.3 Air samplers shall be considered internally contaminated and controlled in accordance with Reference 3.1.5.

4.2 Limitations

- 4.2.1 Calibration shall be performed annually, after maintenance is performed, or if the air sampler proper operation is in question.
- 4.2.2 Calibration shall be performed by the manufacturer or a qualified vendor only.
- 4.2.3 True flow is center of the rotometer ball reading.
- 4.2.4 Some rotometers are calibrated in liters per minute (LPM) vice cubic feet per minute (CFM). 1 CFM = 28.32 LP
- 4.2.5 Air samplers shall be operated in accordance with this procedure and Reference 3.1.3.
- 4.2.6 Only F & J TEDA impregnated (or equivalent) charcoal cartridges shall be used during operation of the air samplers.
- 4.2.7 Only F & J Model FP47 type (or equivalent) filters should be used for particulate air sampling.

5.0 RESPONSIBILITIES AND QUALIFICATIONS

5.1 Responsibilities

- 5.1.1 The ATG Radiological Field Operations Manager (Project Manager) is responsible for:
- 5.1.1.1 Implementation of this procedure.
 - 5.1.1.2 Periodic reviews of adherence to the requirements of this procedure.
 - 5.1.1.3 Ensure Health Physics Technicians are qualified by training and experience to perform the requirements of this procedure.
- 5.1.2 Health Physics Supervisors are responsible to:
- 5.1.2.1 Perform periodic surveillance of the use and maintenance of the air sampler.
 - 5.1.2.2 Ensure the air samplers are calibrated at specified intervals.

- 5.1.2.3 Ensure that records pertaining to use and maintenance of air samplers are maintained on file throughout the duration of the project and copies retained in the permanent project file.
- 5.1.3 Health Physics Technicians are responsible for:
 - 5.1.3.1 Performance of the requirements of this procedure.
 - 5.1.3.2 Documentation of all records in this procedure.
 - 5.1.3.3 Notification to Health Physics Supervision of any unsafe or unusual conditions observed during operation of the air sampler.

5.2 Qualifications

- 5.2.1 Health Physics Technicians shall be qualified in accordance with the requirements of ANSI 3.1 - 1987 to operate this air sampler.
- 5.2.2 Junior Health Physics and Decontamination Technicians may operate this air sampler under supervision of a Health Physics Technician meeting the requirements of Section 5.2.1.

6.0 PROCEDURE

6.1 Operation

6.1.1 Preparation

- 6.1.1.1 Upon receipt of the air sampler from the manufacturer or qualified vendor, complete form ATGF-028 and place a copy with the air sampler.
- 6.1.1.2 Verify that the instrument has a valid Calibration Data Sticker, Exhibit Label #ATGL-ASC.
- 6.1.1.3 Inspect the air sampler for any obvious physical damage.
- 6.1.1.4 Air sampling equipment should be prepared prior to entering work areas in order to minimize potential contamination of equipment.
- 6.1.1.5 Check for adequate power supply prior to entering the work area.

6.1.1.6 The Model LV-1 air sampler is provided with a six and one-quarter amp fuse for overload protection. Check the fuse located near the on/off power switch prior to air sampler operation. Replace if necessary.

6.2 Sample Collection

6.1.2.1 Air samples shall be collected in accordance with the provisions of Reference 3.1.3.

6.1.2.2 Load a new particulate and new charcoal cartridge (if applicable) into the sample holder. Particulate filter should be placed "fuzzy" side in (away from the flow). Charcoal cartridge should be placed in the sampler with the air flow indicator facing toward the pump.

NOTE: An inspection of the sample holder should be made prior to the placing of the filter(s) in the holder. Insure all O-rings are in place prior to use of the sample holder.

6.1.2.3 Connect the sample holder to the air sampler inlet connection via the quick disconnect coupling. Insure the sample holder "clicks" into position.

6.1.2.4 Place the air sampler in a position that is appropriate for the area to be sampled.

6.1.2.5 Turn on the air sampler and observe the flow rate. Using the Calibration Data Sticker (Label # ATGL-ASC) as a reference; adjust the flow rate by rotating the flow adjustment knob at the bottom of the air flow regulator to the desired flow rate. Clockwise movement increases flow; counter clockwise movement decreases flow.

6.1.2.6 Record the sample start date/time and flow rate on the appropriate forms in accordance with the provisions of Reference 3.1.3.

