SAND2013-9560P
Unlimited Release

FEDERAL RADIOLOGICAL

MONITORING AND ASSESSMENT CENTER

FRMAC FLY AWAY LABORATORY MANUAL

The Federal Manual for Performing Laboratory Analysis during a Radiological Emergency

November, 2013

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation,
A wholly owned subsidiary of Lockheed Martin Corporation,
For the United States Department of Energy's National Nuclear Security Administration
Under Contract DE-AC04-94AL85000. Approved for public release: further dissemination unlimited

SAND2013-9560P
Unlimited Release

FRMAC Fly Away Laboratory Manual

Sonoya T. Shanks
FRMAC Laboratory Analysis Working Group
Sandia National Laboratories
Albuquerque, NM

Carolyn T. Wong
FRMAC Laboratory Analysis Working Group
Lawrence Livermore National Laboratory
Livermore, CA

Arthur Shanks Jr., Technical Chairman
FRMAC Laboratory Analysis Working Group
Sandia National Laboratories
Albuquerque, NM

Ricky Honaker, FRMAC Program Manager
Consequence Management/Federal Radiological Monitoring and Assessment Center
U.S Department of Energy, National Nuclear Security Administration
Nevada Site Office, Las Vegas, Nevada

Dan Blumenthal, Consequence Management Program Manager
Office of Emergency Response
U.S. Department of Energy
National Nuclear Security Administration
Headquarters Office of Emergency Operations, Washington, D.C

This work was supported by the U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, under Contract No. DE-AC08-96NV11718.

FRMAC is an acronym for Federal Radiological Monitoring and Assessment Center.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

AVAILABILITY

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.gov
online ordering: http://www.ntis.gov/ordering.htm

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: reports@adonis.osti.gov

Also available at the FRMAC website,

http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/manuals.aspx

Preface

This manual was written for those personnel who respond to a radiological/nuclear incident that will be called upon to provide proper analysis support. Overall, this manual provides general guidance and some specific diagrams and forms. However, it is understood that site- and event-specific operational decisions and procedures may need to be modified at the time of an emergency event. This manual is intended to provide guidance for Fly Away Laboratory personnel without limiting FRMAC's ability to integrate the work with other partners or stakeholders.

The NNSA/NSO has the overall responsibility for maintaining the master copy of all FRMAC manuals. Please provide comments on this manual to:

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Attn: FRMAC Program Manager
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Acknowledgments

Creation of the *FRMAC Fly Away Laboratory (FAL) Manual* was a major undertaking to which many people contributed. Special thanks go to Sean Fournier and Ken Sansone of Sandia National Laboratories; Manuel Franco Jr. and Luis Valdivia of Apple One; Wendy Pemberton of the Remote Sensing Laboratory; and Richard Bibby, Cynthia Conrado, Jay Dixon, Mark Johnson and Phil Torretto of Lawrence Livermore National Laboratory who developed and organized much of the material in this revision.

Acronyms and Abbreviations

ADC	Analog to Digital Converter
ALARA	As Low As Reasonably Achievable
ARF	Analysis Request Form
ARMS	Asset Readiness Management System
CM	Consequence Management
CMHT	Consequence Management Home Team
CMRT I	Consequence Management Response Team phase I
DOE	Department of Energy
DQO	Data Quality Objectives
EOTA	Emergency Operations Training Academy
FAL	Fly Away Laboratory
FRMAC	Federal Radiological Management Assessment Center
FWHM	Full Width at Half Maximum
GAB	Gross Alpha/Beta
HPGe	High Purity Germanium
HVPS	High Voltage Power Supply
ICS	Incident Command System
LAN	Local Area Network
LLD	Lower Level Discriminator
LSC	Liquid Scintillation Counting
MCA	Multi-Channel Analyzer
MQO	Measurement Quality Objectives
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Security Administration
NSO	Nevada Site Office
QA	Quality Assurance
QC	Quality Control
RSL	Remote Sensing Laboratory
SCF	Sample Control Form
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
USB	Universal Serial Bus

Table of Contents

		Revision Date
Section 1. Introduction	1-1	11/13
Section 2. Roles and Responsibilities	2-1	11/13
Section 3. Quality Control	3-1	11/13
Section 4. Sample Control	4-1	11/13
Section 5. Logistics	5-1	11/13
Section 6. Gamma Spectroscopy Procedures	6-1	11/13
Section 7. iSOLO™ Operations	7-1	11/13
Section 8. Liquid Scintillation Procedure	8-1	11/13
Section 9. Analytical Balance Use	9-1	11/13
Section 10. iCAM/Glovebox/Fumehood Procedures	10-1	11/13
Section 11. Data Handling and Verification/Validation	11-1	11/13

List of Appendices

Appendix A: iSOCS™ Geometry Composer Tutorial	A-1	11/13
Appendix B: Fly Away Laboratory Forms	B-1	11/13
Appendix C: Fly Away Laboratory Sample Tracking Database Tutorial	C-1	11/13
Appendix D: LSC Quench Overview	D-1	11/13
Appendix E: LSC Data Entry Sheets	E-1	11/13
Appendix F: Triathler™ Programming	F-1	11/13

This page is intentionally left blank

Section 1: Introduction

When the FRMAC responds to a radiological/nuclear incident, monitoring, sampling, and radioanalytical support will arrive from a number of different sources. The respondents providing this support will, in all likelihood, have received varying levels of training and will have experience with a variety of monitoring, sampling, and radioanalytical equipment and procedures. It is important that an acceptable and established set of standard operating procedures (SOPs) be followed by all personnel having responsibilities for processing and analyzing samples during the emergency. Overall, this manual provides general guidance and some specific diagrams and forms. However, it is understood that site- and event-specific operational decisions and procedure parameters will need to be established and documented at the time of an emergency.

The purpose of this manual is to provide guidance to Fly Away Laboratory (FAL) personnel responsible for the analysis of time sensitive radiological samples. With proper training, preparation, and equipment, FAL personnel will be able to quickly provide reliable results for radiological samples that have been deemed immediately important to the health and safety of emergency response personnel as well as the general public. Upon deployment of the FRMAC, the Consequence Management Response Team will have set up shelter and workspace for the FAL. Equipment load-outs have been designed to be able to be shipped via commercial airlines or DOE aircraft. In this way, the FAL will most likely be the first field laboratory on-site and will be crucial in the rapid analysis of emergency-phase samples.

It is the responsibility of CMRT personnel to deploy the laboratory specific-equipment and begin operations upon arrival. This manual will provide guidance as to how to set up an efficient laboratory working area. However, it will be up to the FAL personnel to be able to adapt to any situation that may come up during an event. Although a part of the FRMAC, the FAL will be acting as a laboratory entity with respect to the other FRMAC functions (Laboratory Analysis, Assessment, Monitoring and Sampling, Health and Safety) and will take direct instruction from the FAL Manager and FRMAC Laboratory Analysis personnel.

Work in the Fly Away Laboratory may require working outdoors in possibly extreme conditions. Watch for snakes, rodents, insects, and other potentially hazardous flora or fauna. Be aware of changing weather conditions, and immediately follow all orders regarding the protection of your health and safety.

This page is intentionally left blank

Section 2: Roles and Responsibilities

Table of Contents

2.1 Position Descriptions 2
2.2 Required Training Matrix 2

Tables

Table 2.1: FAL Personnel Training Requirements 2

2.1 Position Descriptions

The FRMAC Fly Away Laboratory Position Descriptions are located in the Laboratory Analysis Division folder at the following URL:
http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/manuals.aspx

2.2 Required Training Matrix

Table 2.1: FAL Personnel Training Requirements

Description	Frequency	Fly Away Lab Manager	Laboratory Staff
EOTA CMP-101DW: Operations Overview for CM	1 time	X	X
EOTA CMP-104DW: Health & Safety Orientation Course	1 time	X	X
ICS 100- Introduction to ICS	1 time	X	X
ICS-200 – ICS for Single resources and Initial Action Incidents	1 time	X	X
ICS-800.b National Response Framework (NRF)Introduction.	1 time	X	X
DOE Rad Worker II (or equivalent)	Current	X	X
FAL -100 – FAL Field Logistics	3 yrs	X	X
FAL-200 – FAL Gamma Spectroscopy Operations	3 yrs	X	X
FAL-300 – FAL Gross Alpha/Beta Operations	3 yrs	X	X
FAL-400 – FAL Liquid Scintillation Operations	3 yrs	X	X
FAL-500 – FAL Analytical Balance	3 yrs	X	X
FAL-600 – FAL Gamma Spectrometer Maintenance	3 yrs	X	
FAL-700- FAL Gross Alpha/Beta Routine Maintenance	3 yrs	X	
FAL-800 - FAL Liquid Scintillation Counter Maintenance	3 yrs	X	

Section 3: Quality Control

Table of Contents

3.1 Introduction 2
3.2 QC Sample Assignment and Preparation 2
3.3 QC Sample Processing 2
3.3.1 Quality Control Samples 2
3.3.2 Blank Samples 2
3.3.3 Laboratory Control Samples (LCS) 3

3.1 Introduction

The purpose of processing quality control (QC) samples is to provide continuing assurance of laboratory performance and to make internal laboratory performance audits more effective. Positive controls (laboratory control sample [LCS], blind quality control sample [BQC], and matrix spike samples) serve as a monitor of the overall accuracy of all steps in the analysis, including sample preparation. Negative controls (matrix blanks, backgrounds, and reagent blanks) are used to assess the existence and magnitude of contamination problems as well as natural background contributions. If problems with any QC sample exist, all data associated with the batch shall be carefully evaluated to determine whether the sample results are adversely affected.

Acceptance limits are predetermined and set in the software for each piece of instrumentation. These values are typical acceptance limits for laboratory based information. However, due to the variability in the environment, the Fly Away Laboratory Manager has the authority to alter acceptance limits based on the situation.

3.2 QC Sample Assignment and Preparation

At a minimum, a set of QC samples should consist of one positive control and one negative control. Assign a set of QC samples to each preparation batch of samples. The minimum number of QC samples shall be one set included in each batch, where the batch does not exceed a total of 20 samples. If reasonable, positive controls should have activity concentrations appropriate for the required measurement quality objectives (MQOs). Typically LCS, BQCs, and/or matrix spike sample concentrations should be at least 10 times the required critical level (Lc) if possible.

3.3 QC Sample Processing

3.3.1 Quality Control Samples

QC samples serve as indicators of method performance. If the QC results fall outside of the acceptance limits, all data associated with the batch shall be carefully evaluated to determine if the samples were compromised, and appropriate corrective actions shall be taken. Reprocess any samples that are suspected to be compromised. If reprocessing is not possible, contact the FAL Manager. Reprocesses are documented in the case file associated with the group for samples in question. Suspect results are qualified on the customer report. Instrument QC checks should be performed routinely to ensure the instrument has not been contaminated and is operating within control. Appropriate corrective actions (adjustments to the instrumentation, decontamination, and/or recalibration) shall be performed if an instrument is determined to be operating outside of tolerance limits. Record any corrective actions in the instrument’s logbook.

3.3.2 Blank Samples

Blank analysis results are assessed to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks apply to any blank associated with the samples. Review the results of the blanks. If the blank results fall outside the appropriate tolerance limits, all data associated with the batch shall be carefully evaluated to determine whether the samples were contaminated. Reprocess any samples that are suspected to be contaminated. If

reprocessing is not possible, contact the FAL Manager. Document reprocesses in the batch file associated with the group of samples in question. Qualify suspect results are on the customer report.

3.3.3 Laboratory Control Samples (LCS)

The LCS serves as a monitor of the overall accuracy and performance of all steps in the analysis, including the sample preparation. The LCS should contain an activity greater than 10 times the radionuclide's critical level, if possible. All LCS results should fall within the pre-established tolerance limits, if applicable. If the LCS recoveries fall outside the appropriate tolerance limits, all data associated with the batch shall be carefully evaluated to determine whether the actual sample results were affected, and appropriate corrective actions shall be taken. Reprocess any samples that are suspected to be affected. If reprocessing is not possible, contact the FAL Manager.

This page is intentionally left blank

Section 4: Sample Control

Table of Contents

4.1 Introduction 2
4.2 Setup of the Sample Control Staging Area 2
4.3 Sample Login and Tracking Process 3

Figures

Figure 4.1: Example - Sample Control Staging Area Recommended Setup 2
Figure 4.2: Tracking Database Main Menu 4

4.1 Introduction

Upon deployment of the FRMAC Fly Away Laboratory, CMRT personnel will have deployed the materials for an appropriate staging area. This section of the manual outlines the recommended setup of the sample control area, where samples that are collected in the field will be brought and logged into the FAL system. This section also outlines the logistical requirements of the sample tracking process.

4.2 Setup of the Sample Control Staging Area

There likely will be adequate tables and chairs to establish a sample control staging area onsite. This area includes designated areas for temporary storage of samples received, a computer login station, and three areas for samples that require gamma analysis, liquid scintillation analysis, and gross alpha/beta analysis. The designated storage areas are marked off with tape and labeled with a marker.

Refer to Figure 4.1 for an example of the staging area layout.

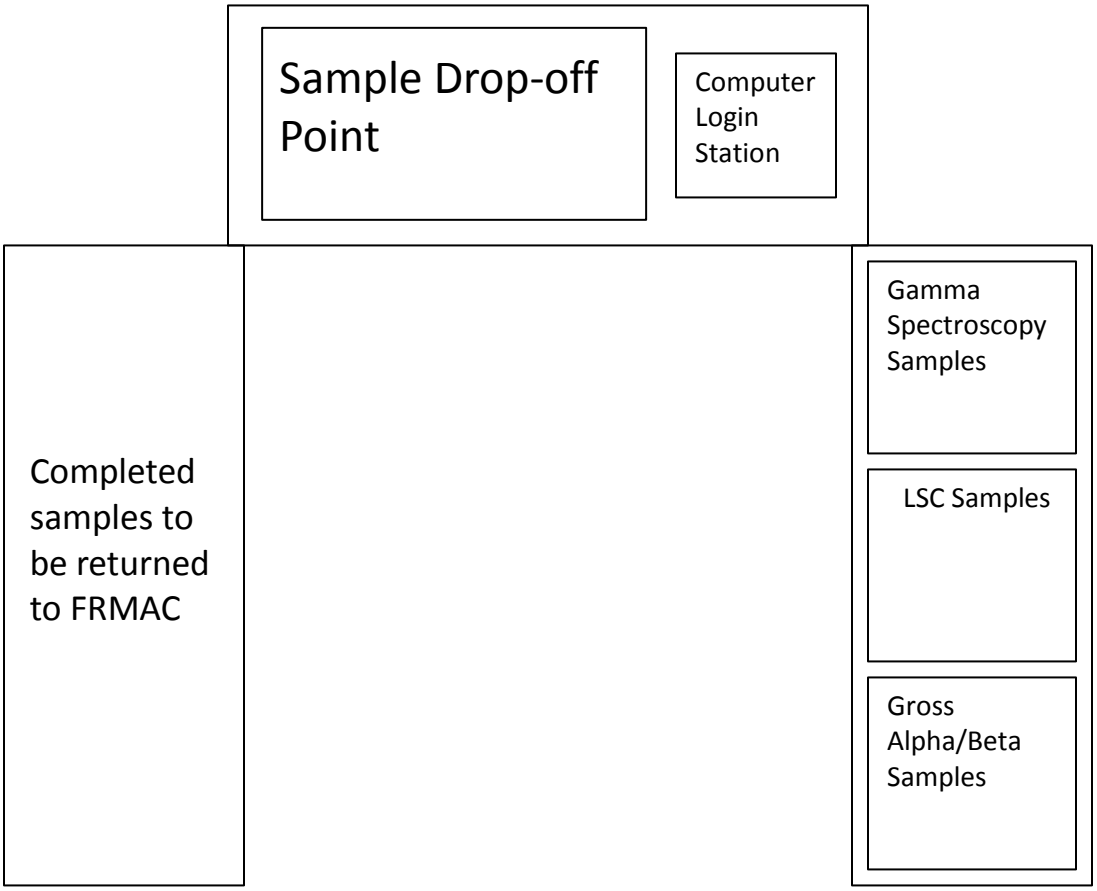


Figure 4.1: Example - Sample Control Staging Area Recommended Setup

It is recommended to set up the sample control staging area in such a way that it is clear which samples have been logged into the system and are ready for analysis. All samples must be processed through such a staging area before entering the laboratory area.

4.3 Sample Login and Tracking Process

Routinely, samples are brought by FRMAC Laboratory Analysis personnel to the Fly Away Laboratory sample control staging area. Each group of samples has an Analysis Request Form (ARF). This ARF includes all of the required information to perform the analysis of the sample(s). Each sample in a batch has a unique number associated with it, known as a "Sample Control Form (SCF) or Sample number." Upon receipt of a batch of samples, FAL Staff complete the following:

- Have a FRMAC radiological control technician (RCT) screen the samples for external removable contamination.
- Confirm that all of the samples listed on the ARF are included in the shipment to the staging area.
- Confirm the safe condition of all samples.
- Have the courier of the samples sign the chain-of-custody line on the ARF indicating that the samples are now leaving their possession.
- Sign the chain-of-custody line on the ARF indicating that you (FRMAC Fly Away Laboratory) are now in custody of the samples. If the sample is contaminated, contact the FAL Manager for guidance.
- Place the samples in the designated drop-off point.
- Open the FAL login database at the computer station located on the desktop named XXXXXX_FAL_DB where *XXXXXX* represents the name and/or year of the event. Figure 4.2 is an example of the database main menu.

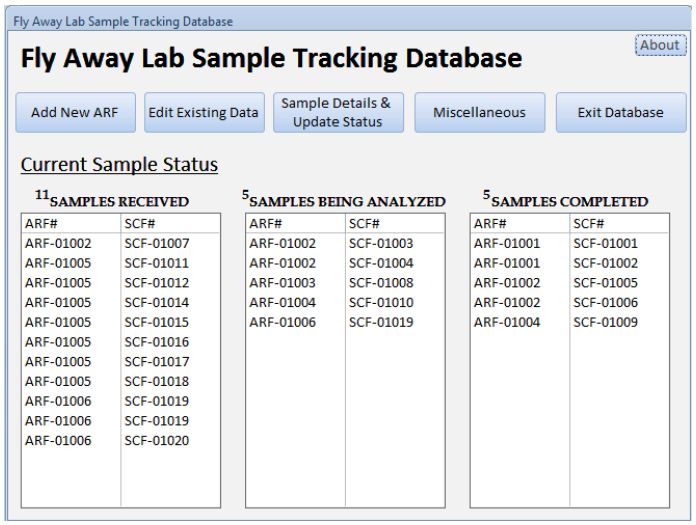


Figure 4.2: Tracking Database Main Menu

Enter the following from the ARF into the database for each sample by clicking **ADD NEW ARF** on the main menu. Add the ARF # and then input the # of SCFs associated with the ARF.

a. ARF #
b. # of SCF(s)
c. SCF #
d. Collection Date/Time
e. Requested Analysis (Gamma Spec, LSC, GAB)
f. Sample Matrix
g. Sample Status "RECEIVED"
h. Comments as needed

Once a new ARF is added along with SCFs, more ARFs can be added by clicking **ADD NEW ARF**. It is also possible to scroll through the newly added ARFs to review the newly added data by clicking on the left/right arrows. Details on how to use the data base can be found in Appendix C.

Place each sample in the appropriate storage location next to the computer station. If the samples are high activity samples, ask the FAL manager for further assistance. As samples are picked up from the storage location, change the status of the sample in the login database to "BEING ANALYZED."

Upon completion of the analysis and review of the results, change the status of the sample to "COMPLETED" in the database. Place completed samples in the "Return to FRMAC" location. When the courier arrives to pick up samples, transfer the chain of custody of the samples back to FRMAC by signing the appropriate chain of custody line on the ARF. Be sure to have the courier sign as accepting possession of the sample(s). Make a copy of the ARF, retain the copy, and provide the original ARF to the courier.

Section 5: Logistics

Table of Contents

5.1 Fly Away Laboratory Overview 2
5.2 Equipment Load-Out 2
5.3 On-Site Equipment Needs 2
5.4 Safety Hazards and Required Facility 3
5.5 Communication Requirements 3

Figures

Figure 5.1: Fly Away Laboratory Floor Diagram 4

5.1 Fly Away Laboratory Overview

The DOE FAL is an asset capable of transporting its equipment via commercial, contract, military, or charter aircraft. The laboratory equipment is located at the Remote Sensing Laboratory (RSL) in Nevada and deployed as part of FRMAC. FAL personnel shall be responsible for developing instrument capabilities, ensuring personnel are trained on the calibration and use of the instrumentation, and ensuring that all equipment is available for immediate deployment when called upon.

Deployed equipment is capable of analyzing samples for alpha-, beta- , and gamma-emitting radionuclides, as well as low energy beta-emitters, such as tritium. They have the ability to process all types of samples including, but not limited to: soil, air filters, swipes, and liquid samples.

The equipment is "exercised" regularly to ensure that the equipment is ready to be used on short notice, and that personnel maintain training on the equipment.

Figure 5.1 provides an example layout of the Fly Away Laboratory processes. Due to the close proximity of the counting equipment, particular analyses may be impacted by the samples submitted to the FAL for analysis. For example, if a high activity sample is received for iSOLO analysis, the background counts of the gamma spectroscopy units may be impacted.

5.2 Equipment Load-Out

If possible, a minimum of two of each of the following instruments will be maintained at the RSL:

- Gamma Detector, Associated Computers, Software, Printers, and Standard Sources
- Radon Compensating Alpha/Beta Counter (iSOLO™), Associated Computer, Software, Printers, and Standard Sources
- Portable Liquid Scintillation Counter, Associated Computers, Software, Printers, and Standard Sources

NOTE: It is acceptable to have a single network printer for the entire Fly Away Laboratory.

Additional larger equipment items such as a portable fume hood, iCAM, and additional supplies will be staged at RSL for deployment.

5.3 On-Site Equipment Needs

The following are the on-site equipment needs:

- Six 6-ft tables
- Two 4-ft tables
- Six chairs
- Sample Storage containers
- Refrigeration capabilities (if required)

5.4 Safety Hazards and Required Facility

Handling of radioactive sources and samples will be necessary. One should keep radiation exposure as low as reasonably achievable (ALARA) by minimizing the handling of sources and sample material. Care shall be exercised in handling samples according to their associated hazards, whether they are a biological, chemical, and/or radiological.

When the potential for external contamination exists on the sample container(s), protective gloves shall always be worn while handling the samples.

The operation of a germanium detector requires a high voltage of 3 to 5 KV at a few mA. Caution must be exercised to avoid touching any high voltage connections. Work in the Fly Away Laboratory may require working outdoors in possibly extreme conditions. Watch for snakes, rodents, insects, and other potentially hazardous flora or fauna. Be aware of changing weather conditions and immediately follow all orders regarding the protection of your health and safety. Care should be taken when lifting heavy weights to avoid personal injuries.

The balances are not allowed to be used in hazardous areas/locations because they do not have EX approval certificates certifying them as electrical apparatuses for potentially explosive atmospheres (Certificate of Conformity).

The following are facility requirements:

- Climate controlled 150 ft^2 lockable building/tent
- Sample storage area/tent (size dependent on the size of the incident)
- 110V power with a minimum of 12 outlets
- Generator fueled for 24/7 hour operations
- Located near Sample Control Tent (desirable)

5.5 Communication Requirements

The following are the communication requirements:

- Email access to forward electronic results
- Internet access
- Wireless hotspot
- Telephone and fax line

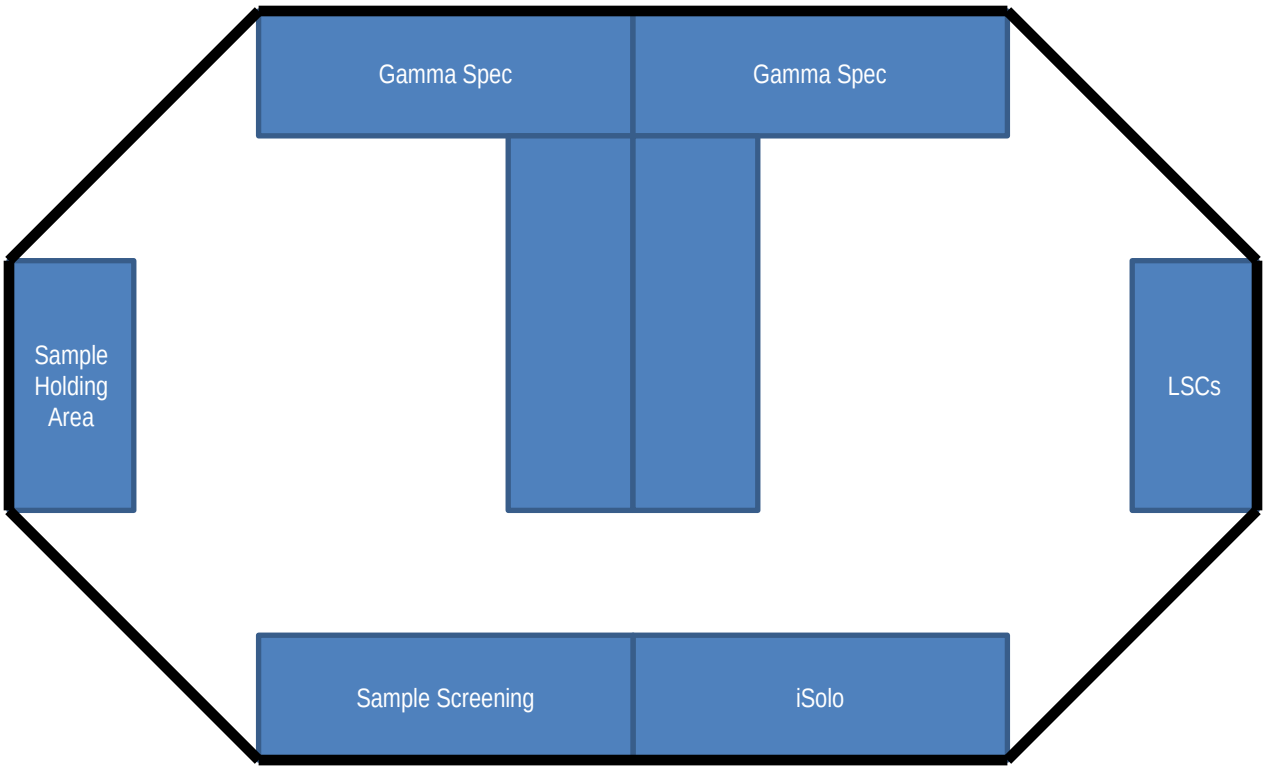


Figure 5.1: Fly Away Laboratory Floor Diagram

Section 6: Gamma Spectroscopy Procedures

Table of Contents

6.1 Purpose 3
6.2 Scope 3
6.3 Summary of Method 3
6.4 Apparatus and Materials 3
6.5 Routine Operations 4
6.5.1 On-site Setup of the FALCON™ 4
6.5.2 Initializing the High Voltage 8
6.5.3 Quality Control (QC) Check 9
6.5.4 Acquiring a Background Spectrum 10
6.5.5 Sample Analysis using the FALCON™ 11
6.5.6 Laboratory Control Samples 14
6.6 Non-Routine Operations 15
6.6.1 Calibration 15
6.6.2 Initial Setup from Factory (New FALCON™ Unit) 21
6.6.3 Acceptance Testing 39

Figures

Figure 6.1: FALCON 5000™ Power Setup 6
Figure 6.2: FALCON 5000™ Control/Display Panel 6
Figure 6.3: FALCON 5000™ Battery ports and connectors 7
Figure 6.4: FALCON 5000™ Control/Display Panel 7
Figure 6.5: Proper Placement of the QC Source 9
Figure 6.6: Energy Calibration Curves Window Showing Peaks 17
Figure 6.7: Energy Calibration Curves Window Showing the Shape Curve 17
Figure 6.8: Placement of Foam Spacers to Avoid Damage to Connector 22
Figure 6.9: Access to the RS232 Port underneath the Display/Control Panel 23
Figure 6.10: Example of the HyperTerminal 24
Figure 6.11: Example of the detector.txt File 37
Figure 6.12: Example of Data To Be Copied to detector.txt on the Machine 38

Tables

Table 6.1: Calibration Descriptions 12
Table 6.2: Routine Analysis Required Sample Information 13
Table 6.3: Suggested Calibration Values 16
Table 6.4: FALCON 5000™ MCA Input Definition (MID) Settings Part 1 28
Table 6.5: FALCON 5000™ MCA Input Definition (MID) Settings Part 2 29
Table 6.6: QC QAF File Settings Part 1 30
Table 6.7: QC QAF File Settings Part 2 31
Table 6.8 QC QAF File Settings Part 3 31
Table 6.9: Required Executable Files 34
Table 6.10: Required Nuclide Library (.nlb) and Energy Files 34
Table 6.11: Required Template (.tpl) Files 34
Table 6.12: Required Calibration Files 34
Table 6.13 Routine Batch File Shortcuts 35
Table 6.14 Non-Routine Batch File Shortcuts 35
Table 6.15: Example iSOCS™ Characterization Files 37

6.1 Purpose

The purpose of this procedure is to describe the proper use of the FALCON™ portable gamma spectroscopy system. The following activities are documented in this procedure:

- On-Site Setup of the FALCON™
- Quality Control
- Sample Preparation
- Sample Analysis
- Calibration of the FALCON™
- Maintenance and Acceptance Testing

6.2 Scope

The FALCON™ 5000 is an electronically-cooled high purity germanium detector. This highly mobile portable gamma spectrometer can rapidly provide nuclide identification and quantification for gamma emitting isotopes in calibrated geometries. iSOCS™ calibration files can be quickly and easily generated in the field for many geometries, freeing the user from the requirement of having calibrated geometries prior to analysis. This capability allows for timely and accurate analysis for almost any sample that may be collected in the field. The FALCON™ is an instrument that can provide accurate and timely information under demanding circumstances.

6.3 Summary of Method

The FALCON™ 5000 can identify and quantify gamma emitting radionuclides of interest using the established geometries and libraries. iSOCS™ can be used to accomplish similar tasks, but it allows for more flexibility in the geometry. However, in analyses involving samples with a high atomic mass, high density, and/or heavy materials, one must be aware of the attenuation effects in the methodology.

6.4 Apparatus and Materials

- FALCON™ 5000 High Purity Germanium Gamma Spectroscopy System
- Laptop computer with Windows, 2000 or XP
- HyperTerminal program
- RS232 (serial) cable
- Radioactive mixed gamma sources
- External DC power supply
- Lithium-ion batteries
- Collimator
- Genie™ 2000 software
- FAL developed batch files
- Latex gloves or equivalent (i.e., Nitrile Gloves)
- In-Situ Sourceless Calibration Software (iSOCS™)

6.5 Routine Operations

6.5.1 On-site Setup of the FALCON™

Specific Required Equipment (Refer to FALCON™ Inventory List in ARMS):

- FALCON™ 5000
- Power Supply
- Power Cable (Power Supply to FALCON™)
- Computer
- Computer Power Supply
- LAN Cable
- FALCON™ Batteries (more than one may be required for this procedure).

Optional Equipment:

- Extension Cord
- Keyboard
- Mouse
- Printer
- USB Printer Cable
- Network Switch.

6.5.1.1 Setup of Printing Capabilities

The method in which samples are counted on the Falcon uses Rexx Batch Programming Language. The batch files run through a DOS interface with some graphical user interface. Commands issued in Rexx are similar to DOS commands. DOS has a very limited printing interface, thus only recognizes printers attached to the LPT1 or the parallel port. To print to contemporary printers it is necessary to “trick” the computer into printing to a USB or network printer.

Setup the Printer

- Install the printer interface and all necessary printer drivers.
- From the Start Menu maneuver to Printers and Faxes.
- Right click on the printer and select Properties.
- Under the Sharing tab, Select the radio button “Share this printer.”
- Enter a simple printer name in the “Share name” text box; Note the share name for later use.
- Click Ok to exit.
- Again, from the Start Menu go to the control panel.
- Select “Add Hardware.” The computer will search for any new added device.
- When the computer asks if the hardware is already connected, Select “Yes, I have already connected the hardware” and then click “Next.”
- In the “Installed hardware” list scroll all the way down to the bottom of the list.
- Select “Add a new hardware device” and click “Next.”

- Select “Install the hardware that I manually select from a list (Advanced)” and click “Next.”
- Select “Network adapters” and click “Next.”
- In the “Network Adapter” list, select “Microsoft Loopback Adapter” and click “Next.”
- Click “Next” again and then “Finish.”
- From the control panel or Start Menu (if present) enter into “Network Connections.”
- Right click the newly created connection and select “Properties.”
- Select “Internet Protocol (TCP/IP)” and click on the Properties button.
- Select “Use the following IP address:”
- For the IP address enter a value of 198.162.0.1. For Subnet mask enter 255.255.255.0 and then click “OK.” Close the Local Area Connection.
- From the Start Menu click “Run…”
- Enter “cmd” (without the quotations).
- The following commands should be entered into a file and saved as a DOS batch file.
- In the command line or batch file enter:

```
NET USE LPT1: /DELETE
NET USE LPT1: \\%COMPUTERNAME%\[printer share name] /PERSISTENT:YES
```

- The first line deletes the old reference to the printer and the second line re-establishes the connection. If the commands are entered into a batch file, save it on the desktop as RELOAD_PRINTER.bat.
- To check if the connection is viable, type in the command line: NET USE.
- If the connection was successful then the response will be that the device is connected; if not, the response will show that it is disconnected.

6.5.1.2 Setup of FALCON™ with Access to Electricity

1. Unpack the detector, accompanying power supply, batteries (2 per unit), and associated cable.
   a. Inspect the FALCON™ unit for any defects or missing parts.
   b. Inspect the power supply for any damaged or frayed cords.
   c. Inspect the batteries for damage, leakage, or corrosion.
2. Place the FALCON™ detector on a hard flat surface or wooden base where you intend to count samples. Situate the FALCON™ so that it is unlikely to get wet or have excessive contact with dirt or other substances that may hinder effectiveness.
3. Place the power supply close to the FALCON™ in a location where it is unlikely to get wet or excessively dirty or be in the line of sight between the detector crystal and the sample.
4. Ensure the power supply is set to the off position.
5. Attach the power supply to the FALCON™ with the gray power cable. This is the only cable that fits in the appropriate holes. See Figure 6.1 below.

Figure 6.1: FALCON 5000™ Power Setup

6. Attach the LAN cable from the FALCON™ to the Tablet computer.
7. If desired, attach mouse, keyboard, and printer to Tablet computer.
8. Plug both the FALCON™ power supply and computer power supply into a power outlet.
9. Turn the FALCON™ power supply on.
10. Turn on the FALCON™ by pressing and holding the black button on the back panel of the FALCON™ near the base.
11. The FALCON™ begins to cool itself electronically while in standby mode. This process may take up to 4 hours.
12. There is a digital display on the top of the FALCON™ on the detector side. See Figure 6.2 below.

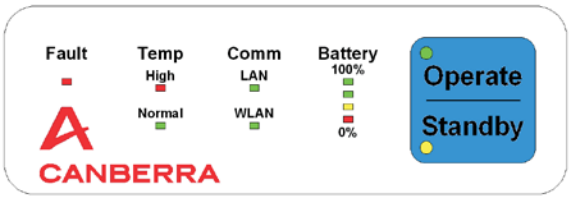


Figure 6.2: FALCON 5000™ Control/Display Panel

13. When the FALCON™ is not ready for use, a red light appears under the Temp High label. When this light is on, the high voltage is locked out and the FALCON™ is unable to operate. When the temperature has fallen to an acceptable range, the red light goes out and a green light under the label Temp Normal lights up.
14. On the same panel as in the previous step, there is a large blue button **STANDBY/OPERATE**. When turning the FALCON™ on, a yellow light is on next to the label **STANDBY**. When the green temperature light is lit, hold the blue **STANDBY/OPERATE** button for about 3 seconds, until the green light next to **OPERATE** turns on.
15. The Green light under **COMM LAN** should be on; if not, check the cable on both ends and make sure the tablet computer is on.
16. Continue to Section 6.5.2, Initializing the High Voltage.

6.5.1.3 Setup of FALCON™ with Batteries

1. Place the FALCON™ detector on a hard flat surface or wooden base where you intend to count samples. Situate the FALCON™ so that it is unlikely to get wet or have excessive contact with dirt or other substances that may hinder effectiveness.
2. Remove the battery panel, which is on the back of the FALCON™ near the top; it is a black panel with four thumb screws. The FALCON™ should look as shown in Figure 6.3.

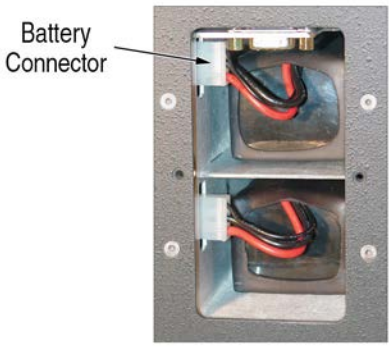


Figure 6.3: FALCON 5000™ Battery ports and connectors

3. Install the two 76 watt-hour batteries, one in each slot by sliding the battery into its slot and plugging in the white clips. Replace the foam behind the batteries so that they do not slide around.
4. Replace the cover and hand tighten the screws (**do not use a screw driver**).
5. Attach the LAN cable from the FALCON™ to the Tablet computer
6. If desired, attach a mouse, keyboard, and printer to the Tablet computer.
7. Turn on the FALCON™ by pressing the black button on the back panel of the FALCON™, near the base.
8. The FALCON™ takes about 4 hours to cool depending on the ambient temperature. The batteries last less than 3 hours. A "hot swap" is required to complete the cool down.
9. On the top of the detector near the front is a white panel. See Figure 6.4 below:

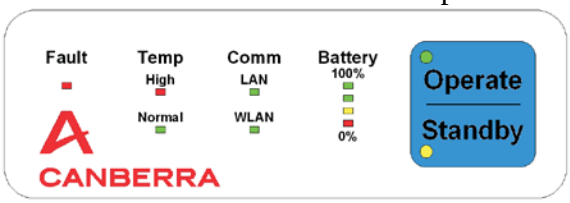


Figure 6.4: FALCON 5000™ Control/Display Panel

10. Watch the battery power level indicator. If the yellow light goes out and the red light comes on, this indicates that the power level in the batteries is less than 25%. Remove the battery cover.
11. To perform a hot swap of the batteries, change out the batteries one at a time. If you remove both batteries, the detector quickly heats back up, and you will have to reinitiate the cooling process.

12. Replace the battery panel and hand tighten the screws.
13. When the FALCON™ is not ready for use, a red light appears under the Temp High label. When this light is on, the high voltage is locked out and the FALCON™ is unable to operate. When the temperature has fallen to an acceptable range, the red light goes out and a green light under the label Temp Normal lights up.
14. On the same panel as in the previous step, there is a large blue button **STANDBY/OPERATE**. When turning the FALCON™ on, a yellow light is on next to the label **STANDBY**. When the green temperature light is lit, hold the blue **STANDBY/OPERATE** button for about 3 seconds, until the green light next to **OPERATE** turns on.
15. The green light under **COMM LAN** should be on; if not, check the cable on both ends and make sure the tablet computer is on.

6.5.2 Initializing the High Voltage

1. At this point, the FALCON™ should be setup and cooled down to the operating temperature. The green light next to the "Operate" label should be lit. If not, repeat the above steps.
2. Open the folder "Genie 2000" on the Windows desktop.
3. Inside the Genie 2000 folder, double click on the "Gamma Acquisition and Analysis" file.
4. Open the detector by going to **FILE**, and then select **OPEN DATA SOURCE**. This opens a new window.
5. Near the center of the window are two radio buttons, file and detector. Click the detector radio button. This will populate a list of detectors that have been installed on this computer.
6. Select the appropriate detector (i.e., FAL03 or FAL05) and then click **OPEN**. If you receive an error indicating that the required hardware is unavailable, a system reboot of the computer and/or the detector may be necessary. If the problem persists, consult the troubleshooting guide.
7. Near the top left of the screen, select **MCA** and then click **ADJUST**. This will open a new window near the bottom of the screen.
8. Near the top of the new screen are several radio buttons. Select the HVPS (High Voltage Power Supply) tab.
9. In the middle left of the window are two buttons under **STATUS**. Select the **ON** radio button. In the top left of this window, a sign that says "Wait" appears. If the detector is not defined on the system refer to the manufacturer's detector sheet for the appropriate voltage to apply.
10. Wait until this sign goes away; it will take between 10 and 30 seconds.
11. Alternatively, you can turn the HVPS on by double-clicking the icon titled **HV ON** under the routine batch files folder on the desktop.
12. Place the QC source on the detector; refer to Section 6.5.3, Quality Control (QC) Check, for instructions on how to place the source.
13. To the left of the black screen in the Genie 2000 window are several buttons: **START**, **STOP**, **EXPAND** and **CLEAR**. Press the **START** button.
14. The FALCON™ begins to acquire and display the spectrum on the screen. If desired, click the **EXPAND** button, which opens a new screen above the main screen that

displays a zoomed-in portion of the spectrum. You can adjust the expanded view by moving the white box that has appeared in the primary screen to move the zoomed section left and right, and you can zoom in and out with the up and down arrow keys.

