

PNNL OS3700 Tritium Monitoring System Software and Hardware Operations Manual

Revision 2

January 2024

JP Rishel
MC Klein
JM Barnett

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Pacific Northwest National Laboratory
Richland, Washington 99354

Summary

The Pacific Northwest National Laboratory (PNNL) OS3700 Tritium Monitoring System Software and Hardware Operations Manual describes how to install and operate the software and hardware on a personal computer operating in conjunction with the Berthold Technologies LB110 flow-through proportional counter detector system. Included are operational details for the software functions, how to read and use the dropdown menus, how to understand readings and calculations, and how to access the database tables.

Acronyms and Abbreviations

Bq	Becquerel, disintegrations per second
CAM	continuous air monitor
CD	compact disc
CFM	cubic feet per minute
CPM	counts per minute
CPS	counts per second
DVD	digital video disc
L	liter
μCi	micro-curie
$\mu\text{Ci/L}$	micro-curie per liter
$\mu\text{Ci/mL}$	micro-curies per milliliter
m ³	cubic meters
mL	milliliter
min	minute
PC	personal computer
PCI	Peripheral Component Interconnect
PNNL	Pacific Northwest National Laboratory
PNNL OS3700	PNNL OS3700 Tritium Monitoring System
QA	quality assurance
SQL	Software Query Language
V	volt
yr	year

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1.0 Introduction

The tritium stack monitoring system is controlled by a personal computer (PC) and measures tritium activity concentration in real time. It consists of the data acquisition system designed solely for use with the Berthold Technologies LB110 flow-through proportional counter detector system, a pump, and the detector system.¹ Air is routed from the stack sample probe to the LB110 CAM where tritium and other gases (e.g., Kr-85, Xe-133) are measured through a gas-flow proportional counter chamber (Barnett and Snyder 2021). The software and the associated acquisition electronics are not intended for use with any other instrument. The stated tritium minimum detection limit for the LB110 CAM is 1.03 E-07 $\mu\text{Ci/mL}$. This limit meets American National Standards Institute standard ANSI N42.18-2004, Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity In Effluents, which establishes the minimum detection limit of 5 E-6 $\mu\text{Ci/mL}$.

This manual describes how to install and operate the Pacific Northwest National Laboratory (PNNL) OS3700 Tritium Monitoring System (PNNL OS3700) and use the software. For details on the LB110 detector, its maintenance, and its calibration procedure, refer to the hardware manual that accompanies the LB110 (Berthold Technologies 2009).

1.1 Formatting Conventions

Software menus are **bolded** in this manual. At times, the words **Menu 1**|**Menu 2** are used to tell the user to select **Menu 1** and then, from a dropdown menu, select the option labeled **Menu 2**. Clickable buttons are in *italics*. Form labels and text in message boxes, such as “Enter your name,” is surrounded by quotation marks.

1.2 Terms and Definitions

background	The count rate of either the Tritium or Channel B channel in the LB110 caused by naturally occurring radioactivity, ambient air surrounding the detector, or components of cosmic radiation.
breakout box	Connector box used to route signals from external instruments, such as the LB110, to the LabMaster [®] card ² through a 68-pin connector and cabling. It also contains a power supply and universal relay circuit board that is used to drive external alarm relays.
Channel B	The second of the two channels in the LB110 monitoring system, usually set up as a Kr-85 channel. See the term “tritium channel” for a definition for the first channel.
continuous air monitor	An instrument, such as the LB110, that continuously samples and measures the levels of airborne radioactive material in “real time” and has alarm capabilities at pre-set levels.

Note: The term continuous air monitor (CAM) is used in this manual to indicate the entire detection system.

¹ Berthold Technologies GmbH & Co. KG, Calmbacher Straße 22, 75323 Bad Wildbad, Germany

² Scientific Solutions, 9323 Hamilton Drive, Mentor, OH 44060, USA

database	Microsoft® SQL (Software Query Language) ³ database file where the PNNL OS3700 data are stored.
efficiency	The measured count rate from a known activity input into either channel of the LB110, usually measured as a fraction (e.g., 0.55) or a percentage (e.g., 55.0%).
total activity	The total activity released during the 24-hour period beginning at midnight of the current day or a user-defined “reset” time.
LB110	Berthold Technologies gas flow-through proportional counter used to detect and quantify tritium and other gases in air streams.
long count time	A user-supplied period of time (minutes) over which the channel total activities are updated. The long count time must be an integer multiple of short count time and range between 2 and 200 minutes.
personal computer (PC)	The PC on which the PNNL OS3700 software is installed.
PCI-1780U	A multi-function data acquisition input/output Peripheral Component Interconnect (PCI) card, which includes the counter/timers for collecting data from the LB150D and LB110 detectors, manufactured by AdvanTech. ⁴
quality assurance (QA)	Information relating to the PNNL OS3700 detection system. The QA data are logged to the database “AlphaBetaTritium_XX” in the table “QATable” and contain records of measurements from calibration such as efficiency, background, and the date.
rolling average	A user-selected function in the software’s Utilities Count Times menu that causes a rolling average of previous reading to be used when calculating the activity concentration. The number of points to average must be entered by the user. When a new short count is obtained, the oldest short count of the averaging period is discarded and the average is recalculated.
sample flow rate	Flow rate of sample air through the LB110 detector system. This is a fixed value and is set according to the procedure in the LB110 hardware manual.
stack flow rate	Flow rate of the stack exhaust sampled by the LB110 detector system.
short count time	A user-supplied period of time (minutes) over which the instantaneous channel activity concentrations are calculated. The short count time must be an integer number. The activity concentration alarms are based on the short count time or a running average (if this option has been selected from the Utilities Count Times menu).