6.1.2.7 Run the sampler until a volume indicated in Reference 3.1.3 has been collected.

6.1.2.8 Upon collection of the desired volume, observe the flow rate to ensure it has not changed significantly, and turn off the air sampler.

6.1.2.9 Record the stop time and flow rate on the appropriate forms in accordance with the provisions of Reference 3.1.3.

- 6.1.2.10 Remove the filter and cartridge (if applicable) from the sample holder and place them in an envelope or bag taking care not to cross contaminate the filter and cartridge.
- 6.1.2.11 Count the filter(s) in accordance with the provisions of Reference 3.1.3.

6.2 Maintenance

- 6.2.1 No special storage requirements.
- 6.2.2 Electrical repair of this instrument shall be performed by the manufacturer or an approved vendor only.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 ATGF-028, Instrument Service Record - Low Volume Air Sampler
- 7.2 ATGL-ASC, Calibration Data Sticker

8.0 FORMS

- 8.1 ATGF-028, Instrument Service Record - Low Volume Air Sampler
- 8.2 ATGL-ASC, Calibration Data Sticker (Label)

EXHIBIT 8.2

AIR SAMPLER CALIBRATION DATA STICKER (LABEL)

ATGL-ASC

Air Sampler Calibration

Gauge Model No. _____

Gauge Serial No. _____

Pump Model No. _____

Pump Serial No. _____

Calibration Date:

Calibration Due Date:

Indicated Flow	Actual Flow

Calibrated By: _____

**INSTRUMENT SERVICE RECORD
LOW VOLUME AIR SAMPLER**

SECTION 1: INSTRUMENT DATA

AIR SAMPLER SERIAL NO:

MAKE:

MODEL:

CALIBRATION DATE:

CALIBRATION DUE DATE:

SECTION 2: CALIBRATION DATA

PHYSICAL CONDITION OF INSTRUMENT:

SATISFACTORY

UNSATISFACTORY

SECTION 3: REMARKS

REVIEWED BY:

DATE:

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

OPERATION AND CALIBRATION OF THE MODEL H-9400
HIGH VOLUME AIR SAMPLER

Allied Technology Group, Inc.
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Allied Technology Group, Inc.

PROCEDURE/PLAN APPROVAL PAGE

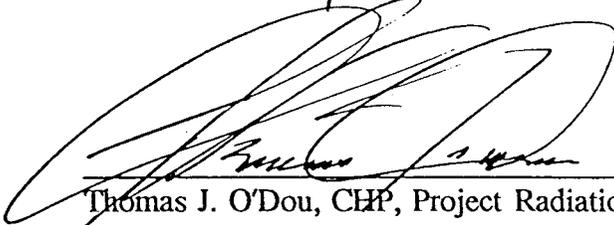
This procedure: HP-IP-008 has been reviewed and approved by the following:

APPROVAL SIGNATURES:



William G. Haney, Project Director

4/12/95
Date



Thomas J. O'Dou, CHP, Project Radiation Safety
Officer, HP Technical Support

4/12/95
Date

REVISION RECORD INDICATING
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Procedure Number: HP-IP-008

Title: Operation and Calibration of the Model H-9400 High Volume Air Sampler

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OPERATION AND CALIBRATION OF THE MODEL H-9400 HIGH VOLUME AIR SAMPLER

1.0 SCOPE

This procedure sets forth the specific requirements to be used for the operation and calibration of the F & J Specialty Products Model H-9400 High Volume Air Samplers used on Allied Technology Group, Inc. field projects.

2.0 PURPOSE

The purpose of this procedure is to provide instructions for the operation, use, and calibration of the F & J Specialty Products Model H-9400 High Volume Air Samplers in accordance with the requirements of Reference 3.1.

3.0 REFERENCES

3.1 References

- 3.1.1 Regulatory Guide 10.8, Rev. 2-1987, Guide for the Preparation of Applications for Medical Use Programs
- 3.1.2 ANSI N3.1-1987, Selection, Qualification and Training of Personnel for Nuclear Power Plants
- 3.1.3 HP-OP-010, Air Sampling and Analysis
- 3.1.4 Technical Manual for the F & J Specialty Products Model H-9400 High Volume Air Sampler
- 3.1.5 HP-OP-005, Control of Radioactive Material

4.0 PRECAUTIONS, LIMITATIONS

4.1 Precautions

- 4.1.1 Do not operate air samplers in an explosive environment unless the air sampler is specifically certified and designated for such use.
- 4.1.2 Ensure the power switch is in the "off" position prior to plugging any air sampling devices into electrical outlets.