15. Ensure that the following is true:
    - 1274.53 keV peak is approximately in channel 3480.
    - 86.54 keV peak is approximately in channel 237.
16. If the peaks need adjusting, press **STOP** and then press **CLEAR** and wait about a minute and try again by pressing **START**. If after 3 attempts the peaks do not appear where they should, a gain adjustment may be needed.
17. If the peaks are in their anticipated locations, close this window by clicking the **X** in the top right of the screen. When a pop-up appears asking if you want to save your changes, select **NO**.
18. Continue on to Section 6.5.3, Quality Control (QC) Check.

6.5.3 Quality Control (QC) Check

1. Remove the collimator or cover, if applicable. For ease, place the detector in a "looking up" position before removing collimator.
2. Attach the QC source so that the collar is snugly attached around the detector and the stop is touching the detector face. This places the source about 3 inches from the detector face, as shown in Figure 6.5.

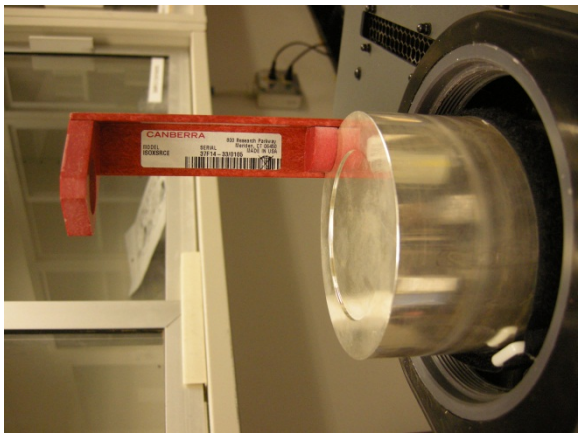


Figure 6.5: Proper Placement of the QC Source

3. On the Windows desktop, double click the "Routine Batch Files" folder.
4. Double click on the icon titled **QC**.
5. As prompted by the batch procedure, enter your user id and click on the **OK** button.
6. Select the designated detector (i.e. FAL03 or FAL05), and click on the **OK** button.
7. The computer prompts you to place the correct source on the detector. Click **OK**.
8. If the error message "Detector not available" appears at this point, check to make sure that the detector is not open in another application window. Also, make sure that the detector is in the "operate" mode and the green LED light is on. If this still does not fix the problem, perform the following steps:
    a. Close the QC program.
    b. Place the detector in standby mode.

   c. Reset the VDM (Virtual Data Manager).
   d. Place the detector in the "Operate" mode.
   e. Restart the HVPS.
   f. Restart the QC program.
9. Next, the batch procedure automatically clears the MCA, acquires a spectrum, and analyzes and performs a peak centroid, efficiency, and FWHM check. The QA values automatically update the FALQC#.QAF (where # is the detector number) file. Should the error "Too few points to perform test" appears, simply click OK and rerun the QC measurement until there are enough points. If there are enough points, the quality assurance report is then sent to the computer screen for review:
   a. Review the spectrum to ensure that the expected peaks are present.
   b. If no parameters are flagged on the report in the sample driven test column (SD), the system is ready for use.
   c. If any of the parameters of the quality assurance report fall in-between 3 to 4 standard deviations of the calculated mean, the parameter(s) are flagged with an "In," and another quality assurance measurement should be performed.
   d. If any of the parameters of the quality assurance report are greater than 4 standard deviations of the calculated mean, the parameter(s) are flagged with an "Ac." If an "Ac" flag occurs, click **END VIEW**, and rerun the QC.
   e. If the second count returns any parameter between 3 to 4 standard deviations of the calculated mean, tag the detector as out of service and investigate the problem. Record the out of service in the instrument logbook. Consult the FAL manager to determine the appropriate action.

6.5.4 Acquiring a Background Spectrum

During a response, radiological conditions (i.e., background) could change drastically from time to time. It is very important to have a spectrum that characterizes the environmental background when performing gamma spectroscopy. A background spectrum must be taken once every 24 hours ***at a minimum.*** If there is reason to believe that the background has changed, it is very important to take a new background measurement.

1. Select the "Routine Batch Files" folder on the desktop.
2. Double click on the **BACKGROUND** icon.
3. Next, a series of pop-ups guides you through the remainder of the analysis. The following steps describe pop-ups and what is expected.
4. The computer prompts you to enter a user id (person performing analysis).
5. You are prompted to select a detector ID (FAL##, where ## is the detector number).
6. A warning message appears prompting you to ensure that the area is clear around the detector. Use your best judgment to ensure that the background will be as close as possible to the environment in which the samples will be counted because the background will be subtracted from the results.
7. Enter the count time in seconds. It is a best practice to attempt to count the background for as long as you expect to count samples. However, if the times do not match for the background and a sample, the Genie™ 2000 algorithms correct for this.
8. Enter the background filename in the following format: BFMMDD##
   B- background, must be in all filenames

F- FALCON™ detector number (ex. If FAL04 is used than F = 4)
MMDD- date of background count; MM is for the month; DD is for the day
- sequential background id number for the day MMDD. Start numbering with 01 and increase by 1 as necessary. Every calendar day, restart the numbering at 01.

9. Wait for the count to finish.
10. When the analysis is complete, the file is saved with the name you provided. During a routine analysis, you can choose this background to be subtracted from a sample spectrum.

6.5.5 Sample Analysis using the FALCON™

1. Place the sample in the appropriate geometry that matches the calibrations on the machine.
2. On the Windows desktop, double click the folder "Routine Batch Files."
3. Double click the **ROUTINE ANALYSIS** icon.
4. Once you get to this point, a series of pop-ups guide you through the remainder of the analysis. The following steps show the pop-ups and explain the response the computer is expecting.
5. The computer prompts you to enter an analyst ID (person performing analysis).
6. You are prompted to select a detector ID, FAL##, where ## is the detector number.
7. Is the sample a standard geometry? (Yes, No or Close)
   a. Select **Yes** if the sample exactly matches the calibrated geometry in matrix, location, and size.
   b. Select **Close** if the sample is similar to the calibrated geometry in matrix, location, or size. Note that this selection will apply a caveat to the analytical report stating that the counting geometry was imprecise and could lead to biases in the results. This option is to only be used when the deviation from the calibrated geometry is minor. For example, if the calibrated geometry is one gallon of water in a Cubitaner counted against the collimator face, but the sample is 0.95 gallons of water in the same container and counted in the same location, the **Close** option should be used.
   c. Select **No** if the sample was not counted in a configuration that was calibrated for or if the sample was not close to the calibration standard. This will lead to a caveat on the report that states that the results are to be used as identification only. Quantification is impossible when the sample was counted in a configuration that was not calibrated for or modeled.
8. Select an Efficiency File (i.e., 2AFOAT3F.CAL). If no calibrated geometry is available, refer to Appendix A of this manual to create an efficiency calibration using iSOCS™. Note that a sample can be counted with a "dummy" calibration file and reanalyzed with the proper mathematical efficiency model at a later time. Table 6.1 describes commonly encountered calibrations that are performed on the FALCON™.

Table 6.1 shows the common calibrations performed on the FALCON™ system.

Table 6.1: Calibration Descriptions

Calibration Name	**Description**
#AF2.CAL	2 inch glass fiber air filter on contact with collimator cover
#SMAR.CAL	500 mL Marinelli beaker with solid equivalent resin stacked on top of collimator cover
#WMAR.CAL	500 mL Marinelli beaker with water equivalent resin stacked on top of collimator cover
#CUB.CAL	1-Liter Cubitainer
#SGLD.CAL	Gladware container with approximately 500 grams of soil counted on contact with the collimator cover with the larger surface facing the detector.
#AFCC.CAL	2 inch face loaded charcoal cartridge counted with the inlet side on contact with the collimator cover.
Suffix	**Description**
AT1FT	Sample was counted exactly 1 foot and on axis with the detector collimator face
AT3FT	Sample was counted exactly 3 feet and on axis with the detector collimator face

NOTE: # denotes the detector number that the calibration applies to.

9. Enter run-count time of analysis. The minimum count time is determined by the FAL manager. This is done using the required critical level which is indicated on the ARF.
10. Select Library (i.e. FRMAC.nlb).
11. Background Subtraction: Select **NO** if a background has not yet been run. If one has not been run yet, the background can be subtracted at a later time.
    a. If a background has been run and analyzed, select **YES**, and a new pop-up prompts you to select the appropriate background from a list.
    b. Choose the background count that most closely characterizes the environmental radiation levels at the time of sample acquisition. If there is any doubt as to what background to use, or if a new background should be run, consult the FAL manager.

NOTE: In most portable count situations, the acquisition time for the background should be set to the same acquisition time as the sample for which the background analyses will be applied. However, the software will make time corrections if the count times differ.

NOTE: In practice, the environmental background is taken prior to sample analysis. While this is possible in most situations, samples may need to be counted prior to the determination of background. This is acceptable if it can be shown that the environmental levels of radiation had not changed between the sample measurement and the background measurement. The sample spectrum must be reanalyzed with the most applicable background. If the detector is moved, a new background must be taken.

Record any detector movements or changes in the radiological environment in the instrument logbook**.**

12. The batch procedure then prompts you to update a number of sample-specific parameters. Using the information on the Analysis Request Form supplied with the samples, update the sample parameters using Table 6.2 as guidance:

Table 6.2: Routine Analysis Required Sample Information

FALCON™ Sample Input Parameters

Analysis Request #	This must match the tracking number on the analysis request form (e.g. ARF-00002)
SCF identification	Enter the Customer's sample number (e.g. SCF-1123)
Event ID	Enter the name of the event
Customer Program ID	Pull down menu (FRMC, EPA, CDC, RAP, FDA, DoD, OTH)
Sample Matrix	Pull Down (Air Filter, Feed, Food, Instrument, Milk, Moving Air Filter, Moving Instrument, Other, Soil Swipe, Vegetation, Water)
Sample Type	Sample, Sample Duplicate, Lab Control Sample, Matrix Spike, Matrix Blank
Sample Description	Sample Description (e.g. Soil sample, air sample, water sample). Briefly describe the sample condition and if applicable, how the measurement differed from the calibrated geometry. (e.g. Cubitaner on contact with ¼ in air gap on top)
Sample Aliquot/Units	Enter desired aliquot along with the associated units. The analysis units must match those indicated on the ARF for the required critical level (Lc).
Sample Date/Time	Sample collection date - all activities will be decay corrected to this date. This value is typically set to the sample collection date/time unless specified differently on the Analysis Request Form. **Format:** mm-dd-yy hh:mm:ss AM or PM **Example**: 12-01-94 12:00:00 PM
Received Date/Time	Enter the time that the sample was received at the FAL
Activity Units	pCi, uCi, dpm, Bq, NSU The analysis units must match those indicated on the ARF for the required critical level (Lc).
Moisture Property	*only applies to soils. If the soil was dried in a laboratory and the mass entered was the dry mass, select **dry**. If the sample was not dried and the wet mass was used as the aliquot, select **wet**. For matrices other than soil, or if no soil mass was used as the aliquot, select **N/A**.

13. After updating the selections, click on the **OK** button, which saves the sample information.
14. Once data acquisition is complete, the spectrum is analyzed and a detailed report is generated along with an output excel file to provide to the customer. The electronic data deliverable (EDD) excel file is located in c:\genie2k\repfiles*.xls, where * is the sample ID assigned from above. Click Print on the displayed report to print out a hardcopy.
15. Carefully review the analysis report for mistakes or problems with the data. Sign and date the "Analyzed by" line on the report.
16. Have the report reviewed a second time by another FAL staff that is trained in gamma spectroscopy.
17. Review the EDD for consistency with the hardcopy report.

Samples that are analyzed by the FAL gamma spectrometer can be reanalyzed with different efficiency files, libraries, backgrounds, etc. at any time.

1. Run the re-analysis procedure by double-clicking the REPLAY icon in the ROUTINE BATCH FILES folder
2. Follow the on-screen prompts and select all of the appropriate calibration files, libraries, backgrounds, etc.
3. Print the report and review it using the same process as the initial report.

6.5.6 Laboratory Control Samples

A laboratory control sample (LCS) must be run as a quality control with each batch of samples. A batch must be less than or equal to 20 samples including any QC samples. The LCS is used to track instrument performance and help ensure data quality. An LCS must be run on each detector that is used to count samples of the same QC batch. For example, if ten samples are batched together and two detectors are used, then there must be one LCS for each detector within the batch. The Fly Away Laboratory uses the FALCON™ QC source as the gamma spectroscopy laboratory control sample.

1. Obtain the FALCON™ QC source.
2. Place the source on the detector, as seen in Section 6.5.3, Quality Control (QC) Check.
3. On the Windows desktop, double click the folder "Routine Batch Files."
4. Double click the **LCS** icon.
5. Once you get to this point, a series of pop-ups guide you through the remainder of the analysis. The following steps explain the response the computer is expecting.
6. The computer prompts you to enter an analyst ID (person performing analysis).
7. You are then prompted to select a detector ID, FAL##, where ## is the detector number.
8. You are prompted to select a background spectrum that is to be subtracted from the LCS count. Choose the background spectrum that most closely characterizes the radiation background of the LCS count that is being done. The appropriate spectrum is usually but not always the background counted last (i.e., the background with a time-stamp nearest to the acquisition time of the LCS). Consult the FAL manager if there is any doubt as to what background to choose.
9. A window appears that prompts you to input the sample information:
   a. Input the ARF number that corresponds to the samples that the LCS applies to.
   b. For "SCF Identification," enter a unique identifier with the following format: LCS-MMDDYY-##, where *MMDDYY* is the date and ## is a sequence starting with 01, 02, … that denotes the LCS number run that day. Consult the FAL manager if you do not know how many LCS's have been run that day.
10. Enter the Event ID.
11. In the sample type field, choose **LAB CONTROL SAMPLE**.
12. For sample date/time, check that the value matches the date/time of the count that determined the LCS's activity. If you do not know this date/time, consult the instrument logbook or the FAL manager.
13. Leave the rest of the parameters as the defaults.

14. Click **OK**.
15. The program acquires a spectrum and then transfers the results to the QA engine, which generates a report. Print, review, and sign the report and submit it to the FAL QA staff, who will review the data and submit the LCS with the appropriate group of samples.
16. Confirm that all QA checks have passed by inspecting the QA report.
    a. If no parameters are flagged in the user driven (UD) test column, the system is ready for use.
    b. If any of the parameters of the quality assurance report are outside of +/- 25% of the measured LCS activity, confirm that the source was placed on the detector correctly and rerun the LCS.
    c. If the second count returns any parameter outside +/- 25%, tag the detector as out of service and investigate the problem. Record this out of service tag in the instrument logbook. Consult the FAL manager to determine the appropriate action.
17. If the QA checks pass, print the report, date, and initial it. Submit this with the LCS data package to the FAL Manager. Also, review and sign/date the LCS analysis report. Be sure to give the report to a second reviewer so that there are two signatures on the report before it is submitted to the customer.

6.6 Non-Routine Operations

6.6.1 Calibration

6.6.1.1 Certificate Creation

Certificate creation can be performed by several methods in Genie™. The following presents the recommended method. It is acceptable for an experienced user of Genie™ to use short-cuts. Genie™ references a user selected certificate as a reference point to determine the energy dependent efficiencies.

1. With the assistance of the FAL Laboratory Manager, select an appropriate NIST Traceable source for a calibration. Each source comes with a certificate declaring the radionuclides in the source, their activity, and reference date.
2. If necessary, open the “Genie 2000” program group by double clicking the icon.
3. Double click on the icon titled **CERTIFICATE FILE EDITOR.**
4. At the top third of the Certificate File Editor screen are entry fields for Title, Quantity, and Assay Date. Edit the Title information to include source manufacturer, source geometry, and manufacturer’s source number. Enter “1” in the sample Quantity field. Edit the Assay Date to reflect the date and time of source fabrication.

NOTE: The Assay Date is used for decay correction during efficiency calibrations. Enter the Assay Date in the format mm-dd-yy hh:mm:ss AM or PM. **(Example:** 03-01-99 12:00:00 PM.)

5. In the center of the screen are the fields Nuclide, Half-Life, Energy, Half-Life Uncertainty, Emission Rate and Emission Rate Uncertainty. Be sure the appropriate radio button is selected for the Half-Life units.

NOTE: You are allowed only one line per nuclide. If more than one line is being used for the calibration, you need to enter the nuclide twice, such as 1173 KeV and 1332 KeV for Co-60.

6. Check all entries against the original source certificate for accuracy and correctness. Due to the tedious nature of certificate creation and the need for high accuracy, also have another FAL member check the entries.
7. Select the **SAVE AS** command from the Certificate File Editor File menu. In the **FILE NAME** field, enter the manufacturer source number with the extension CTF. In the **DESCRIPTION** field, enter the source geometry.
8. Click on the **OK** button to save the certificate file. The certificate file is saved in directory C:\genie2k\camfiles with the manufacturer source number for file name and with the extension "CTF."

6.6.1.2 Initial Energy Calibration

An initial energy calibration is recommended ONLY when setting up a new instrument or after receiving an instrument from the manufacturer following any repairs. The point of the initial energy calibration is to align the peaks to their correct channel based on 3000keV at channel 8192.

1. The following points are suggested values to use:

Table 6.3: Suggested Calibration Values

Nuclide	Energy(keV)	Channel
Am241	59.9	163
Cs137	661.2	1809
Co60	1173.2	3203
Co60	1332.5	3638

2. To determine the correct channel for the source being used or desired energies, a simple ratio can be applied by dividing the 8192 ch/3000 keV.
3. Take each energy peak in keV and multiply by the ratio. Round to the nearest whole number to obtain the channel. Note these channels and energies for later use.
4. Open the gamma acquisition and analysis window.
5. From the File menu select **OPEN DATASOURCE…**
6. Select the Falcon unit.
7. If any spectrum counters are present, clear the spectrum.
8. From the Calibrate menu, select **ENERGY ONLY CALIBRATION…**
9. Enter the energy and channel, and then click **ACCEPT** for each peak.
10. Delete the peaks if necessary by selecting the peak and click **DELETE**.
11. After entering all peaks, click the **SHOW…** button.

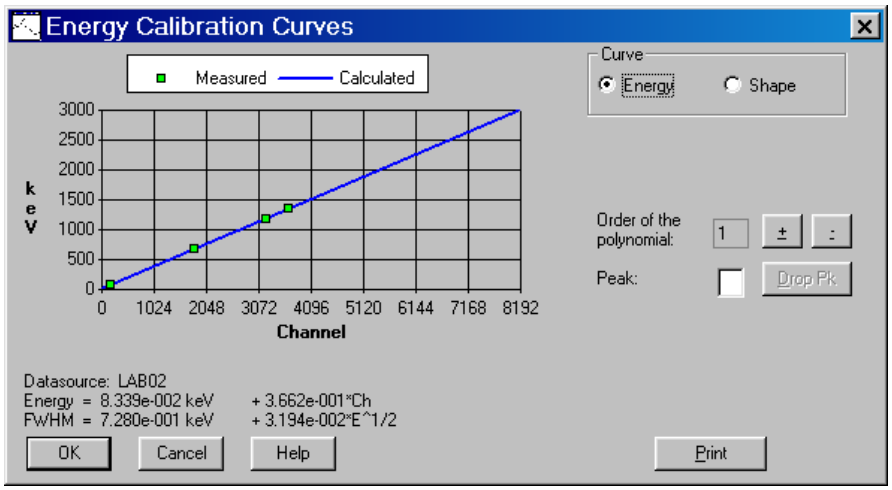


Figure 6.6: Energy Calibration Curves Window Showing Peaks

12. The peaks are represented as green squares. They should all line up on the blue line.
13. Select **SHAPE** to view the shape curve. This curve should be hyperbolic (square root (y=√x) shape).

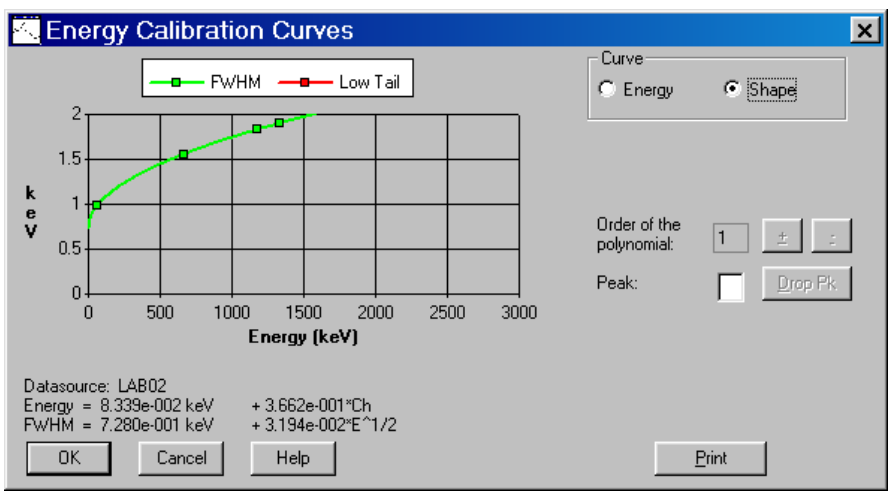


Figure 6.7: Energy Calibration Curves Window Showing the Shape Curve

14. Each square should line on the curve or close to it.
15. After verifying the points, click **OK** to exit out of the curves.
16. When complete, click **OK** to complete the energy calibration.
17. Place a source on the detector face. The following steps assume that an Am241, Cs137, and Co60 source is being used. Make the necessary adjustments for different sources.
18. Adjust the present time to at least 1000 seconds. If the deadtime of the detector is >10% you will need to move the source further away from the detector.
19. Click on MCA menu.
20. Select **ACQUIRE SETUP.**
21. Ensure that seconds is selected.

22. Enter 1000.
23. Select **OK** to exit.
24. Click **START** under the Acquire to being counting.
25. Adjust the ADC zero, amplifier gain, and fine gain until the 59.5 keV line from Am-241 and 1332.5 keV line from Co-60 are approximately at the desired channels (**Example:** Channel 162 and Channel 3639, respectively, for a 3000 keV/8192 channel relationship).

NOTE: Use the Clear button to erase spectral data after adjustment of the amplifier gain and fine gain.

26. Adjust the ADC Lower Level Discriminator (LLD) setting so that the channels representing the first 5 keV and 35 keV are clear for an n-type and p-type germanium detector, respectively.
27. When adjustments have been made, stop the count by clicking **STOP**.
28. Exit out the gamma acquisition and analysis window. When prompted by the software, select that you wish to save the changes.
29. Record this calibration in the instrument logbook and proceed to Section 6.6.1.3, Energy and Shape (FWHM) Calibration.

6.6.1.3 Energy and Shape (FWHM) Calibration

1. The following steps require radioactive sources that are not available in the FAL load out. This procedure cannot be performed in the field unless a proper source is available. When performing the calibration, the deadtime of the detector should be kept below 10%. To decrease the deadtime you will need to move the source further away from the detector.
2. If necessary, open the "Non-Routine Batch Procedures" folder by double clicking on the icon. It is important that at this time the system perform a viable QC.
3. To start the ENERGY.REX batch procedure, double click on the icon titled **ENERGY & SHAPE CALIBRATION**.
4. A reminder that an initial calibration is needed is displayed. If an initial calibration has been performed, click on the **CONTINUE** button; otherwise, click on the **CANCEL** button to terminate the batch file and perform an initial calibration.
5. As prompted by the batch procedure, enter your name or initials and click on the **OK** button.
6. Enter the Detector ID and click on the **OK** button.
7. Select the appropriate detector and click on the **OK** button.
8. Select the certificate file corresponding to the mixed-nuclide source to be used for the energy calibration and click on the **OK** button. The source used for the QC can be used for this step. *If source certificate(s) are not on the laptop consult the FAL Manager.*
9. Enter the acquisition live time in seconds and click on the **OK** button.

NOTE: If this is the first energy calibration after the initial calibration a prompt may appear that mentions a questionable calibration. Select "yes" and continue the procedure.

NOTE: The acquisition live time should be set to ensure that most of the source peaks have an area of at least 10,000 counts.

10. As directed by the batch procedure, place the appropriate source on the detector and click on the **OK** button. Next, the batch procedure clears the MCA, acquires a spectrum for the entered live time, performs an energy calibration, and displays the energy calibration curve.
11. Evaluate the energy calibration curve for the desired energy per channel relationship.
12. Evaluate the energy and shape calibration curves for outliers and drop peaks as necessary. By removing outliers, the calibration curves are re-generated until satisfactory results are obtained.
13. It is recommended to not remove outliers that are at the lowest and highest end of the energy spectrum. Once outliers are moved they cannot be retrieved. To remove outliers:
    a. Count the green data points from the left to the right.
    b. Enter the number of the peak you wish to drop in the small dialog box labeled "Peak:"
    c. Click **DROP PK** to drop the peak from the calibration.
    d. Repeat this process for all outliers.
14. When complete and if a printer is available, click on the **PRINT** button to obtain a hard copy of the energy and shape calibration curves. Click on the available radio button to toggle between energy and shape curves.
15. Click on the **OK** button to terminate the "Energy Calibration Curve" screen.
16. The spectrum is saved as C:\genie2k\calfiles\E#YYMMDD.cal, where # is the detector number and *YYMMDD* is the year, month, and day the calibration is performed.
17. Next, peak search and energy calibration reports are displayed on the computer screen. If available, click on the **PRINT** button to obtain hard copies of the reports.
18. Finally, the energy calibration information is saved to the open detector, and the batch file is terminated.
19. Click "no" when prompted to save changes. The file has already been saved.
20. Obtain a copy of the Portable Gamma Spectroscopy Calibration checklist and approval form from in Appendix B.
21. Obtain the Peak Analysis Report:
    a. Open Gamma Acquisition and Analysis, select **FILE,** then **OPEN DATASOURCE**
    b. Navigate to C:\genie2k\calfiles\E#YYMMDD.cal, where E#YYMMDD.cal is the energy calibration file that was saved.
    c. In the GAA window, click **ANALYZE** from the top menu.
    d. Hover cursor over **EXECUTE SEQUENCE.**
    e. Click **PEAK ANALYSIS W/REPORT**.
    f. Next, click **FILE => PRINT REPORT WINDOW**.
22. Fill out the form and attach the supporting documents on the checklist. Retain this paperwork for filing with the efficiency calibration packages.
23. Record this calibration in the instrument logbook.

6.6.1.4 Efficiency Calibration

1. Run the daily quality control check prior to performing the efficiency calibration to ensure that the detector is functioning properly.
2. Make sure a background has been taken in the same orientation that the detector is in to ensure that there will be no interfering lines with the calibration.

3. Obtain a mixed-nuclide standard in the geometry of interest. Do not use the source used for QC (unless this is an LCS calibration). If necessary, create a certificate file as described in the Section 6.6.1.1, Certificate Creation.
4. If necessary, open the "GENIE 2000 Non-Routine Batch Procedures" by double clicking on the icon.
5. To start the EFFCAL.REX batch procedure, double click on the icon titled **EFFICIENCY CALIBRATION**. (This will turn on the detector high voltage.)
6. As prompted by the batch procedure, enter your name or initials and click on the **OK** button.
7. Enter the Lab ID and click on **OK**.
8. Select the appropriate detector and click on the **OK** button.
9. Select the certificate file corresponding to the mixed-nuclide source to be used for the efficiency calibration and click on the **OK** button.
10. Select the Sample Geometry name from the pull down menu and click on the **OK** button.
11. Enter the acquisition live time in seconds and click on the **OK** button.

NOTE: The acquisition live time should be set to ensure that most of the source peaks have an area of at least 10,000 counts.

12. As directed by the batch procedure, place the appropriate source on the detector and click on the **OK** button. Next, the batch procedure clears the MCA, acquires a spectrum for the entered live time, saves the spectrum as the appropriate geometry file (e.g., 3AF2.cal for 2 inch glass fiber air filter on contact with detector), performs peak locate and peak area analyses on the saved file, and displays the peak search results.
13. Evaluate the peak search results to ensure the correct location of the peaks and that most peaks have good statistics (>10,000 counts). Click on the **PRINT** button to obtain a hard copy of the peak locate report.
14. Next, the "Efficiency Calibration" curve is displayed on the computer screen.
15. Evaluate the efficiency calibration curve for outliers and drop peaks as necessary. By removing outliers, the calibration curve is regenerated until satisfactory results are obtained.
16. When complete, click on the **PRINT** button to obtain a hard copy of the efficiency calibration curve. Print both the linear and log-scale plots.
17. Click on the **OK** button to terminate the efficiency calibration curve screen.

NOTE: A copy of the calibration file is archived in directory C:\genie2k\calfiles as F#YYMMDD.geomname, where # is the detector number, *YYMMDD* is the year, month, and day the calibration is performed, and the extension "geomname" is the sample geometry name (e.g., AF2).

18. Next, the efficiency calibration report is displayed on the computer screen. If a printer is available, click on the **PRINT** button to obtain a hard copy of the report.
19. Review the report for consistency, completeness, and correctness.
20. Count an identical source (preferably a different source than the one used for calibration if possible) using the routine analysis procedure. Verify (at a minimum) that Am-241, Cs-137, and Co-60 values match the certified values to within +/- 20%. Retain the analysis report and the bias calculations for the calibration package.

21. Obtain a copy of Gamma Spectroscopy Efficiency Calibration checklist and approval form from Appendix B.
22. Fill out the form and attach the supporting documents according to the checklist. Next, sign the "Reviewed By" line and have the FAL Manager or designee approve the form.
23. File the efficiency calibration package in accordance with FRMAC processes.
24. Record each calibration in the instrument logbook.

6.6.2 Initial Setup from Factory (New FALCON™ Unit)

This section describes how to connect and set up the FALCO™N 5000 portable gamma spectrometer. **The section should only be used if it is the initial setup of the detector or the detector was sent back to the factory and everything needs to be reinstalled.**

6.6.2.1 Required Equipment

- FALCON™ 5000 portable High Purity Germanium Detector with integrated InSpector
- Laptop computer with Windows, 2000, or XP
- HyperTerminal program
- RS232(serial) cable
- Virtual RS232 port via USB if applicable
- Radioactive Source (mixed gamma) and holding jig issued by Canberra
- External DC Power Package
- Lithium-ion batteries
- Tungsten Collimator
- Genie™ 2000 Software

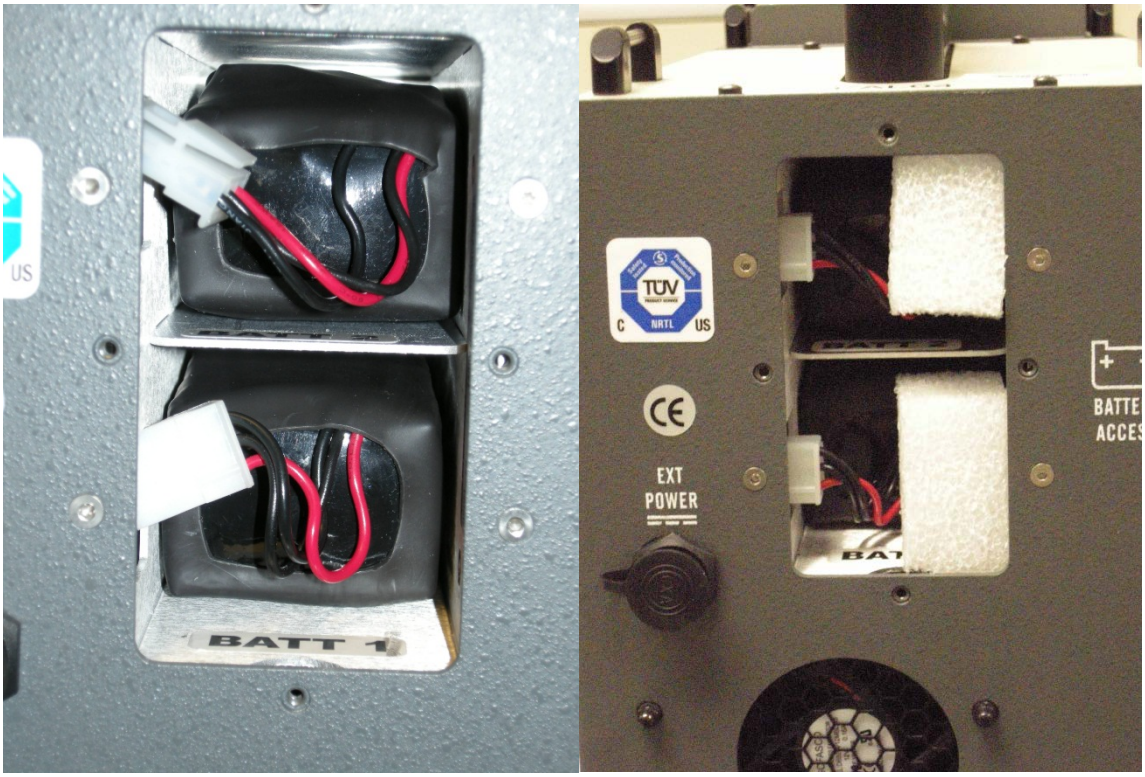
6.6.2.2 PPE Requirement

None

6.6.2.3 Setup Procedure

1. Unpack the detector, the accompanying power supply, batteries (2 per unit), and associated cables.
2. Inspect the FALCON™ unit for any defects, missing parts, and the protective detector cap.
3. Inspect the power supply for any damage or frayed cords.
4. Inspect the batteries for damage, leakage, or corrosion.
5. If anything is damaged or out of place, contact the manufacturer's service representative to report any damage.
6. Assign a name to the detector (FAL##, where ## is a number).
7. Place a label with the assigned name on the detector.
8. Remove the battery compartment screws on the back of the FALCON™.
9. Install the batteries such that each battery slides easily into each battery compartment. If there is any resistance in sliding the battery, remove the battery and re-adjust the orientation of the batteries. The electrical connection of the battery should extend toward the back of the FALCON™.

10. Connect the battery's electrical connection to the left side of the unit located inside the battery compartment. The release clip on the connector should point toward the front of the unit.
11. The batteries are shipped with two rectangular pieces of foam, one per battery. Install the foam on the right side of the electrical connection. As seen in Figure 6.8, the battery wire should not contact the right side of the battery compartment.



INCORRECT ***CORRECT***

Figure 6.8: Placement of Foam Spacers to Avoid Damage to Connector

12. Place the battery compartment cover back into place. Hand-tighten all four bolts.
13. Connect external power supply to the FALCON™ unit**.**
14. Remove protective end cap and screw on collimator.
15. Switch the power switch to the on position on the power supply.
16. Press and hold the power button on the FALCON™, until the power LED on top of the unit is on.
17. Each unit requires up to **4 hours** to reach normal operating temperature depending on the initial conditions in the room.
18. When the cryostat reaches the desired temperature, the temperature light indicates **NORMAL**. If after 6 hours the temperature light does not indicate normal, this may be a failure of the cryostat mechanism. Report this to the FAL manager.

6.6.2.4 Establishing the Local Area Network (LAN)

Every FALCON™ (from the manufacturer) is set up with the wireless LAN enabled. If the unit is purchased with a tablet computer, the computer also has the "WIFI" enabled. In both

instances, the "WIFI" needs to be disabled. While disabling the WIFI, the wired LAN has to be enabled to allow communication with the computer.

NOTE: Performing the following steps to disable the WIFI requires a computer with a serial port or a computer with a serial port adapter. The computer should have the Windows XP operating system. Windows XP is the last operating system to have HyperTerminal.

1. If a USB to Serial adaptor is being used the computer port must be setup prior to connection. If a normal serial cable is being used, skip to step 8.
2. Connect the serial adapter to a USB port on the computer.
3. Right click on My Computer and select Manage.
4. Click on Device Manager.
5. Scroll down to Ports, right click, and select Scan for Hardware.
6. Insert the USB to Serial adapter driver CD and follow the prompt to install the driver.
7. Take note of the port name that the computer assigns the new hardware (i.e. COM4), this will be the port that you must assign the HyperTerminal connection to.
8. If applicable, shutdown the FALCON™ unit by pressing and holding the off button on the FALCON™ unit.
9. The top of the FALCON™ unit has a LED display that shows the status of the unit. Remove the four hex socket heads that hold down the LED display.

CAUTION: Do not perform these steps while the unit is powered up. This may lead to an electric shock or damage to the unit.

NOTE: Do not pull hard on the LED display cover as it is attached by wires.

10. Slightly lift the display cover. Inside is a ribbon cable with the RS232 female connection. Pull out the cable, being careful not to pull the RS232 from the unit, but enough to allow access to the port (Figure 6.9).

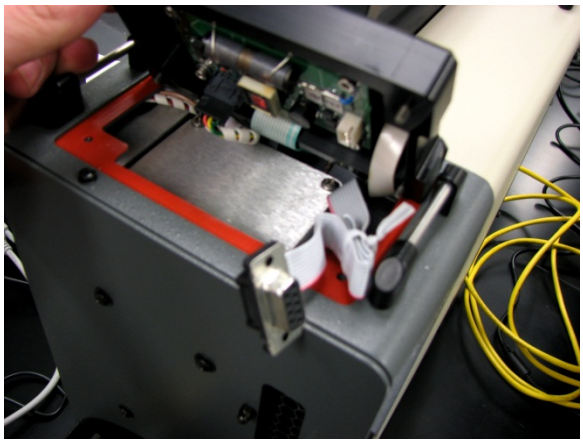


Figure 6.9: Access to the RS232 Port underneath the Display/Control Panel

11. Attach the RS232 cable to the FALCON™, and then attach it to the computer's serial cable.

12. Open the HyperTerminal program located in the Windows startup menu (**All Programs > Accessories > Communications**).
13. The HyperTerminal program prompts for the new connection name. Enter "FALCON."
14. Select the communications port (it will mostly likely be COM1, but it may also be whatever the program selects as the default COM port). Enter the following communication properties:
    - Baud rate: 57600 bits per second
    - Data bits: 8 data bits
    - No Parity
    - 2 stop bits
    - No flow control.
15. Now that the HyperTerminal is setup, hold down the **W** key and at the same time power up the FALCON™ via the push button. Hold both the **W** key and the power button until all the lights are lit on the LED display cover. Release the power button and then the **W** key.
16. Once the connection is established, not only with all the LEDs be lit, but the HyperTerminal displays the following (Figure 6.10):

```
Change Setup:
  0 Server
  1 Channel 1
  2 Channel 2
  3 E-mail
  4 WLAN
  5 Expert
  6 Security
  7 Defaults
  8 Exit without save
  9 Save and exit            Your choice ? 0

Network mode: 0=Wired Only, 1=Wireless Only, 2=Bridging(One Host) (1) ? 0

IP Address : (192) .(000) .(000) .(100)
Set Gateway IP Address (N) ?
Netmask: Number of Bits for Host Part (0=default) (0)
Change telnet config password (N) ?
```

Figure 6.10: Example of the HyperTerminal

17. Press **0 SERVER**.
18. Press **0** again to shift to "Wired only."
19. If not already set, set the IP address of 192.0.0.###, where ### is the three-digit detector ID number (e.g., FAL03 would have an IP address of 192.0.0.003).
20. Set the net mask as 255.255.255.0, and the default 'No' to change telnet config password.
21. Press **9** to save and exit.
22. Power off the FALCON™ unit, and remove the serial cable from the computer and the FALCON™ unit.
23. Tuck the FALCON™'s serial cable back into its case and screw down each hex head bolt.

24. HyperTerminal may be closed out. Connect the LAN cable to the units LAN connection, as well as to the computer. If the computer is already connected to a network, a network switch or router needs to be obtained. If connecting to a switch or router the I.P. address in the FALCON™ may need to be changed to conform to the network gateway.

NOTE: Contact the computer's system administrator to setup the network connections if the computer is having trouble communicating with the FALCON™.

6.6.2.5 Software Installation

1. Consult the FAL Manager or designee before installation to verify the correct versions of all installation software (i.e., Genie™ 2000).

NOTE: There may be computers where CD-ROM installation is not available; consult the FAL Manager.

2. Insert the Genie™ 2000 Basic Spectroscopy CD in the CD-ROM in the computer.
3. Click on the Windows Start menu.
4. Select **RUN**.
5. Type in the drive letter followed by the colon symbol (e.g., d:).
6. Click on **SETUP.EXE**. This loads the Genie™ 2000 menu.

Sentinel Driver Installation

NOTE: The Sentinel Drivers come with Genie™ 2000 starting with version 3.2.