³ Microsoft Corporation, 15030 Ne 36th St, Redmond, WA 98052 USA

⁴ AdvanTech America, 380 Fairview Way, Milpitas, CA 95035 USA.

Tritium channel	The first of the two channels in the LB110 monitoring system, where counts for tritium (pulses) are collected and sent to the data acquisition electronics.
totalizer	Flow total value for either the stack or sample flow rates equal to the flow rate times the integration period (e.g., 1 L/min × 60 min = 60 L of totalized flow).

2.0 Installation

The PNNL OS3700 software is designed to run on any PC with a 64-bit Microsoft Windows® operating system. It interacts with the Advantech™ PCI-1780 data acquisition PC card to obtain raw counts from the LB110 CAM. The PCI-1780 data acquisition PC card and drivers must be installed before installing the software. The software also interacts with Microsoft SQL Server® and is configured for communication with two local database instances (“AlphaBetaTritium_XX” and “RPL_OS3700_ConfigParams_XX”) that must be built prior installing the monitoring software. The databases have a numerical designation (XX) that references what system the database exchanges information with (e.g., “AlphaBetaTritium_01” serves the data exchange processes for one system whereas “AlphaBetaTritium_02” serves the data exchange process for an identical but independent system). The LB110 CAM feeds data concurrently to two identical but independent PCs with OS3700 installed on them at the 325 Radiological Processing Laboratory: one is hooked up to the annunciator panel for alarming purposes while the other serves as a backup. For information on installing PNNL OS3700 software, write to the following organization:

Pacific Northwest National Laboratory
Environmental Protection and Regulatory Programs
Environmental Radiation Task Lead
P.O. Box 999, Mail Stop J2-25
Richland, WA 99352

3.0 Software Operation

The software for the PNNL OS3700 provides the following function:

- Sets the information flow,
- Collects data at regular intervals,
- Stores results in a database,
- Displays the data collected,
- Runs calibration and source test utilities.

Each function is discussed in the following sections.

3.1 General Operations Information

This section describes the information flow between the LB110 detector and the PNNL OS3700 software, including data collection.

3.1.1 Information Flow

The LB110 detector collects pulses (signals) and stores them to one of two channels—Tritium or Channel B. The pulse height discriminator circuits determine which channel the counts will be stored based on their rise time. The pulses from these two circuits are sent through Bayonet Neill Concelman (BNC)⁵ cables from the detectors to the breakout box and then to the PCI-1780U data acquisition card through a 68-pin cable, where the pulses are logged as counts in their respective channels. The PCI-1780U card contains counters and associated timers. When instructed by the software, the counters collect the number of pulses from the LB110 over a period of time equal to the user-selected short count time.

After each short count, the PNNL OS3700 software requests the time and number of counts from the PCI-1780U card, increases the count time by one short time interval, and restarts the measurement process. The software uses the counts and time values from the PCI-1780U card, as well as the sample volume, to calculate the Tritium and Channel B activity concentrations during the short count. These values are compared to alarm set points for alarming purposes.

The Tritium and Channel B activity released from the stack also are calculated during each long count by multiplying the short count activity concentrations by the stack flow volume and then summing the resulting activities. The Tritium and Channel B long count activity are added to their respective daily “total activity.” The total activities then are compared to alarm set points for alarming purposes. The Tritium and Channel B total activity are normally reset each day at midnight but can be manually reset by an operator.

During each short count time, the software checks the Tritium and Channel B activity concentration values against the alarm set points. If either alarm set point is exceeded, the software automatically changes the long count time to the short count time for faster data

⁵ Bayonet Neill Concelman electrical cable connector cables are miniature quick connect/disconnect radio frequency connectors used with standard coaxial cables.

integration of the total activity. Upon returning to a non-alarm state, the long count time is returned to the user-defined value.

After each long count time, the software stores the activity concentration and activity to a database along with other relevant information (such as the raw counts from the PCI-1780U card). Optionally, during the short count time, the raw and calculated data can be stored in a separate database table for reconstructing each long measurement dataset.