- 4.1.3 Air samplers shall be considered internally contaminated and controlled in accordance with Reference 3.1.5.

4.2 Limitations

- 4.2.1 Calibration shall be performed annually, after maintenance is performed, or if the air sampler proper operation is in question.
- 4.2.2 Calibration shall be performed by the manufacturer or a qualified vendor only.
- 4.2.3 Air samplers shall be operated in accordance with this procedure and Reference 3.1.3.
- 4.2.4 Some gauges are calibrated in liters per minute (LPM) vice cubic feet per minute (CFM). 1 CFM = 28.32 LPM
- 4.2.5 Only F & J Model FP-4.0 (4 inch) type (or equivalent) filters should be used for particulate air sampling.

5.0 RESPONSIBILITIES AND QUALIFICATIONS

5.1 Responsibilities

- 5.1.1 The ATG Radiological Field Operations Manager (Project Manager) is responsible for:
- 5.1.1.1 Implementation of this procedure.
 - 5.1.1.2 Periodic reviews of adherence to the requirements of this procedure.
 - 5.1.1.3 Ensure Health Physics Technicians are qualified by training and experience to perform the requirements of this procedure.
- 5.1.2 Health Physics Supervisors are responsible to:
- 5.1.2.1 Perform periodic surveillance of the use and maintenance of the air sampler.
 - 5.1.2.2 Ensure the air samplers are calibrated at specified intervals.
 - 5.1.2.3 Ensure that records pertaining to use and maintenance of air samplers are maintained on file throughout the duration of the project and copies retained in the permanent project file.

- 5.1.3 Health Physics Technicians are responsible for:
 - 5.1.3.1 Performance of the requirements of this procedure.
 - 5.1.3.2 Documentation of all records in this procedure.
 - 5.1.3.3 Notification to Health Physics Supervision of any unsafe or unusual conditions observed during operation of the air sampler.

5.2 Qualifications

- 5.2.1 Health Physics Technicians shall be qualified in accordance with the requirements of ANSI 3.1 - 1987 to operate this air sampler.
- 5.2.2 Junior Health Physics and Decontamination Technicians may operate this air sampler under the direct supervision of a Health Physics Technician meeting the requirements of section 5.2.1.

PROCEDURE

6.1 Operation

6.1.1 Preparation

- 6.1.1.1 Upon receipt of the air sampler from the manufacturer or qualified vendor, complete Form ATGF-029 and place a copy with the air sampler.
- 6.1.1.2 Verify that the instrument has a valid Calibration Data Sticker, Exhibit Label # ATGL-ASC.
- 6.1.1.3 Inspect the air sampler for any obvious physical damage.
- 6.1.1.4 Air sampling equipment should be prepared prior to entering work areas in order to minimize potential contamination of equipment.
- 6.1.1.5 Check for adequate power supply prior to entering the work area.

6.2 Sample Collection

- 6.1.2.1 Air samples shall be collected in accordance with the provisions of Reference 3.1.3.
- 6.1.2.2 Load a new 4" particulate filter into the filter holder by unscrewing (counter-clockwise) the outer retaining ring on the filter holder.

Particulate filter should be placed "fuzzy" side in (away from the flow). After filter is centered in the filter holder, screw back on the outer retaining ring (clockwise). Hand tighten only.

- NOTE: An inspection of the filter holder should be made prior placing the filter in the holder. Ensure the mesh backing screen is in place and not damaged. Ensure the flow gauge is not damaged and is securely fit into the air sampler exhaust port.
- 6.1.2.3 Place the air sampler in a position that is appropriate for the area to be sampled.
- 6.1.2.4 Turn on the air sampler and observe the flow rate on the gauge. Using the Calibration Data Sticker (Label # ATGL-ASC) as a reference; record the sample start date/time and flow rate on the appropriate forms in accordance with the provisions of Reference 3.1.3.
- 6.1.2.5 Run the sampler until a volume indicated in Reference 3.1.3 has been collected.
- 6.1.2.6 Upon collection of the desired volume, observe the flow rate to ensure it has not changed significantly, and turn off the air sampler.
- 6.1.2.7 Record the stop time and flow rate on the appropriate forms in accordance with the provisions of Reference 3.1.3.
- 6.1.2.8 Remove the filter from the filter holder and place it in an envelope or bag taking care not to cross contaminate the filter.
- 6.1.2.11 Count the filter in accordance with the provisions of Reference 3.1.3.