1. Select Install/Update Sentinel Driver.
2. Follow the setup and accept the defaults.
3. For setup type, select **COMPLETE**.

Genie 2000 Basic Spectroscopy Installation

1. Select **INSTALL GENIE™ 2000**.
2. Select the default language.
3. Select **INSTALL GENIE™ 2000 S504 INSPECTOR BASIC SPECTROSCOPY** for the install type.
4. Accept the terms of the license.
5. Installation prompts to verify installation to destination folder of c:\genie2k. Click **NEXT**.
6. Install the Genie™ 2000 documentation and click **NEXT**.
7. Verify correct setup and click **NEXT**.
8. Select **STANDARD** install and click **NEXT**.

SNAP Driver Installation

1. Do not exit out of the CD-ROM. Open the following directory: d:\Bin\G2KVx.x.x\XP_Vista, where *x.x.x* is the version number. Verify that the aimsnap5.inf file is present.
2. The CD-ROM may be closed out.

3. Click on the Start Menu.
4. Go to My Network Places. If it is not located in the Start Menu, it is in the control panel.
5. On the left side of the My Network Places screen, click on **VIEW NETWORK CONNECTIONS**.
6. Right click on **LOCAL AREA CONNECTION**. Select any connection to edit.
7. Select **PROPERTIES**.
8. Select **INTERNET PROTOCOL (TCP/IP)**.
9. Click **INSTALL**.
10. Select **PROTOCOL** and then **ADD**.
11. Click on **HAVE DISK**.
12. Select **BROWSE**.
13. On the Locate File dialog box under Look in, find the CD-ROM drive.
14. Locate the aimsnap5.inf located on the CD-ROM under the directory above.
15. Select the aimsnap5.inf and then **OPEN**.
16. On the Install from disk dialog, click **OK**.
17. Click **OK** for the Canberra NDIS 5.0 SNAP Protocol Driver Vx.x, where *x.x* is the version number of the SNAP driver.
18. Close out all the windows and restart the computer.

Gamma Analysis Software Installation

1. Remove the Basic Spectroscopy CD and insert the Gamma Analysis Software
2. Click on the Windows Start menu.
3. Select **RUN**.
4. Type in "d:" without the quotation marks if d: is the drive letter for the CD-ROM drive.
5. Click on **SETUP.EXE**.
6. Select **ENGLISH** and then accept the licensing agreement.
7. The program loads a series of applications in the directory "c:\Documents and Settings\All Users\Start Menu\Programs\Genie-2000."
8. Press the **DIRECTORY** button (it looks like a folder with an arrow coming out of it).
9. Right click the Genie 2000 folder and copy.
10. Close out all windows.
11. On the desktop, right click and select paste. This action pastes a copy of the Genie 2000 folder.
12. Open the folder and verify that the icons for applications are in the Genie 2000 folder.

Interactive Peak Fit Software Installation

NOTE: Interactive Peak Fit Version 1.3.1 is the first version of software contained on a CD. All previous versions are contained on a 3.5" floppy disk. If the version of Interactive Peak fit is on a floppy disk, open up the setup.exe from the a: drive.

1. Remove the Gamma Analysis Software CD and insert the Interactive Peak Fit CD.
2. Open the CD by the same method as the other two CDs.
3. Start the setup.exe file.
4. Select **ENGLISH** and accept the licensing agreement.

5. The Interactive Peak fit will install and then close out of all windows.

Batch Programming Support Installation

1. Remove the Interactive Peak Fit CD and insert the Batch Programming Support CD.
2. Open the CD by the same method as the initial two CDs.
3. Start the setup.exe.
4. Select **ENGLISH** and accept the licensing agreement.
5. Select the default install location.
6. The Batch Programming Support will install, and then the program will request to restart the computer.
7. Restart the computer.

Quality Assurance Installation

NOTE: Insert the USB thumb drive to a port on the computer.

1. Open the disk in the same manner as the CDs except instead of a "d:" drive substitute with the name of the USB drive. (i.e., "e:/").
2. Click on the setup.exe file and select the defaults.
3. The directory "c:\Documents and Settings\All Users\Start Menu\Programs\Genie-2000" is displayed.
4. Right click on the Quality Assurance Editor and copy the icon.
5. Open the Genie2k folder on the desktop and paste the icon in the Genie2k folder.
6. Select **ENGLISH** and then accept the licensing agreement.

Falcon5000 software Installation

1. Insert the Falcon5000 (S513) Installation disc.
2. Open the disc and run the setup.exe file.
3. Follow the on-screen instructions and agree to all of the defaults.

6.6.2.6 SETUP OF Multi-Channel Analyzer Input Definition (MID) File

The MID file describes the detector and its detector's parameters.

1. Open the Genie2000 folder on the desktop.
2. Start the MCA Input Definition Editor. If you receive an "ICP node connect" error, uninstall **GENIE™ 2000 S504 INSPECTOR BASIC** and **Gamma Analysis,** then reinstall.
3. On the menu bar, click on **FILE**.
4. Select **NEW**.
5. On the menu bar, click **EDIT**.
6. Select **ADD MCA**.
7. Under the Network MCA's, select **FALCON™ 5000 USING I2K-F5K**.
8. Click on **ADD**.

9. On the menu bar, click **DEVICES**. For the following parameters under device, select:

Table 6.4: FALCON 5000™ MCA Input Definition (MID) Settings Part 1

MCA	
MCA Full Memory	8k
No of ADCs	1
Acq. Mode	PHA
IP Address	192.0.0.### (where ### is the 3-digit detector number. Ex. FAL03 would have an IP Address of 192.0.0.003)
Stabilizer	
Device Driver	I2K D-Stab
Control	Programmable
Internal	MCA
Power Management	
Device Driver	I2K Power
Control	Programmable
Internal	MCA
DSP Gain	
Device Driver	I2K Gain
Control	Programmable
Internal	MCA
DSP Filter	
Device Driver	I2K Filter
Control	Programmable
Internal	MCA

10. On the menu bar, click **SETTINGS**. For the following parameters under setting, select:

Table 6.5: FALCON 5000™ MCA Input Definition (MID) Settings Part 2

MCA	
None	
Stabilizer (defaults)	
Gain Centroid	7680 ch
Gain window	8 chs
Gain Spacing	64chs
Gain ratio	1.000
Gain rate div	1
Correction rng	Ge
High Voltage	
Range	Above the voltage if positive Below the voltage if negative Must encompass the voltage setting
Voltage Limit	Set slightly beyond the Voltage
Voltage (established at factory)	Voltage setting is located on the falcon and support box. Consult the detector manual to obtain the operating voltage.
Inh signal	Positive
Power Management	
Standby delay	100min
DSP Gain	
Gain Attenuator	Off
FDisc Mode	Auto
LLD Mode	Manual
Fine Gain	1.4001x*
S-fine gain	0.99999%*
Course gain	X40*
FDisc Setting	1.0%
LLD	0.1%*
Inp. Polarity	Negative
Inh. Polarity	Positive
DSP Filter (default settings)	
Rise Time	5.6
BLR mode	Auto
Preamp type	RC
Flat Top	0.8
FDisc shaping	Normal
Input	
Input Name	FALNN (NN is the detector number, ie 03)
DetectorType	Gamma or X Ray – Ge
Input Size (Channels)	8192

** most likely to change during initial setup*

11. Save as FALNN, where *NN* is the detector number.
12. Load the database after closing the MID file or the editor.
13. Reopen the MCA Input Definition Editor if necessary.
14. Click on **DATABASE**.
15. Click on **LOAD TO**.
16. Select the newly created MID file and click **LOAD**.
17. Click **DONE**.
18. Close the MCA Input Editor.

6.6.2.7 Setup of the Quality Control QAF File

The QAF file should only be setup if it is the initial setup of the detector or if the QAF file needs to be recreated. The QAF stores quality data about each QC performed as well the QC parameters. The following steps assume the iSOCS™ characterization source issued by Canberra is used. If other sources are used, the names of each isotope and the energy lines should be changed to match the source. The QC.NLB will have to be changed to account for the energy lines described below (Tables 6.6, 6.7, and 6.8).

1. Open the Quality Assurance Editor.

NOTE: If an error appears that reads "Add-Defs menu creation error: "2", you must reinstall the quality assurance editor.

2. Select **FILE** on the menu bar select "new".
3. Select **ADD-DEFS** on the menu bar. If a "menu creation error: '2'" is displayed, the quality assurance software must be uninstalled and reinstalled.
4. Select **PEAK SEARCH, PEAK CENTROID**.

Table 6.6: QC QAF File Settings Part 1

Description	**CNTRD 87 keV**	**CNTRD 105 keV**	**CNTRD 1274 keV**
Name (analysis type)	PSCENTRD	PSCENTRD	PSCENTRD
Store Error	checked	checked	checked
Energy Line	86.54	105.31	1274.53
Conv. Factor	1.00	1.00	1.00
Units:	Ch	Ch	Ch
N-Sigma Tests Investigate (sigma)	3.00	3.00	3.00
N-Sigma Tests Action (sigma)	4.00	4.00	4.00
Sample Driven Test	Checked	Checked	Checked

5. Select **OK** to close out parameter window.
6. Select **ADD-DEFS** on the menu bar.
7. Select **PEAK SEARCH, PEAK FWHM**.

Table 6.7: QC QAF File Settings Part 2

Description	FWHM 87 keV	FWHM 105 keV	FWHM 1274 keV
Name (analysis type)	PSFWHM	PSFWHM	PSFWHM
Store Error	checked	checked	checked
Energy Line	86.54	105.31	1274.53
Conv. Factor	1.00	1.00	1.00
Units:	keV	keV	keV
N-Sigma Tests Investigate (sigma)	3.00	3.00	3.00
N-Sigma Tests Action (sigma)	4.00	4.00	4.00
Sample Driven Test	Checked	Checked	Checked

8. Select **OK** to close out parameter window.
9. Select **ADD-DEFS** on the menu bar.
10. Select **ENERGY LINE, DECAY CORRECTED ACTIVITY**.

Table 6.8 QC QAF File Settings Part 3

Description	DCA 87 keV	DCA 105 keV	DCA 1274 keV
Name (analysis type)	NLACTVTY	NLACTVTY	NLACTVTY
Store Error	checked	checked	checked
Nuclide	Eu-155	Eu-155	Na-22
Energy Line	86.54	105.31	1274.53
Conv. Factor	1	1	1
Units:	DCA	DCA	DCA
N-Sigma Tests Investigate (sigma)	3.00	3.00	3.00
N-Sigma Tests Action (sigma)	4.00	4.00	4.00
Sample Driven Test	Checked	Checked	Checked

11. Save the file as falqc#.qaf, where # is the detector number.

6.6.2.8 Setup of the Quality Control Nuclide Library (QC.NLB) File

The following steps assume the iSOCS™ characterization source issued by Canberra is used. The same QC.nlb file may be used for other sources containing the same nuclide. Likewise, the same QC.nlb file may be used on other computers; thus, the QC.nlb can be copied, avoiding this portion of the procedure. Using different mixed sources does not negate the steps in this portion of the procedure. The same steps may be used to accomplish the same goal with different mixed sources.

1. Open the Genie2k folder on the desktop.
2. Start the Nuclide Library Editor.
3. On the menu bar, click on **OPTIONS**.
4. Select **EXTRACT**.
5. The Extract Library Nuclides dialog box appears.

6. Click on **OPEN**. An Open Library dialog box appears, and there is list of NLB files displayed in the dialog box. All used NLB files are stored on the local computer in the c:\genie2k\camfiles directory.
7. Starting with Eu-155, select the E_G.NLB, where *E_G* is the list of nuclides beginning with E and ending with G.
8. Click on **SELECT**.
9. Select the nuclide you wish to add (Na-22)
10. Press **OK**.
11. Repeat the above steps to add all the nuclides you need to the library.

NOTE: The following steps must be performed after all of the Necessary Files have been installed (see Section 6.6.2.10, Necessary Files).

12. Open C:/Genie2k/EXEFILES/frmc_qc.rex.
13. Scroll down to the "Hard Coded Source Information" section.
14. Change the source name so that it matches the identifying number on the source.

NOTE: Pressing an **E** toggles through all the nuclides beginning with the letter **E**.

NOTE: Many types of library files can be created using the same method. Not only can you add whole nuclides to libraries but add or delete lines from nuclides. Be sure to save the library as QC.NLB when completed.

Now that the library has been defined, the QC measurement must be run many times to establish a baseline for the instrument. Rerun the QC measurement a minimum of ten times over the course of a few days or weeks if possible. Each time, remove the source and replace it to mimic the variability of field QC runs.

6.6.2.9 Source Certificate Setup

Source certificates are used for efficiency and energy calibrations. It is the electronic version of the paper certificate that comes from the source's manufacturer in a format that the Canberra software can read. Certificate files can be imported from other machines. All certificate files go in C:/Genie2k/camfiles/. Also, obtain a copy of the manufacturer's source certificate to keep with the instrument files.

1. Open the Genie 2000 folder on the desktop.
2. Start the Certificate File Editor.
3. Certificate files are created in the same manner as the library files.
4. In the title text box, enter "Certificate for {source ID}," where sourced *ID* is the source name or source serial number.
5. Enter 1 for quantity.
6. Enter the assay date for the source. This is typically called the reference time.
7. On the menu bar, select **OPTIONS**.
8. Select **LIBRARY EXTRACT**.
9. To enter a new nuclide, for example Am-241, select the A_D.nlb file.
10. Scroll down to find Am-241.

11. If the activity on the paper source certificate is in Becquerel or curies, enter the value and uncertainty, and click Change and then **OK**. The conversion to gammas per sec and its uncertainty are calculated in the main screen.
12. If the activity units are not in Becquerel or curies, either convert the activity to either Becquerel or curies, or enter that conversion factor into the box, and click **CHANGE** and then **OK**.
13. If the activity on the source certificate is in gamma per second, enter "1" for both the activity and the uncertainty, and click **CHANGE** and **OK**.
14. In the Emission Rate box, enter the correct gamma per second value from the paper certificate and its uncertainty, and click **CHANGE**.
15. If this energy line is to be used as part of a calibration, click on the **USE FOR CALIB/INIT.**
16. Enter the emission rate uncertainty at 1-sigma.

NOTE: Certificates vary in what coverage factor (k=1,2 or 3) that is printed on the certificate. Be aware of this and make sure the value entered in the electronic file is the 1-sigma combined standard uncertainty of the emission rate.

17. If there are multiple energy lines for one nuclide, ensure each line has the correct emission rate and uncertainty entered.
18. Perform these steps for each additional nuclide.
19. Select **FILE** then **REPORT** to obtain a copy of the electronic report

NOTE: The report displays the uncertainty at the 2-sigma level (which assumes the value was entered as the 1-sigma combined standard uncertainty.

20. When complete, have another FAL member review your work for consistency. The creator and reviewer should date and initial the paperwork and file with the instrument records.

6.6.2.10 Necessary Files

Many of the support files listed below have already been created. Most of these files are too complicated to create from scratch, such as any Rexx batch programming files. To take advantage of existing support files, copy each of the files listed below from their storage locations to the local computer (Tables 6.9 - 6.14).

Copy the following files to the c:\genie2k\exefile directory on the local computer:

Table 6.9: Required Executable Files

FRMC_Acq.rex	FRMC_Qc.rex	Detname.fds*	Spcfile.fds
FRMC_Bknd.rex	Recal.rex	GNAME.fds	Solangle.fds
Effcal.rex	FRMC_Replay.rex	Labid.fds	
Energy.rex	StdConverter.py	FRMC_Oprname.fds*	
Initcal.rex	Sident.fds	Outname.fds*	
FRMC_Qaview.rex	Bkgfile.fds	FRMC_Params.fds*	
FRMC_Lcs.rex	Certname.fds	FRMC_Qaview.fds	

*override these files in the exefiles directory

Copy the following files to the c:\genie2k\camfile directory on the local computer:

Table 6.10: Required Nuclide Library (.nlb) and Energy Files

Energy.ctf	QC.nlb
Falcon_lib.nlb	

Copy the following files to the c:\genie2k\ctlfiles directory on the local computer:

Table 6.11: Required Template (.tpl) Files

Calib.tpl	Qarpt.tpl*
Frmc.tpl	Certlis.tpl*
FRMC_Std.tpl	FALCON_ASF.ASF

*override these files in the ctlfiles directory.

Copy the following files to the c:\genie2k\calfiles directory on the local computer:

Table 6.12: Required Calibration Files

QC.cal	LCS_FAL##.cal *Note: change ## to match the current detector number*

Next, shortcuts must be established on the computer's desktop. This will allow users to easily run the necessary Rexx files that were previously installed.

1. On the computer's desktop, right click and select **NEW -> FOLDER**
2. Name the new folder "FRMAC Routine Batch Files"
3. Open the folder, right click on the empty space and select **NEW -> SHORTCUT**
4. Click **BROWSE** and navigate to C:/Genie2k/EXEFILES
5. Choose the Rexx file you wish to create a shortcut for. (i.e. FRMC_Acq.rex)
6. Click **OK** and then **NEXT**.
7. Type in what you want the shortcut to be named (i.e. Routine Analysis)

8. Click **OK.**
9. Repeat this process for all of the routine analysis procedures.

Table 6.13 Routine Batch File Shortcuts

REXX filename	**Shortcut Display name**
FRMC_Acq.rex	ROUTINE ANALYSIS
FRMC_Bknd.rex	BACKGROUND
FRMC_Qaview.rex	QA VIEW
FRMC_QC.rex	QC
FRMC_Replay.rex	REPLAY
FRMC_LCS.rex	LCS

10. Create a new desktop folder called "FRMAC Non-Routine batch files
11. Create shortcuts for each of the non-routine batch files shown in Table 6.14.

Table 6.14 Non-Routine Batch File Shortcuts

REXX filename	**Shortcut Display name**
EFFCAL.REX	EFFICIENCY CALIBRATION
ENERGY.REX	ENERGY CALIBRATION
INITCAL.REX	INITIAL ENERGY CALIBRATION

6.6.2.11 Installation of the Python programming language and the Python Excel module

NOTE: Both the Python programming language and the Excel module can be obtained from the internet.

Python language can be obtained at www.python.org; at the time of this writing the current version of Python being used is 2.7. If newer versions of python are used, check the compatibility of StdConvert.py with the new version. If necessary, the Python website will list depreciated functionality of older versions of Python. Python 2.7 will be the default version.

The Excel module can be obtained at www.python-excel.org. There are three different modules listed: xlrd, xlwt, and xlutils. The correct module is the xlwt for writing to Excel files.

1. After obtaining the copy of the Python executable, double click on the file.
2. Follow the directions of the install manager.
3. Since there is only one account on the computer running the Falcon, it is not necessary to select the program to be used by all users.
4. The default location of the install is Python27, for version 2.7.

5. The installation of Python provides for not only the language interpretation but a simple Interactive Development Environment. This is where you will be able to edit the StdConvert.py file.
6. After installing Python, install the xlwt module. This file is an executable install file.
7. Double click on the file.
8. Follow the directions.
9. Next, the environment variable must be set on the computer. Navigate to **MY COMPUTER**, right click on the icon, click **PROPERTIES**, select the **ADVANCED** button, Click on **ENVIRONMENT VARIABLES**, click on **PATH** and add C:/python## where ## is the version number installed in step 4.

6.6.2.12 iSOCS™ Installation and Detector Characterization File Setup

1. Close the VDM (virtual data manager) and all other Windows programs that may be open. To do this, right click on the Areva icon (a small letter A) in the bottom right corner of the screen and select "Close"….
2. Insert the iSOCS™ disc.
3. Click on the Windows Start menu.
4. Select **RUN**.
5. Type in "d:" without the quotation marks, were d: is the drive letter for the CD-ROM drive.
6. Click on **SETUP.EXE**.
7. Click **INSTALL iSOCS**.
8. Be sure to use the default directory structures suggested by the setup program.

NOTE: To use iSOCS™ correctly, the detector must have been characterized by Canberra, and you must have the characterization files on-hand. Two files of interest include the *.par file, which contains the characterization data, and the detector.txt file, which includes instructions that iSOCS™ uses to find the *.par file. The following steps detail how and where to place these files in the default directory structure so that iSOCS™ can run correctly.

9. Insert the iSOCS™ characterization disc for the detector that is to be used. The disc will be marked with the Canberra issued serial number for the detector.
10. Using Windows Explorer, open the disc to view the files. An example of the files that are included in the disc are shown in Table 6.15 below.

Table 6.15: Example iSOCS™ Characterization Files

Filename	**Description**
33P20828.par	This file contains all of the detector characterization data for detector #33p20828
ACK_718384_SN_33P20828_CHAR.pdf	This file is the validation package of the characterization process for detector #33p20828
detector.txt	This file contains instructions that allow iSOCS™ to find the *.par files for all the detectors on the machine
DETutil.exe	This is an executable that installs the .par files automatically (**This will not be used, the placement of the .par file will be done manually)**
Readme.txt	This lists instructions for the install of the characterization files

11. Open detetector.txt with Microsoft Notepad. Figure 6.11 is an example of what the file looks like.

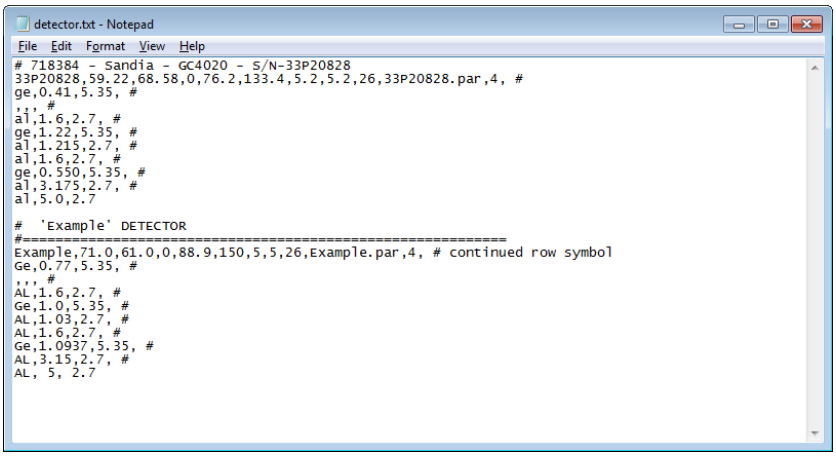


Figure 6.11: Example of the detector.txt File

12. In line two of the file, edit the first parameter (in this example “33p20828”) so that it reads as the name of the detector that is to be used (ex. FAL04). This is the name of the detector that will be shown in the list of characterized detectors.
13. Save the file.
14. Copy the group of data for the detector that is to be used. In this example, the data that is to be copied is as follows (Figure 6.12):

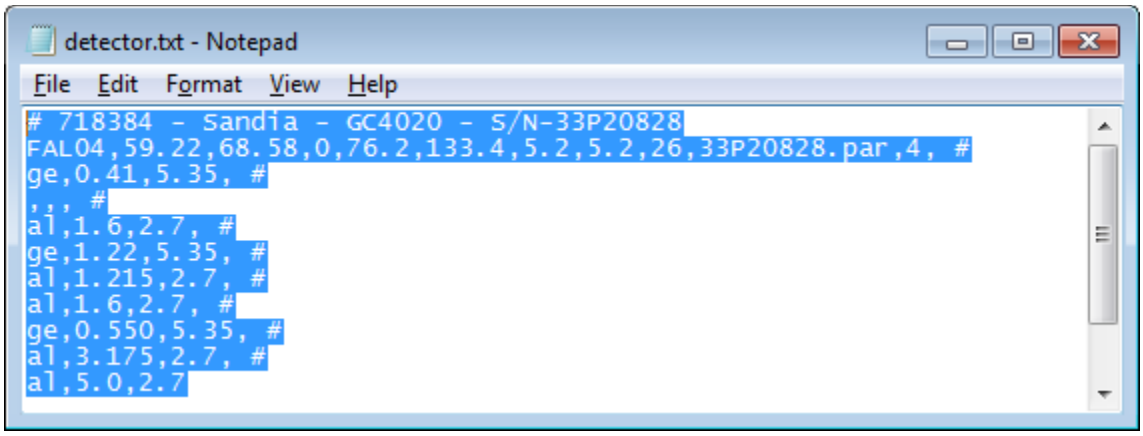


Figure 6.12: Example of Data To Be Copied to detector.txt on the Machine

15. Using Windows Explorer, navigate to the following directory: C:\GENIE2K\isocs\data\PARAMETERS
16. Open the file "detector.txt."

NOTE: This detector.txt file is different than the one on the characterization disc; it is the file that is used by iSOCS™.

17. Paste in the copied data to the end of the file; be sure to have a blank line between the last group of data and the new group of data.
18. Save the file by clicking **FILE => SAVE.**
19. Return to the iSOCS™ characterization disc using Windows Explorer.
20. Copy the file *.par, where * is the detector serial number.

NOTE: Do not change this filename.

21. Go to the directory: C:\GENIE2K\isocs\data\DCG.
22. Paste the *.par file into this directory.
23. Once the above tasks are completed, iSOCS™ can be used to generate efficiency curves for any modeled geometry. See Appendix A for a tutorial on how to use iSOCS™.

6.6.2.13 Setup of the LCS QAF Parameters

The laboratory control sample (LCS) is used to determine instrument stability during a response. The data from an LCS is reported to the FRMAC Laboratory Analysis group as proof that the instrument is in calibration and that sample results are valid. This section describes how to setup the QAF parameters so that you can easily identify if the instrument passes or fails QA checks.

NOTE: It is very important that this is the last step of initial setup as it requires that a count be done on the calibrated, QC checked detector. This section is written under the assumption that the quality control check source is used as the laboratory control sample. A different source can be used, but you must be aware of the changes that need to be made. Consult the FAL manager if a source other than the Canberra issued check source is used.

1. Perform a normal count of the check source using the routine acquisition procedure. Count the sample for 600 seconds, choose the geometry that the source is being counted in (if none exist, use iSOCS™ to create one), choose QC.NLB as the library, set the sample time equal to the acquisition start date/time, and display units in uCi/Each.
2. Obtain the measured activity of Eu-155 and Na-22 from the analysis report. Record these values and the date/time of the measurement in the instrument logbook. The values need to be entered into the quality assurance file for the LCS. The date is used for all LCS measurements so that the source decay is accounted for.
3. Open C:/Genie2k/EXEFILES/frmc_lcs.rex.
4. Scroll down to the "Hard Coded Source Information" section.
5. Change the source name so that it matches the identifying number on the source.
6. Change the variable STIME to equal the date/time that the LCS was counted.
7. Save the file and close it.
8. Open the Quality Assurance Editor from the Genie 2000 folder located on the desktop.
9. Select **FILE => NEW**, and then **FILE => SAVE**.
10. Save the blank quality assurance file as: lcsfal#.qaf, where # denotes the detector number (e.g, FAL03 has a qaf with filename lcsfal3.qaf).
11. Click **ADD DEFS => NUCLIDE => WTD MEAN ACTIVITY**.
12. A window appears that allows you to enter information that the program will use to perform QA checks.
    a. Description: *Nuclide Name* Activity (ex. EU-155 Activity)
    b. Nuclide Name: Enter the nuclide name that you are working on (**NOTE**: nuclide names are always in all-capital letters, for example Eu-155 is written as EU-155)
    c. Units: uCi/unit
    d. Conv factor: 1.00
    e. Set Investigate equal to 3 and Action equal to 4
    f. Click the boundary test box and enter the lower and upper bounds (in uCi/Each) for the nuclide you are entering.
        - Lower Bound = Activity – 0.25*Activity
        - Upper Bound = Activity + 0.25*Activity
    g. Enter the mean and standard deviation (equal to 25% of the mean) to match the bounds above for the user driven and sample driven tests.
    h. Leave all other parameters as the default.
13. Click **NEXT** and enter the information for NA-22.
14. Click **OK**.
15. When the information is entered, save the QA file.
16. Run the LCS procedure 3-4 times to ensure that the limits are reasonable. Most of the counts should be within the limits. If you think that the limits are too narrow, consult the FAL manager.

6.6.3 Acceptance Testing

1. Open the GENIE™ folder and start the Gamma Acquisition & Analysis program. Under **FILE,** select **OPEN DATA SOURCE** and select **DETECTOR**. Open the FALNN, where *NN* is the designated detector number.

NOTE: If you experience the "Required Hardware Unavailable" Error, set the FALCON to standby and reset the power. Attempt to open the detector again.

2. Select **MCA** and then **ADJUST** from the menu bar.
3. In the Adjust window, click on the **HVPS** radio button. Click on the **ON** radio button to turn the HV on and wait a few minutes for the system to stabilize.
4. Place the Canberra-provided source (QC source for the detector) on the detector and begin an acquisition.
5. Adjust the Amplifier Gain in the Adjust window. Click on the **GAIN** radio button. Adjust the Course, Fine, or Super Fine to fit the following peaks:
   - 1274.53 keV peak falls in the neighborhood of channel 3480.
   - 86.54 keV peak falls in the neighborhood of channel 237.

   These channels are a rough fit and are adjusted later in the calibrations to yield an energy calibration curve.
6. If the above step cannot be achieved, contact the Canberra service representative to help adjust the system.
7. Adjust the LLD. On the adjust window click the **GAIN** radio button. Click **NEXT** until the LLD radio button is visible.
8. Click on **MANUAL LLD**.
9. Adjust the LLD percentage. After every adjustment, clear the spectrum and re-start the acquisition. The LLD is the first channel from the left that has counts in it. Adjust the LLD such that the first 30 channels in the spectrum have no counts in them.
10. Record the proper setup and acceptance testing of the detector in the instrument logbook.

Section 7: iSOLO™ Procedures

Table of Contents

7.1 Purpose 3
7.2 Scope 3
7.3 Summary of Method 3
7.4 Interferences and Limitations 4
7.5 Apparatus and Materials 4
7.5.1 Unit Identification #1 4
7.5.2 Unit Identification #2 5
7.5.3 Sample Holders 5
7.5.4 Printer-Brother HL 2070N Network laser printer 5
7.5.5 iSOLO™ Log Book: 5
7.6 Operations Procedure 5
7.6.1 Counting Samples 9
7.7 Reporting 11
7.7.1 Printing Reports 11
7.7.2 Record Keeping 11
7.7.3 EDD and Laptop Report Creation 13
7.8 Quality Control 17
7.9 References 18
7.10 Document History 18
7.11 Calibration 18

Figures

Figure 7.1: Main Sample Screen 6
Figure 7.2: QC Screen Shot 6
Figure 7.3: QC Acceptance Screen 7
Figure 7.4: Alpha QC Standard Screen 7
Figure 7.5: Alpha QC Acceptance Screen 8
Figure 7.6: Beta QC Standard Screen 8
Figure 7.7: Beta QC Acceptance Screen 8
Figure 7.8: iSOLO™ Data Screen 10
Figure 7.9: Print Menu Screen 11

Figure 7.10: System Report Screen 11
Figure 7.11: iSOLO™ Manager Screen 13
Figure 7.12: Batch and Sample Definition screen 14
Figure 7.13: Batch Worklist 15
Figure 7.14: iSOLO™ Manager Screen with Batch Data 16
Figure 7.15: RAP/FRMAC Report Screen 17
Figure 7.16: iSOLO™ Setup Screen 18
Figure 7.17: Calibration Screen 19
Figure 7.18: Calibration Execution Screen 19
Figure 7.19: Calibration Routine List Screen 19
Figure 7.20: Calibration Type Screen 19
Figure 7.21: Blank Calibration Source Screen 20
Figure 7.22: Blank Calibration Acceptance Screen 20
Figure 7.23: Calibration Type Screen 20
Figure 7.24: Alpha Calibration Source Screen 20
Figure 7.25: Alpha Calibration Acceptance Screen 21
Figure 7.26: Calibration Type Screen 21
Figure 7.27: Beta Calibration Source Screen 21
Figure 7.28: Beta Calibration Acceptance Screen 22
Figure 7.29: Calibration Completion Screen 22

Tables

Table 7.1: Estimated Background Rates 4
Table 7.2: NIST Traceable Calibration Sources and Blank Sample 5
Table 7.3: Procedure Selection Table 9
Table 7.4: iSOLO™ Report Fields 12

7.1 Purpose

This procedure provides instructions for the calibration and use of the Canberra *iSOLO*™ Radon Compensating Alpha/Beta Counting System (*iSOLO*™) that is used for counting air filters and swipe samples. This detector is capable of providing limited radioisotope identification (e.g., it can discriminate between radon daughters and plutonium).

7.2 Scope

It is anticipated that the iSOLO™ alpha/beta counting equipment will be primarily used to perform field analysis of air filters and smears/swipes in support of the Federal Radiological Measurement and Assessment Center (FRMAC) operations. Air filter results are typically requested by the FRMAC in terms of $\mu Ci/m^3$. Swipes/smears are typically analyzed to determine if the area smeared meets contamination control criteria, which are generally specified in terms of dpm/100 cm^2 (or dpm/cm^2).

Data accuracy and reliability require defensible calibrations, quality assurance, and analysis processes and documentation. This section seeks only to establish parameters for the equipment setup relative to these processes.

7.3 Summary of Method

A traditional approach for determining the activity of long-lived radionuclides present in the air is based on sampling a measured volume of air through a filter, thus collecting radioactive dust particulates, and measuring the filter at a later time with an alpha/beta counter. The natural presence of Radon and Thoron gas in the atmosphere represents a significant problem when trying to rapidly quantify such an activity (e.g., without waiting for the Radon/Thoron signature to decay). Alpha particles resulting from the decay of Radon/Thoron progeny can down scatter into the lower energy region of the spectrum, where signals indicative of the presence of long-lived radionuclides would normally be detected. It is this interference that must be quantified and corrected for. The Canberra *iSOLO*™ instrument utilizes a series of algorithms to evaluate the Radon and Thoron contribution to the spectrum to dramatically reduce the interference from Radon and Thoron progeny on the long-lived alpha emitting radionuclides.

The iSOLO™ provides the system operator with gross alpha/beta results. Pulses from detected charged particles are sorted by energy. These regions of interest allow the user to reasonably determine which nuclide is present in a sample if a highly compensated alpha result is encountered. The following regions may be selected to be reported:

- Total Alpha Region: 3.0 MeV to 9.6 MeV
- Uranium Region: 3.0 MeV to 5.0 MeV
- Uranium, Am and Pu Region: 3.0 MeV to 5.6 MeV
- Curium Region: 3.0 MeV to 6.4 MeV
- Total Beta Region: 125 keV to 2.2 MeV

7.4 Interferences and Limitations

Limitations for AIR FILTERS ONLY

To determine if there is alpha activity (excluding Radon and Thoron daughters) on an air filter soon after it has been removed from the air flow, the filter needs to be counted for 2 minutes to determine the gross level of activity. It then needs to be recounted for 10 minutes to more accurately determine the activity.

The background subtract algorithm does not always give a result of 'zero' dpm if there is no activity on the filter.

The algorithm was tested by sampling with two filters overnight in a clean room and reading the filters in the morning. The test was repeated 5 times. Results are shown below. Note that the 2 minute count results varied from –120 to +10 dpm. Therefore, given the algorithm subtracts 120 dpm as background, it would be possible to have 120 dpm of Pu on the filter and have the result indicate '0 dpm.' Longer count times lessen the likelihood of not reporting 'real' activity.

Table 7.1: Estimated Background Rates

Length of count following a 1 to 3 day sampling interval	Bkgd results for 'clean' air (dpm)
2 min	-120 to +10
10 min	-50 to +40
30 min	-15 to +5
60 min	-1 to +10

NOTE: 5 dpm represents 0.6 DAC-hr of Class W ^{239}Pu and 0.2 DAC-hr of Class Y ^{239}Pu (assuming air flow sampling rate of 30 lpm)

7.5 Apparatus and Materials

The two iSOLO™ 300G low background Alpha/Beta counters are manufactured by Canberra. These units are portable, firmware based, single sample, manual, gas-less alpha/beta counters designed specifically for the analyses of air filters and smear or swipe samples. The counters weigh less than 19 pounds, use a solid state silicon PIPS detector, and can be operated for 10 or more hours with internal batteries (nickel metal hydride) after fully charging for about 12 hours.

7.5.1 Unit Identification #1

- Unit ID #1: DOE 8783941
- Unit Serial Number: 09052941
- DAQBD
  - Temp: 33.12 C
  - Det Bias: 73.12 V
  - Det Leakage: 1.73E-02 uA
- Firmware Version 1.12
- Build Time: Mon Aug 18 15:41:32 2008

7.5.2 Unit Identification #2

- Unit ID #2:
- Unit Serial Number: 09052942
- DAQBD
  - Temp:
  - Det Bias:
  - Det Leakage:
- Firmware Version 1.11
- Build Time: Thu Dec 14, 2006 15:34:53

7.5.3 Sample Holders

- 25 mm loose filter media (typically used for smears)
- 47 mm loose filter media (typically used for swipes and air filters)
- 100 mm loose filter media (typically used for air filters)
- Standard insert for any non-filter sample type up to 60mm diameter

7.5.4 Printer-Brother HL 2070N Network laser printer

The Fly Away Laboratory equipment shall include a network-capable printer.

7.5.5 iSOLO™ Log Book:

Each iSOLO™ counter shall have a log book that contains the following information:

- Air Sample/Swipe Data Sheet
- Periodic Background and Efficiency QC Sheet
- Annual Calibration Report
- Background, Efficiency, QC charts and other iSOLO™ generated reports that support the data entered on the iSOLO™ 1-3 forms listed below.

Table 7.2: NIST Traceable Calibration Sources and Blank Sample

Source type	ID #	Diameter	Ref. Date	Activity (dpm)	Activity (Bq)	Activity (uCi)
Sr/Y-90	NT 565	25 mm	9/19/2005	105,120	1752	0.0474
Sr/Y-90	NT 566	50 mm	9/19/2005	74,520	1242	0.0336
Sr/Y-90	RK 907	50 mm	8/20/2008	70,440	1134	0.0317
Sr-Y-90	SX 754	50 mm	8/25/2010	39,960	666	0.0180
Am-241	SX 753	50 mm	8/10/2010	39,960	666	0.0180
Am-241	NT 567	50 mm	9/19/2005	34,380	573	0.0155
Am-241	NT 568	25 mm	9/19/2005	40,380	673	0.0182
Am-241	RK 908	50 mm	8/20/2008	36,600	610	0.0165

7.6 Operations Procedure

The following instructions cover routine “Background,” “Efficiency QC,” and counting samples on the *iSOLO*™.

1. Turn on the iSOLO™ by turning the switch on the right side of the *iSOLO*™ to the "1" position. The Power LED glows when the instrument is powered. Immediately upon being turned on, the *iSOLO*™ initializes and runs a diagnostic check on the major subsystems.
2. Perform "Background QC" Measurements:
   a. Verify the instrument is on and ready to count:
      - Verify that the display shows the correct date and time.
      - Verify that the instrument is ready to count indicated by the "Main Sample Screen" below.

```
Date                                Time
                Insert Sample:
        Selected Procedure:

        Press <Sel Procedure>
                    or
        Press <Count> to Begin
```

Figure 7.1: Main Sample Screen

   b. Load blank sample.
   c. Locate the blank sample (use 47 mm sample holder).
   d. Open sample drawer.
   e. Remove any existing sample.
   f. Load blank sample.
   g. Close the sample drawer.
3. Activate Daily background count:
   a. Press the **BKG** button located in the **DAILY** panel. The **DAILY** panel is located to the left of the main display screen.
   b. The following screen is displayed:

```
Daily QC
            Insert BkgBlank
            Src
            Press Enter
            to continue
```

Figure 7.2: QC Screen Shot

   c. Wait until the count is complete.
   d. Accept the value if it is reasonable.
   e. After the count completes, inspect the values reported for both the α and β counts displayed on main screen below.

```
QC PROCEDURE COMPLETE

   α Backgnd:                cpm

   β Backgnd:                cpm

Press Enter to Accept

Press Cancel to Reject
```

Figure 7.3: QC Acceptance Screen

f. Enter the results into the iSOLO™ Bkg & Eff QC sheet.
g. Compare results to acceptance ranges and press **ENTER** located in the panel to the right of the screen to accept the count.
h. If the counts are outside the range, recalibrate by following calibration procedures in Section 7.11, Calibration.

4. Perform "Alpha Efficiency QC" Measurements:
   a. Unload blank sample and load Am-241 50 mm standard.
   b. Locate the Am-241 standard assigned to the counter.
   c. Open sample drawer.
   d. Remove the blank sample.
   e. Load the Am-241 standard.
   f. Close the sample drawer.
   g. Activate the alpha efficiency count.
   h. Press the **α EFF** button located in the **DAILY** panel. The **DAILY** panel is located to the left of the main screen.
   i. The following screen is displayed:

```
Daily QC
                Insert Am-50mm NT567 Src
                Press Enter
                to continue
```

Figure 7.4: Alpha QC Standard Screen

   j. Wait until the count is complete.
   k. Accept the value if reasonable.
   l. After the count completes, inspect the value reported for the α count displayed on the main screen below.

```
QC PROCEDURE COMPLETE

        α Efficiency:          %

Press Enter to Accept
Press Cancel to Reject
```

Figure 7.5: Alpha QC Acceptance Screen

m. Enter result into iSOLO™ Bkg & Eff QC sheet.
n. Compare results to acceptance range on iSOLO™ Bkg & Eff QC sheet and press **ENTER** located in the panel to the right of the screen to accept the count.
o. If the count is outside the range, recalibrate by following calibration procedures in Section 7.11, Calibration.

5. Perform "Beta Efficiency QC" Measurements:
   a. Unload Am-241 α standard and load Sr-90 β 50 mm standard.
   b. Locate the Sr-90 standard assigned to the counter.
   c. Open Sample drawer.
   d. Remove the Am-241 standard.
   e. Load the Sr-90 standard.
   f. Close the sample drawer.
   g. Activate the beta efficiency count.
   h. Press the **β EFF** button located in the **DAILY** panel. The **DAILY** panel is located to the left of the main display screen.
   i. The following screen is displayed:

```
Daily QC
                Insert Sr-50mm NT566 Src
                Press Enter
                to Continue
```

Figure 7.6: Beta QC Standard Screen

j. Wait until count is complete.
k. Accept the value if reasonable.
l. After the count completes, inspect the value reported for the β count displayed on the main screen below.

```
QC PROCEDURE COMPLETE

   β efficiency:          %

Press Enter to Accept
Press Cancel to Reject
```

Figure 7.7: Beta QC Acceptance Screen

m. Enter the result into iSOLO™ Bkg & Eff QC sheet.

n. Compare result to acceptable range on iSOLO™ Bkg & Eff QC Sheet and press **ENTER** located in the panel to the right of the screen to accept the count.
o. If the count is outside the range, recalibrate by following calibration procedures in Section 7.11, Calibration.
p. Unload the β standard.
q. Open sample drawer.
r. Remove the standard.
s. Close the sample drawer.

7.6.1 Counting Samples

1. Load the sample:
   a. Open sample drawer.
   b. Select the appropriate sample holder as indicated in Table 7.3.
   c. Remove the old sample holder by positioning your fingers along the side of the sample slide. From underneath the slide, place your thumbs on the access holes and gently push up on the sample holder. This action releases the sample holder from the sample slide.
   d. Insert new sample holder by aligning the holes in the sample holder with the post on the slide. Press down firmly.
   e. Load sample into holder.
   f. Close the sample drawer.
2. Select Procedure:
   a. Press **SEL PROCEDURE** to list the procedures available for sample analysis as seen below in Table 7.3, and using the arrow keys, place the cursor ">" beside the procedure of choice for a batch of samples.
   b. Press **ENTER** to select the procedure.

Table 7.3: Procedure Selection Table

Cursor	Procedure Name	Sample Type	Diameter	Count Time (min)	Sample Holders		
					25 mm	47 mm	100 mm
A	25mm 2 min dpm	Smear	1"	2	X		
B	47mm 2 min dpm	Swipe	1.5" & 2"	2		X	
C	25mm 10 min dpm	Smear	1"	10	X		
D	47mm 10 min dpm	Swipe	1.5" & 2"	10		X	
E	47mm 10 min uCi	Air Filter	2"	10		X	
F	100mm 10 min uCi	Air Filter	4"	10			X
G	47mm 60 min uCi	Extended Air Filter	2"	60		X	
H	100mm 60 min uCi	Extended Air Filter	4"	60			X

   c. Count the first sample.
   d. Press **COUNT** to start the analysis of the first sample.
   e. The green LED **COUNT** key blinks when the sample is finished counting.
   f. Enter the results into the iSOLO™ Hotspot iSOLO™ Data Sheet from screen below.

```
Date                                Time
Procedure                           ID
                T:      min
                α:      dpm
                β:      dpm
            Radon
------      Compensated             ------
                α:      dpm
                β:      dpm
```

Figure 7.8: iSOLO™ Data Screen

g. If there are no more samples to be counted using the selected procedure, press **GROUP DONE** to terminate the Group. The following screen is displayed:

Declare Group Done?

1. No
2. Yes

If "Yes," sample results need to be printed. See Section 7.7, Reporting, for printing instructions.

h. If counting more than one sample from selected procedure:
i. Open sample drawer.
j. Place the next sample in the sample holder.
k. Close the sample drawer.
l. Press **COUNT** again.
m. Enter the results in the iSOLO™ Hotspot iSOLO™ Data Sheet.
n. Repeat until all samples are counted.
o. When all the samples in a group (e.g., samples counted with the same procedure) have been counted, press **GROUP DONE** to declare this group of samples as complete.
p. A screen is displayed that asks you to confirm.

Declare Group Done?

1. No
2. Yes

q. If another sample needs to be counted as part of this same group, place the cursor ">" by 1 No and press the **ENTER** key. Place another sample in the sample holder and count it as part of this original group.
r. At the end of each group, print the most recent group results, and file results in iSOLO™ Log Book. Refer to Section 7.7, Reporting, for instructions for printing reports.
s. Remove sample holder and insert calibration source holder.

7.7 Reporting

At the end of each group, print and file the results.

7.7.1 Printing Reports

1. Ensure that the iSOLO™ is connected to the appropriate printer and turned on.

Print Most Recent Group:

a. On the front panel of the iSOLO™ press the **PRINT** key.
b. Move the cursor to **1, MOST RECENT GRP** from the Print Menu below and press **ENTER.**

PRINT MENU	
Cursor	Description
1	Most Recent Group
2	All Grps
3	Select Grp/Rpt
4	System Reports

Figure 7.9: Print Menu Screen

Print System Reports:

a. On the front panel of the iSOLO™ press the **PRINT** key.
b. Move the cursor to **4, SYSTEM REPORTS** from the Print Menu above and press "**Enter.**"
c. Using arrow keys, select system report requested and press **ENTER**.

System Reports	
1	System Params
2	Proc Params
3	QC Report

Figure 7.10: System Report Screen

7.7.2 Record Keeping

A report is generated after each Group is completed. The following fields are displayed on the printed report:

Table 7.4: iSOLO™ Report Fields

Sample Date	[Sample date]
Sample Start	[Start time]
Alpha Procedure Activity	[alpha activity (units specified by procedure)]
Beta Procedure Activity	[beta activity (units specified by procedure)]
Alpha (3-6.4 MeV) Procedure Activity	[region alpha activity (units specified by procedure)]
Alpha (3-6.4 MeV) Activity ±X Sigma	[region alpha total uncertainty]
Alpha (3-6.4MeV) Decision Level	[region alpha decision level (~MDA)]
Beta Comp. Procedure Activity	[Radon comp. beta activity (units specified by procedure)]
Beta Activity ±X Sigma	[Radon comp. beta uncertainty]
Beta Comp. Decision Level	[Radon comp. beta decision level (~MDA)]

All reports generated by the iSOLO™ must be printed and filed in the Hotspot log book.

NOTE: Sample data is stored in battery-backed memory in the *iSOLO*™. Data from 300 samples can be stored in this memory at one time. In order to prevent sample data from being inadvertently over-written, once 300 sets of sample data are stored, the *iSOLO*™ halts operation and displays an “Insufficient Memory” error message. The memory must be cleared before another sample can be counted.

7.7.3 EDD and Laptop Report Creation

1. Open the iSOLO™ reporter.exe software (located in C:\Documents and Settings\hotspot\Desktop\iSOLO™), and a user interface appears.

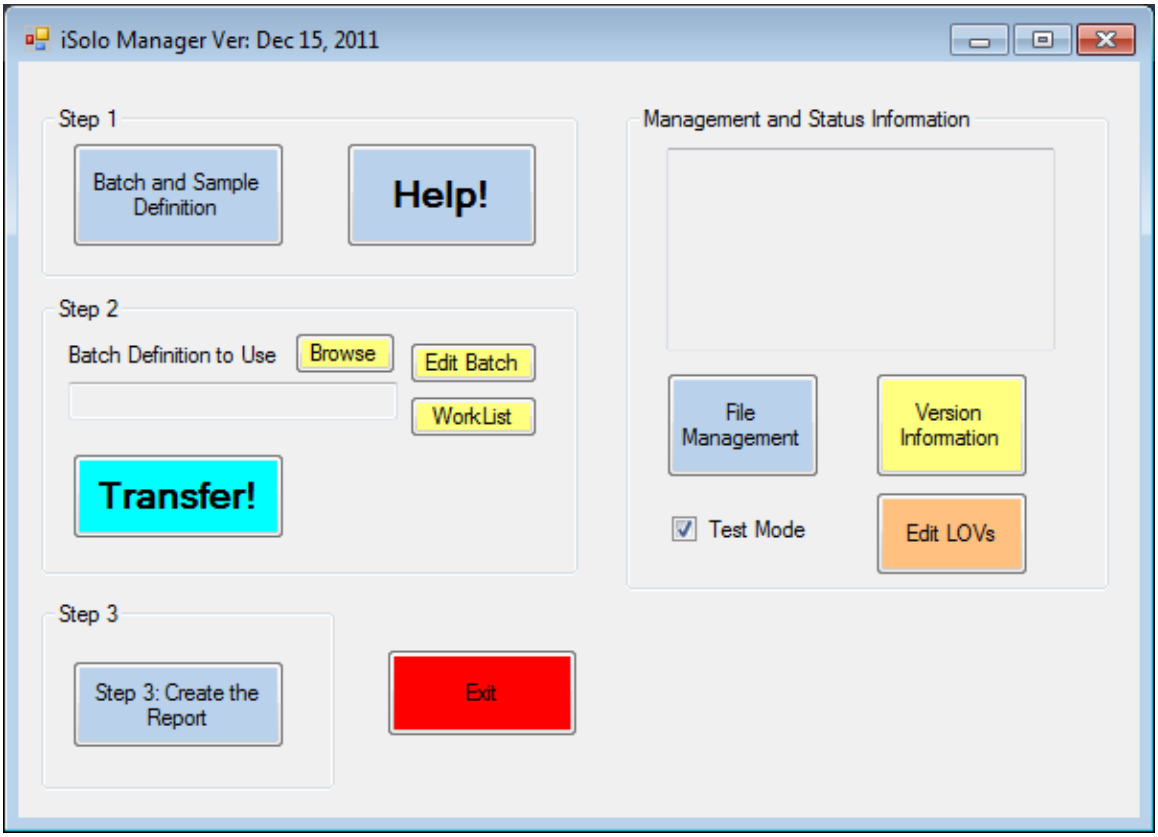


Figure 7.11: iSOLO™ Manager Screen

From the **STEP ONE** field, select **BATCH AND SAMPLE DEFINITION**, which opens a second screen:

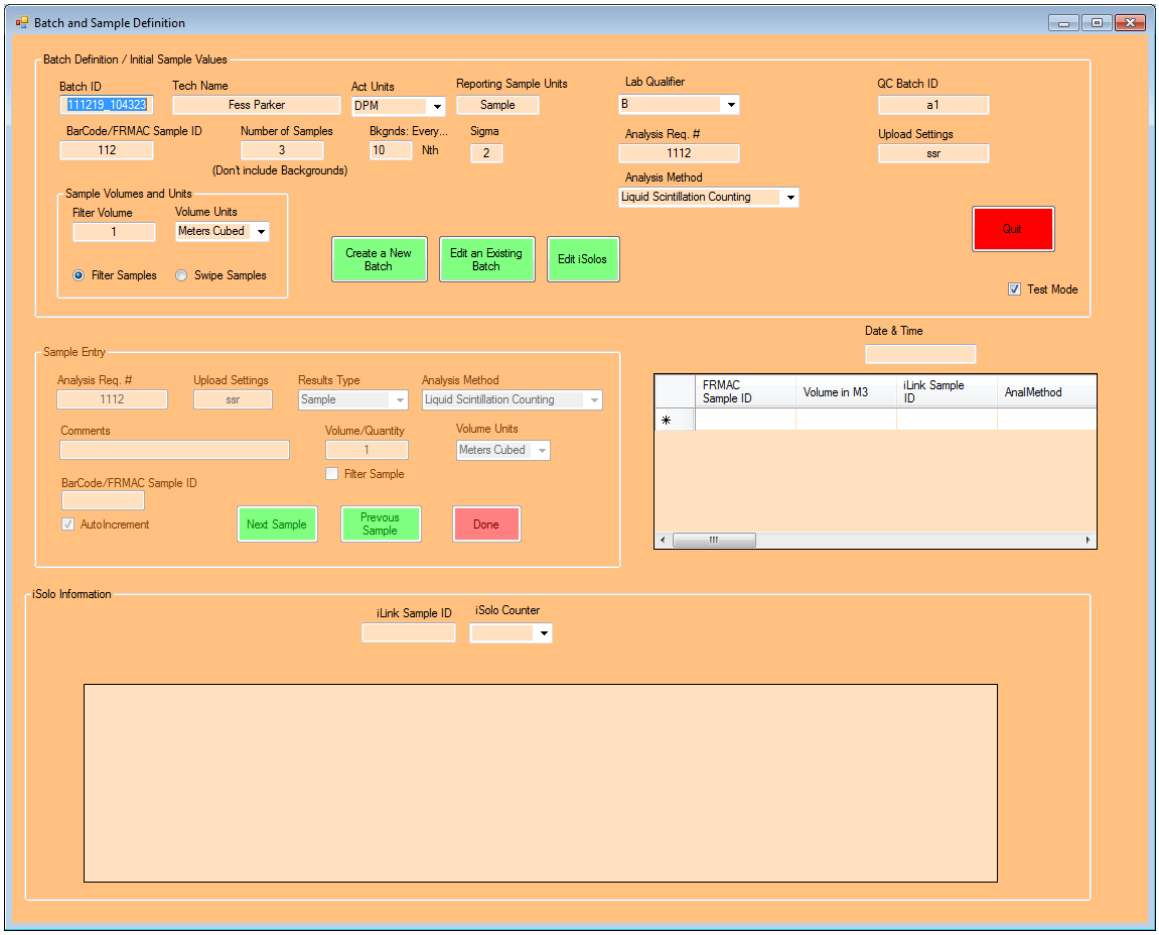


Figure 7.12: Batch and Sample Definition screen

In the appropriate fields, enter the sample information for the batch to be counted and note the following:

- The default batch ID is a date/time stamp.
- The first and last sample of any batch are background counts.
- After the first value in the **BARCODE SAMPLE ID** field is entered, auto increment can be used to fill in subsequent samples.
- Make sure to select the iSOLO™ you are using from the **EDIT ISOLO™** list.

Once the **DONE** button is selected, the sample work list is created, and it lists all the samples to be counted for the batch.

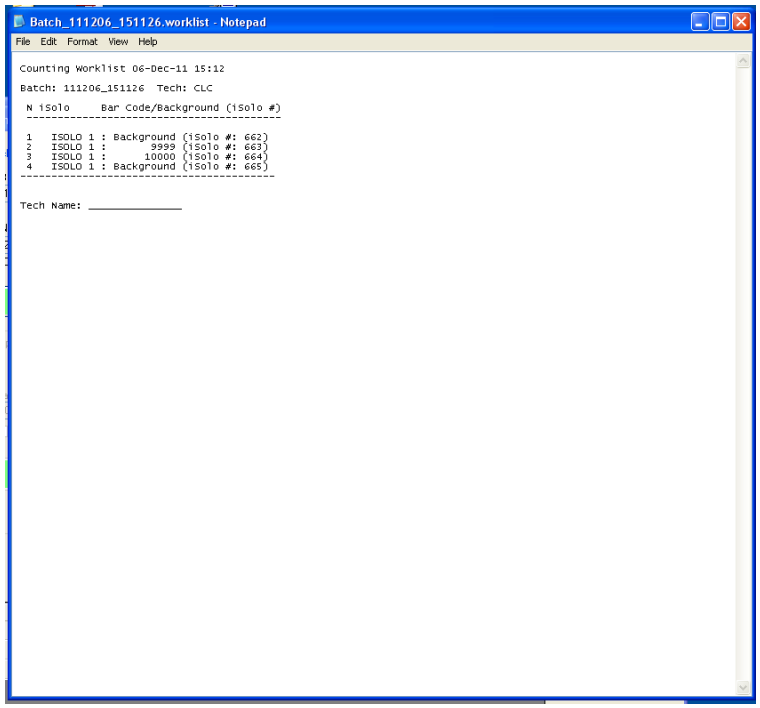


Figure 7.13: Batch Worklist

Counting on iSOLO™:

a. Place a background sample into the iSOLO™ tray and begin the batch counting by pressing the **COUNT** button on the front of the iSOLO™.
b. Once a count is done, the light next to the **COUNT** button flashes yellow. Remove the sample and load the next sample to be counted, and press the **COUNT** button. Repeat for all samples in batch.
c. At the end of counting a batch, press the **GROUP DONE** button on the front of the iSOLO™. If the results are acceptable, from the iSOLO™ menu, select **YES** to complete batch counting.

Creating EDD and Report

a. In the iSOLO™ Manager interface, in the **STEP 2** field, select the batch to be reported.

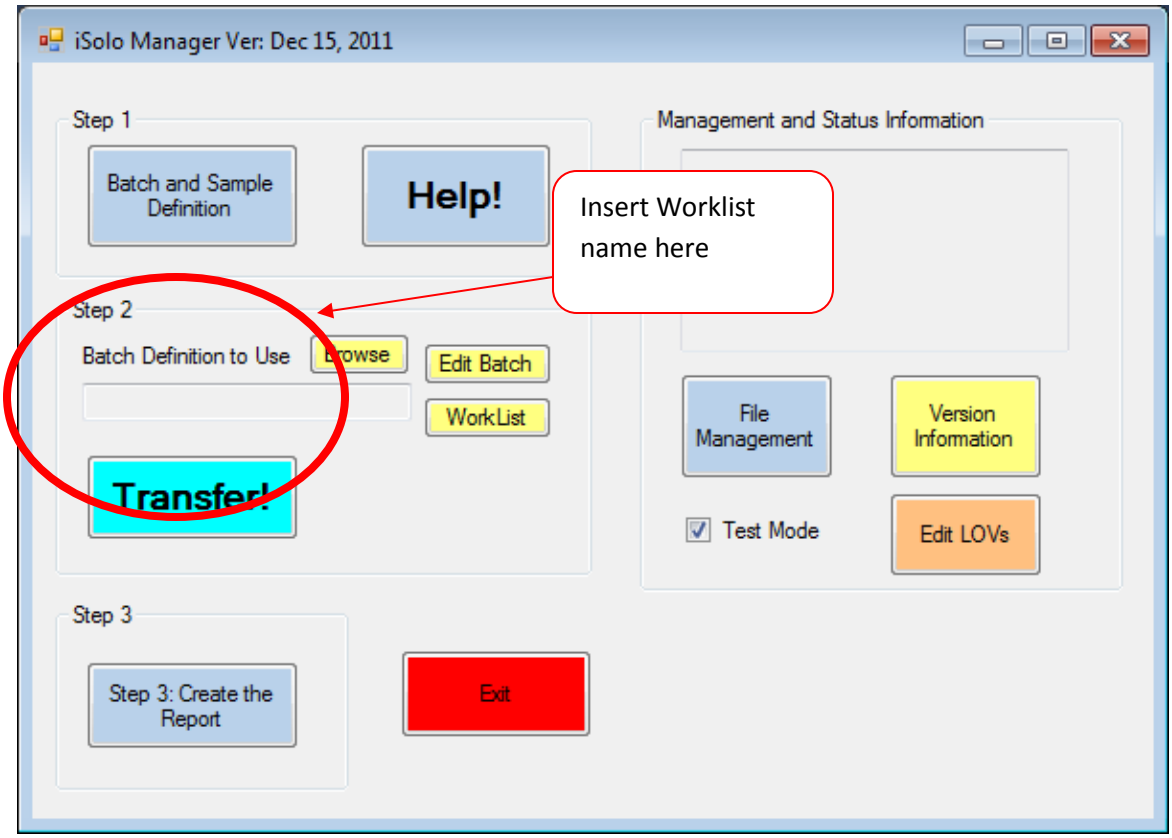


Figure 7.14: iSOLO™ Manager Screen with Batch Data

b. Click the **TRANSFER!** button (the data from the iSOLO™ and iLINK™ are transferred into the reporting software).
c. In the iSOLO™ Manager interface, click **STEP 3: CREATE THE REPORT**, and a new window, labeled "RAP/FRMAC Reporter," opens.

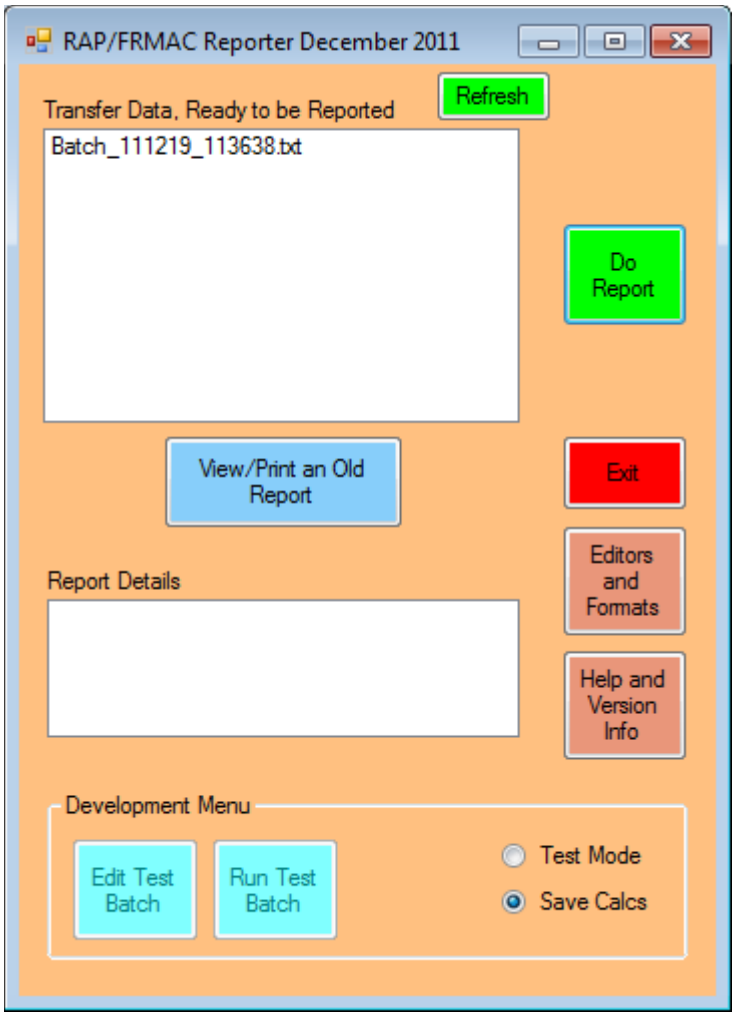


Figure 7.15: RAP/FRMAC Report Screen

Select the batch for reporting and click the **DO REPORT** button.

a. The Report file is created and saved in the folder C:\HotSpot\iSOLO™\Completed\Reports.
b. The EDD file is created and saved in the folder C:\HotSpot\iSOLO™\Completed\ReportCSVs.

7.8 Quality Control

- All alpha/beta standards in use are traceable to NIST or similar national standardizing body.
- Calibration of iSOLO™ is described in accordance with procedures documented in the *iSOLO™ Alpha/Beta Counting System User's Manual*.
- Instrument QC includes continuing background, alpha and beta efficiency calibration checks.
- Daily/Initial/Shift Field Performance Verification.

- Periodic Instrument Background Verification (~ every 20 samples).
- Control charts.

7.9 References

iSOLO™ Alpha/Beta Counting System User's Manual

7.10 Document History

Johnson, Mark, *Hotspot iSOLO™ Low Background Alpha/Beta Counting Equipment*, 2006

Bibby R., Conrado C., Hume R., *Hotspot iSOLO™ Low Background Alpha/Beta Counting Equipment*, 2011

Bibby R., Conrado C., Hume R., Torretto P., *Hotspot iSOLO™ Low Background Alpha/Beta Counting Equipment*, 2012

7.11 Calibration

1. To start the calibration process, press **SETUP** on the lower right side of the iSOLO™ front panel. See main screen prompt below:

NOTE: Do not change any setup parameter other than the calibration process described below unless reviewed by laboratory staff.

Setup	
1	Delete Data
2	Set Security Level
3	Define Procedure
4	System Information
5	Setup Printer
6	Define Report
7	Define Std Sources
8	Detector Parameters
9	Calibrations
10	Quality Control
11	Set Date/Time
12	Define Users
13	Clear QC Log
14	Set Analysis Parms

Figure 7.16: iSOLO™ Setup Screen

Using the arrow keys, position the cursor to #9 on the main screen.

Press **ENTER** and the following screen is displayed:

```
CALIBRATION
            1  Define Calibration
            2  Execute Calibration
```

Figure 7.17: Calibration Screen

Define Calibration:

a. If you have no need to review these parameters, go to next section. Select **1, DEFINE CALIBRATION** and press **ENTER** if you want to review calibration parameters. Select **1, PRIMARY CALIBRATION**.
b. Press the **CANCEL** key to return to the CALIBRATION Menu. **NOTE**: Please do not make any changes unless reviewed by the Fly Away Laboratory Manager.

Execute Calibration:

a. Using the arrow keys select **2, EXECUTE CALIBRATION,** to execute calibration and press **ENTER**.

```
CALIBRATION
            1  Define Calibration
            2  Execute Calibration
```

Figure 7.18: Calibration Execution Screen

b. Using the arrow keys, move cursor to **2, PRIMARY CALIBRATION**, and press **ENTER**.

```
Select Calibration
1  Primary Calibration
2  Field Calibration
3  Calibration 3
4  Calibration 4
5  etc….
```

Figure 7.19: Calibration Routine List Screen

Perform "Background Calibration" Measurements:

NOTE: Background calibrations should always be performed prior to efficiency calibrations as efficiency values are background corrected.

a. Press **ENTER**, and the main screen is displayed:

```
Execute Calibration
1  Background
2  α efficiency
3  β efficiency
```

Figure 7.20: Calibration Type Screen

b. Select **1** and press **ENTER**, and the following screen is displayed:

```
CALIBRATION

    Insert BkgBlank Src

    Press Enter
```

Figure 7.21: Blank Calibration Source Screen

c. Locate the blank sample.
d. Open sample drawer.
e. Remove any existing sample.
f. Load blank sample.
g. Close the sample drawer.
h. Press **ENTER**.
i. Press **COUNT** on main front panel of iSOLO™.
j. When count is complete, the following screen is displayed:

```
CAL PROCEDURE COMPLETE

    α Backgnd:          Cpm
    β Backgnd:          Cpm
Press Enter to Accept
Press Cancel to Reject
```

Figure 7.22: Blank Calibration Acceptance Screen

k. Press **ENTER** to accept.

Perform "Alpha Efficiency Calibration" Measurements:

a. Using the arrow keys, select **2** and press **ENTER.**

```
Execute Calibration
1  Background
2  α efficiency
3  β efficiency
```

Figure 7.23: Calibration Type Screen

b. The following screen is displayed:

```
CALIBRATION
   Insert Am-50mm NT567 Src
   Press Enter
```

Figure 7.24: Alpha Calibration Source Screen

c. Locate the Am-241 standard assigned to the counter.
d. Open sample drawer.
e. Remove the blank sample.

f. Load the Am-241 standard.
g. Close the sample drawer.
h. Press **ENTER**.
i. Press **COUNT** on main front panel of iSOLO™.
j. When count is complete, the following screen is displayed:

```
CAL PROCEDURE COMPLETE

   α Efficiency:                    %

Press Enter to Accept
Press Cancel to Reject
```

Figure 7.25: Alpha Calibration Acceptance Screen

k. Press **ENTER** to accept if in acceptable range.

Perform "Beta Efficiency Calibration" Measurements:

a. Using the arrow keys, select **3** and press **ENTER**.

```
Execute Calibration
 1  Background
 2  α efficiency
 3  β efficiency
```

Figure 7.26: Calibration Type Screen

b. The following screen is displayed:

```
CALIBRATION
   Insert Sr-50mm NT566 Src
   Press Enter
```

Figure 7.27: Beta Calibration Source Screen

c. Locate the Sr-90 standard assigned to the counter.
d. Open Sample drawer.
e. Remove the Am-241 standard.
f. Load the Sr-90 standard.
g. Close the sample drawer.
h. Press **ENTER**.
i. Press **COUNT** on main front panel of iSOLO™.
j. When count is complete, the following screen is displayed:

```
CAL PROCEDURE COMPLETE

   β efficiency:                    %

Press Enter to Accept
Press Cancel to Reject
```

Figure 7.28: Beta Calibration Acceptance Screen

k. Press ENTER to accept if in acceptable range. The following screen is displayed:

```
Field Calibration
Is Complete
Press Any Key
```

Figure 7.29: Calibration Completion Screen

l. Open sample drawer.
m. Remove the standard.
n. Close the sample drawer.

Print out System Parameters. See Section 7.7, Reporting, for instruction on printing system reports. Below is the set of the iSOLO™ internal procedures:

Calibration Procedure (based upon 2" dia. sources)

- Name = "Primary/Field Calibration"
- Background Cal Parameters
  - Count time = 4 minutes
  - Repeat = 5 (20 minutes total background count time)
- Alpha Eff Cal Parameters
  - Count time = 1 minute
  - Repeat = 5 (5 minutes total count time)
  - Alpha source = "Am-50mm NT567"
- Beta Eff Cal Parameters
  - Count time = 1 minute
  - Repeat = 5 (5 minutes total count time)
  - Beta source = "Sr-50mm NT566"
- Total calibration procedure time = 30 minutes

QC Procedure (Daily/Periodic)

- Name = "Daily QC"
- Reference calibration = "Primary/Field Calibration"
- Daily Bkg Parameters
  - Count time = 4 minutes
  - Repeat = 1 (4 minutes total background count time)
  - Warning level = 2
  - Lockout level = OFF
- Daily Alpha Eff Parameters
  - Count time = 1 minute
  - Repeat = 1 (1 minute total count time)
  - Warning level = 2
  - Lockout level = OFF

- Daily Beta Eff Parameters
  - Count time = 1 minute
  - Repeat = 1 (1 minute total count time)
  - Warning level = 2
  - Lockout level = OFF
- Total QC procedure time = 7 minutes

#1-A Smear Screening Procedure – 1" Diameter Smears

- Name = "25mm 2 min dpm"
- Reference calibration= "Primary/Field Calibration"
- Unknown sample diameter = 25mm
- Report = "Sample Report"
- Count time = 2 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = "dpm"
- Action limits = n/a

#2-B Swipe Screening Procedure – 1.5"& 2" Diameter Samples

- Name = "47mm 2 min dpm"
- Reference calibration= "Primary/Field Calibration"
- Unknown sample diameter = 47mm
- Report = "Sample Report"
- Count time = 2 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = "dpm"
- Action limits = n/a
- [Primarily for swipe counting, but could also be used to screen air filters]

#3-C Smear Counting Procedure – 1" Diameter Samples

- Name = "25mm 10 min dpm"
- Reference calibration= "Primary/Field Calibration"
- Unknown sample diameter = 25mm
- Report = "Sample Report"
- Count time = 10 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = "dpm"
- Action limits = n/a
- [To be used for smears]

#4-D Swipe Counting Procedure – 1.5"& 2" Diameter Samples

- Name = "47mm 10 min dpm"
- Reference calibration= "Primary/Field Calibration"
- Unknown sample diameter = 47mm
- Report = "Sample Report"
- Count time = 10 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = "dpm"
- Action limits = n/a
- [To be used for swipes]

#5-E Air Filter Counting Procedure – 2" Diameter Sample

- Name = “47mm 10 min µCi”
- Reference calibration= “Primary/Field Calibration”
- Unknown sample diameter = 47mm
- Report = “Sample Report”
- Count time = 10 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = “µCi”
- Action limits = n/a
- [To be used for 2" diameter air filters]

#6-F Air Filter Counting Procedure – 4” Diameter Sample

- Name = “100mm 10 min µCi”
- Reference calibration= “Primary/Field Calibration”
- Unknown sample diameter = 60mm
- Report = “Sample Report”
- Count time = 10 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = “K user defined” [ccfv=1.3E-6, ccfs=1.3E-6, label = µCi]
- Action limits = n/a
- [To be used for 4" diameter air filters]

#7-G Extended Air Filter Counting Procedure – 2” Diameter Sample

- Name = “47mm 60 min µCi”
- Reference calibration= “Primary/Field Calibration”
- Unknown sample diameter = 47mm
- Report = “Sample Report”
- Count time = 60 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = “µCi”
- Action limits = n/a
- [To be used for 2" diameter air filters]
- [Could also be used to provide enhanced results on smears]

#8-H Extended Air Filter Counting Procedure – 4” Diameter Sample

- Name = “100mm 60 min µCi”
- Reference calibration= “Primary/Field Calibration”
- Unknown sample diameter = 60mm
- Report = “Sample Report”
- Count time = 60 minutes
- Sample repeat = 1
- Count presets = 100,000
- Activity units = “K user defined” [ccfv=1.3E-6, ccfs=1.3E-6, label = µCi]
- Action limits = n/a
- [To be used for 4" diameter air filters]
- [To be used for 4" diameter air filters]

Section 8. Liquid Scintillation Procedure

Table of Contents

8.1 Purpose 3

8.2 Scope 3

8.3 Summary of Method 3

8.4 Required Equipment 3

8.5 Maintenance/Calibrations/Performance Checks/Training 4

- 8.5.1 Biennial Maintenance 4
- 8.5.2 Calibrations 5
- 8.5.3 Semi-annual Maintenance 5
- 8.5.4 Required Training 5
- 8.5.5 Semi-annual Instrument Performance Checks 5

8.6 Quick Start Guide - Sample Counting 6

8.7 Sample Handling and Preparation 7

- 8.7.1 General Guidelines 7
- 8.7.2 Swipe Tabs 8
- 8.7.3 Liquid Samples (Including Bioassay) 8

8.8 System Start-up and User Controls 8

- 8.8.1 Set-up 8
- 8.8.2 Start up the Triathler™ 9
- 8.8.3 LCD Display and User Controls 9
- 8.8.4 Selecting a Protocol for Analysis 11
- 8.8.5 Data Buffer 12
- 8.8.6 Spectral Display 14

8.9 Sample Counting 16

- 8.9.1 Gross Alpha/Beta/Tritium (Gabh3) 16
- 8.9.2 Tritium External Standard (H3ext) 19
- 8.9.3 Tritium Quench or DPM (H3que, H3dpm) 21

8.10 Calibration 24

- 8.10.1 Tritium External Standards (H3ext) 24
- 8.10.2 Tritium Quench (H3que) 26
- 8.10.3 Tritium Instant DPM (H3dpm) 28
- 8.10.4 Gross Alpha/Beta/Tritium (Gabh3) 31

8.11 Creating the Counting Protocols 33

- 8.11.1 H-3 Protocols 33
- 8.11.2 Gabh3 Protocol 39

8.12 Optimizing the System 47

- 8.12.1 Optimizing the Y-Gain 47

8.12.2 Optimizing the Tritium Window 47
8.12.3 Adjusting the Alpha/Beta Discriminator 48
8.12.4 Setting the Bias Voltage 48
8.13 Initial Set-up of the LSC After Chip Replacement or System Reset 49
8.13.1 Setting the System Clock 49
8.13.2 Setting the System Default Parameters 50
8.14 References 52

Figures

Figure 8.1: Hidex LCD Display Showing the Soft Keys 10
Figure 8.2: Tritium Spectrum 14
Figure 8.3: Cl-36 Spectrum 14
Figure 8.4: Am-241 Spectrum 15
Figure 8.5: Am-241 2D Spectrum 15
Figure 8.6: Cl-36 2D Spectrum 15

Tables

Table 8.1: Keyboard Protocols 11
Table 8.2: Summary of differences between tritium protocols 33

8.1 Purpose

This procedure provides instructions for the calibration and use of the Hidex Triathler™ Portable Liquid Scintillation Counter that is used for counting liquid samples and swipe samples. This instrument is capable of providing gross alpha, gross beta, and tritium measurements.

8.2 Scope

It is anticipated that the Hidex Triathler™ LSC will be used primarily to perform field analysis of liquid samples and swipe samples in support of the Federal Radiological Monitoring and Assessment Center (FRMAC) operations. Liquid sample results are typically requested by the FRMAC in terms of μCi/liter. Swipes are typically analyzed to determine if the area swiped meets contamination control criteria, which are generally specified in terms of dpm/100cm^2 (or dpm/cm^2). Swipe samples may also be used to estimate surface deposition when no other samples are available.

8.3 Summary of Method

The Triathler™ is a compact portable liquid scintillation counter (LSC) that can be used to measure emissions from alpha, beta, and gamma emitting isotopes. The Triathler™ is designed to work alone to display the results immediately after each measurement, store the data in a buffer for later download, or the results can be sent to a computer or printer.

The Triathler™ is equipped with three plastic scintillation adapters to count microtubes (e.g., Eppendorf type), 7 mL LSC vials, and 20 mL LSC vials. To perform measurements correctly, insert the appropriate plastic scintillation adapter into the measurement chamber before analysis. The 20 mL LSC vials are generally used.

The Triathler™ can measure: 1) isotopes that produce light directly, such as beta emitting isotopes; 2) gamma radiation; 3) alpha emitters; and 4) high energy beta emitting isotopes. Please read the *Triathler™ Owner's Handbook*, page 11 and 12 for details.

8.4 Required Equipment

- Hidex Triathler™ Portable Liquid Scintillation Counter
- Normal Cap (NormCap)
- External Standard Cap (containing Eu-152 source) (ExtCap)
- PC-style computer with Comfiler-II program
- Null Modem Cable (to connect Triathler to computer, a standard serial cable will not work)
- Set of LSC QC Standards
    - Unquenched Am-241 Standard
    - Unquenched Cl-36 Standard
    - Unquenched Blank
    - Set of 10 Tritium Quench Standards in Ultima Gold
- Scintillation cocktail (Ultima Gold) with 10 mL auto dispenser or automatic pipettor,
- Clean polyethylene scintillation vials – 20 mL

- Lab coat
- Safety glasses
- Gloves – surgical, latex, nitrile, or polyvinyl
- Clean swipe tabs
- Wash and aliquot bottles containing deionized water
- Deionized or distilled water
- Lint free towels (Kaydry or KimWipe)
- Fine point pen
- 1 mL auto pipette with disposable tips
- 0.2 ml to 1.0 ml adjustable pipette with disposable tips
- Tweezers
- Air filter cutting block and press (if available)
- Photo-trays, various sizes

8.5 Maintenance/Calibrations/Performance Checks/Training

8.5.1 Biennial Maintenance

1. The tritium quench set should be replaced every two years (there is an expiration date on the certificate). After the new standards are purchased:
   a. Update the Activity (DPM) and Reference Date for the H-3 (3UG) on the Data Entry Templates.
      i. Open the Data Entry **GAB_H3_YYYY_MM_YY.xlt** template.
      ii. Select the Daily QC Check.
      iii. Enter the new DPM value for the Activity (DPM) for the H-3 (3 UG) standard.
      iv. Enter the new Reference date for the H-3 (3 UG) standard.
      v. Repeat steps i through iv for the Data Entry **H3 YYYY_MM_DD.xlt** template.
2. Recalibrate the instrument with the new tritium quench set as described in Section 8.10, Calibration.
3. Perform the Semi-annual Instrument Performance Checks for the three tritium protocols (H3ext, H3que, H3dpm) as described in Section 8.5.5, Semi-annual Instrument Performance Checks.
4. Properly dispose of the expired tritium standards.
5. Examine the Am-241 and Cl-36 unquenched standards. Replace these standards if they become colored or no longer provide acceptable results for the Semi-Annual Instrument Performance Check. After new standards are purchased:
   a. Update the Activity (DPM) and Reference Date for the Am-241 and Cl-36 on the Data Entry Template.
      i. Open the Data Entry GAB_**H3 YYYY_MM_DD.xlt** template.
      ii. Select the Daily QC Check.
      iii. Enter the new DPM value for the Activities (DPM) for the Am-241 and Cl-36 standards.
      iv. Enter the new Reference dates for the Am-241 and Cl-36 standards.

6. Recalibrate the instrument with the new Am-241 and Cl-36 standards as described in Section 8.10.4 Gross Alpha/Beta/Tritium (Gabh3).
7. Perform the Semi-annual Instrument Performance Check for the Gabh3 protocol.
8. Properly dispose of the expired Am-241 and Cl-36 standards.

8.5.2 Calibrations

Once the LSCs are calibrated, it is not necessary to re-calibrate the instruments each time it is used. Instrument performance checks should be performed semi-annually, and with each use to demonstrate that the calibrations are still valid and the instrument is operating normally. If the performance checks fail, the instrument may need to be recalibrated. Steps for performing instrument calibration are included in Section 8.10, Calibration.