6.2 Maintenance

- 6.2.1 No special storage requirements.
- 6.2.2 Electrical repair of this instrument shall be performed by the manufacturer or an approved vendor only.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

7.1 ATGF-029, Instrument Service Record - High Volume Air Sampler

7.2 ATGL-ASC, Calibration Data Sticker Label

8.0 FORMS

8.1 ATGF-029, Instrument Service Record - High Volume Air Sampler

8.2 ATGL-ASC, Calibration Data Sticker

EXHIBIT 8.2

AIR SAMPLER CALIBRATION DATA STICKER (LABEL)

ATGL-ASC

Air Sampler Calibration

Gauge Model No. _____

Gauge Serial No. _____

Pump Model No. _____

Pump Serial No. _____

Calibration Date: _____

Calibration Due Date: _____

Indicated Flow	Actual Flow

Calibrated By: _____

**INSTRUMENT SERVICE RECORD
HIGH VOLUME AIR SAMPLER**

SECTION 1: INSTRUMENT DATA		
AIR SAMPLER SERIAL NO:	MAKE:	MODÉL:
CALIBRATION DATE:	CALIBRATION DUE DATE:	
SECTION 2: CALIBRATION DATA		
PHYSICAL CONDITION OF INSTRUMENT:	<input type="checkbox"/> SATISFACTORY	<input type="checkbox"/> UNSATISFACTORY
SECTION 3: REMARKS		
REVIEWED BY:		DATE:

ATG, INC.

HP-IP-011

Revision 0

ALLIED TECHNOLOGY GROUP FIELD OPERATIONS
HEALTH PHYSICS OPERATING PROCEDURE

OPERATION OF THE LUDLUM MODEL 18 ANALYZER WITH THE LUDLUM
MODEL 43-68 GAS PROPORTIONAL DETECTOR

Allied Technology Group, Inc.
47375 Fremont Blvd.
Fremont, California 94538

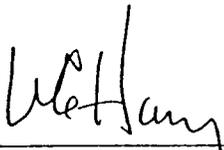
Prepared by
D. Spicuzza

Allied Technology Group, Inc.

PROCEDURE/PLAN APPROVAL PAGE

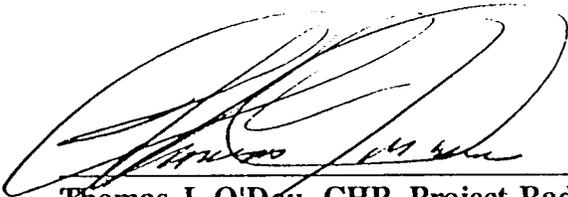
This procedure: HP-IP-011, OPERATION OF THE LUDLUM MODEL 18 ANALYZER WITH THE LUDLUM MODEL 43-68 GAS PROPORTIONAL DETECTOR, has been reviewed and approved by the following:

APPROVAL SIGNATURES:



William G. Haney, Project Director

4/10/95
Date



**Thomas J. O'Dou, CHP, Project Radiation Safety
Officer, HP Technical Support**

4/10/95
Date

**REVISION RECORD INDICATING
LATEST DOCUMENT REVISION**

Procedure Number: HP-IP-011

Title: OPERATION OF THE LUDLUM MODEL 18 ANALYZER WITH THE LUDLUM
MODEL 43-68 GAS PROPORTIONAL DETECTOR

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Rev. No.	Date
0	2/16/95

REVISION RECORD	
Rev. No.	Date

CURRENT REVISION	
Rev. No.	2
Date	2/16/95
Approval	

OPERATION OF THE LUDLUM MODEL 18 ANALYZER WITH LUDLUM MODEL 43-68 GAS PROPORTIONAL DETECTOR

1.0 SCOPE

This procedure sets forth specific requirements to be used for the operation of the Ludlum Model 18 Analyzer with Ludlum Model 43-68 Gas Proportional Detector for use on A.T.G. field projects.

2.0 PURPOSE

The purpose of this procedure is to provide instructions for the operation of the Ludlum Model 18 Analyzer with Ludlum Model 43-68 Gas Flow Proportional Detector.