8.5.3 Semi-annual Maintenance

1. Ensure the following files are loaded on the computer:
   a. Commfiler II
   b. Data Entry GAB_H3 YYYY_MM_DD.xlt
   c. Data Entry H3 YYYY_MM_DD.xlt
2. Ensure all items are functional.
3. Perform the Semi-annual Instrument Performance Checks as described in Section 8.5.5, Semi-annual Instrument Performance Checks.
4. Ensure all items on the packing list are present in the shipping box.

8.5.4 Required Training

Fly Away Laboratory Analysts who operate the LSCs are required to complete FAL-400 FAL Liquid Scintillation Operations once in three years.

8.5.5 Semi-annual Instrument Performance Checks

1. Connect a computer to the LSC using the null modem cable.
2. Turn on the LSC and allow to warm-up for five minutes.
3. Turn on the computer and login.
4. Start the **CommfilerII** program.
5. Open the **Data Entry GAB_H3** template.
6. Select the **DAILY QC CHECK** worksheet, and enter the Instrument, Count Date and Count Time in the highlighted cells.
7. Select the **Gabh3** counting protocol on the LSC.
8. Count the indicated backgrounds and standards. (Use the Unquenched Blank for the background.)

   NOTE: It may be necessary to discard the results for the first one or two backgrounds counted if the results are high due to photoluminescence.

9. Review the QC results and ensure that the results are acceptable. If not the instrument may need to be re-calibrated.

10. Save the file, print the Daily QC Check worksheet and store in the binder located in the shipping box.

11. Open the **Data Entry H3.xlt** template.
12. Select the **Daily QC Check** worksheet, and enter the Instrument, Count Date and Count Time in the highlighted cells.
13. Select the **H3ext** counting protocol on the LSC.
14. Count the indicated backgrounds and standards.
15. Review the QC results and ensure that the results are acceptable. If not the instrument may need to be re-calibrated.
16. Save the file, print the Daily QC Check worksheet and store in the binder located in the shipping box.
17. Repeat steps 13 and 16 for the **H3que** and **H3dpm** protocols.

8.6 Quick Start Guide - Sample Counting

Following are the procedures for counting samples. Each day/shift Daily QC Checks and background measurements should be made (steps 5 through 9). The average of the measured backgrounds is used for background correction. After the Daily QC Checks and backgrounds are measured and the results are acceptable, the samples are counted (steps 10 through 13). Detailed steps for setting the count time, performing the Daily QC Checks, and counting the samples are described in Section 8.9, Sample Counting.

1. Connect a computer to the LSC using the null modem cable.
2. Turn on the LSC and allow to warm-up for five minutes.
3. Turn on the computer and login.
4. Start the **CommfilerII** program.
5. Open the appropriate Excel template for the type of analysis to be performed.
   - **Data Entry GAB_H3 YYYY_MM_DD.xlt**
   - **Data Entry H3 YYYY_MM_DD.xlt**
6. Select the **DAILY QC CHECK** worksheet, and enter the Instrument, Count Date and Count Time in the highlighted cells.
7. Select a counting protocol on the LSC.
   - **Gabh3** – Use when analyte is unknown or gross alpha or gross beta is required.
   - **H3ext** – Uses the ExtCap to determine quench (this protocol may be used for all tritium analysis).
   - **H3que** –Determines quench from the sample spectrum (do not use this protocol for low activity samples, tritium < 500 CPM)/

Display Modes
Press **9** to switch the display mode from Counts to CPM to DPM. Press **0** to switch the ROI being displayed from Alpha to Beta to H3.

View the Spectrum or 2D Graph
Press **1** then **ENTER** to send the beta spectrum to the Commfiler II program. Press **4** then **ENTER** to send the alpha spectrum to the Commfiler II program. Press **3** then **ENTER** to send the 2D Graph to the Commfiler II program.

- **H3dpm** – Not recommended for use (may be appropriate when quench calibrations do not exist).

8. Count the indicated backgrounds and standards and record the results on the Daily QC worksheet.

   NOTE: It may be necessary to discard the results for the first one or two backgrounds counted if the results are high due to photoluminescence.

9. Review the QC results and ensure that the results are acceptable. If not the instrument may need to be re-calibrated.
10. Select the **SAMPLE RESULTS** worksheet and enter the Analysis Request #, Sample Type, Sample Size, Unc. Sigma, QC Batch ID and the provided DRLs and/or L_Cs.
11. Place the sample in the LSC and start the count.
12. On completion of the count, enter the results on the "Sample Results" worksheet.
13. Count a prepared background after every tenth sample.
14. Create the EDD by selecting the cells in grey along with the Upload Settings field and paste into a new Workbook using **Paste Special, Values and Number formats.**

8.7 Sample Handling and Preparation

This procedure outlines the preparation of all samples received for analysis by liquid scintillation counting. These sample types include swipes, air filters, liquids, and bioassay samples.

8.7.1 General Guidelines

1. All sample and standard preparation should be performed within trays lined with absorbent material or in racks on top of absorbent material to prevent work surfaces from being contaminated in the event of a spill.
2. All possible low-level samples should be prepared first, before any suspected high-level or known high-level samples are prepared. Where practical, any suspected high-level samples should be prepared in separate photo-trays.
3. All background samples should be prepared using a volume of distilled water that is identical to the volume that the associated samples are prepared with. All sample backgrounds in a batch of samples should be prepared with water and cocktail from the same source.
4. All prepared vials should be turned several times for mixing.
5. If the time allows, prepared samples and backgrounds should be placed in a dark enclosure away from any source of light for 20 minutes before the start of analysis. This should allow any light induced photoluminescence that is created during preparation to decay away.
6. Prepared vials should be transported to the analysis area of the Fly Away Laboratory using racks or some other containment to ensure safe transport.

8.7.2 Swipe Tabs

1. Prepare a background sample consisting of 1 clean swipe tab, 1 mL of distilled water, and 10 mL of cocktail solution.
2. Verify that the counting samples received match the paperwork submitted with the samples.
3. To prevent cross-contamination of the sample vials and work area, wipe the outside of the vials with a dampened lab wipe (e.g., a KayDry).
4. Check each scintillation vial to ensure that each contains only one swipe tab.
5. Pipette 1 mL of deionized or distilled water into each vial using an auto-pipette.
6. Pipette 10 mL of scintillation cocktail solution into each vial using an auto-dispensing pipette affixed to the cocktail container or an auto-pipette.
7. Cap the vial and gently turn the sample for 5 to 10 seconds. Ensure aqueous and organic phases are well mixed.
8. Number the vial caps and the paperwork to show the position of the samples in the counting run. If there is no paperwork, be sure to number the samples so you can tell them apart later on.

8.7.3 Liquid Samples (Including Bioassay)

1. Prepare a background sample consisting of 1 mL of distilled water, and 10 mL of cocktail solution.
2. Verify that the counting samples received match the paperwork submitted with the samples.
3. To prevent cross-contamination of the sample vials and work area, wipe the outside of the original vials with a disposable lab wipe (e.g., a KayDry).
4. Pipette 1 mL of the sample into the vial and record the sampled volume on the accompanying paperwork.
5. Pipette 10 mL of scintillation cocktail solution into each vial using the auto dispensing pipette affixed to the cocktail container.
6. Cap the vial and gently turn the sample for 5 to 10 seconds. Ensure aqueous and organic phases are well mixed.
7. Number the vial caps and the paperwork to show the position of the samples in the counting run. If there is no paperwork, be sure to number the samples so you can tell them apart later on.

NOTE: Bioassay samples will often produce a large amount of chemiluminescence, and positive samples should be recounted after being stored in the dark for 12 hours.

8.8 System Start-up and User Controls

8.8.1 Set-up

Typically when the Fly Away Laboratory is deployed, the LSC is connected to a computer and the computer is connected to a printer (Section 8.8.1.1, LSC Connection to a Computer). When a computer is unavailable, the results may be read directly from the LCD Display (Section 8.8.2, Start up the Triathler™). Data are also stored in a data buffer on the instrument for later retrieval.

8.8.1.1 LSC Connection to a Computer

The computers assigned to the Fly Away Laboratory are preloaded with the HIDEX Commfiler software. The Commfiler program captures the data along with the spectra for samples analyzed. A shortcut to the Commfiler program and the data entry templates, are located in the LSC folder on the Desktop of the laptop.

Using the null modem cable, connect the Triathler™ to the computer. Optionally connect the computer to a printer. Turn on the computer and printer and ensure that the printer is ready for use.

1. From the Windows desktop, open the HIDEX portable LSC folder.
2. Double click the Commfiler.exe program to enable data collection.

As samples are run, sample data and spectra are automatically collected by the Commfiler program.

8.8.1.2 LSC Direct Readout

The Triather™ may be used as a standalone instrument. The instrument has a 32-character liquid crystal display (LCD) from which the count information may be read. A description of the LCD Display and User Controls is provided in Section 8.8.3, LCD Display and User Controls.

8.8.2 Start up the Triathler™

Switch the instrument on at the rear of the Triathler™. The following display screens appear in succession:

1. The first window shows the parameters used in the previous measurements.

```
Clear
Save Parameters
```

2. The second window indicates the program version.

```
Powerin up
Version:    1.8
```

3. The third window indicates last protocol used.

```
<H3ext>  Ready
Start  Sys Edit
```

4. The instrument is now in the “Ready” state and ready for use.

Allow a minimum of five minutes for the instrument to warm up.

If necessary, follow the steps in Section 8.13.1, Setting the System Clock, to set the current date and time.

8.8.3 LCD Display and User Controls

The Triathler™ has a 32-character liquid crystal display (LCD), a keyboard consisting of 16 tactile keys to control the operation of the Triathler™, and the four soft keys (purple) situated below the display (Figure 8.1). The LCD display shows two rows of text. Text boxes in this

section show the information displayed by the LCD display. During a count the results may be read directly from the screen.

The system software controls the functions of the keys. The user interface provides multi-layered menus. Within each menu the function of each soft key is generally indicated by the second row of text in the LCD display, appearing just above the soft key.

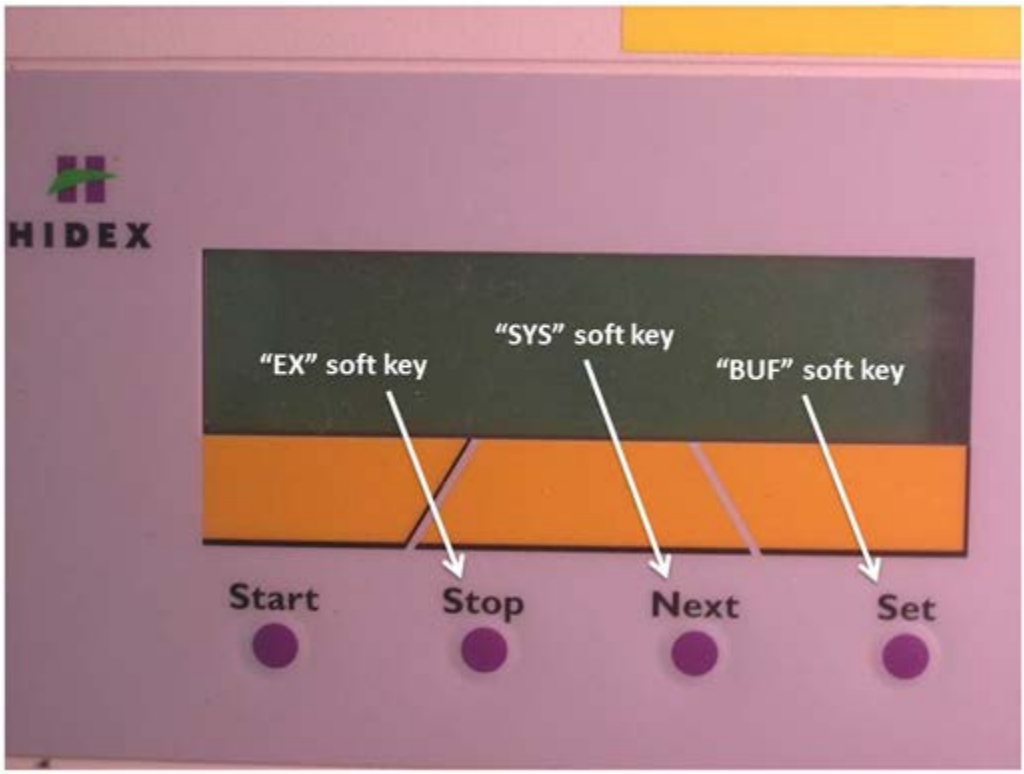


Figure 8.1: Hidex LCD Display Showing the Soft Keys

1. The HIDEX LCD displays the analysis result of a sample during and after counting (until the next sample is started). During a count, the display looks like this:

```
<H3ext>S:    #
T   ##  D:    ###
```

2. During the count, you can display the counts (C), count rate (R), and disintigration rate (D) by using the **9** key to scroll through the displays.

3. Press **0** to scroll between the various channels for multichannel protocols (alpha/beta/H-3). (The channel you are viewing will not be displayed.)

4. After the count has finished, the screen looks like this:

```
S:   #  D:    ###
   Ex. Next Edit
```

8.8.4 Selecting a Protocol for Analysis

When the Triathler™ is in the "Ready" state, the current isotope is shown in the first row of the display. (*e.g.* <H3ext> indicates the H3ext protocol is being used.)

The Triathler™ has built-in protocols that include 13 of the most common types of isotopes, such as H-3, C-14, P-32, P-33, I-125 and Cr-51. Keys 1and 7 through 9 are customized for use by the Fly Away Laboratory. On the keyboard, the following keys are dedicated for certain protocols:

Table 8.1: Keyboard Protocols

Key #	Protocol
1	H3ext (custom, see Section 8.9.2, Tritium External Standard (H3ext))
2	C-14
3	P-32
4	S-35
5	P-33
6	Luminescence
7	Gabh3 (custom, see Section 8.9.1, Gross Alpha/Beta/Tritium (Gabh3))
8	H3que (custom, see Section 8.9.3, Tritium Quench or DPM (H3que, H3dpm))
9	H3dpm (custom, see Section 8.9.3, Tritium Quench or DPM (H3que, H3dpm))

Select a protocol by pressing the dedicated label key on the keyboard.

Each of these protocols is optimized for specific isotopes. For example, protocol # 1 on the keyboard is set up for the measurement of H-3 using the external standards method. Counting parameters such as counting time and the counting window can be changed using the protocol editing instructions provided in Section 8.11, Creating the Counting Protocols.

It is important to count all samples using the Gross Alpha/Beta/Tritium (Gabh3) protocol first to determine if there are sufficient counts to warrant a follow-up H-3 analysis using the external standards method below. Following is a description of the protocols for use in the Fly Away Laboratory.

1. **Gross Alpha/Beta/Tritium (Gabh3)**

   The tritium calibration for this method is based on a single quench standard and uses this value to calculate the DPM for the samples. The selected quench standard is a mid-range quench standard (#3 UG) whose quench is typical of samples counted. Large biases in sample activity may be introduced for samples whose quench varies greatly from the calibration standard. Such samples should be reanalyzed using either the **H-3 External Standards** Method or the **H-3 Quench Method**.

For gross alpha/beta measurements, there will be approximately 5% crossover between the alpha and beta regions (*i.e.*, 5% of the alpha activity will appear in the beta region and 5% of the beta activity will appear in the alpha region).

2. **H3 External Standard (H3ext)**

   The external standards method of counting H-3 samples provides a method of correcting for sample quench, especially on low-level H-3 samples. Samples are first screened using the **Alpha/Beta/H3 (Gabh3)** protocol above. If the H-3 result is greater than 500 CPM, then continue with this procedure. If H-3 results using the **Alpha/Beta/H-3 (Gabh3)** protocol are less than 500 CPM, depending on the amount of quench in the sample, the LSC may have a relatively difficult time accurately measuring the H-3 activity.

3. **H3 Quench Standard (H3que)**

   The H3 quench method provides a means of correcting for sample quench when the ExtCap is unavailable. This method relies on H-3 activity in the sample to determine quench.

   For low level or background measurements (<500 CPM), this method is less reliable than the external standards method of counting H-3 samples. Always look at the CPM value of a sample; if it is less than 500 CPM, then the DPM estimate should be disregarded. Such samples should be reanalyzed using the **H-3 External Standards Method (H3ext)**.

4. **H3 Instant DPM (H3dpm)**

   The Instant DPM method provides a method of analyzing a tritium samples when there is no calibration for the External Standards or Quench methods.

   This method uses a proprietary calculation to determine the sample quench. Like method H-3 Quench Method above, it depends on H-3 activity in the sample to determine the quench. A single quench standard is used to determine a DPM/CPM factor. This factor, along with the sample quench, is used to determine the results.

   Samples without any activity will grossly overestimate the quench and assign a high activity value (false positive) to the sample. Always look at the CPM value of a sample; if it is less than 500 CPM, then the DPM estimate should be disregarded. Large biases in sample activity may be introduced for samples whose quench varies greatly from the calibration standard. Such samples should be reanalyzed using the **H-3 External Standards Method (H3ext)**.

8.8.5 Data Buffer

The data is also stored in a buffer on the instrument and the stored data may be downloaded at a later date. If you plan to retrieve results from the buffer at a later date, make sure the buffer is clear before beginning (if the buffer is full, no new data will be saved!). To later retrieve results from the buffer, ensure that the Triathler™ is connected to the printer. Also ensure that the Triathler™ and the printer are on, and the printer is ready for use.

8.8.5.1 Clear the Buffer

1. Press the **SYS** soft key and press the **BUF** soft key.

```
Time (1)  port (2)
Time ex  edit  buf
```

```
Vers (3)  refr (4)
Time ex  edit  buf
```

2. Press the **CLR** soft key.

```
Used  36%
Send  ex  test  clr
```

3. Press the **YES** soft key when asked "Clear Buffer?"

```
Clear buffer?
Yes   exit       no
```

4. Press the **EX** soft key to exit.

```
Time (1)  port (2)
Time  ex  edit  buf
```

```
Vers (3)  refr (4)
Time ex  edit  buf
```

5. The instrument will return to the ready state.

```
<H-3>  Ready
Start  Sys  Edit
```

8.8.5.2 Send Data in the Buffer

1. Stop the current count and return to the main menu.
2. Press the **SYS** softkey and press the **BUF** softkey.

```
Time (1)  port (2)
Time ex  edit  buf
```

```
Vers (3)  refr (4)
Time ex  edit  buf
```

3. Press the **SEND** softkey.

```
Used   #  %
Send  ex  test  clr
```

4. Press the **SND** softkey.

```
<H3ext>  #  Mar.
View  ex. snd  skip
```

5. Wait for the data in the buffer to be sent to the computer.

```
Sending
Please wait
```

6. Press **EX** twice to exit.

```
Used   #  %
Send  ex  test  clr
```

8.8.6 Spectral Display

Spectral data are sent to the Commfiler program and displayed in the upper left window of the Commfiler program. Stored spectra may be displayed by selecting it from the window on the right.

If spectral data is desired, then a computer with the Commfiler and Excel software must be connected to the serial port of the Triathler. From the Windows desktop, click to open the Commfil.exe. Next, click on the Spectr2d.xls file to open it from the Windows desktop.

8.8.6.1 Send the Beta Spectrum

1. After the sample is counted, press **<1>** then **<Enter>**.
2. After the data is sent, click on the **<Insert Spectrum>** button on the Command worksheet of the Spectr2d.xls file.
3. The spectrum will now be displayed as a new worksheet which can be viewed or printed.

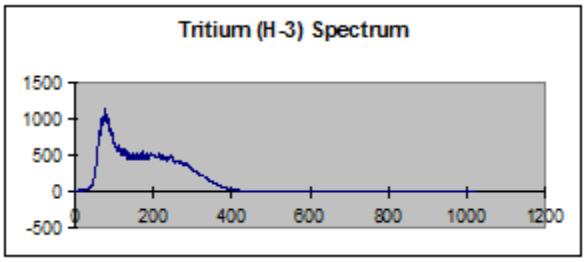


Figure 8.2: Tritium Spectrum

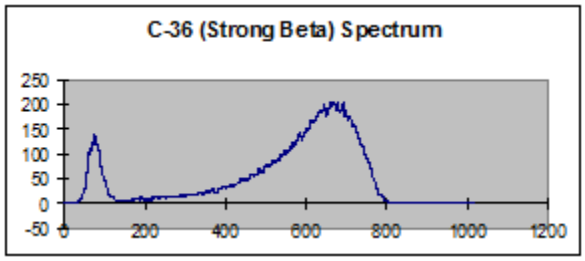


Figure 8.3: Cl-36 Spectrum

8.8.6.2 Send the Alpha Spectrum

1. After the sample is counted, press **<4>** then **<Enter>**.
2. After the data is sent, click on the **<Insert Spectrum>** button on the Command worksheet of the Spectr2d.xls file.
3. The spectrum will now be displayed as a new worksheet which can be viewed or printed.

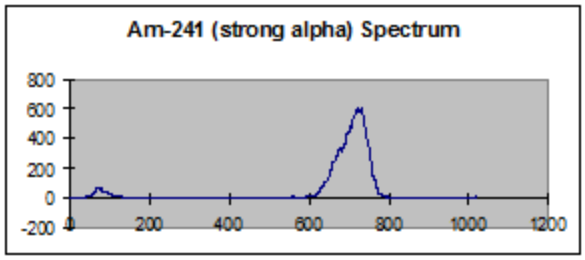


Figure 8.4: Am-241 Spectrum

8.8.6.3 Send the GABH3 2D Spectrum

1. After the sample is counted, press **<3>** then **<Enter>**.
2. After the data is sent, click on the **<Insert Alpha>** button on the Command worksheet of the Spectr2d.xls file.
3. The 2D plot will now be displayed as a new worksheet which can be viewed or printed.

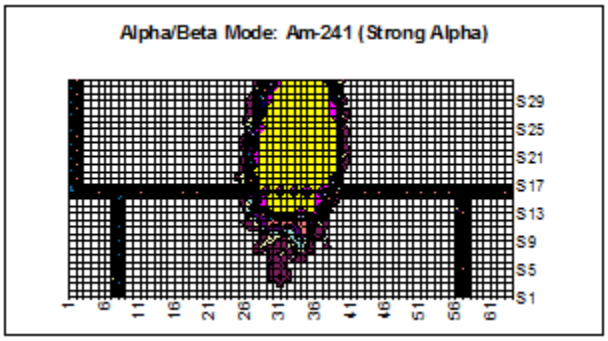


Figure 8.5: Am-241 2D Spectrum

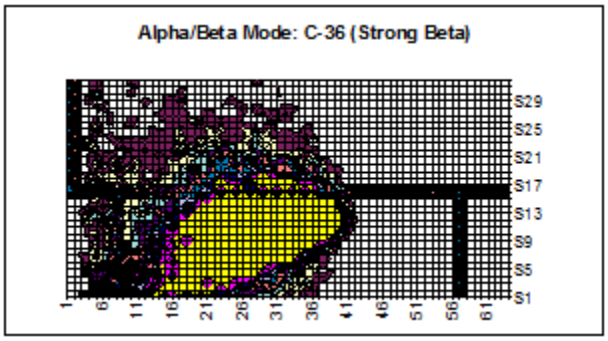


Figure 8.6: Cl-36 2D Spectrum

8.9 Sample Counting

8.9.1 Gross Alpha/Beta/Tritium (Gabh3)

8.9.1.1 Required Supplies

- Normal Cap (NormCap)
- Unquenched Am-241 Standard
- Unquenched Cl-36 Standard
- #3 UG Standard
- Background vial prepared using scintillation vials, cocktail, and deionized water in use at the site (the unquenched blank may be used if prepared background vials are unavailable)
- Prepared Samples

8.9.1.2 Instrument Set-up

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes

2. Open the **Data Entry GAB_H3 YYYY_MM_DD.xlt** data sheet and select the **Daily QC Check worksheet**. Fill-in the highlighted cells for the Instrument, Count Date and count time.

3. On the Triathler™ Select the nuclide **Gabh3** (**7** on the keypad).

8.9.1.3 Set the Count Time

1. Select **EDIT**.

```
<Gabh3>   Ready
Start  Sys  Edit
```

2. Enter the count time in seconds. Samples are typically counted for 300 seconds.

```
Meas.time  <sec>:
unit    300
```

3. Press **Enter**, press the **Stop** soft key.

8.9.1.4 Count the Backgrounds

1. Place a background vial prepared using the scintillation vial, cocktail, deionized water, and swipe tab (if used) used as the site. Cover the chamber with the NormCap and lock in place.

2. Select the **START** soft key (purple key).

```
<Gabh3>   Ready
Start  Sys  Edit
```

3. The following may display:

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

5. The counter will begin counting the sample for the preset count time (generally 300 seconds).

```
<Gabh3>S:   # A
T    ##  C:  #
```

6. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:   # R:   ####
Ex. Next  Edit
```

7. Enter the count rates (CPMs) and disintegration rates (DPMs) for the background on the **Daily QC Check** worksheet.

8. Repeat the background count at least four times. Ensure that the results are acceptable for each of the backgrounds measured. If not, inform the Fly Away Laboratory Manager.

   NOTE: The first one or two counts may yield high results due to exposure to light. If this is the case delete the data for the first one to two counts and repeat the background until there are a total of five background counts. High background can occur when operating the Triathler™ in elevated radiation fields. The ExtCap contains a Eu-152 source that elevates the background. Store this source a minimum of 3 feet (arm's length) from the Triathler™ when not in use. Check around the instrument to ensure that there are no other sources nearby.

8.9.1.5 Count the Tritium Standard

1. Remove the background and insert the #3 UG tritium source vial. Replace the NormCap.

2. Select the **NEXT** soft key. The count will begin on the Tritium standard.

```
S:   # R:   ####
Ex. Next  Edit
```

3. When the count is complete enter the count rates (CPMs) and disintegration rates (DPMs) for the alpha standard on the **Daily QC Check** worksheet. Ensure that the results are acceptable. If not, inform the Fly Away Laboratory Manager.

8.9.1.6 Count the Alpha Standard

1. Remove the #3 UG tritium source vial and replace it with the Am-241 standard. Replace the NormCap.

2. Select the **NEXT** soft key. The count will begin on the alpha standard.

```
S:   # R:   ####
Ex. Next  Edit
```

3. When the count is complete enter the count rates (CPMs) and disintegration rates (DPMs) for the alpha standard on the **Daily QC Check** worksheet. Ensure that the

results are acceptable. Verify that <10% of the activity appears in the beta channel. If not, inform the Fly Away Laboratory Manager.

8.9.1.7 Count the Beta Standard

1. Remove the Am-241 standard and insert the Cl-36 standard. Replace the NormCap.

2. Select the **NEXT** soft key. The count will begin on the beta standard.

```
S:   # R:   ####
Ex. Next  Edit
```

3. When the count is complete enter the count rates (CPMs) and disintegration rates (DPMs) for the alpha standard on the **Daily QC Check** worksheet. Ensure that the results are acceptable. Verify that <10% of the activity appears in the alpha channel. If not, inform the Fly Away Laboratory Manager.

8.9.1.8 Count the Samples

1. Select the **Sample Results** worksheet and enter the Analysis Request #, Sample Type, Sample Size, Unc. Sigma, QC Batch ID and the provided DRLs and/or L_Cs.

2. Place the sample in the chamber. Cover the chamber with the NormCap and lock in place.

3. Select the **START** soft key (purple key).

```
<Gabh3>  Ready
Start sys  Edit
```

4. The counter will begin counting the sample for the preset count time (generally 300 seconds).

```
<Gabh3>S:    #
T    ##D:  ####
```

5. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:   # C:   ###
Ex. Next  Edit
```

6. Enter the count rates (CPMs) and disintegration rates (DPMs) for the sample on the **Sample Results** worksheet.

7. Place the next sample in the chamber with the NormCap and select the **NEXT** soft key to count the remaining samples.

8. Count a background after every tenth sample.

9. When all of the samples have been counted select the **EX SOFT KEY.**

```
S:   # C:   ###
Ex. Next  Edit
```

10. Select the **YES** soft key.

```
End counting?
No   Yes
```

11. Create the EDD by selecting the cells in grey along with the Upload Settings field and paste into a new Workbook using **Paste Special, Values and Number formats**.

8.9.2 Tritium External Standard (H3ext)

8.9.2.1 Required Supplies

- Normal Cap (NormCap)
- External Standard Cap (containing Eu-152 sourece) (ExtCap)
- #3 UG Standard
- Background vial prepared using scintillation vials, cocktail, and deionized water in use at the site (the unquenched blank may be used if prepared background vials are unavailable)
- Prepared samples

8.9.2.2 Instrument Set-up

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Open the **Data Entry H3 YYYY_MM_DD.xlt** data sheet and select the Daily QC Check worksheet. Fill-in the highlighted cells for the Instrument, Count Date and count time.

3. On the Triathler™ Select the nuclide **H3ext** (**1** on the keypad).

Each background,standard and sample must be counted **TWICE**, first with the **ExtCap**, and then with the **NormCap**. The instrument indicates which cap to use at each time, but remember to always start counting a sample with the ExtCap.

8.9.1.3 Set the Count Time

1. Select **EDIT**.

```
<H3ext>   Ready
Start  Sys  Edit
```

2. Enter the count time in seconds. Samples are typically counted for 300 seconds.

```
Meas.time  <sec>:
unit    300
```

3. Press **Enter**, press the **Stop** soft key.

8.9.2.4 Count the Backgrounds

1. Place a background vial prepared using the scintillation vial, cocktail, deionized water, and swipe tab (if used) used as the site. Cover the chamber with the ExtCap and lock in place.

2. Select the **START** soft key (purple key).

```
<H3ext>   Ready
Start  Sys  Edit
```

3. The following may display:

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

5. Select the **YES** soft key.

```
Ext   Cap
Yes  ex.   no
```

6. The counter begins counting the background for the preset count time (generally 300 seconds).

```
<H3ext> S:    #
t   #  D:  ####
```

7. When the count is complete, the following screen is displayed:

```
Norm Cap
Yes  ex.   no
```

8. Replace the ExtCap with the NormCap and select the **YES** soft key. The second count on the background will begin.

```
<H3ext> S:    #
t   #  D:  ####
```

9. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:  # C:   ####
Ex. Next  Edit
```

10. Enter the count rates (CPMs) and disintegration rates (DPMs) for the background on the **Daily QC Check** worksheet.

11. Replace the NormCap with the Ext Cap and select **NEXT** to count the background again.

```
S:  # C:   ####
Ex. Next  Edit
```

12. Repeat steps 5 through 11 to count the background at least five times. Ensure that the results are acceptable for each of the backgrounds measured. If not, inform the Fly Away Laboratory Manager.

NOTE: The first one or two counts may yield high results due to exposure to light. If this is the case delete the data for the first one to two counts and repeat the background until there are a total of five background counts. High background can occur when operating the Triathler™ in elevated radiation fields. The ExtCap contains a Eu-152 source that elevates the background. Store this source a minimum of 3 feet (arm's length) from the Triathler™ when not in use. Check around the instrument to ensure that there are no other sources nearby.

8.9.2.5 Count the Tritium Standard

1. Remove the background vial and insert the #3UG vial. Cover with the ExtCap.
2. Select the **NEXT** soft key.
3. Repeat steps 5 through 9 in Section 8.9.2.4, Count the Backgrounds (above).

4. Enter the count rates (CPMs) and disintegration rates (DPMs) for the tritium standard on the **Daily QC Check** worksheet.
5. Ensure that the results are acceptable for the H-3 standard. If not inform the Fly Away Laboratory Manager.

8.9.2.6 Count the Samples

1. Remove the #3UG vial and insert the first sample. Cover with the ExtCap.
2. Select the **NEXT** soft key.
3. Repeat steps 5 through 9 in Section 8.9.2.4, Count the Backgrounds (above).
4. Enter the count rates (CPMs) and disintegration rates (DPMs) for the sample on the **Sample Results** worksheet.
5. Place the next sample in the chamber with the NormCap and select the **NEXT** soft key to count the remaining samples.
6. Count a background after every tenth sample.
7. When all of the samples have been counted select the **Ex** soft key.

```
S:   # C:   ####
Ex. Next  Edit
```

8. Select the **YES** soft key.

```
End  counting
No  Yes
```

9. Create the EDD by selecting the cells in grey along with the Upload Settings field and paste into a new Workbook using **Paste Special, Values and Number formats**.

8.9.3 Tritium Quench or DPM (H3que, H3dpm)

8.9.3.1 Required Supplies

- Normal Cap (NormCap)
- #3 UG Standard
- Background vial prepared using scintillation vials, cocktail, and deionized water in use at the site (the unquenched blank may be used if prepared background vials are unavailable)
- Prepared samples

8.9.3.2 Instrument Set-up

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Open the Data Entry **H3 YYYY_MM_DD.xlt** data sheet and select the **Daily QC Check** worksheet. Fill-in the highlighted cells for the Instrument, Count Date and count time.

3. On the Triathler™ Select the nuclide **H3que** or **H3dpm** (**8** or **9** on the keypad).

8.9.1.3 Set the Count Time

1. Select **EDIT**.

```
<H3que>   Ready
Start  Sys  Edit
```

2. Enter the count time in seconds. Samples are typically counted for 300 seconds.

```
Meas.time  <sec>:
unit    300
```

3. Press **Enter**, press the **Stop** soft key.

8.9.3.4 Count the Background

1. Place a background vial prepared using the scintillation vial, cocktail, deionized water, and swipe tab (if used) used as the site. Cover the chamber with the NormCap and lock in place.

2. Select the **START** soft key (Purple key).

```
<H3que>   Ready
Start  Sys  Edit
```

3. The following may display

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (approximately 10 seconds).

```
MCA calibration
   please wait
```

5. The counter will begin counting the sample for the preset count time (generally 300 seconds).

```
<H3que>S:   # A
T    ##  C:  #
```

6. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:   # R:   ####
Ex. Next  Edit
```

7. Enter the count rates (CPMs) and disintegration rates (DPMs) for the background on the **Daily QC Check** worksheet.

8. Repeat the background count at least four times. Ensure that the results are acceptable for each of the backgrounds measured. If not, inform the Fly Away Laboratory Manager.

   NOTE: The first one or two counts may yield high results due to exposure to light. If this is the case delete the data for the first one to two counts and repeat the background until there are a total of five background counts. High background can occur when operating the Triathler™ in elevated radiation fields. The ExtCap contains a Eu-152 source that elevates the background. Store this source a minimum of 3 feet (arm's length) from the Triathler™ when not in use. Check around the instrument to ensure that there are no other sources nearby.

8.9.3.5 Count the Tritium Standard

1. Remove the background and insert the #3 UG tritium source vial. Replace the NormCap.

2. Select the **NEXT** soft key. The count will begin on the Tritium standard.

```
S:   # R:   ####
Ex. Next  Edit
```

3. When the count is complete enter the count rates (CPMs) and disintegration rates (DPMs) for the alpha standard on the **Daily QC Check** worksheet. Ensure that the results are acceptable. If not, inform the Fly Away Laboratory Manager.

8.9.3.6 Count the Samples

1. Select the **Sample Results** worksheet and enter the Analysis Request #, Sample Type, Sample Size, Unc. Sigma, QC Batch ID and the provided DRLs and/or L_Cs.

2. Place the sample in the chamber. Cover the chamber with the NormCap and lock in place.

3. Select the **START** soft key (purple key).

```
<H3que>  Ready
Start sys Edit
```

4. The counter will begin counting the sample for the preset count time (generally 60 seconds).

```
<H3que>S:    #
T  ##D:  ####
```

5. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:   # C:   ###
Ex. Next  Edit
```

6. Enter the count rates (CPMs) and disintegration rates (DPMs) for the sample on the **Sample Results** worksheet.

7. Place the next sample in the chamber with the NormCap and select the **NEXT** soft key to count the remaining samples.

8. Count a background after every tenth sample.

9. When all of the samples have been counted select the **Ex** soft key**.**

```
S:   # C:   ###
Ex. Next  Edit
```

10. Select the **YES** soft key.

```
End counting?
No   Yes
```

11. Create the EDD by selecting the cells in grey along with the Upload Settings field and paste into a new Workbook using **Paste Special, Values and Number formats**.

8.10 Calibration

8.10.1 Tritium External Standards (H3ext)

The Triathler™s have the capability of creating a quench calibration curve using the external standards method. In this method, the quench standards are analyzed twice, once while exposed to an external gamma source (ExtCap) to determine the quench factor, and once with the NormCap to determine the count rate for the quench standard. An efficiency versus quench (calibration) curve is derived and stored by the instrument. Samples are then counted once with the ExtCap to determine the quench and once with the NormCap. The count rate (CPM) is then converted to disintegration rate (DPM) based on the efficiency determined from the calibration cuve.

8.10.1.1 Required Supplies

- Normal Cap (NormCap)
- External Standard Cap (containing Eu-152 source) (ExtCap)
- Tritium quench standards – #1UG, #2UG, #3UG, #5UG, #7UG, #9UG

8.10.1.2 Instrument Set-up

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Select the nuclide 1**, H3ext**. (The protocol should already have been set-up following the steps in Section 8.11.1, H-3 Protocols).

```
<H3ext>  Ready
start   sys Edit
```

3. Select the **SYS** soft key.

```
<H3ext>  Ready
start   sys Edit
```

```
Time(1)port(2)
Time ex edit buf
```

4. Select **4** on the keypad.

```
Vers (3) refr(4)
Time ex edit buf
```

5. Select the **EXT.** soft key.

```
Count Reference?
int. ex. ext. no
```

6. Select the **EX** soft key.

7. The instrument is now ready to begin counting the quench standards.

```
<H3ext>  Ready!
Start  sys Edit
```

8.10.1.3 Count the Quench Standards

Each quench standard must be counted **TWICE**; first with the **ExtCap**, and then with the **NormCap**. The instrument indicates which cap to use at each time, but remember to always start counting a sample with the ExtCap.

The standards should be counted in the order of least quenched (lowest standard number) to most quenched (highest standard number). Count tritium quench standards numbers 1,2,3,5,7 and 9 for the calibration.

1. Place the first quench standard in the chamber. Cover the chamber with the ExtCap and lock in place.

2. Select the **START** soft key (purple key).

```
<H3ext>   ReadyE!
Start  Sys  Edit
```

3. The following may display:

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

5. Select the **YES** soft key.

```
Ext   Cap
Yes  ex.   no
```

6. The counter begins counting the background for the preset count time (generally 300 seconds).

```
<H3ext> S:    #
t   ## D:  ####
```

7. When the count is complete, the following screen is displayed:

```
Norm Cap Std ( 1)?
yes  ex.   no
```

8. Replace the ExtCap with the NormCap and select the **YES** soft key. The second count on the background will begin.

```
<H3ext> S:    #
t   ## D:  ####
```

9. When the count is complete, the result is sent to the Commfiler program. The following screen is displayed:

```
S:  # C:   ####
Ex. Next  Edit
```

10. Place the next quench standard in the chamber with the ExtCap and select the **NEXT** soft key.

11. Repeat steps 5 through 10 above for each of the remaining standards in the quench set.

12. After completing both counts on the last quench standard, select **EX** to end the run.

13. Select **YES** to end the counting.

```
End counting?
No  Yes
```

14. The instrument displays the MaxDPM (maximum disintigration rate for the quench standards).

```
MaxDPM:     ####
Sd DPM:
```

15. Determine the decay corrected disintegration rate (DPM) for the quench standard set and enter as the Sd DPM using the numeric keypad. Press **ENTER.**

$$A_{T_1} = A_{T_0} exp^{-\left(\frac{\ln(2)}{(T_{1/2})(365.25)}\right)(T_1 - T_0)}$$

Where:

A_{T_1} = decay corrected activity
A_{T_0} = activity at reference date
$T_{1/2}$ = half-life for H-3, 12.35 years
T_1 = count date of the standard
T_0 = reference date of the standard

The Triathler™ prints the quench parameters and the corresponding efficiencies of the standards. It also indicates the efficiency taken from the curve and an error percentage (err %), which is the difference between the measured efficiency and the efficiency obtained from the quench curve.

16. Select **YES** to select Linear and save the calibration.

```
<LIN>Save stds
Yes  No     REG
```

```
Standards
Value saved
```

To test the system, count quench standard #3UG to determine how closely the measured "DPM" result matches the decay-corrected DPM value.

8.10.2 Tritium Quench (H3que)

This method determines the sample quench based on the tritium activity in the sample. An efficiency versus quench (calibration) curve is derived and stored by the instrument. Samples are then counted and the count rate (CPM) is converted to disintegration rate (DPM) based on the efficiency determined from the quench calibration cuve.

8.10.2.1 Required Supplies

- Normal Cap (NormCap)
- Tritium quench standards – #1UG, #2UG, #3UG, #5UG, #7UG, #9UG

8.10.2.2 Instrument Setup

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler

program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Select the nuclide 8**, H3que**. (The protocol should already have been set-up following the steps in Section 8.11.1, H-3 Protocols).