3.0 REFERENCES

- 3.1.1 Regulatory Guide 10.8, Rev.2-1987, Guide for the Preparations of Applications for Medical Use Programs
- 3.1.2 ANSI N3.1-1987, Selection, Qualification and Training of Personnel For Nuclear Power Plants
- 3.1.3 Manufacturer's instruction manual for the Ludlum Model 18 Analyzer.
- 3.1.4 Manufacturer's instruction manual for the Ludlum Model 43-68 Gas Proportional Detector
- 3.1.5 Manufacturer's instruction manual for the Ludlum Model 2750 Flow Control Meter
- 3.1.6 ANSI N323-1978, Instrument Test and Calibration

4.0 PRECAUTIONS, LIMITATIONS

4.1 Precautions

- 4.1.1 Take care not to puncture the thin mylar window of the gas proportional detector.
- 4.1.2 To prevent contamination of the probe, avoid contact with the person(s) or object(s) being surveyed.
- 4.1.3 When using this instrument in a known or suspected contaminated area, seal the instrument case in a protective media (i.e., plastic, poly) to prevent contamination of the instrument case.

4.2 Limitations

- 4.2.1 The operation of the Model 18 depends on the condition of the battery. Therefore, the battery check should be performed before operation and periodically during use to ensure proper operation.
- 4.2.2 Calibration shall be performed semiannually, after maintenance is performed, if the instrument fails the performance test or if its proper operation is in question.
- 4.2.3 A daily performance test is required when the instrument is in use.

5.0 RESPONSIBILITIES AND QUALIFICATIONS

5.1 Responsibilities

- 5.1.1 ATG Radiological Field Operations Manager is responsible to:
 - 5.1.1.1 Implement this procedure.
 - 5.1.1.2 Periodically review the adherence of personnel to the requirements of this procedure.
 - 5.1.1.3 Ensures by training and experience Health Physics Technicians are qualified to perform the requirements of this procedure.
- 5.1.2 Health Physics Supervisors are responsible to:
 - 5.1.2.1 Perform periodic surveillance of the use and maintenance of the instrument.
 - 5.1.2.2 Ensure the instrument is calibrated at specified intervals.
 - 5.1.2.3 Ensure that records pertaining to the instrument are maintained on file throughout the duration of the project and copies retained in the permanent project file.
- 5.1.3 Health Physics Technicians are responsible to:
 - 5.1.3.1 Perform the requirements in Section 6.1, and 6.3 of this procedure.
 - 5.1.3.2 Document all records in this procedure.
 - 5.1.3.3 Notify Health Physics Supervision of any unsafe or unusual conditions observed during operation of the instrument.

5.2 Qualifications

5.2.1 Health Physics technicians shall be qualified in accordance with the requirements of Reference 3.1.2 operate this instrument for any of the following:

Surveys, radiation work permits and job coverage.

5.2.2 Junior Health Physics and Decontamination Technicians may operate this instrument under supervision of a Health Physics Technician meeting the qualification requirements of section 5.2.1.

6.0 PROCEDURE

6.1 Flushing the Ludlum Model 43-68 Gas Proportional Detector

6.1.1 The Ludlum Model 43-68 Gas Proportional Detector must be flushed prior to use.

6.1.2 Connect the Ludlum Model 43-68 Gas Proportional Detector to the Ludlum Model 18 Analyzer using the supplied cable with series "C" type connectors.

6.1.3 The following is a list of recommended equipment for flushing the detector:

- a) P-10 Gas (90% argon, 10% methane)
- b) Dual Stage Regulator (One stage to show supply pressure. Second stage to reduce supply pressure to 1-2 psi).
- c) Needle valve between the second regulator stage and flowmeter for easier flow adjustment.
- d) Ludlum Model 2750 Flow Control Meter 0-100 cc/min.

6.2 Flush

6.2.1 Connect the counting gas input and output lines to the detector.

CAUTION

The Model 43-68 uses double ended quick connects. Both the male and female quick connects have to be connected to allow gas flow through the detector. DO NOT flow gas into the detector unless both inlet and outlet are connected. It will rupture the detector.