```
<H3que>  Ready
start   sys Edit
```

3. Select the **SYS** soft key.

```
<H3que>  Ready
start   sys Edit
```

```
Time(1)port(2)
Time ex edit buf
```

4. Select **4** on the keypad.

```
Vers (3) refr(4)
Time ex edit buf
```

5. Select the **YES**. soft key.

```
Count Reference?
Yes  ex.      no
```

6. Select the **EX** soft key.

7. The instrument is now ready to begin counting the quench standards.

```
<H3que>  Ready!
Start  sys Edit
```

8.10.2.3 Count the Quench Standards

The standards should be counted in the order of least quenched (lowest standard number) to most quenched (highest standard number). Count tritium quench standards numbers 1,2,3,5,7 and 9 for the calibration.

1. Place the first quench standard in the chamber. Cover the chamber with the NormCap and lock in place.

2. Select the **START** soft key (purple key).

```
<H3que>   Ready!
Start  Sys  Edit
```

3. The following may display:

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

5. The counter will begin counting the sample for the preset count time (generally 300 seconds).

```
<H3que>S:   #
t    #  D:  ####
```

6. When the count is through, place the next standard to be counted in the LSC and press the **NEXT** soft key.

```
S:   # D:   ####
Ex. Next Edit
```

7. Repeat this step for all 6 standards.

8. After the last standard is finished counting, press the **EX** soft key to end the run.

9. Select **YES** to end the counting.

```
End counting?
No  Yes
```

10. The instrument displays the MaxDPM (maximum disintigration rate for the quench standards).

```
MaxDPM:    ####
Sd DPM:
```

11. Determine the decay corrected disintegration rate (DPM) for the quench standard set and enter as the MaxDPM using the numeric keypad. Press **ENTER.**

$$A_{T_1} = A_{T_0} exp^{-\left(\frac{\ln(2)}{(T_{1/2})(365.25)}\right)(T_1 - T_0)}$$

Where:

A_{T_1} = decay corrected activity
A_{T_0} = activity at reference date
$T_{1/2}$ = half-life for H-3, 12.35 years
T_1 = count date of the standard
T_0 = reference date of the standard

The Triathler™ prints the quench parameters and the corresponding efficiencies of the standards. It also indicates the efficiency taken from the curve and an error percentage (err %), which is the difference between the measured efficiency and the efficiency obtained from the quench curve.

12. Select **YES** to select Linear and save the calibration.

```
<LIN>Save stds
Yes  No     REG
```

```
Standards
Value saved
```

To test the system, count quench standard #3UG to determine how closely the measured "DPM" result matches the decay-corrected DPM value.

8.10.3 Tritium Instant DPM (H3dpm)

The Instant DPM method uses a proprietary calculation to determine the sample quench. Like the Quench Curve method described above, it depends on H-3 activity in the sample to determine the quench. A single quench standard is used to determine a DPM/CPM factor. This factor, along with the sample quench, is used to determine the calibration.

8.10.3.1 Required Supplies

- Normal Cap (NormCap)

- #3 UG Standard

8.10.3.2 Instrument Setup

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Select the nuclide 9**, H3dpm**. (The protocol should already have been set-up following the steps in Section 8.11.1, H-3 Protocols).

```
<H3dpm>  Ready
start   sys Edit
```

8.10.3.3 Reset the Response Factor

1. Access the special "service mode" by entering <**2557**> on the numeric keypad. This activates service mode, which is indicated by an "*" soft key. The following menu is displayed.

2. Press the **EDIT** soft key.

```
<H3dpm>  Ready
Start* Sys Edit
```

3. Press **ENTER** until the following is displayed:

4. Press the **YES** soft key to edit the protocol.

```
<yes>Res.factor
yes exit    no
```

5. Enter the 1.0000 (use the **START** soft key to enter the decimal point), then, press **ENTER.**

```
F:  0.9460
<'.'>:1.0000
```

```
<single>
Sing.ex. 2ch ch
```

6. Press the **STOP** soft key to return the normal menu.

```
<H3dpm>
Start*  sys edit
```

7. Enter <**2557**> on the keyboard to exit from the special "service mode." The "*" should disappear.

```
<H3dpm>
Start  sys edit
```

8.10.3.4 Count the Quench Standard

1. Place the UG#3 quench standard in the chamber. Cover the chamber with the NormCap and lock in place.

2. Select the **START** soft key (purple key).

```
<H3dpm>   Ready!
Start  Sys  Edit
```

3. The following may display:

```
Stabilizing
   please wait
```

4. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

5. The counter will begin counting the standard for the preset count time (generally 300 seconds).

```
<H3dpm>S:   #
t    #  D:  ####
```

6. When the count is through, press the **Ex** soft key.

```
S:   # D:   ####
Ex. Next Edit
```

7. Look at the LSC reported DPM (second column). Divide the decay corrected DPM by the reported DPM. This will be your Response Factor (Res. Factor).

$$\text{Res Factor} = \frac{\text{True DPM}}{\text{Reported DPM}}$$

8. To access a special "service mode", type in **<2557>** using the LSC keyboard. This activates service mode, which is indicated by an "*" soft key. The following menu is displayed.

9. Press the **EDIT** soft key.

```
<H3dpm  Ready
Start* Sys Edit
```

10. Press **ENTER** until the following is displayed:

11. Press the **YES** soft key to edit the protocol.

```
<yes>Res.factor
yes exit    no
```

12. Enter the Res Factor you calculated above; use the **START** soft key to enter the decimal point. Then, press **ENTER.**

```
F:  1.0000
<'.'>:
```

```
<single>
Sing.ex. 2ch ch
```

13. Press the **STOP** soft key to return the normal menu.

```
<H3dpm>
Start*  sys edit
```

14. Enter **<2557>** on the keyboard to exit from the special "service mode." The "*" should disappear.

```
<H3dpm>
Start  sys edit
```

To test the system, count quench standard #3UG to determine how closely the measured "DPM" result matches the decay-corrected DPM.

8.10.4 Gross Alpha/Beta/Tritium (Gabh3)

The Gross Alpha/Beta/Tritium (Gabh3) protocol uses single-point efficiency (Response Factors) calibrations. Unquenched Am-241 and Cl-36 standards are used to determine the Response Factor (DPM/CPM).

8.10.4.1 Required Supplies

- Normal Cap (NormCap)
- Unquenched Am-241 Standard
- Unquenched Cl-36 Standard

8.10.4.2 Instrument Setup

1. Ensure that the Triathler™ is connected to a computer and printer; the Triathler™, computer, and printer are on; and the printer is ready for use. Start the Commfiler program by selecting commfiler.exe from the Hidex folder. Allow the LSC to warm-up for five minutes.

2. Select the nuclide 7**, Gabh3**. (The protocol should already have been set-up following the steps in Section 8.11.2, Gabh3 Protocol).

```
<Gabh3>  Ready
start   sys Edit
```

8.10.4.3 Count the Standards

1. Reset the Response Factor to 1.0000 as indicated in Section 8.11.2, Gabh3 Protocol.

2. Place the Am-241 standard in the chamber. Cover the chamber with the NormCap and lock in place.

3. Select the **START** soft key (purple key).

```
<Gabh3>   Ready!
Start  Sys  Edit
```

4. The following may display:

```
Stabilizing
   please wait
```

5. Wait until the system completes stabilizing (appoximately 10 seconds).

```
MCA calibration
   please wait
```

6. The counter will begin counting the sample for the preset count time (generally 300 seconds).

```
<Gabh3>S:   #
t    #  D:  ####
```

7. When the count is through, place the next standard to be counted in the LSC and press the **NEXT** soft key.

```
S:   # D:   ####
Ex. Next Edit
```

8. Look at the LSC reported DPM. Divide the decay corrected DPM by the reported DPM. This will be your Response Factor (Res. Factor).

$$\text{Res Factor} = \frac{\text{True DPM}}{\text{Reported DPM}}$$

9. Repeat steps 1 through 7 with the Cl-36 standard and the #3UG tritium standard.

10. Enter the Response Factors as indicated in Section 8.11.2, Gabh3 Protocol.

To test the system, count unquenched Am-241 and Cl-36 standards to determine how closely the measured "DPM" result matches the decay-corrected DPM.

8.11 Creating the Counting Protocols

8.11.1 H-3 Protocols

Protocols 1, 8 and 9 are modified to provide three different protocols for counting tritium samples as follows:

Protocol 1	H3ext	Tritium analyses using the external standard
Protocol 8	H3que	Tritium analyses using a stored quench curve
Protocol 9	H3dpm	Tritium analyses using the Instant DPM method

The three tritium protocols are similar. However, they use different methods for correcting for sample quench. The following steps are followed to create the protocols. Separate options are included where appropriate for each of the three protocols.

Table 8.2: Summary of differences between tritium protocols

Protocol	H3ext	H3que	H3dpm
Protocol Number	1	8	9
Response Factor	No	No	Yes
Quench Correction	Yes	Yes	Yes
Instant DPM	No	No	yes
Sample Mode (Smode)	(2)ex.Stand	(0)none	(0)none

1. Select the protocol to be modified by pressing the protocol number on the keypad.
   - For H3ext select <**1**>
   - For H3que select <**8**>
   - For H3dpm select <**9**>

```
<name >    Ready
start   sys edit
```

2. Place the instrument in the “service mode” by entering <**2557**> on the keypad. Service mode is indicated by an “*” following the word “start” on the second line of the display.

```
<name >    Ready
start*  sys edit
```

3. Select <**edit**> on the soft keys. Set the parameters as described below.
   - Press **ENTER** on the keypad to move through the main screens.
   - Press the purple soft key below the selection to select the value.
   - Use the numeric keypad to enter numeric values.
   - Press **ENTER** on the keypad to accept the value/setting.
   - Press the **STOP** soft key (<**ex.**>, <**exit**>) to exit from editing the protocol.
4. Enter the count time in seconds (typically 300 seconds).

```
Meas.time <sec>
unit 300
```

5. Enter the channels for the tritium window (typically channels 30 to 120).

```
<name> Window
  30 low
```

```
<name> Window
 120 high
```

6. Enter the count rate to be subtracted from all samples (enter 0 for no background subtraction).

```
<name>Bg CPM
Bg:   0
```

7. The Response Factor is determined in step 8.10.3 for H3dpm.
   - Enter < **no**> for H3ext and H3que.
   - Enter <**yes**> for H3dpm, then enter the calculated Response Factor on the next screen (use the **START** soft key to enter the decimal point).

```
< no>Res. Factor
yes exit      no
```

```
F: 1.0000
<','>:
```

8. Select single channel (<**sing.**>) for the tritium protocols.

```
<Single>
sing.ex. 2ch 3ch
```

9. The next screens allow you to select and edit the various parameters.
   - On the numeric keypad press the number key corresponding to the number in the parenthesis following the parameter, or select the purple soft key below the parameter.
   - Enter/select the values shown below.
   - **Note: Pressing the <ex.> will exit you from the edit protocol screens**.

```
Spect(1) Disp(2)
rate ex.view prt
```

```
Mx.C(3)Repeat(4)
rate ex.view prt
```

10. Enter the starting and stopping channels for the spectrum display (typically channels 10 to 1024).

<1>

```
<name> Spectrum
  10 Start
```

```
<name> Spectrum
1024 Stop:
```

11. Enter <**down**> for the timer to count down, and <**up**> for the timer to count up (default is <**down**>).

<2>

```
Count(down)
up  ex.     down
```

12. Enter the preset counts the detector should count to. Entering **0** allows the counter to count until the preset time is reached.

<3>

```
<name>Mx.counts
Mx:     0
```

13. Enter <**yes**> to repeat the sample counts and < **no**> to count each sample once (default is < **no**>).

<4>

```
< no> Repeat
yes ex.      no
```

14. Select the unit to report the count rate in (<**CPM**>).

<rate>

```
<CPM> Rate unit
CPM ex.     CPS
```

15. Select the unit to report the activity in (<**DPx**>).

<view>

```
<DPx> View unit
CPx ex. DPx CNT
```

16. Select the parameters to be sent to the Commfiler program.
    - On the numeric keypad press the number key corresponding to the parameter you wish to edit.
    - Alternately press the <**step**> soft key to scroll through all of the parameters.
    - Press **ENTER** or <**set**> to edit the displayed parameter.
    - In the parameter edit screen, press the associated soft key (<**yes**>, < **no**>) to change the setting, or press **ENTER** to accept the current setting.

<prt>	`Set(0)Windows` `ex. step set`	**<0>**	`Set(0)Windows` `ex. step set`	`<yes>Windows` `yes exit no`
		<1>	`Set(1)Time` `ex. step set`	`<yes>Time` `yes exit no`
		<2>	`Set(2)Counts` `ex. step set`	`< no>Counts` `yes exit no`
		<3>	`Set(3)CPM` `ex. step set`	`<yes>CPM` `yes exit no`
		<4>	`Set(4)DPM` `ex. step set`	`<yes>DPM` `yes exit no`
		<5>	`Set(5)ElapsTime` `ex. step set`	`< no>ElapsTime` `yes exit no`
		<6>	`Set(6)Deadtime` `ex. step set`	`<yes>Deadtime` `yes exit no`
		<7>	`Set(7)Spectra` `ex. step set`	`<yes>Spectra` `yes exit no`
		<8>	`Set(8)Qparam` `ex. step set`	`<yes>Qparam` `yes exit no`

17. Press < **ex.**> to continue to the next screen.

`Spect(1) Disp(2)` `rate ex.view prt`	`Mx.C(3)Repeat(4)` `rate ex.view prt`

18. Press **ENTER** to continue.

19. Select <**yes**> to perform quench corrections.

```
<yes>Quench corr
yes exit      no
```

20. Select or deselect the Instant DPM mode.
    - For H3ext and H3que select < **no**>.
    - For H3dpm select <**yes**>.

```
< no>InstantDPM
yes exit      no
```

21. Enter the windows for the external sample channel ratios (ESCR).

```
<name> ESCR:
 100 LowW.:
```

```
<name> ESCR:
 200 MidW.:
```

```
<name> ESCR:
1023 HighW.:
```

22. Select the sample mode.
    - Use the **ENTER** key to scroll through the sample modes, or select the sample mode by pressing the numeric key that corresponds to the number in parenthesis following the sample mode.
    - Select <**0**> for H3que and H3dpm.
    - Select <**2**> for H3ext.

```
Smode(2)Ex.Stand
    ex. step set
```

```
Smode(0)None
    ex. step set
```

```
Smode(1)Dicopac
    ex. step set
```

```
Smode(2)Ex.Stand
    ex. step set
```

23. Select the scale (linear vs. logarithmic) to display the data (default is **<lin>**).

```
<lin>Scale
lin ex. log
```

24. Select **< no>** for high activity.

```
< no>High activ.
Yes exit      no
```

25. Enter the name for the protocol (accept the default name).

```
New name:name
Sel ex. step new
```

26. Select the Label for the analysis being performed.
    - Use the **ENTER** key to scroll through the labels, or select the label by pressing the numeric key that corresponds to the number in parenthesis following the sample mode.
    - Select **<2>** beta for tritium analyses.

```
Label(2)beta
    ex. step
```

```
Label(0)gamma
    ex. step
```

```
Label(1)ex_gamma
    ex. step
```

```
Label(2)beta
    ex. step
```

```
Label(3)h_beta
    ex. step
```

```
Label(4)alpha
    ex. step
```

```
Label(5)lumi
```

```
ex. step
```

27. Press **ENTER** to finish editing the protocol.

```
<name >    Ready
start*  sys edit
```

28. Press **<2557>** to exit the "service mode".

```
<name >    Ready
start   sys edit
```

8.11.2 Gabh3 Protocol

The manufacturer does not dedicate a number on the keyboard for the Gabh3 protocol. Since the I-125 protocol (protocol 7) is not widely used, it was replaced with the Gabh3 protocol. The following procedure will guide you through the process to create the Gabh3 protocol.

1. Select the Gabh3 protocol on the numeric keypad **<7>**.

```
<Gabh3>    Ready
start   sys edit
```

2. Place the instrument in the "service mode" by entering <**2557**> on the keypad. Service mode is indicated by an "*" following the word "start" on the second line of the display.

```
<Gabh3>    Ready
start*  sys edit
```

3. Select **<edit>** on the soft keys. Set the parameters as described below.
   - Press **ENTER** on the keypad to move through the main screens.
   - Press the purple soft key below the selection to select the value.
   - Use the numeric keypad to enter numeric values.
   - Press **ENTER** on the keypad to accept the value/setting.
   - Press the **STOP** soft key (**<ex.>**, **<exit>**) to exit from editing the protocol.

4. Enter the count time in seconds (typically 300 seconds).

```
Meas.time <sec>
```

```
unit 300
```

5. Enter the channels for the alpha window (typically channels 300 to 1000).

```
<Gabh3>A.Window
 300 low
```

```
<Gabh3>A.Window
1000 high
```

6. Select the channel type (<alp>).

```
<Alpha>Ch type
bet ex. A+B alp
```

7. Enter the alpha to beta discriminator setting (pulse length indicator, PLI) determined in section 8.12.3 Adjusting the Alpha/Beta Discriminator.

```
Gabh3>Cutoff
352 PLI:
```

8. Enter the count rate to be subtracted from all samples (enter 0 for no background subtraction).

```
<name>Bg CPM
Bg:   0
```

9. The Response Factor for the alpha standard (Am-241) is determined in step 8.10.4. Select **<yes>**, then enter the calculated Response Factor on the next screen (use the **START** soft key to enter the decimal point).

```
<yes>Res. Factor
yes exit      no
```

```
F: 1.0000
<','>:
```

10. Select **<3ch>**. (Do not press Enter or the <**ex.**> soft key. This will exit you from editing the protocol.) After selecting <3ch> a second screen will appear which will allow you to edit the second and third channels.

```
<3ch>
sing.ex. 2ch 3ch
```

```
Edit(2) Edit(3)
sing.ex. 2ch 3ch
```

- On the numeric keypad press the number key corresponding to the channel you wish to edit.

- Enter/select the values shown below.

11. Select the second window (Beta) by pressing **<2>** on the numeric keypad. Enter the channels for the beta window (typically 150 to 1000)

<2>

```
< beta>Window
 150 low:
```

```
< beta>Window
1000 high:
```

12. Enter the beta window channel type **(<beta>)**.

```
< beta>Ch type
bet ex. A+B Alp
```

13. Enter the count rate to be subtracted from all samples (enter **0** for no background subtraction).

```
< beta>Bg CPM
Bg:    0
```

14. The Response Factor for the beta standard (Cl-36) is determined in step 8.10.4. Select **<yes>**, then enter the calculated Response Factor on the next screen (use the **START** soft key to enter the decimal point).

```
<yes>Res. Factor
yes exit      no
```

```
F: 1.0000
<','>:
```

15. Enter the name for the window (**Beta**) (accept the default name).

```
New name: Beta
sel.ex. step new
```

16. Select the third window (H3) by pressing **<3>** on the numeric keypad. Enter the channels for the tritium window (typically 18 to 150).

<3>

```
<   H3>Window
  18 low:
```

```
<   H3>Window
 150 high:
```

17. Enter the tritium window channel type (**<beta>**).

```
< beta>Ch type
bet ex. A+B Alp
```

18. Enter the count rate to be subtracted from all samples (enter 0 for no background subtraction).

```
<   H3>Bg CPM
Bg:    0
```

19. The Response Factor for the tritium standard (#3UG) is determined in step 8.10.4. Select **<yes>**, then enter the calculated Response Factor on the next screen (use the **START** soft key to enter the decimal point).

```
<yes>Res. Factor
yes exit      no
```

```
F: 1.0000
<','>:
```

20. Enter the name for the window (**H3**) (accept the default name).

```
New name:   H3
sel.ex. step new
```

21. Press **<ex.>** to continue to the next screen.

```
<3ch>
sing.ex. 2ch 3ch
```

```
Edit(2) Edit(3)
sing.ex. 2ch 3ch
```

22. Press **ENTER** to move to the next screen.

23. The next screens allow you to select and edit the various parameters.
    - On the numeric keypad press the number key corresponding to the number in the parenthesis following the parameter, or select the purple soft key below the parameter.
    - Enter/select the values shown below.
    - **Note: Pressing the <ex.> will exit you from the edit protocol screens**.

```
Spect(1) Disp(2)
```

```
Mx.C(3)Repeat(4)
```

```
rate ex.view prt
```

```
rate ex.view prt
```

24. Enter the starting and stopping channels for the spectrum display (typically channels 10 to 1024).

<1>

```
<name Spectrum
  10 Start
```

```
<name> Spectrum
1024 Stop:
```

25. Enter the starting channel for the 2Dplot (default is 0).

```
<Gabh3>2Dplot
   0 Start:
```

26. Enter <**down**> for the timer to count down, and <**up**> for the timer to count up (default is <**down**>).

<2>

```
Count(down)
up  ex.     down
```

27. Enter the preset counts the detector should count to. Entering **0** allows the counter to count until the preset time is reached.

<3>

```
<Gabh3>Mx.counts
Mx:     0
```

28. Enter <**yes**> to repeat the sample counts and < **no**> to count each sample once (default is < **no**>).

<4>

```
< no> Repeat
yes ex.      no
```

29. Select the unit to report the count rate in (<**CPM**>).

<rate>

```
<CPM> Rate unit
CPM ex.     CPS
```

30. Select the unit to report the activity in (<**DPx**>).

<view>

```
<DPx> View unit
CPx ex. DPx CNT
```

31. Select the parameters to be sent to the Commfiler program.
    - On the numeric keypad press the number key corresponding to the parameter you wish to edit.
    - Alternately press the <**step**> soft key to scroll through all of the parameters.

- Press **ENTER** or <**set**> to edit the displayed parameter.
- In the parameter edit screen, press the associated soft key (<**yes**>, < **no**>) to change the setting, or press **ENTER** to accept the current setting.

<prt>	`Set(0)Windows` `ex. step set`	**<0>**	`Set(0)Windows` `ex. step set`	`<yes>Windows` `yes exit no`
		<1>	`Set(1)Time` `ex. step set`	`<yes>Time` `yes exit no`
		<2>	`Set(2)Counts` `ex. step set`	`< no>Counts` `yes exit no`
		<3>	`Set(3)CPM` `ex. step set`	`<yes>CPM` `yes exit no`
		<4>	`Set(4)DPM` `ex. step set`	`<yes>DPM` `yes exit no`
		<5>	`Set(5)ElapsTime` `ex. step set`	`< no>ElapsTime` `yes exit no`
		<6>	`Set(6)Deadtime` `ex. step set`	`<yes>Deadtime` `yes exit no`
		<7>	`Set(7)Spectra` `ex. step set`	`<yes>Spectra` `yes exit no`
		<8>	`Set(8)Aspectra` `ex. step set`	`<yes>Qparam` `yes exit no`
			`Set(9)2Dplot` `ex. step set`	`<yes>2Dplot` `yes exit no`

32. Press < **ex**> to continue to the next screen.

`Spect(1) Disp(2)` `rate ex.view prt`	`Mx.C(3)Repeat(4)` `rate ex.view prt`

33. Press **ENTER** to continue.

34. Enter thy Y-gain determined in step 8.12.1 Optimizing the Y-gain.

```
<Gabh3>2Dplot
 86 y-gain>
```

35. Enter the Y-position (y-pos) determined in the procedure.

```
<Gabh3>2Dplot
 52 y-pos:
```

36. Enter the default delay of 30.

```
<Gabh3>2Dplot
 30 delay:
```

37. Enter the bias voltage determined in step 8.12.4 Setting the Bias Voltage. Entering **0** uses the default bias voltage (recommended).

```
<Gabh3>Bias V.:
  0 Volts:
```

38. Select the scale (linear vs. logarithmic) to display the data (default is **<log>**).

```
<log>Scale
lin ex. log
```

39. Enter the name for the protocol (accept the default name).

```
New name:Gabh3
sel ex. step new
```

40. Select they Label for the analysis being performed.
    - Use the **ENTER** key to scroll through the labels, or select the label by pressing the numeric key that corresponds to the number in parenthesis following the sample mode.
    - Select **<2>** beta for tritium analyses.

```
Label(4)alpha
    ex. step
```

```
Label(0)gamma
```

```
    ex. step
```

```
Label(1)ex_gamma
    ex. step
```

```
Label(2)beta
    ex. step
```

```
Label(3)h_beta
    ex. step
```

```
Label(4)alpha
    ex. step
```

```
Label(5)lumi
    ex. step
```

41. Press **ENTER** to finish editing the protocol.

```
<name >    Ready
start*  sys edit
```

42. Press **<2557>** to exit the "service mode".

```
<name >    Ready
start   sys edit
```

8.12 Optimizing the System

8.12.1 Optimizing the Y-Gain

1. Place a high energy beta emitter (like Cl-36) in the counting chamber.

2. Press the <**start**> Softkey.

```
<Alpha>  Ready
Start*  sys Edit
```

3. At count completion, record the number of counts in the Alpha channel.

```
<Alpha>S:   # A
t    # C:     ##
```

```
S:   # C:    ##
   Ex. Next Edit
```

4. Press the <**Stop**> softkey. Answer <**Yes**> to "stop counting?"

5. Press the <**Edit**> softkey.

```
<Alpha>  Ready
Start*  sys Edit
```

6. Then press the <**Enter**> key on the keypad until the following is displayed.

```
<Alpha>  2Dplot
  ## Y-gain:
```

7. If the counts reported in the Alpha channel are < 1% of the true activity, increase the Y-gain by 5. If the activity reported in the Alpha channel is > 5% of the true beta activity, decrease the Y-gain by 5.

8. Then press the <**Enter**> key until you return to the ready mode.

```
<Alpha>  Ready
Start*  sys Edit
```

9. Repeat the steps 2 through 8 above until the 1% to 5% of the beta counts appear in the alpha channel.

10. Now load the alpha standard in the LSC. Observe the counts in the beta channel (switch to the beta channel by pressing <**0**> on the keypad). If < 6% of the alpha counts appear in the beta channel, then increase the Y-gain by 5 and count the Beta standard again. If the activity reported in the Alpha channel is > 5% of the true beta activity, proceed to Section 8.12.3, Adjusting the Alpha/Beta Discriminator.

8.12.2 Optimizing the Tritium Window

1. To optimize the "h3" window, first count the unquenched blank sample using the Alpha protocol. Either export the 1D spectrum to a computer, or perform several counts using different lower windows settings. The goal is to adjust the LOW channel on the window as low as possible and yet maintain < 100CPM when counting the unquenched blank sample.

8.12.3 Adjusting the Alpha/Beta Discriminator

1. Connect the LSC to a computer running Commfil.exe and the Spectr2d.xls program.
2. Select the alpha-beta protocol by pressing **<4>** on the keyboard.
3. Count an unquenched Alpha Standard.
4. Record the results of the count in both the Alpha and Beta channels. This can be done by pressing the **<0>** on the keyboard to switch back and forth between the Alpha & Beta channels, or by viewing the Commfil window after the count.
5. Send the 2Dplot to the computer by pressing **<3>** **<Enter>** during or after the count.
6. After the data is sent over, click on the **[Import Alpha]** button on the Command worksheet of the Spectr2d.xls program to view a 2D plot.
7. Replace the Alpha Standard with the Beta Standard in the counting chamber. Count the beta standard by pressing the **<Next>** softkey.
8. Record the results of the count in both the Alpha and Beta channels. This can be done by pressing the **<0>** key on the LSC to switch back and forth between the Alpha & Beta channels, or by viewing the Commfil window after the count.
9. Send the 2Dplot to the computer by pressing **<3>** **<Enter>** after the count.
10. Look at the beta low energy tail on the 2D plot. If there are a significant number of counts in the Alpha Window, Increase the Zadd parameter by 10.
11. Next, try increasing the HV (using the service mode, <*> softkey) by 5 or 10 points.
12. Next try; pressing the **<Edit>** softkey followed by the **<Enter>** (?? Times) key until the following is displayed:

```
<Alpha>  Cutoff
500          PLI
```

13. Look at the 2 plots produced, adjust the PLI (in increments of 50) to try and obtain the following objectives:

Source Type	Alpha Channel Cpm/source DPM	Beta Channel CPM/souce DPM
Alpha	>90%	<10%
Beta	<10%	>80%

14. After changing the PLI, re-measure the alpha and beta standards until achieving the desired results.

8.12.4 Setting the Bias Voltage

1. Select **<H3dpm>** on the LSC keyboard (**<3>** on the keypad).

```
<H3dpm>  Ready
Start sys  Edit
```

2. To access a special "**service mode**", type in **<2557>** using the LSC keyboard. This activates the service mode which is indicated by an "*" softkey. The following menu will be on the display.

```
<  H-3>  Ready
Start*  sys  Edit
```

3. Place the #1UG H-3 standard in the LSC. Decay correct its activity and multiply by 0.27. This is your target CPM value during the following voltage adjustments.

4. Press the <**Start**> softkey to start counting.

```
<  H-3>  Ready
Start*  sys  Edit
```

```
<  H-3>S:   #
Start*  sys  Edit
```

5. Compare the reported CPM value to your target value. If it differs by more than 5%, make the following adjustments.

   a. Press the <**Ex.**> softkey.

```
S:   # C:  ####
   Ex. Next Edit
```

   b. Press the <**Yes**> softkey when asked "End Counting?"

```
End counting ?
No  Yes
```

   c. Press the <*> softkey (also labeled "Stop").

```
<  H-3>  Ready
Start*  sys Edit
```

   d. If the reported CPM was too high, then lower the voltage by **5** (then press <**Enter**>).

```
<HV> Bias V.:
### :
```

   e. If the reported CPM was too low, then raise the voltage by **5** (then press <**Enter**>).

6. Repeat from step 4 until the desired voltage is obtained.

7. Press the <**Ex.**> softkey.

8. Press the <Yes> softkey.

```
End counting ?
No  Yes
```

```
<  H-3>  Ready
Start*  sys Edit
```

8.13 Initial Set-up of the LSC After Chip Replacement or System Reset

Several changes are made to the default setup for effective use in field conditions. With the exception of occasional re-calibrations, these changes only need to be made once after a chip replacement or system reset (See the "Master Clear" section of the Triathler manual).

8.13.1 Setting the System Clock

1. At the ready window, Press the <**sys**> softkey.

```
<H-3> Ready
```

```
Start sys  Edit
```

```
Time(1) port(2)
time ex.edit buf
```

```
Vers(3) refr(4)
time ex.edit buf
```

2. Press <**1**> on the numeric keypad to display the current time and date.

```
HH: MM : SS
DD  MMM.  YYYY
```

3. Press the **STOP** soft key to exit.

```
Time(1) port(2)
time ex.edit buf
```

```
Vers(3) refr(4)
time ex.edit buf
```

4. Enter the current time and date.
   - Press the <**time**> softkey.
   - Use the numeric keypad to enter the value for the current seconds, minutes, hour (24-hour format), date, month, and 2-digit year.
   - Press enter to move to the next selection.

<time>

```
<  59> Set sec:
  ## sec:
```

```
<  59> Set min:
  ## min:
```

```
<  23> Set hour:
  ## hour:
```

```
<  31> Set date:
  ## day:
```

```
<  12>Set month:
  ## month:
```

```
<  99> Set year:
  ## year:
```

5. Press the <**yes**> soft key to accept the new values.

```
New values?
yes exit      no
```

```
HH: MM : SS
DD  MMM.  YYYY
```

6. Press the **STOP** softkey to return to the main screen

```
<H-3> Ready
Start sys  Edit
```

8.13.2 Setting the System Default Parameters

1. At the ready window, Press the <**sys**> softkey.

```
<H-3> Ready
Start sys  Edit
```

```
Time(1) port(2)
time ex.edit buf
```

```
Vers(3) refr(4)
time ex.edit buf
```

2. Press the **<edit>** softkey.
   - On the numeric keypad press the number key corresponding to the parameter you wish to edit.
   - Alternately press the <Step> soft key to scroll through all of the parameters.
   - Press **ENTER** or **<set>** to edit the displayed parameter.
   - In the parameter edit screen, press the associated soft key (**<yes>**, **< no>**) to change the setting, or press **ENTER** to accept the current setting.
3. Select **<yes>** to ensure the system provides an extended parameter list.

<0>

```
Set(0) ex_edit
    ex step set
```

```
<yes>ex_edit
yes exit      no
```

4. Select **<yes>** to set the system to always beep after a count.

<1>

```
Set(1) buzzer
    ex step set
```

```
<yes>buzzer
yes exit      no
```

5. Select **< no>** to set the system to **not** send the spectra to the buffer.

<2>

```
Set(2)spec>>buff
    ex step set
```

```
< no>spec>>buff
yes exit      no
```

6. Select **<yes>** to set the system to send the data to the buffer.

<3>

```
Set(3)data>>buff
    ex step set
```

```
<yes>data>>buff
yes exit      no
```

7. Select **<yes>** to allow the system to perform alpha counting.

<4>

```
Set(4)alpha_win
    ex step set
```

```
<yes>alpha_win
yes exit      no
```

8. Select **< no>** to **not** allow TTL output.

<5>

```
Set(5)TTL output
    ex step set
```

```
< no> TTL output
yes exit      no
```

9. Select **< no>** to allow editing of parameters.

```
Set(6) Lock_Edit
    ex step set
```

```
< no>Lock_Edit
yes exit      no
```

10. Select **< no>** to **not** lock the system.

```
Set(7) Lock_All
    ex step set
```

```
< no>Lock_All
yes exit      no
```

11. Select **< no>**, this function is not in use.

```
Set(8) Injector
    ex step set
```

```
< no>Injector
yes exit      no
```

12. Select < **no**>, this function is not in use.

```
Set(9) Pipette
    ex step set
```

```
< no>Pipette
yes exit      no
```

13. Press the <**exit**> soft key to exit.

```
Vers(3)  refr(4)
Time ex edit buf
```

```
Vers(3)  refr(4)
Time ex edit buf
```

14. Press the <**ex**> soft key to return to the ready menu.