- 6.2.2 Connect the regulator to the P-10 gas supply bottle. Ensure the gas bottle supply is off. Ensure the outlet valve of the regulator is in the closed position.
- 6.2.3 Connect the gas supply line to the "SUPPLY" port of the flowmeter.
- 6.2.4 Connect the gas line from the "TO DET" port of the flowmeter to the gas input line of the detector.
- 6.2.5 Connect the gas line from the output of the detector to the "FROM DET" port of the flowmeter.
- 6.2.6 Open the "EXHAUST" port of the flowmeter by connecting a male quick connect to the port.
- 6.2.7 Ensure the needle valve located at the bottom of the "IN" gauge on the flowmeter is fully closed (clockwise).
- 6.2.8 Turn main supply on and flush detector at 100 cc/min at 1- 2 psi gauge pressure for (1) hour.
- 6.2.9 The flow of gas through the detector can be increased by opening (turning counterclockwise) the needle valve at the bottom of the "IN" gauge on the flowmeter and vice versa.

NOTE

A faster flush time can be realized if the output gas line is disconnected from the output of the detector. A male quick connect must be connected to the output port of the detector to ensure gas flow through the detector. Flush time may be reduced to 20-30 minutes.

CAUTION

The main supply should be reduced to less than 50 cc/min before the output gas line is reconnected.

- 6.2.10 After flush is complete, set flow to 30-50 cc/min.

- 6.2.11 After the output line is reconnected check for detector leakage by comparing the readings on the "IN" and "OUT" gauges on the flowmeter. If a difference of more than 5 cc/min is observed tag the detector out of service and do not use until the detector has been repaired.
- 6.2.12 Disconnect the input quick connect on the detector.
- 6.2.13 Disconnect the output quick connect on the detector.
- 6.2.14 Turn the main gas supply off.
- 6.2.15 After two hours of use or when a noticeable decrease in detector efficiency is observed during use, whichever come first, the detector must be re-flushed.
- 6.2.16 Re-flush the detector following Steps 6.2.1 thru 6.2.14.

6.3 Operation

- 6.3.1 Verify that the instrument has a valid Calibration Data Sticker Label # ATGL-DCK and is not out of calibration, and the daily performance test has been completed and initialled on the Performance Test Daily Check Sticker. If the performance test has not been completed, have a Health Physics Technician perform the test (Section 6.3).
- 6.3.2 Inspect the instrument for any obvious physical damage which could interfere with its proper operation. It should include inspecting for loose, damaged knobs, buttons, broken or damaged meter movements/displays, dented or corroded instrument cases, punctured/deformed probe/probe window(s). Particular attention should be given to cables and connectors, since these components frequently become damaged or worn. Any instrument or detector having a questionable physical condition shall not be used until properly corrected.
- 6.3.3 Perform a battery check on the instrument by moving the switch to the "BAT" position. Observe the meter indication for the current battery condition.
- 6.3.4 If unsatisfactory results are obtained, refer to Reference 3.1.3 for the replacement of the batteries and repeat the check. The instrument shall display a satisfactory battery check prior to each use.
- 6.3.5 Set the audio switch to the "on" position. Set the response switch to the slow "s" position, and range selector to the lowest setting.

NOTE

The Model-18 analyzer has a 3 position high voltage adjustment switch labeled HV1, HV2, and HV3 that allows for selection of desired voltage operating points. The positions of the switch are as follows:

HV-1: Alpha	~ 1,200 volts
HV-2: Beta/Alpha	~ 1,700 volts
HV-3: Not Used (GM Detector Use Only)	~ 900 volts

- 6.3.6 Position the high voltage adjustment switch to the HV-1 (Alpha) position. In a low background area perform a background check on the instrument. Observe the instrument's reading. Reading should be between 0 and 5 cpm. If a greater reading is noted, the detector's mylar window may be damaged, the instrument should be taken out of service and Health Physics Supervision notified immediately.

NOTE

When using the Model 43-68 detector, to do an evaluation of a surface which may contain natural radioactivity (such as concrete or plaster), determine background near contact with a non-contaminated section of the material. This will ensure that activity determination accounts for the presence of low-level natural radioactivity in the material.