```
<H-3>  Ready
Start sys  Edit
```

8.14 References

1. Triathler™ Multilabel Tester Owner's Handbook, Document #410-001-1.800.

Section 9. Analytical Balance Use

Table of Contents

9.1 Introduction 3
- 9.1.1 Scope and Application 3
- 9.1.2 Summary of Method 3
- 9.1.3 Responsibilities 3

9.2 Balance Setup 3
- 9.2.1 Safety/Environment/Precautions 3
- 9.2.2 Required Equipment 5
- 9.2.3 Installation Location and Requirements 5
- 9.2.4 Assembly 6
- 9.2.5 Conditioning the Balances 7
- 9.2.6 Leveling 7
- 9.2.7 Connecting to AC Power 7
- 9.2.8 Energizing/De-energizing 7
- 9.2.9 Calibration/Adjustment 8

9.3 Daily Linearity, Reproducibility, and Accuracy Checks 10
- 9.3.1 Linearity Checks 10
- 9.3.2 Reproducibility Checks 11
- 9.3.3 Accuracy Checks 12
- 9.3.4 Action for Linearity, Reproducibility or Accuracy Check Failure 13

9.4 Procedure 13
- 9.4.1 Weighing Samples 13
- 9.4.2 Taring 14

9.5 Preparation for Transport 14
- 9.5.1 Preparation of Balances for Transport 14
- 9.5.2 Preparation of Weights for Transport 15

9.6 Maintenance 15
- 9.6.1 Annual Calibration and Preventative Maintenance of Balances 15
- 9.6.2 Annual Calibration of Weights 15
- 9.6.3 Safety Inspection 15
- 9.6.4 Balance Cleaning 16

9.7 Records 16
- 9.7.1 Calibration /Adjustment Log 16
- 9.7.2 Daily Linearity and Accuracy Checks Log 16
- 9.7.3 Weekly Reproducibility Check Log 17

9.8 Balance Specifications 17

Tables

Table 9.1: Weights for Linearity Check 11
Table 9.2: Weights for Reproducibility Check 12
Table 9.3: Balance Specifications 17

9.1 Introduction

The Fly Away Laboratory maintains three top-loading precision balances for the purpose of weighing analytical samples in the field. Limiting weight capacity is 6,200 g, and limit of accuracy is 0.001g (0g-500g range). All balances and weights are calibrated annually by a certified vendor. Preventative maintenance service is performed at the time of calibration. Annual calibration and routine check records are located in the designated binder for each balance.

9.1.1 Scope and Application

This procedure describes the steps to set up the Fly Away Laboratory balances, perform and document quality assurance (QA) checks, deal with failure of QA checks, measure samples, and prepare the balances for transport and storage. In addition to the annual calibration and preventative maintenance services, linearity and accuracy checks are performed daily prior to operation on all balances. A reproducibility check is performed weekly.

9.1.2 Summary of Method

Upon setup, a calibration/adjustment and a complete set of accuracy, linearity, and reproducibility checks are performed for each balance and tolerance range(s). Daily prior to measurements, linearity checks, and an accuracy check for each measurement process are performed using the closest certified calibration weight(s). Following initial setup, reproducibility checks are performed weekly.

9.1.3 Responsibilities

Annual calibrations and preventative maintenance are performed by a certified outside vendor. The vendor completes the service, updates the calibration stickers, and provides a calibration certificate for each balance and the weight set.

Fly Away Laboratory personnel are responsible for initial setup of the balances, plus performance and documentation of initial quality assurance checks. In conjunction with the weighing of samples and properly documenting the results, laboratory personnel are responsible for performing and documenting routine quality assurance checks for each balance. With termination of the deployment, Fly Away Laboratory personnel are then responsible for safely preparing the balances for transport.

9.2 Balance Setup

9.2.1 Safety/Environment/Precautions

Safety

- Care should be taken when lifting heavy weights to avoid personal injuries.
- The balances are not allowed to be used in hazardous areas/locations because they do not have EX approval certificates certifying them as electrical apparatuses for potentially explosive atmospheres (Certificate of Conformity).

Environment

In order to pass any test of reproducibility, an instrument must be operating in an acceptable environment. A poor environment degrades the results of a standard deviation (SD) test and falsely suggests that the performance is substandard. There are several aspects of the environment that impact the performance of a laboratory balance. Do not expose balances unnecessarily to:

- Extreme temperatures - The accuracy and overall performance of any laboratory balance is affected by the room temperature. For best stability and performance, the room temperature should be regulated to within one degree Fahrenheit without interruption. The instrument should remain with power ON continuously.
    - Allowable storage temperature: –40°C to +70°C (–40°F to +158°F)
    - Allowable operating ambient temperature range is 0° to 40°C (32° to 104°F)
- Moisture - Do not expose balances to extreme moisture over longer periods. Moisture in the air can condense on the surfaces of balance whenever a cold balance is brought to a substantially warmer place. If you need to transfer a balance to a warmer area, make sure to condition it for about two hours at room temperature.
- Shocks, Blows, or Vibrations - Many laboratory balances are extremely sensitive to vibration or movement. If the weight readings change as you walk around the instrument, or if the readings change as you lean on the table or move objects on the table, then the table and floor are affecting weight readings. You can minimize these effects by using an especially sturdy table and minimizing movement. Users of microbalances often need specially built marble tables on concrete floors.
- Air Drafts – In the cases of measurements with resolution of .001 gram and less, the force exerted by moving air is readily detectable. A shroud or enclosure around the weighing pan will shield the pan from these effects. Avoid plastic materials for draft shields.
- Static Electricity - Static electricity exerts a mechanical force that is readily detectable by analytical and microbalances. An example of static electricity exerting a mechanical force would be lint sticking to clothing. Static will be a problem when it exists on the object being weighed, on the person using the balance, on draft shields, or on weighing vessels. Sources of static are carpets, Vibrum shoe soles, plastic draft shields, plastic weighing vessels, and melamine (Formica) table tops. Low ambient humidity exacerbates static problems.
    - You can test for a static problem easily. On an analytical balance place a metal enclosure (a coffee can works well) over the weighing pan, so that the pan is enclosed by the can but NOT touched by it. If the weight readings stabilize with the can in place, then static may be the cause of the instability.
    - Notice that the coffee can will provide an effective draft shield too.

General Precautions - Handling Test Weights

The weights used to test laboratory balances are precision devices and need to be handled accordingly. When handling weights, avoid direct hand contact with weights by using clean gloves or special lifting tools. Also, avoid sliding weights across any surface, especially across the stainless steel weighing pan of the balance under test. If a weight is dirty, carefully dust it to remove any foreign matter. If a weight is damaged, remove it from service and use another certified weight.

9.2.2 Required Equipment

Balances

- Sartorius CPA1003P [0-500 g, 0.001 g readability / 500-1,010 g, 0.01 g readability], with weighing pan, pan support, base plate, and AC adapter.
- Analytical draft shield for CP1003P, with cover.
- Sartorius CPA6202P [0-500 g, 0.01 g readability / 0-3,000 g, 0.02 g readability / 0-6,200 g, 0.05 g readability], with weighing pan and AC adapter.

Calibrated Weight Set

- 3 each 2 kg class 1 NIST-traceable electronic balance weights
- 2 each 1 kg class 1 NIST-traceable electronic balance weights
- 2 each 500 g class 1 NIST-traceable electronic balance weights
- 2 each 200 g class 1 NIST-traceable electronic balance weights
- 1 each 100 g class 1 NIST-traceable electronic balance weights

Supplies and associated equipment

- Dusting brush
- Gloves (cotton, surgical or nitrile)
- Wipes (lint-free cloth, Kim wipes, or similar material)
- Level (bubble)
- Thermometer
- Balance binder(s) [one for each balance]
    - Balance Manufacturer's Operating Manual
    - Balance Calibration Certificates
    - Calibration/Adjustment logsheets
    - Daily Linearity, and Accuracy check logsheets
    - Weekly Reproducibility check logsheets
- Weight Set Binder
    - Weight Calibration Certificates
- Stainless steel wipes
- Mini-vac with hose extension

9.2.3 Installation Location and Requirements

After unpacking the balances and associated components, check each immediately for any visible damage as a result of rough handling during shipment. If this is the case, proceed as directed in Section 9.6.3, Safety Inspection.

Choose a location that is not subject to the following negative influences:

- Heat (heater or direct sunlight)
- Drafts from open windows and doors
- Extreme vibrations during weighing
- Excessive moisture

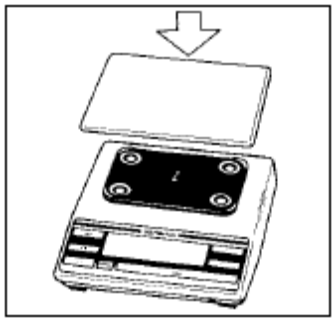
Allowable operating ambient temperature range is 0° to 40°C (32° to 104°F)

Refer to the Environment subsection of Section 9.2.1, Safety/Environment/Precautions, for more information.

9.2.4 Assembly

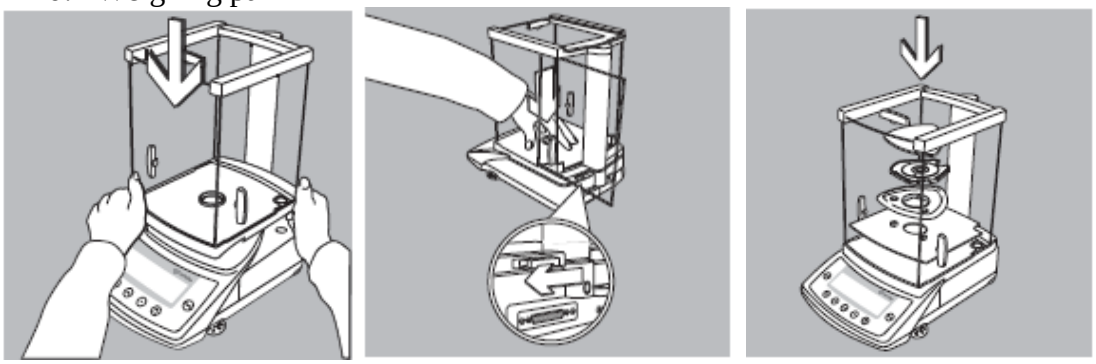
PT3100 and CPA6202P

1. Remove balance from its case. Be sure to lift from the sides or bottom, and not to grab from the balance top.
   i. Place the balance on a flat, level surface.
   j. Place the weighing pan on the balance.



CPA1003P

1. Remove balance from its case. Be sure to lift from the sides or bottom, and not to grab from the balance top.
2. Place the balance on a flat, level surface.
3. Check the sliding lock device on the back of the draft shield. Make sure it is in the "open" position (to the right).
4. Position the draft shield carefully on the balance.
5. Secure the draft shield by pressing lightly on the draft shield base and moving the sliding lock to the left.
6. Place components inside the chamber in the following order:
   a. Base plate
   b. Shield ring
   c. Pan support
   d. Weighing pan



9.2.5 Conditioning the Balances

Moisture in the air can condense on the surfaces of a cold balance whenever it is brought into a substantially warmer place. Upon initial setup or if you transfer a balance to a warmer area, make sure to condition it for about 2 hours at room temperature, leaving it unplugged from AC power.

9.2.6 Leveling

Purpose: To compensate for unevenness at the place of installation.

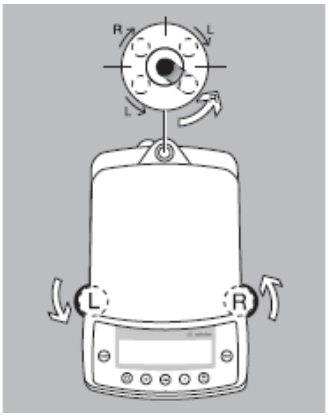
PT3100

1. The PT3100 balance lacks a built-in level and adjustable feet.

Using a bubble level on the balance pan, shim the front balance feet (or table feet) to level the balance.

CPA1003P and CPA6202P

1. Only the 2 front feet are adjusted to level the balance; the level indicator is at the rear of the balance.
2. Extend the two rear feet.
3. Turn the 2 front feet until the air bubble is centered within the circle of the level indicator.



9.2.7 Connecting to AC Power

1. Connect the angle plug to the balance/scale.
2. Connect the power cord to the AC adapter.
3. Plug the power cord into the wall outlet.

9.2.8 Energizing/De-energizing

To turn the balance on and off, press the key (PT3100) or key (CPA1003P and CPA6202P).

- Self test - After the power has been turned on, a test of all essential electronic functions (PT3100 only) and/or the display is run automatically.

- Warm up - To deliver exact results, the balance must warm-up for at least 30 minutes after initial connection to AC power. Only after this time will the balance have reached the required operating temperature.

9.2.9 Calibration/Adjustment

Adjust the balance after setting it up at the place of use.

Purpose

Calibration is the determination of the difference between the weight readout and the true weight (mass) of a sample. Calibration does not entail making any changes within the balance.

Adjustment is the correction of any difference between the measured value displayed and the true weight (mass) of the sample, or the reduction of the difference to an allowable level within the maximum permissible error limits.

Features

Calibration/adjustment can be performed only when:

- There is no load on the balance,
- The balance is tarred, and
- The internal signal is stable.

NOTE: The menu code setting **1 9 3** must be selected in the Setup menu (refer to manufacturer operating instructions in balance notebook).

Initial Conditions

Before proceeding, ensure that the balance:

- Has been allowed to warm-up for at least 30 minutes
- Is level
- Is free of any load or debris
- Has been tarred (See Section 9.4.2, Taring).

9.2.9.1 Calibration/Adjustment for CPA1003P and CPA6202P

[Manufacturer Operating Manual, pages 20-21; balance logbook]

Inside the balance housing is a motorized calibration weight which is applied and removed automatically for internal calibration. To activate calibration, press (CAL):

- The built-in calibration weight is applied automatically.
- The balance is calibrated.
- If configured for **CALIBRATE THEN AUTO ADJUST IN ONE OPERATION** is selected in Setup menu (1 10 1; factory setting), the balance is now adjusted automatically.
- The internal calibration weight is removed.

NOTE: In the Setup menu, you can configure whether:

- Calibration is always followed automatically by adjustment (1 10 1), or
- You have the choice of ending the sequence or starting adjustment after Calibration (1 10 2). If no difference is determined between nominal and actual weights, you can end the calibration/adjustment routine following calibration. Two keys are active at the point:
  - (CAL) = start calibration/adjustment
  - (CF) = end the sequence

9.2.9.2 Adjustment/Calibration for PT3100

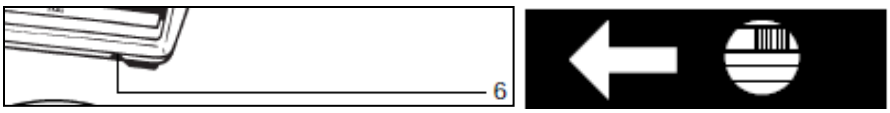
[Manufacturer Operating Manual, page 8; balance logbook]

The PT3100 balance does not have an internal, automatic calibration/adjustment feature; this function is performed using a single, external, calibrated 1,000 g weight.

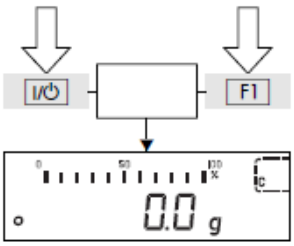
1. Identify and obtain the appropriate certified test weight for the balance to be tested.
   a. For the PT3100 balance, with a single-range of 0-3,100 g, use 1 each 1 kg weight.
   b. Certified test weights with an expired calibration and/or certification shall be labeled conspicuously on the exterior case "Do Not Use," and shall be removed from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is calibrated (See Section 9.6.2, Annual Calibration of Weights).
   c. Wearing gloves, examine the test weight for cleanliness and damage (e.g., nicks, scratches, etc.). As needed, carefully dust the certified test weight with a dry, lint-free cloth to remove any foreign matter. If damage is found, clearly note on the exterior case "Do Not Use," and remove the weight from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is repaired (if feasible – or replaced), re-certified, and calibrated (See Section 9.6.2, Annual Calibration of Weights).

During calibration with a calibration weight, the sensitivity of the balance is adjusted to changes in ambient conditions.

Remove the protective cap located on the front right of the balance and slide the access switch (6) in the direction of the arrow

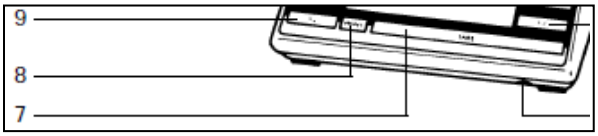


With the balance turned off, hold down the F1 key and briefly press the I/⏻ key.

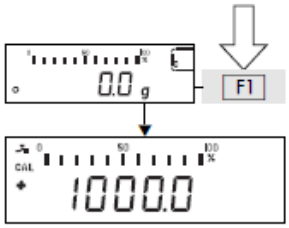


Upon completion of the automatic self-test, release the F1 key as soon as the "C" is displayed (upper right corner of display).

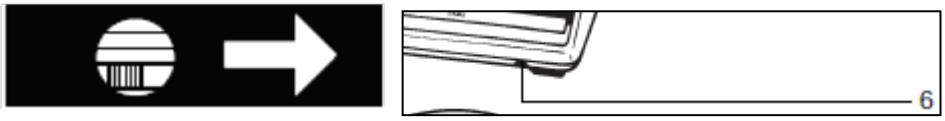
Unload the balance and press the tare control (7) to zero the display.



When the display shows a zero readout, press the F1 key. "CAL" and the calibration weight readout will now be displayed.



Center the 1,000 g calibration weight on the weighing pan, and then the balance self-calibrates automatically. The end of the calibration/adjustment is indicated by the weight unit symbol that appears on the display.
Relock the calibration access function by sliding the access switch back to its original setting (to the left), and replace the protective cap.



After calibration, use the I/⏻ key to turn the balance off and then on again so that you have direct access again to the weighing mode.

9.3 Daily Linearity, Reproducibility, and Accuracy Checks

9.3.1 Linearity Checks

Linearity testing verifies the accuracy of the instrument at intermediate values of weight. The balance linearity test measures the ability of the balance to accurately measure an added weight before and after a non-measured weight load has been placed on the balance. Prior to operation, on a daily basis, follow the Linearity Check procedure outlined below. Record results on the "Daily Linearity Check Log" record sheet (see Section 9.7.2, Daily Linearity and Accuracy Checks Log).

The procedure is as follows:

1. Identify and obtain the appropriate certified test weights for the balance to be tested (see Table 9.1). Use two sets of weights, each of approximately one-half the weighing capacity of the balance. It is imperative that these two weights not be interchanged

within this procedure. These two weights are referred to as "weight A" and "weight B."

Table 9.1: Weights for Linearity Check

Weight Range	PT3100	CPA6202P	CPA1003P
0 – 3100 g	1 kg + 500 g		
0 – 3000 g		1 kg + 500 g	
3000 – 6200 g		2 x 2 kg	
0 – 500 g			200 g
500 – 1010 g			500 g + 200 g

a. Certified test weights with an expired calibration and/or certification shall be labeled conspicuously on the exterior case "Do Not Use" and shall be removed from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is calibrated (See Section 9.6.2, Annual Calibration of Weights).
b. Wearing gloves, examine the test weight for cleanliness and damage (e.g., nicks, scratches, etc.). As needed, carefully dust the certified test weight with a dry, lint-free cloth to remove any foreign matter. If damage is found, clearly note on the exterior case "Do Not Use," and remove the weight from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is repaired (if feasible, or replaced), re-certified, and calibrated (See Section 9.6.2, Annual Calibration of Weights).

Re-zero (tare) the display. Place "A" on the pan (at the center) and record the reading on the "Linearity Chart" in the column marked "0% - 50%."
Remove "A" and place "B" on the pan (at the center). Re-zero (tare) the display with "B" still on the pan. Again place "A" on the pan, with "B" still on the pan. Record the reading under the column marked "50% - 100%."Calculate the difference between the two (0%-50% & 50%-100%) readings. The difference should be less than the linearity tolerances for each balance and range:

- PT3100: ± 0.2 g
- CPA6202P, 0-3,000 g: ± 0.02 g / 3,000-6,200 g: ± 0.05 g
- CPA1003P, 0-500 g: ± 0.001 g / 500-1,010 g: ± 0.01 g

9.3.2 Reproducibility Checks

Reproducibility testing entails repeatedly weighing a given object, recording the results, and analyzing those results. Prior to operation, on a daily basis, follow the Linearity Check procedure outlined below. A test weight equal to, or nearly equal to, the weighing capacity of the instrument should be selected.

Twenty pairs of readings should be taken for 2 data sets: "full-scale reading" and "zero reading." Record results on the Daily Reproducibility Check Log record sheet (see Section 9.7.3, Weekly Reproducibility Check Log).

A detailed procedure is as follows:

1. Identify and obtain the appropriate certified test weights for the balance to be tested (see Table 9.2).

Table 9.2: Weights for Reproducibility Check

Weight Range	PT3100	CPA6202P	CPA1003P
0 – 3100 g	2 kg, 1 kg		
0 – 3000 g		2 kg, 1 kg	
3000 – 6200 g		3 x 2 kg	
0 – 500 g			500 g
500 – 1010 g			1 kg

   a. Certified test weights with an expired calibration and/or certification shall be labeled conspicuously on the exterior case "Do Not Use" and shall be removed from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is calibrated (See Section 9.6.2, Annual Calibration of Weights).
   b. Wearing gloves, examine the test weight for cleanliness and damage (e.g., nicks, scratches, etc.). As needed, carefully dust the certified test weight with a dry, lint-free cloth to remove any foreign matter. If damage is found, clearly note on the exterior case "Do Not Use," and remove the weight from further service. Notify the Laboratory Test Lead and ensure that, when possible, the weight is repaired (if feasible, or replaced), re-certified, and calibrated (See Section 9.6.2, Annual Calibration of Weights).

2. Tare the instrument to read all zeros. Do not record the initial zero reading.
3. Place the test weight on the pan. Record the reading in the column labeled "FULL SCALE READING."
4. Remove the weight (do not rezero), and record the reading under "ZERO READING."
5. Repeat steps 2 and 3 until lines 1 through 10 are all filled in.
6. Transcribe the 2 columns of numbers into the Reproducibility Check spreadsheet.
7. Use the Reproducibility Check spreadsheet to calculate the standard deviation and coefficient of variation (CV) of both columns of numbers.
8. Calculated standard deviations larger than allowed in the instrument specifications indicate that the instrument is either operating in an unstable environment (static, air draft, warm-up, vibration, etc.), or that the instrument is in need of repair:
   - PT3100: ± 0.1 g
   - CPA6202P, 0-3,000 g: ± 0.01 g / 3,000-6,200 g: ± 0.03 g
   - CPA1003P, 0-500 g: ± 0.001 g / 500-1,010 g: ± 0.01 g

9.3.3 Accuracy Checks

Prior to each measurement process, on a daily basis, verify balance accuracy for a target sample. This verification is performed using the closest estimated certified weight as follows:

1. Identify and obtain the appropriate balance binder/log for the balance to be used.

2. Check the calibration sticker on the balance and weight set to ensure the calibration is current.
3. Clean the balance pan and weighing chamber of residual dust and drippings.
4. Check the balance level indicator. The bubble should be within the black outlined circle. Readjust the leveling feet if necessary.
5. Zero the balance by pressing the tare bar.
6. Place the required certified weight (the closest to the estimated weight to be measured) on the balance pan. Wait for the balance to be stabilized and record the result in the balance logbook. Remove the weight from the balance pan.
7. The allowable control limit is ± 0.1% of the certified weight value across the entire weight range. Notify the Laboratory Team Lead if the balance fails to pass the accuracy test. Place a conspicuous "Out of Order" sign on the balance and follow the procedures outlined in Section 9.2.9, Calibration/Adjustment.

9.3.4 Action for Linearity, Reproducibility or Accuracy Check Failure

1. Perform a calibration/adjustment on the balance (see Section 9.2.9, Calibration/Adjustment) if daily linearity, reproducibility, or accuracy checks fail.
2. Repeat linearity, reproducibility, and accuracy checks if a calibration/adjustment is performed.
3. If the balance continues to fail linearity, reproducibility, or accuracy checks, remove the balance from service.

9.4 Procedure

9.4.1 Weighing Samples

Refer to the balance manufacturer's operating instructions for specific procedures on the proper operating techniques unique to that particular balance.

9.4.1.1 CPA1003P with Draft Shield

To weigh an unknown:

1. Verify successful completion of operational accuracy check for balance/measurement process.
2. Clean the balance pan and weighing chamber of residual dust and drippings.
3. Check the balance level indicator. The bubble should be within the black outlined circle. Readjust the leveling feet if necessary.
4. Ensure that the glass doors of the weighing chamber are completely closed.
5. Turn the display on and carefully watch the automatic digital readout demonstration.
6. If any segment fails to light during the readout demonstration, place an "Out of Order" sign on the balance, and follow the procedures outlined in Section 9.2.9, Calibration/Adjustment.
7. Zero the balance by pressing the tare bar.
8. Display subsequently indicates zero (weighing mode). The number of decimal places depends on the readability of the balance as well as the selected weighing range. The balance is now ready to weigh an unknown.

9. Open a door on the weighing chamber and carefully place the unknown on the balance pan.
10. Close the weighing chamber door.
11. Wait for stability and read the results.

9.4.1.2 Top-Loading Balance

To weigh an unknown:

1. Verify successful completion of operational accuracy check for balance/measurement process.
2. Clean the balance pan of residual dust and drippings.
3. Check the balance level indicator. The bubble should be within the black outlined circle. Readjust the leveling feet if necessary.
4. Turn the display on by briefly pressing the control/tare bar.
5. If any segment fails to light during the readout demonstration, place an "Out of Order" sign on the balance, and follow the procedures outlined in Section 9.2.9, Calibration/Adjustment.
6. Zero the balance by pressing the tare bar.
7. Display subsequently indicates zero (weighing mode). The number of display digits depends on the readability of the balance as well as the selected weighing range. The balance is now ready to weigh an unknown.
8. Carefully place the unknown on the balance pan.
9. Wait for the stability and record the result.

9.4.2 Taring

To tare an item:

1. Place the container on the balance pan.
2. Briefly press the tare bar.
3. The container has now been tared. The weighing range minus the tare weight is now available for weighing.

9.5 Preparation for Transport

Care must be taken in preparing the balances, weights, and associated components for transport to ensure they will be operationally ready for subsequent deployments.

9.5.1 Preparation of Balances for Transport

To prepare a balance for transport:

1. De-energize balance (See Section 9.2.8, Energizing/De-energizing).
2. Disconnect power cord and AC adapter.
3. Clean balance (all) and draft shield (CPA1003P) (See Section 9.6.4, Balance Cleaning).

4. Before disassembling and packing balances and associated components, check each immediately for any visible damage as a result of mishaps during weighing operations. If this is the case, proceed as directed in Section 9.6.3, Safety Inspection.
5. Disassemble each balance by reversing the processes covered in Section 9.2.4, Assembly.
6. Carefully re-pack each balance and associated components back into their transport cases. Be sure to handle the balances only from the sides or base; do not grab the sensitive component area on top of the balance.

9.5.2 Preparation of Weights for Transport

Care must be taken in preparing the balances, weights, and associated components for transport to ensure they will be operationally ready for subsequent deployments. Improper storage and/or prolonged contact with moisture, fingerprints, or other foreign matter may damage or invalidate the calibration of the weights.

To prepare certified weights for transport:

1. Inspect each weight for any visible damage. If any is found, remove it from service and make note of this in the Annual Calibration and Maintenance Log (see Section 9.6.1, Annual Calibration and Maintenance of Balances). When possible, have the weight serviced by trained personnel. If the damage is excessive, the weight needs to be replaced.
2. Wearing gloves, wipe each weight with a clean, dry cloth.
3. Place each weight into its individual storage case; then, place each storage case into the weight set transport case.

9.6 Maintenance

9.6.1 Annual Calibration and Preventative Maintenance of Balances

1. On an annual basis, ensure that preventative maintenance and calibration is performed for each balance by a certified vendor.
2. Upon completion of the annual preventative maintenance and calibration, inspect each balance (see Section 9.6.3, Safety Inspection) and then verify calibration certificate and stickers.
3. Place the new calibration certificate in the associated balance binder.

9.6.2 Annual Calibration of Weights

1. On an annual basis, ensure that preventative maintenance and calibration is performed for each weight by a certified vendor.
2. Upon completion of the annual preventative maintenance and calibration, inspect each weight and then verify calibration certificate and stickers.
3. Place the new calibration certificate in the certified weight set binder.

9.6.3 Safety Inspection

If there is any indication that safe operation of the balance is no longer warranted:

1. Turn off the power and disconnect the equipment from AC power immediately.
2. Label the equipment as out-of-service and lock it in a secure place to ensure that it cannot be used until the safety issue has been resolved. Notify the Fly Away Laboratory Manager .
3. When possible, have the equipment repaired by trained service technicians.

9.6.4 Balance Cleaning

Cleaning the Balance Housing

1. Unplug the AC adapter from the wall outlet.
2. Clean the balance using a piece of cloth that has been wetted with a mild detergent (soap) solution.
    k. Make sure that no liquid or other foreign objects or dust (powder) enters the balance housing.
    l. Do not use any aggressive cleaning agents (solvents or similar agents).

After cleaning, wipe down the balance with a soft, dry cloth.

Cleaning Stainless Steel Surfaces

1. Clean all stainless steel parts regularly.
2. Remove the stainless steel weighing pan and thoroughly clean it separately.
3. Use a damp cloth or sponge to clean any stainless steel parts on the balance by wiping them down. You can use any commercially available household cleaning agent that is suitable for use on stainless steel. Then wipe down the equipment to rinse thoroughly, making sure to remove all residues.
4. Afterwards, allow the balance to dry.
5. If desired, you can apply oil to the cleaned stainless steel surfaces as additional protection. Solvents are permitted for use only on stainless steel parts.

Cleaning the Weighing Chamber and Draft Shield

1. Open the draft shield cover and take out the removable parts.
2. Use a hand-held vacuum cleaner and mini-hose to remove any powdered sample material carefully.
3. Use blotting paper to remove any liquid sample material.

9.7 Records

9.7.1 Calibration /Adjustment Log

- PT3100
- CPA1003P
- CPA 62002P

9.7.2 Daily Linearity and Accuracy Checks Log

- PT3100
- CPA1003P
- CPA 62002P

9.7.3 Weekly Reproducibility Check Log

- PT3100
- CPA1003P
- CPA 62002P

9.8 Balance Specifications

Table 9.3: Balance Specifications

Manufacturer **Series** **Model**	**Sartorius Portable** **PT3100**	**Sartorius CP** **CPA1003P**	**Sartorius** **CP** **CPA6202P**
Weighing Capacity g	3,100	500/1,010	1,500/3,000/6,200
Readability g	0.1	0.001/0.01	0.01/0.02/0.05
Tare Range (by subtraction) g	-3,100	-1,010	-6,200
Repeatability, Standard Deviation ≤±g	0.1	0.001/0.01	0.01/0.01/0.03
Maximum Linearity ≤±g	0.2	0.002/0.02	0.02/0.02/0.05
Response time (average) s	1.5	≤ 2	≤1.5
Display update at stability (depends on the filter level selected) s	0.1; 0.2; 0.4	**	**
Display update when load on pan changes s	0.1	**	**
Adaptation to operating requirements and ambient conditions	By selection of 1 of 3 optimized filter levels	**	**
Stability range d	0.25…32 (selectable)	**	**
Operating temperature range °C	**	10° to 30° (50° to 86°F)	10° to 30° (50° to 86°F)
Allowable operating ambient temperature	273-313 K (0°C…+40°C)	0° to 40°C (32° to 104°F)	0° to 40°C (32° to 104°F)
Allowable relative humidity %	15…85 (non-condensing)	**	**
Sensitivity Drift within +10 to +30°C	1.5E-05 /°C	≤± 2E-06 /K	≤± 2E-06 /K
External calibration weight (of at least accuracy class…) g	**	1,000 (E2)	5,000 (F1)
Weighing pan size mm Weighing pan area cm	174x133 231	110 (inner dia.) 120	190x204 388
Weighing chamber height (weighing pan to draft shield cover) mm	**	240	**
Balance housing (WxDxH) mm	185x215x55	213x342x340	213x342x88
Net weight, approx. kg	1.2	6.5	4.7
AC power requirements V~	115 V, 50-60 Hz	AC adapter STNG6, 230 V or 115 V, 48-60Hz	AC adapter STNG6, 230 V or 115 V, 48-60Hz
Allowable voltage fluctuation	-20%...+15%	-20%...+15%	-20%...+15%

Manufacturer **Series** **Model**	**Sartorius Portable** **PT3100**	**Sartorius CP** **CPA1003P**	**Sartorius** **CP** **CPA6202P**
Power consumption, typical	max. 0.5 W for 12 V constant current max. 9 VA (AC adapter)	max. 16 VA typ. 8 VA	max. 16 VA typ. 8 VA

This page is intentionally left blank

Section 10: iCAM/Glovebox/Fumehood Procedures

To be completed at a future date

This page is intentionally left blank

Section 11: Data Handling and Verification/Validation

1. Review the final report against the analysis request form for the following information:
   - Sample ID Numbers
   - Customer Name
   - Sample Type
   - Sample Description
   - Sample Aliquot
   - Sample Units
   - Sample Date/Time
   - ARF Number
   - Count Time
   - Sample Geometry
   - Unidentified Peak Report (if applicable)
   - Appropriate Gamma Library
   - Analytical Method (e.g. LSC, GPC or Gamma)
   - Analyst ID
   - Comments

2. Next perform a technical review of the final report.
   - Once the report is reviewed and acceptable, sign and date the report.
   - Check the final report against the Electronic Data Deliverable (EDD).
   - Provide the entire package to the FAL Manager for final review.
   - Once the FAL Manager approves the data, forward a hardcopy along with the EDD to the customer.

This page is intentionally left blank

Appendix A: iSOCS™ Geometry Composer Tutorial

Introduction

A wide variety of sample configurations are analyzed with portable gamma spectral systems such as the FALCON™ 5000. Qualitative analysis results can be quantified by utilizing the CANBERRA ISOCS™ code in conjunction with the standard ISOCS™ and/or LabSOCS™ geometry templates. Efficiency calibration files can be created for specific counting scenarios. Below is a step by step job aid that will enable the laboratory staff to model a counting geometry and obtain qualitative analysis results.

Procedure

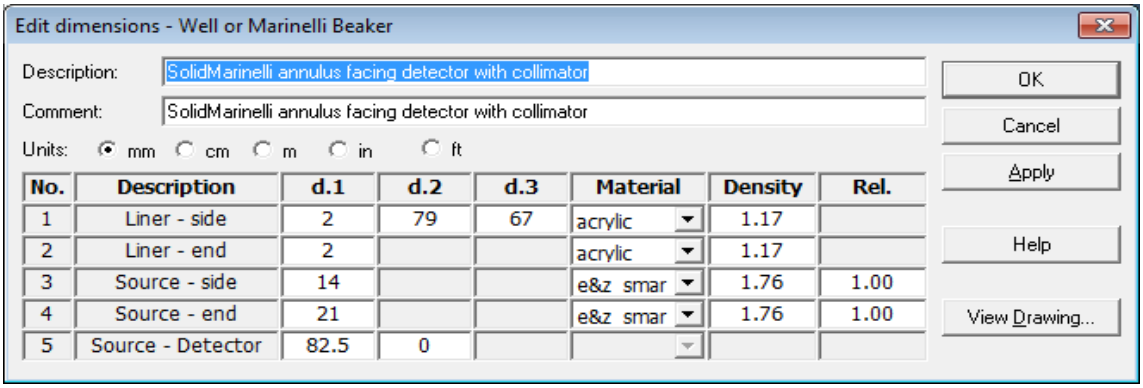
1. You must use an ISOCS™ CALIBRATED PROBE for analysis!!!
2. In the *Canberra ISOCS/LabSOCS™ Manual*, choose the geometry template that best suits the shape or geometry of the sample being analyzed.

Example: plane sphere, rectangular volume, drum, etc.

Open the Geometry Composer from the Genie2000 folder on the desktop: select **FILE-> OPEN** and select the appropriate template.

NOTE: If you are using a pre-defined geometry, select this button to "edit dimensions" of the geometry.

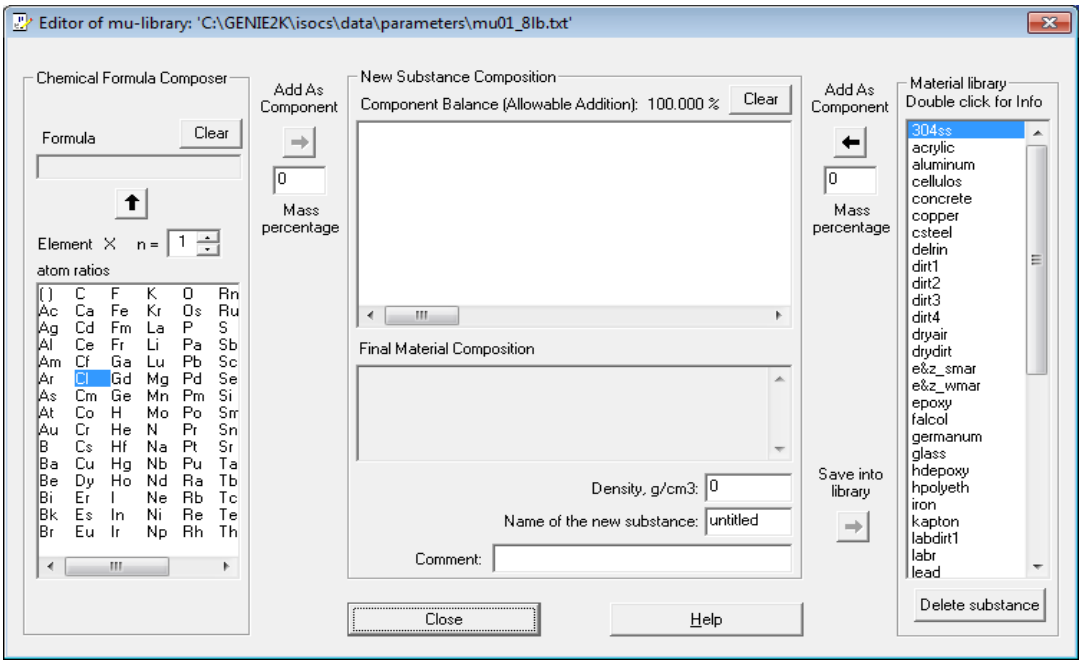
Below is an example of the template provided in the ISOCS™ program that allows you to input material and source dimensions. Based on the drawing, input the proper dimensions and materials here. Be mindful of units.



No.	Description	d.1	d.2	d.3	Material	Density	Rel.
1	Liner - side	2	79	67	acrylic	1.17	
2	Liner - end	2			acrylic	1.17	
3	Source - side	14			e&z smar	1.76	1.00
4	Source - end	21			e&z smar	1.76	1.00
5	Source - Detector	82.5	0				

If a material that matches (or is very close to) the material being analyzed is not listed in the pull-down menu, the "mu editor" can be used to create new materials in the library.

Below is an example of the "mu editor" window.



If the elemental mass ratios are known for the material, it can be defined by using the element selection box to the left. The atomic ratios of each molecule can be input using the "n =" selection box. For example: Water consists of two hydrogen atoms attached to one oxygen atom. To enter this, select **H** from the box, increase "n =" so that it equals 2, and then push the up arrow. To add the oxygen, select **O** from the list, change "n=" to 1, and then press the up arrow. If the matrix consists only of water, then the mass percentage would be 100. If there was salt in the water, then the mass ratio would have to be calculated and the salt would have to be added separately.

Alternatively, you can make a new substance by combining any ratio of the materials in the library using the utility at the right of the screen.

Once the new material is listed in the center box and the "Component Balance" is equal to 0, you must enter the mass density of the material, give it a name, and enter an optional comment to help identify the material. By clicking the **SAVE INTO LIBRARY** button, the new material is saved to the library and can be used in any future models.

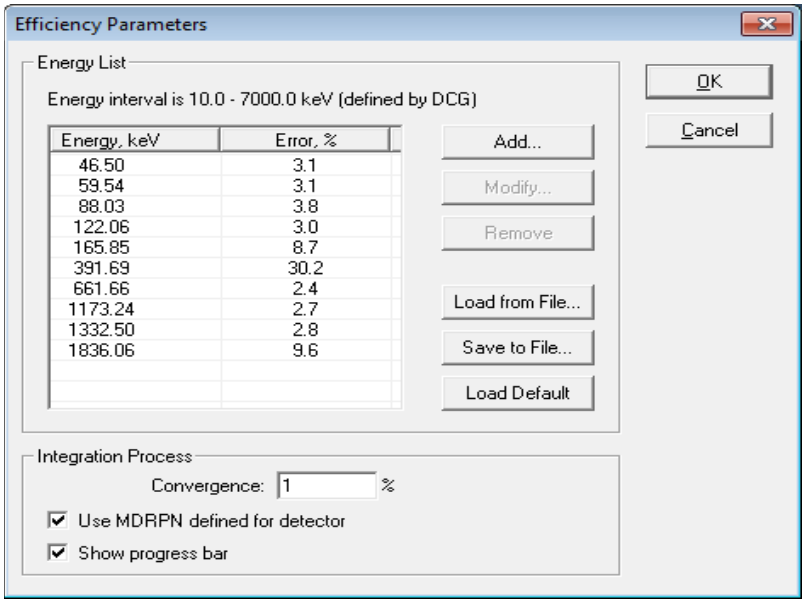
a. Once the correct dimensions and materials have been selected, the efficiency codes are ready to be executed.

b. Check geometry validity by pressing this button: . This utility checks the geometrical parameters to make sure that a logical model has been created. Error messages are usually self-explanatory, and you will be able to figure out how to fix the problem. For errors that are not easily understood, refer to the *Canberra ISOCS™ Manual*.

c. Modify or load energy list by pressing this button:

Below is an example of the utility that allows you to modify the energy list. With this utility, you can choose the energies for which the code will calculate efficiencies. For most applications, the default energy list is sufficient.

A rule of thumb **is to be sure that there are at least 10 data points and that both the lowest and highest gamma energy of all the nuclides of interest are within the bounds of the energies selected**. Just like the mu editor, the energy list can be saved and loaded into future models.



d. Save the model with a unique identifying filename (like the sample control form number "SCF#"). **Take note of where you saved the file.**

e. To run the efficiency calculator press the following button:

Take note of where you saved the file.

f. Select **FILE ->PRINT** to print out the geometry report. Retain this as part of the record.

To use the newly developed efficiency curve, open GENIE2K.

a. Open Gamma Acquisition & Analysis (from the Genie 2000 folder on the desktop).
b. **FILE -> OPEN DATA SOURCE:** Select the CNF. File of the spectrum that is to be analyzed with the iSOCS™ geometry.
c. Select **CALIBRATE -> EFFICIENCY -> BY LABSOCS/ISOCS…**
d. Select the model that was just performed (.ecc file) **Geometry Composer.**
e. Select **NEXT >**.
f. Select **EFFICIENCY** unless instructed otherwise.
g. Select **NEXT >**.
h. Select **SHOW…**

i. Select **LINEAR** as the curve type unless instructed otherwise. Ensure that all of the datapoints lie very close to the calculated curve fit. Print the chart in both linear and log scales and attach this to the geometry composer report. If a point needs to be dropped from the fit, select **LIST PKS…** and drop points as necessary. Be sure to have an experience gamma spectroscopist review the results before data is submitted. When satisfied with the fit, select **OK.**
j. Select **REPORT…** Print this report, and attach it to the geometry composer report and the graphs of the efficiency curve.
k. If the modeled geometry is common enough to be used routinely, you can **STORE** the calibration. Be sure to include information in the filename that points to what detector and geometry it pertains to. Be sure that the first character in the filename matches the detector number for which the model was created. For example, if a water cube was modeled on FAL03, then the filename should read something similar to "5waterbox.CAL."
l. Select **FINISH.**

Go to FRMAC Routine Operations folder located on the desktop.

a. Select Reanalyze Spectrum.
b. Open the file that has the new iSOCS™ efficiency attached to it.
c. Select **NO** when the dialog asks if you would like to attach a new efficiency calibration. The iSOCS™ efficiency has already been attached in Gamma Acquisition and Analysis.

Appendix B: Fly Away Laboratory Forms

PORTABLE GAMMA SPECTROSCOPY

CALIBRATION

Detector ID: _____

Manufacturer and Serial No.: _____

Archive File Names: _____

_____

_____

Source IDs: _____

_____

_____

Calibration Date: _____

CHECK LIST

All Calibration Packages shall include the following items:

- ☐ Peak Search Results Energy and Shape Calibration
- ☐ Energy and FWHM Report and Graphs
- ☐ Peak Search Results Efficiency Calibrations
- ☐ Efficiency Calibration Reports and Graphs
- ☐ Source Certificates
- ☐ Calibration verification package

Reviewed By:_____ Date:_____

Approved By: _____ Date:_____

Fly-Away Laboratory Balance Calibration/Adjustment Log

Type: Sartorius CPA1003P Serial Number: _____ Reference Standard: Internal

Date	Time	Initial Conditions Verification[1] ☑	Calibration/Adjustment Completed Satisfactorily ☑	Comments	Operator Initial
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		

[1] Procedure 10.2.7 Calibration/Adjustment, Item 3

Fly-Away Laboratory Balance Calibration/Adjustment Log

Type: Sartorius CPA6002P Serial Number: _____ Reference Standard: Internal

Date	Time	Initial Conditions Verification[1] ☑	Calibration/Adjustment Completed Satisfactorily ☑	Comments	Operator Initial
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		

[1] Procedure 10.2.7 Calibration/Adjustment, Item 3

Fly-Away Laboratory Balance Daily Linearity and Accuracy Check Log

Type: Sartorius PT3100 Serial Number: 70407399 Date: _____

Linearity Check

Range [g]	Weight "A" #'s	Weight "B" #'s	0%-50% [g]	50%-100% [g]	Difference [g]	Range Linearity Tolerance	Completed Satisfactorily ☑	Operator Initial
0-3,100	500 g _____ 1,000 g _____	500 g _____ 1,000 g _____				±0.2	☐	

Accuracy Checks

Weighing Processes (with process tolerance):

100 g (±0.1 g)	200 g (±0.2 g)	500 g (±0.5 g)	1,000 g (±1 g)	3,000 g (±3 g)

Process Weight [g]	Weight #	Calibrated Weight (1) [g]	Weight #	Calibrated Weight (2) [g]	Total Weight (1+2) [g]	Measured Weight [g]	Difference [g]	Tolerance [g]	Completed Satisfactorily ☑	Operator Initial
									☐	
									☐	
									☐	
									☐	
									☐	

Comments: _____

Fly-Away Laboratory Balance Daily Linearity and Accuracy Check Log

Type: Sartorius CPA1003P Serial Number: _____ Date: _____

Linearity Check

Range [g]	Weight "A" #'s	Weight "B" #'s	0%-50% [g]	50%-100% [g]	Difference [g]	Range Linearity Tolerance	Completed Satisfactorily ☑	Operator Initial
0-500	200 g _____	200 g _____				±0.002	☐	
500-1,010	200 g _____ 500 g _____	200 g _____ 500 g _____				±0.02	☐	

Accuracy Checks

Weighing Processes (with process tolerance):

100 g (±0.1 g)	200 g (±0.2 g)	300 g (±0.3 g)	500 g (±0.5 g)	1,000 g (±1 g)

Process Weight [g]	Weight #	Calibrated Weight (1) [g]	Weight #	Calibrated Weight (2) [g]	Total Weight (1+2) [g]	Measured Weight [g]	Difference [g]	Tolerance [g]	Completed Satisfactorily ☑	Operator Initial
									☐	
									☐	
									☐	
									☐	
									☐	

Comments: _____

Fly-Away Laboratory Balance Daily Linearity and Accuracy Check Log

Type: Sartorius CPA6002P Serial Number: _____ Date: _____

Linearity Check

Range [g]	Weight "A" #'s	Weight "B" #'s	0%-50% [g]	50%-100% [g]	Difference [g]	Range Linearity Tolerance	Completed Satisfactorily ☑	Operator Initial
0-3,000	500 g _____ 1,000 g _____	500 g _____ 1,000 g _____				±0.02	☐	
3,000-6,200	2,000 g _____ 2,000 g _____	2,000 g _____ 2,000 g _____				±0.05	☐	

Accuracy Checks

Weighing Processes (with process tolerance):

100 g (±0.1 g)	500 g (±0.5 g)	1,000 g (±1 g)	2,000 g (±2 g)	4,000 g (±4 g)

Process Weight [g]	Weight #	Calibrated Weight (1) [g]	Weight #	Calibrated Weight (2) [g]	Total Weight (1+2) [g]	Measured Weight [g]	Difference [g]	Tolerance [g]	Completed Satisfactorily ☑	Operator Initial
									☐	
									☐	
									☐	
									☐	
									☐	

Comments: _____

Fly-Away Laboratory Balance Weekly Reproducibility Check Log

Balance: Sartorius PT1300 **Serial Number:** 70407399 **Date:** _____

SD Tolerance: ≤ 0.1 g

Range [g]	Weight # & Calibrated Mass	#	Full Scale Reading [g]	Zero Reading [g]		Range [g]	Weight # & Calibrated Value	#	Full Scale Reading [g]	Zero Reading [g]	Comments	Operator Initial
0-3,100	1 kg	1				n/a	n/a	1	n/a	n/a		
	#: _____	2						2	n/a	n/a		
		3						3	n/a	n/a		
	c.m.: _____ ± ____	4						4	n/a	n/a		
	2 kg	5						5	n/a	n/a		
	#: _____	6						6	n/a	n/a		
	c.m.: _____ ± ____	7						7	n/a	n/a		
		8						8	n/a	n/a		
		9						9	n/a	n/a		
		10						10	n/a	n/a		
CV	Total Calibrated Mass		SD	SD		CV	Total Calibrated Mass		SD	SD	SD < SD Range Tolerance ☑	
	_____ ± ____					n/a	n/a		n/a	n/a	☐	

1. Enter data for weights and measurements for each range.
2. Transcribe values to Reproducibility Spreadsheet (spreadsheet calculates standard deviations (SD) & coefficients of variation (CV)).
3. Transcribe SD & CV values from spreadsheet to log as indicated.
4. If SD values are less than the tolerance SD for each range, the reproducibility check is satisfactory.

Fly-Away Laboratory Balance Weekly Reproducibility Check Log

Balance: Sartorius CPA1003P **Serial Number:** _____ **Date:** _____

0-500 g Range SD Tolerance: ≤ 0.001 g **500-1,010 g Range SD Tolerance: ≤ 0.01 g**

Range [g]	Weight # & Calibrated Mass	#	Full Scale Reading [g]	Zero Reading [g]		Range [g]	Weight # & Calibrated Value	#	Full Scale Reading [g]	Zero Reading [g]	Comments	Operator Initial
0-500	500 g #: _____ c.m.: _____ ± ____	1				500-1,010	1 kg #: _____ c.m.: _____ ± ____	1				
		2						2				
		3						3				
		4						4				
		5						5				
		6						6				
		7						7				
		8						8				
		9						9				
		10						10				
CV	Total Calibrated Mass		SD	SD		CV	Total Calibrated Mass		SD	SD	SD < SD Range Tolerance ☑	
	_____ ± ____						_____ ± ____				☐	

1. Enter data for weights and measurements for each range.
2. Transcribe values to Reproducibility Spreadsheet (spreadsheet calculates standard deviations (SD) & coefficients of variation (CV)).
3. Transcribe SD & CV values from spreadsheet to log as indicated.
4. If SD values are less than the tolerance SD for each range, the reproducibility check is satisfactory.

Fly-Away Laboratory Balance Weekly Reproducibility Check Log

Balance: Sartorius CPA6002P **Serial Number:** _____ **Date:** _____

0-3,000 g Range SD Tolerance: ≤ 0.01 g **3,000-6,200 g Range SD Tolerance: ≤ 0.03 g**

Range [g]	Weight # & Calibrated Mass	#	Full Scale Reading [g]	Zero Reading [g]		Range [g]	Weight # & Calibrated Value	#	Full Scale Reading [g]	Zero Reading [g]	Comments	Operator Initial
0-3,000	1 kg #: _____ c.m.: _____ ± ____ 2 kg #: _____ c.m.: _____ ± ____	1				3,000-6,200	2 kg #: _____ c.m.: _____ ± ____ 2 kg #: _____ c.m.: _____ ± ____ 2 kg #: _____ c.m.: _____ ± ____	1				
		2						2				
		3						3				
		4						4				
		5						5				
		6						6				
		7						7				
		8						8				
		9						9				
		10						10				
CV	Total Calibrated Mass		SD	SD		CV	Total Calibrated Mass		SD	SD	SD < SD Range Tolerance ☑	
	_____ ± ____						_____ ± ____				☐	

1. Enter data for weights and measurements for each range.
2. Transcribe values to Reproducibility Spreadsheet (spreadsheet calculates standard deviations (SD) & coefficients of variation (CV)).
3. Transcribe SD & CV values from spreadsheet to log as indicated.
4. If SD values are less than the tolerance SD for each range, the reproducibility check is satisfactory.

Appendix C: Fly Away Laboratory Sample Tracking Database Tutorial

Introduction

Many samples will be analyzed with multiple requested analyses. It is critical that the sample received is not only accounted for, but also that its current status is known so that the results and the sample can be returned in a timely fashion to the customer. The Tracking Database assists FAL staff in identifying which samples were received, what samples are being analyzed, what type of analysis was done on which sample, and if or not the samples have been completed. Below is a step-by-step job aid to enable the laboratory staff to utilize the database efficiently.

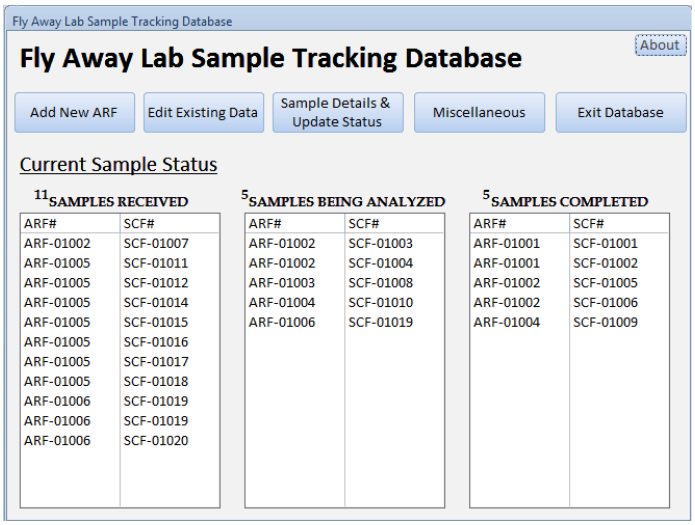
Obtaining, Naming, and Setting Up a New Database

1. One standard access database that is utilized for all events for the Fly Away Laboratory. There is only one database per event. To obtain the database go to C:\FlyawayCustomPrograms\FlyAwayLabDatabasev1.0.0\STANDARD_FALCON_DB.accdb on the login computer.
2. To create a database for an event, copy and paste the standard database in C:\FlyawayCustomPrograms and rename it. Never overwrite the standard falcon database. The standard database is named as: STANDARD_FALCON_DB.accdb
3. If this database were to be used in Japan during the Fukushima reactor accident, the following naming is appropriate:
   - JAPAN2011_FALCON_DB. accdb
   - FUKUSHIMA_FALCON_DB. accdb
   - Or in the case of Chernobyl, the following names are appropriate:
   - RUSSIA1986_FALCON_DB. accdb
   - CHERNOBYL _FALCON_DB. accdb

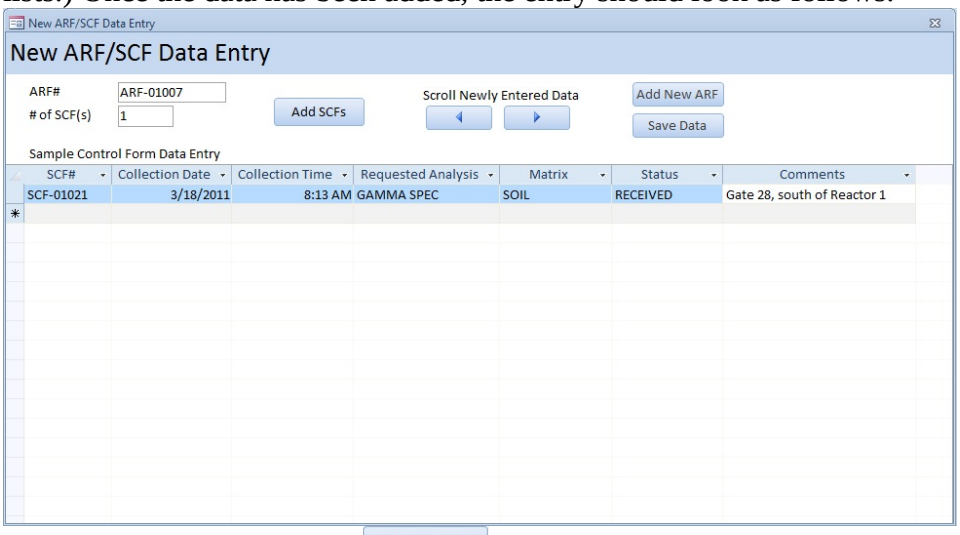
Create a shortcut on the desktop C:\desktop by right clicking on the file and selecting **SEND TO DESKTOP (CREATE SHORTCUT)**. Rename the shortcut to match the file name.
Open the database and a security warning appears in yellow. Click **ENABLE CONTENT**. The database is now ready for use.

Adding a New ARF/SCF

1. Open the MS access database by going on the desktop. If it is not established or found, refer to Step 1. An example of main menu database is shown below.



Select Add New ARF on the opening menu.
Add/Scan the ARF #. (**NOTE**: If there are duplicate ARF#s, the database does not add them both.)
Add the number of SCFs that will be added and then click Generate SCF.
Add/Scan the SCF#, Collection Date/Time, Requested Analysis Matrix, and Status. (**NOTE**: Make sure to select the Status; otherwise, the database does not display it on the main menu lists.) Once the data has been added, the entry should look as follows.

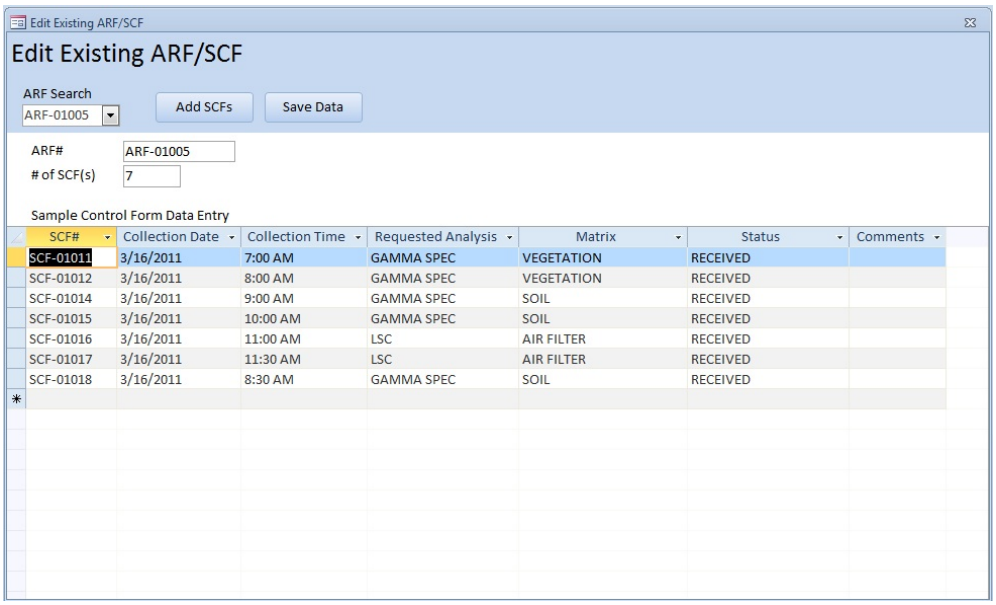


To add another ARF, select Add New ARF. Once the SCF is generated, it is possible to scroll through newly entered ARF#s.
Once done, click Save Data and close window.

Editing Existing Data

1. Select Edit Existing Data on the main menu.
2. Select the ARF # in the drop box.

Once selected, change any information that is needed to be changed.

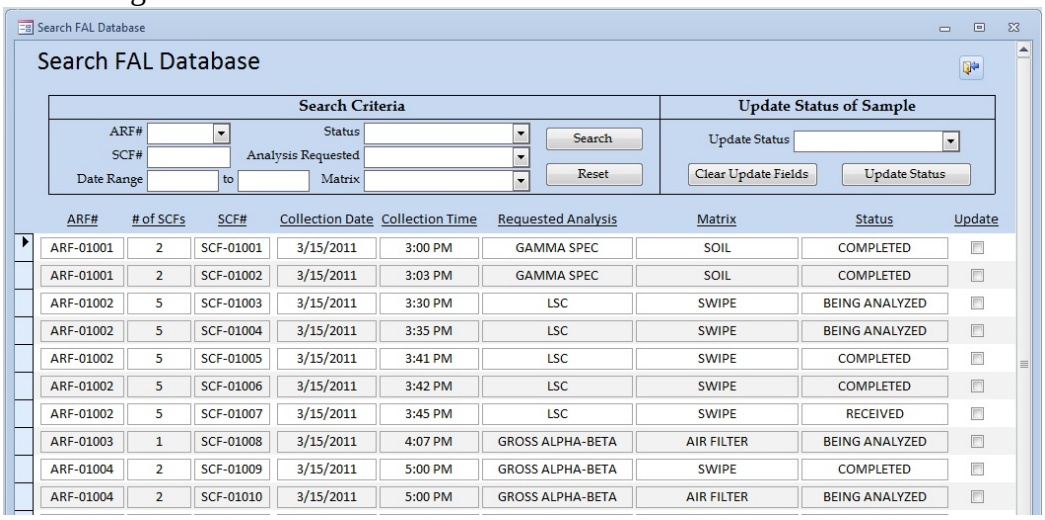


SCF#	Collection Date	Collection Time	Requested Analysis	Matrix	Status	Comments
SCF-01011	3/16/2011	7:00 AM	GAMMA SPEC	VEGETATION	RECEIVED	
SCF-01012	3/16/2011	8:00 AM	GAMMA SPEC	VEGETATION	RECEIVED	
SCF-01014	3/16/2011	9:00 AM	GAMMA SPEC	SOIL	RECEIVED	
SCF-01015	3/16/2011	10:00 AM	GAMMA SPEC	SOIL	RECEIVED	
SCF-01016	3/16/2011	11:00 AM	LSC	AIR FILTER	RECEIVED	
SCF-01017	3/16/2011	11:30 AM	LSC	AIR FILTER	RECEIVED	
SCF-01018	3/16/2011	8:30 AM	GAMMA SPEC	SOIL	RECEIVED	

You can change the status of a sample here, but if you need to change multiple (bulks) statuses of samples, go to Step # 18.
Click Save Data when done.

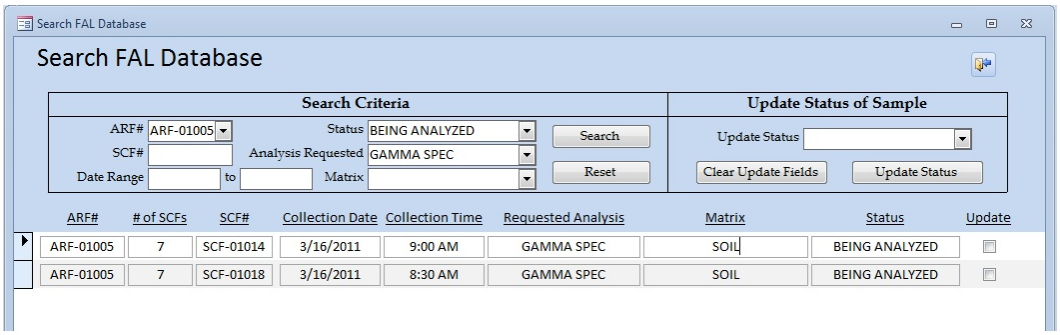
Search for Sample Details

1. Select Sample Details & Update Status to search for existing data to obtain details about an ARF or SCF utilizing the Search Criteria function.



ARF#	# of SCFs	SCF#	Collection Date	Collection Time	Requested Analysis	Matrix	Status	Update
ARF-01001	2	SCF-01001	3/15/2011	3:00 PM	GAMMA SPEC	SOIL	COMPLETED	
ARF-01001	2	SCF-01002	3/15/2011	3:03 PM	GAMMA SPEC	SOIL	COMPLETED	
ARF-01002	5	SCF-01003	3/15/2011	3:30 PM	LSC	SWIPE	BEING ANALYZED	
ARF-01002	5	SCF-01004	3/15/2011	3:35 PM	LSC	SWIPE	BEING ANALYZED	
ARF-01002	5	SCF-01005	3/15/2011	3:41 PM	LSC	SWIPE	COMPLETED	
ARF-01002	5	SCF-01006	3/15/2011	3:42 PM	LSC	SWIPE	COMPLETED	
ARF-01002	5	SCF-01007	3/15/2011	3:45 PM	LSC	SWIPE	RECEIVED	
ARF-01003	1	SCF-01008	3/15/2011	4:07 PM	GROSS ALPHA-BETA	AIR FILTER	BEING ANALYZED	
ARF-01004	2	SCF-01009	3/15/2011	5:00 PM	GROSS ALPHA-BETA	SWIPE	COMPLETED	
ARF-01004	2	SCF-01010	3/15/2011	5:00 PM	GROSS ALPHA-BETA	AIR FILTER	BEING ANALYZED	

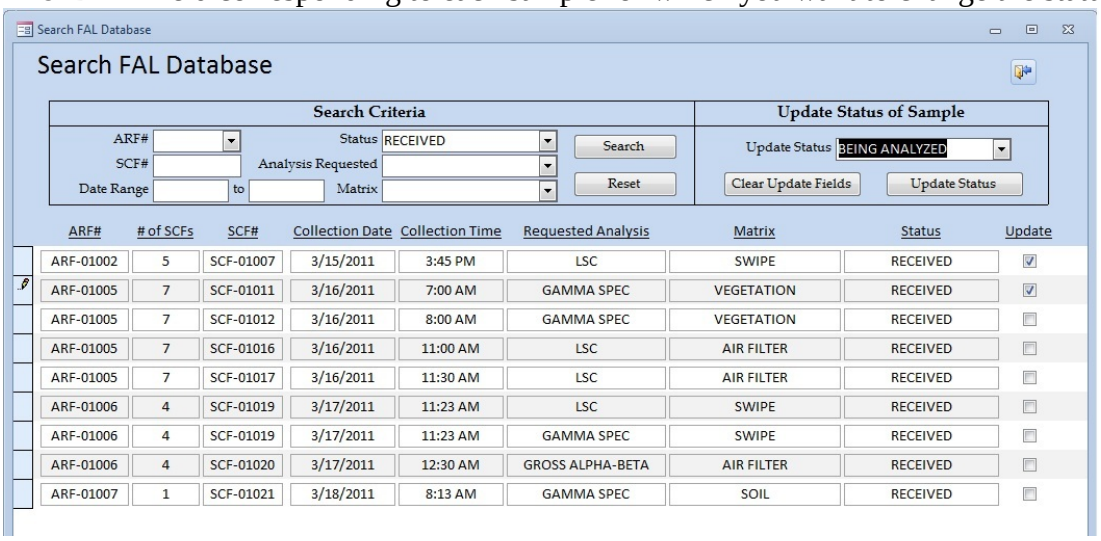
For example, if you want to search for an ARF#, use the combo box for the ARF# and click **SEARCH**; or, if you want to search for a specific matrix with a specific status, the database searches for it.



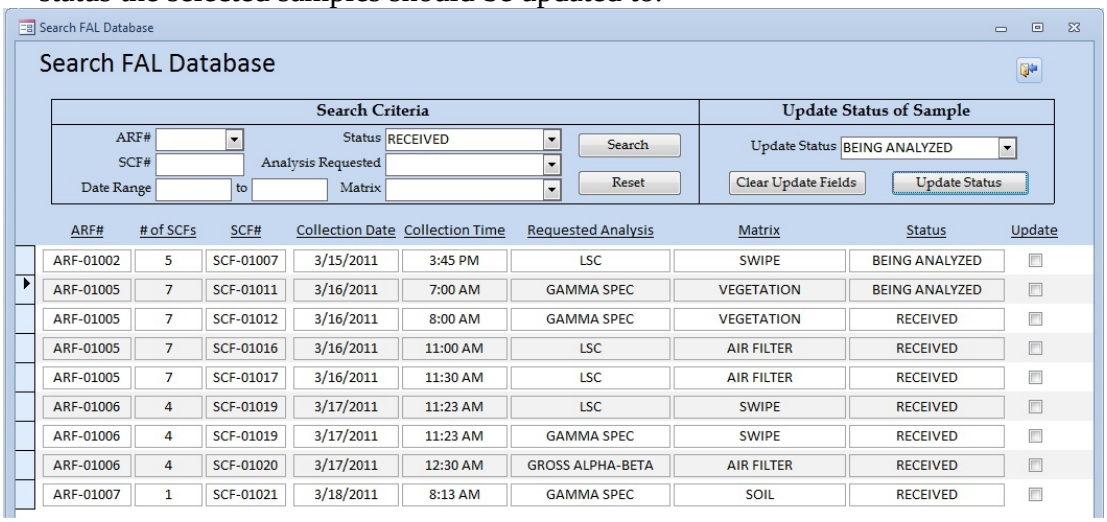
2. To remove search criteria, click the **RESET** button, and all data is displayed.

Update Several Samples at a Time

1. Select Sample Details & Update Status, and on each row at the end, there is an **UPDATE** field. Click on any **UPDATE** field corresponding to each sample for which you want to change the status.



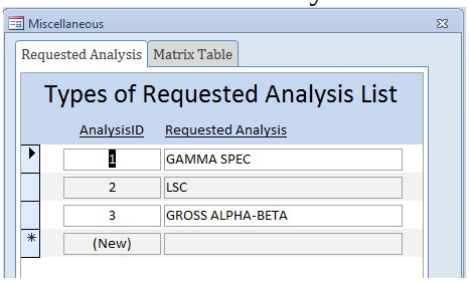
2. When all samples to be updated are selected, in the Update Status of Sample, select the status the selected samples should be updated to.



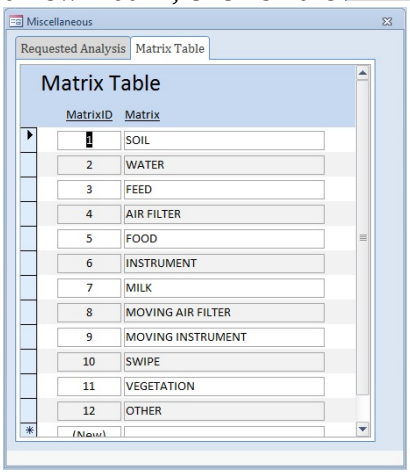
Next, click **UPDATE STATUS,** and all the samples change their status.

Miscellaneous Items

1. Select Miscellaneous in the main menu.
2. To add a Requested Analysis, click on the Requested Analysis tab, if it is not already open, and add the new analysis.



To add a new matrix, click on the Matrix Table Tab, and add the new matrix.



Exit Database

On the main menu, click Exit Database.

This page is intentionally left blank

Appendix D: LSC Quench Overview

Introduction

In a sample vial, the scintillation cocktail converts the radiation emissions of the sample nuclide into light (photons). The liquid scintillation analyzer detects this light when photons enter the photomultiplier tube of the detector. Quenching occurs when something interferes with either the production or the detection of this light. When a sample contains quenching agents, two types of counting interference can occur. First, a chemical quenching agent can interfere with the actual production of photons in the scintillator. Second, a color quenching agent can hinder the detection of the photons from the sample vial into the detector. In either case, the counting efficiency is affected since fewer photons are detected.

When DPM (disintegrations per minute) are being calculated, the sample must be checked for quench. If a sample is not corrected for quench, erroneous DPM results may be reported. Generally, the more the sample is quenched, the lower it's counting efficiency. By comparing the spectra of quenched and unquenched versions of the same sample, you can see two types of spectral changes depending on the type of quench involved, chemical or color.

Chemical quenching causes a loss of beta event energy during the energy transfer from the point of emission to the production of the photon burst. This is reflected in a spectrum that appears to be compressed toward the lower energy end of the keV scale. Since more of the beta events are now detected as lower energy events, there is also an increase in the height of the spectrum at the lower energy end (Figure D-1).

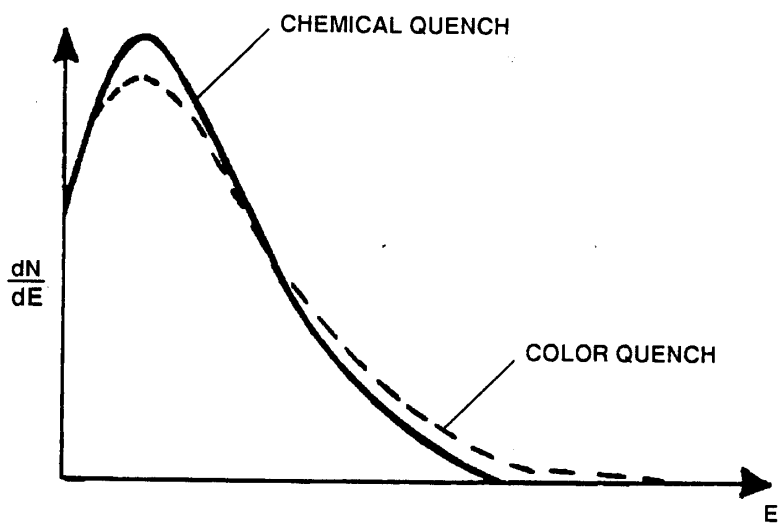


Figure D-1 - Comparison of Unquenched and Chemical Quenched Spectra

Quench Curves

A quench curve correlates the known DPM of a standard to some measured amount of chemical quench. The quench curve is generated by counting a series of standard samples, each containing the same amount of nuclide and varying amounts of the quenching agent. Generally, the sample containing no quenching agent generates the highest counts, while the sample with the most quenching agent generates the lowest counts. The efficiency for each sample is calculated and the quench curve is plotted as % Efficiency vs. amount-of-quench. The amount-of-quench axis is based on a scale relative to the quench indicating parameter selected.

Color quenching does not interfere with the energy transfer of the beta events, but rather blocks the detection of some of the photons emitted from the scintillation cocktail. This is reflected in a spectrum that appears to be somewhat normal but depressed in height.

These two types of quenching can easily be identified using spectrum analysis. The pulse height distributions for chemical and color quenching are different as shown in Figure D-2.

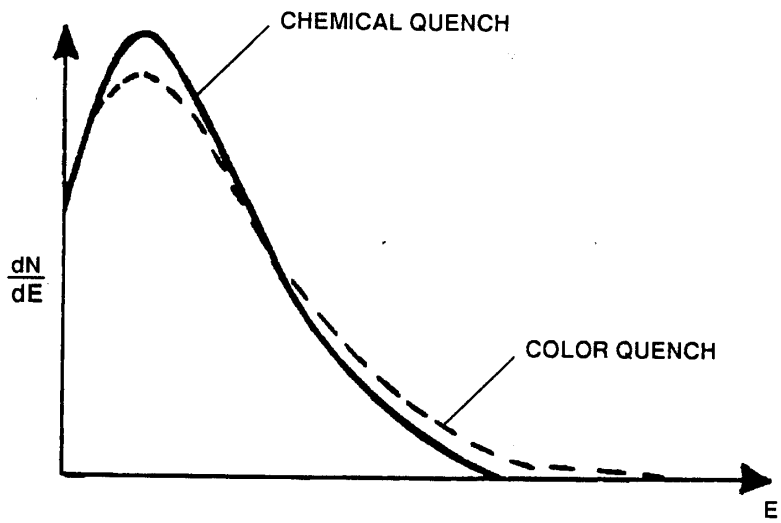


Figure D-2 - Comparison of Chemical and Color Quenched Spectra

The quench correction can be compensated for by using either internal standardization samples or by the quench curve method.

Quench Correction using an Internal Standard

In this method, an unknown sample is first measured and its CPM value is recorded. A known but small volume of desired isotope is added to the counting vial. The solution is mixed well and the sample is recounted. The counting efficiency is:

$$\text{Eff} = \frac{(\text{CPM}_{\text{unknown+standard}} - \text{CPM}_{\text{unknown}})}{(\text{DPM}_{\text{Standard}})}$$

The DPM of the unknown sample can be calculated as:

$$\text{DPM}_{\text{unknown}} = \frac{\text{CPM}_{\text{unknown}}}{\text{Eff}}$$

DPM Counting with the External Standard Cap and Input Quench Curve

Quench Correction

In LSC counting the measured substance is dissolved into a scintillation cocktail *i.e.* a liquid consisting of a solvent and flour which produce light when excited by radiation. Because the sample is mixed with the scintillator its chemical and physical properties may affect the scintillation process resulting in variable light production. This phenomena is called quenching and its main forms are chemical quench, in which light production is affected by the sample's chemical composition, and color quench, in which light transmission from scintillating atoms to the PMT varies due to the absorption in the scintillation cocktail. The latter varies also according to the sample volume while the chemical quench does not. In addition to these, optical quenching occurs if dirty scintillation vials are used.

Constant Quench

Quench correction should be applied if the quench varies from sample to sample. If it is constant the correction is not needed and it suffices that the result value is multiplied by a factor. The results are then to be expressed as DPM rather than CPM. Because of this connection, quench correction and DPM counting are synonyms in the text which follows.

Variable Quench

You can measure and compensate for the variable quench in LSC samples with the Triathler. There are four methods available. We will only discuss the quench correction with an external standard here.

Quench Correction with an External Standard

The drawback of the quench curve method is that it does not produce reliable results if the samples activity is low. In these conditions statistical fluctuation and background easily corrupt

the results. These problems can be minimized by using an external gamma source, in the vicinity of the sample, to establish the quench value.

The method is based on the fact that a gamma particle interaction will produce similar light production in cocktail as the beta particles and the gamma induced light production obeys the same quench rules as beta particles.

This method relies on the use of an external standard quench curve. The curve establishes the relationship between a quench parameter caused by a gamma source (called external standard) and the counting efficiency. First, the quench curve must be determined by counting a suite of samples with the same activity but variable quenching. Each sample is counter twice, first with the presence of the external standard (quench determination) then without (activity determination).

When test samples are counted, the quench parameter is determined for each sample. Corresponding efficiency for the measured (or interpolated) quench parameter is obtained from the curve and the corresponding DPM value calculated.

The quench parameter indicates a relative light production from the sample and there are many methods to calculate it from the sample spectrum. In the Triathler, the quench paramter (Qp) used is so called ESCR (External Standard Channel Ratio), it is the ratio of counts in two windows.

The windows are in the upper part of the spectrum. If the quench increases the light production decreases and the counts in the “B” window decrease more rapidly than in the “A” window.

ESCR and counting efficiency seldom have a linear relationship. Therefore the quench correction curve is not usually linear either. The Triathler uses either transformed parabolic regression or segmented liner interpolation fit to form the curve.

Counting Samples with the External Standard

Keep the same quench selection settings as in the previous calibration step, reference is now not selected (completed calibration turns it off automatically).

You must count each sample twice, first with the “Ext Cap” then with the “Std Cap”. Triathler indicates which cap to use in each stage.

The quench parameter (in this case ESCR) is calculated and printed only if the quench calculation is enabled.

Samples are counted twice but in other respects the counting procedure is the same as when counting normal LSC samples. If regression fit is used the DPM value is calculated as shown in the quench curve method.

In this method, the quench parameter is influenced by the same random variation as radioactive decay in general. However, on the contrary to other methods, quench parameter is determined using high activity samples even though the actual sample activity is low. As a consequence, QP is stable regardless that sample activity may have the same statistical fluctuation than in other methods.

This method is particularly suitable to count low activity samples. The quench curve is made once and it can be used for a long time without any need to reconstruct it. However, it is important to note that a quench curve applies to only one set of measurement conditions – one nuclide, scintillation cocktail, counting window and sample volume.

Quench correction can be applied for single channel results only. You can use quench correction with multi-label counting but only channel 1 DPM results are corrected. Simultaneous quench and spillover correction are not possible. You can also select quench parameters to be printed out. The parameter is calculated in the same way as when using the quench standard curve. However this parameter is not used when the DPM value is determined.

This page is intentionally left blank

Appendix E: LSC Data Entry Sheets

GAB H3 Daily Calibration Check

Analysis Method:	LSC	Analysis Request #:	
Instrument:		QC Batch ID:	
Count Date:		Sample Type:	
T_s (min.)		Sample Size:	
Unc. Sigma:		Sample Size Units:	
Number of BKGs:	0	Reporting Units:	

Measurement Quality Objectives (MQOs)

Nuclide	DRL	L_C	Units
Gross Alpha			
Gross Beta			
H3			

	H-3 (3 UG)	Am-241	Cl-36
Activity (DPM):	253100	53160	48378
Reference Date:	9/2/2011	6/15/2005	6/15/2005
$T_{1/2}$ (years):	12.35	432.2	3.01E+05
Count Date:	9/2/2011	6/15/2005	6/15/2005
Decay Factor:	1.0000	1.0000	1.0000
Current Activity (DPM):	253100	53160	48378

	Alpha (CPM)	Alpha (DPM)	Beta (CPM)	Beta (DPM)	H3 (CPM)	H3 (DPM)	% Bias	Acceptable?	Acceptance Criteria	
BKG									≤	200 CPM
BKG									≤	200 CPM
BKG									≤	200 CPM
BKG									≤	200 CPM
BKG									≤	200 CPM
Average BKG									≤	200 CPM
STDEVP BKG										
MDC_{95}										
H-3 (3 UG)									≤	25% Bias
Am-241									≤	10% Bias
Cl-36									≤	10% Bias

H3 Daily Calibration Check

Analysis Method:	LSC	Analysis Request #:	
Instrument:		QC Batch ID:	
Count Date:		Sample Type:	
T_s (min.)		Sample Size:	
Unc. Sigma:		Sample Size Units:	
Number of BKGs:	0	Reporting Units:	

Measurement Quality Objectives (MQOs)

Nuclide	DRL	L_C	Units
Tritium			

	H-3 (3 UG)	H3 (Wallac)
Activity (DPM):	253100	200400
Reference Date:	9/2/2011	3/1/2009
$T_{1/2}$ (years):	12.35	12.35
Count Date:	9/2/2011	3/1/2009
Decay Factor:	1.0000	1.0000
Current Activity (DPM):	253100	200400

	H3 (CPM)	H3 (DPM)	% Bias	Acceptable?	Acceptance Criteria	
BKG					≤	200 CPM
BKG					≤	200 CPM
BKG					≤	200 CPM
BKG					≤	200 CPM
BKG					≤	200 CPM
Average BKG					≤	200 CPM
STDEVP BKG						
MDC_{95}						
H-3 (3 UG)					≤	25% Bias
H-3 (Wallac)					≤	10% Bias

Appendix F: Triathler™ Programming

1. Select the Protocol
2. Put the instrument into “service” mode by entering <2557> on the keypad.
3. Select “Edit”.
4. Press “Enter”.
5. Enter the parameters below (items in blue only appear in the Gabh3 protocol).
6. After entering the parameters, exit the “service” mode by entering <2557> on the keypad.

Parameter	Description	Range of values	Value			
Protocol	Protocol Number	1-9	1	8	9	7
Name	Protocol Name	XXXXX	H3ext	H3que	H3dpm	GabH3
Meas. Time	Measurement Time (seconds)		60	60	60	60
A. Window - Low	Tritium (Alpha) ROI - Low	0-1024	30	30	30	300
A. Window - High	Tritium (Alpha) ROI - High	0-1024	120	120	120	999
Ch type	Channel type	Bet/A+B/Alp	----	----	----	Alp
Cutoff	PLI		----	----	----	500
Bg CPM	Background subtracted from all samples (CPM)	n.nn	0	0	0	0
Res. Factor	Response Factor	yes/no	no	no	yes	yes
F:	Enter the calculated Response Factor	n.nnnn	----	----	n.nnnn	n.nnnn
Channels	# of channels	sing./2ch/3ch	Sing.	Sing.	Sing.	3ch
Spill corr.	Spillover correction	yes/no	----	----	----	yes
Edit(2)	Edit the beta window					
Window - Low	Beta ROI - Low	0-1024	----	----	----	120
Window - High	Beta ROI - High	0-1024	----	----	----	1000

Ch type	Channel type	Bet/A+B/Alp	----	----	----	bet
Bg CPM	Background subtracted from all samples (CPM)	n.nn	----	----	----	0
Res. Factor	Response Factor	yes/no	----	----	----	yes
F:	Enter the calculated Response Factor	n.nnnn	----	----	----	n.nnnn
New name	Name of window	Xxxxx	----	----	----	Beta
Edit (3)	Edit the H3 window		----	----	----	
Window - Low	H3 ROI - Low	0-1024	----	----	----	10
Window - High	H3 ROI - High	0-1024	----	----	----	120
Ch type	Channel type	Bet/A+B/Alp	----	----	----	bet
Bg CPM	Background subtracted from all samples (CPM)	n.nn	----	----	----	0
Res. Factor	Response Factor	yes/no	----	----	----	no
New name	Name of window	Xxxxx	----	----	----	h3
Spec(1)	Spectrum Start	0-1024	10	10	10	10
	Spectrum Stop	0-1024	1024	1024	1024	1024
	2DPlot Start	0-1024	----	----	----	0
Disp (2)	Display timer	up/down	down	down	down	down
Mx.C (3)	Maximum counts		0	0	0	0
Repeat (4)	Repeat counts	yes/no	no	no	no	no
Rate	Rate Unit	CPM/CPS	CPM	CPM	CPM	CPM
View	Activity unit	CPx/DPx/CNT	DPx	DPx	DPx	DPx
Prt	Define data to be printed					
Windows (0)	Print ROIs	yes/no	yes	yes	yes	yes
Time (1)	Count time	yes/no	yes	yes	yes	yes
Counts (2)	Counts	yes/no	yes	yes	yes	no
CPM (3)	Count Rate	yes/no	yes	yes	yes	yes
DPM (4)	Activity	yes/no	yes	yes	yes	yes
ElapsTime (5)	Elapsed Time	yes/no	no	no	no	no

Deadtime (6)	Deadtime	yes/no	yes	yes	yes	yes
Spectra (7)	Send spectra to computer	yes/no	yes	yes	yes	no
Aspectra (8)	Send alpha spectra to computer	yes/no	----	----	----	no
2Dplot (9)	Send 2Dplot to computer	yes/no	----	----	----	no
Qparam. (8)	Quench Parameter	yes/no	yes	yes	Yes	
2Dplot	Enter the Y-gain		----	----	----	86
2Dplot	Enter the Y-positon		----	----	----	15
2Dplot	Enter the delay		----	----	----	30
Bias V.	Enter the bias voltage	0 = Use default	----	----	----	0
Quench corr	Quench correction	yes/no	yes	yes	yes	----
InstantDPM	Use Instant DPM	yes/no	no	no	yes	----
DPMbg	Background subtracted from all samples (DPM)	n.nn	0	0	0	----
ESCR	Sample Channel Ratio - Low	0-1024	100	100	100	----
ESCR	Sample Channel Ratio - Mid	0-1024	200	200	200	----
ESCR	Sample Channel Ratio - High	0-1024	1023	1023	1023	----
Smode	External Standard Mode	Smode(0)None Smode(1)Dicopac Smode(2)Ex.Stand	Smode(2)Ex.Stand	Smode(0)none	Smode(0)none	----
Scale	Curve fitting	lin/log	lin	lin	lin	log
High activ.	High activity samples?	yes/no	no	no	no	----
New name	Name of protocol	Xxxxx	H3ext	H3que	H3dpm	Alpha
Label	Type of analysis	Label(0)gamma Label(2)ex_gamma Label(2)beta label(3)h_beta Label(4)alpha Label(5)lumi	Label(2)beta	Label(2)beta	Label(2)beta	Label(4)alpha