- 6.3.7 Position the high voltage adjustment switch to the HV-2 (Beta/Alpha) position. In a low background area perform a background check on the instrument. Observe the instrument's reading. Reading should be between 200 and 300 cpm. If a greater reading is noted, the detector's mylar window may be damaged, the instrument should be taken out of service and Health Physics Supervision notified immediately.
- 6.3.8 If a low background rate cannot be achieved check the instrument probe face for contamination. Decontaminate if necessary, taking care not to damage the probe face.
- 6.3.9 Proceed with operation in accordance with the desired use.
- 6.3.10 If performing a direct probe survey for beta/gamma surface contamination, the detector face should be within 1/2" of the surface being surveyed. The movement rate of the detector probe should be one probe width per second or slower.

6.4.11 If the instrument passes the performance test, record "P" for pass on form ATGF-003, then initial the Performance Test Daily Check Sticker on the instrument and initial the Performance Test Log Sheet.

6.5 Calculation of Minimal Detectable Activity (MDA)

6.5.1 Calculation of MDA when meter is used for stationary (static) readings.

6.5.1.1 After obtaining a background count rate, the MDA can be calculated using the following formula:

$$MDA = \frac{4.65}{E * (A/100)} \times \text{SQRT} (B_R/2t_c)$$

where

MDA = activity level in disintegrations/minute/100cm²
B_R = background count rate in counts/minute
t_c = meter time constant in minutes
E = detector efficiency in counts/disintegration
A = active probe area in cm²

6.5.2 Calculation of MDA when meter is used for scanning.

6.5.2.1 After obtaining a background level the MDA can be calculated using the following formula:

$$MDA = \frac{3 \times R_B}{E \times (A/100)}$$

where

MDA = activity level in disintegrations/minute/100cm²
R_B = background rate in counts/minute
E = detector efficiency in counts/disintegration
A = active probe area in cm²

NOTE

This yields an approximation of MDA based on a scan rate of approximately 2 inches per second. The MDA will increase with higher scan rates.

- 6.3.11 If performing a direct probe survey for alpha surface contamination, the detector face should be within 1/4" of the surface being surveyed. The movement rate of the detector probe should be one probe width per second or slower.
- 6.3.12 If counting smears, masslinn etc. the counting time should be a minimum of 30 seconds, or when meter deflection stabilizes.
- 6.3.14 When performing direct scan surveys of objects, surface areas etc., static readings should be performed frequently to insure the detection of residual activity.

6.4 Performance Test

- 6.4.1 Conduct a performance test daily check on the instrument and record all data on form ATGF-003, Performance Test Log Sheet.
- 6.4.2 Obtain a 100cm² Tc-99 Performance Test source.
- 6.4.3 Record the information for each section of form ATGF-003.
- 6.4.4 Examine the instrument for any obvious physical damage which could interfere with its proper operation.
- 6.4.5 Verify that the instrument has a current Calibration Data Sticker and Performance Test Daily Check Sticker.
- 6.4.6 Perform a Battery Check to ensure that the battery is within the Batt OK range on the meter.
- 6.4.7 Place the high voltage adjustment switch in the HV-2 position. Expose the detector to the performance test source. If the response is within the designated range for the source, proceed to step 6.4.11. If the instrument fails, record "F" for fail on form ATGF-003 and remove the instrument from service for repair or calibration.
- 6.4.8 Obtain a 100cm² Th-230 Performance Test source.
- 6.4.9 Place the high voltage adjustment switch in the HV-2 position. Expose the detector to the performance test source. If the response is within the designated range for the source, proceed to step 6.4.11. If the instrument fails, record "F" for fail on form ATGF-003 and remove the instrument from service for repair or calibration.
- 6.4.10 If the instrument fails any portion of the performance test, log the instrument as failing on the Performance Test Log Sheet, remove from service and notify Health Physics Supervision.

6.6 Maintenance

- 6.6.1 Instruments shall be stored in areas which prevent damage by movement, accumulation of moisture or dust. Detector covers shall be used for storage when practical.
- 6.6.2 Electronic maintenance (except probe and cable replacements) shall be performed by an Health Physics Instrumentation Technician, by the manufacturer or by an approved vendor.

7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure.

- 7.1 Form ATGF-003 Daily Instrument Performance Test Log Sheet
- 7.2 Calibration Data Sticker
- 7.3 Performance Test Daily Check Sticker

8.0 FORMS AND EXHIBITS

8.1 Forms

- 8.1.1 ATGF-003 - Daily Instrument Performance Test Log Sheet

8.2 Exhibits

- 8.2.1 Performance Test Daily Check Sticker
- 8.2.2 Calibration Data Sticker