3.1.2 Data Collection

The software automatically retrieves data from the PCI-1780U card, calculates activities, and stores the data to the database file. The time period over which the PCI-1780U card is polled for status varies, depending on the current state of the software. When operating in normal mode (i.e., the status screen is on), the PCI-1780U card is polled approximately every second (or slightly longer when data need to be stored to the database). When a user is interacting with the software (e.g., changing parameters, etc.), the PCI-1780U card is polled approximately every 60 seconds. If the PCI-1780U card has completed a short counting period when the system makes a check, the following events occur:

- Data in the counters are read.
- The activity concentrations are calculated, written to the database (if option is enabled), and compared to alarm set points.
- If a long count time has been reached, the total activities are calculated, written to the database, and compared to alarms set points.
- If a long count time has not been reached and the software does not detect an alarm condition, the count time in the PCI-1780U card is incremented by one short count time, and the process is repeated.
- If the software detects an alarm, the counters are cleared, and the pre-set long count time is set to the short count time interval for faster integration of the total activity.

3.2 PNNL OS3700 Menu Operations

This section explains the menu functions of the PNNL OS3700 software. The software main screen is shown in Figure 1. The menu runs across the top of the software.

Note: Menu options may not be available at all times and depends on whether data acquisition is in progress or not.

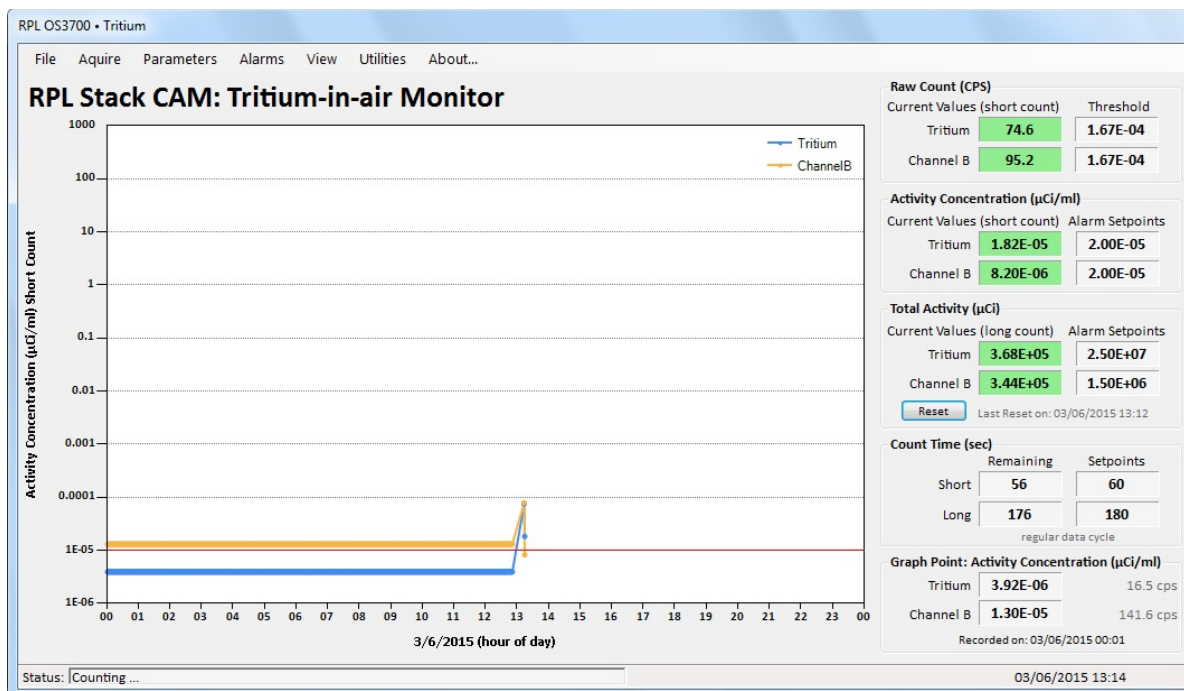


Figure 1. OS3700 Main Screen and Menus

3.2.1 File Menu

The following options are available from the **File** menu (Figure 2):

- Print Config Doc: Prints a configuration document of all current OS3700 operational parameters to a locally available printer.
- Exit: Closes the PNNL OS3700 software. This presents the user with a dialog asking for confirmation of this action.

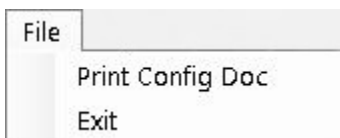


Figure 2. Menu: File

3.2.2 Acquire Menu

The following options are available from the **Acquire** menu (Figure 3):

- Start: Starts the data acquisition process for the Tritium and Channel B counters.
- Stop: Stops the data acquisition process for the Tritium and Channel B counters.



Figure 3. Menu: Acquire

3.2.2.1 Start

The **Acquire|Start** menu option starts the routine data acquisition from the LB110 CAM. If data acquisition is not in progress, this menu option will not be available.

3.2.2.2 Stop

The **Acquire|Stop** menu option allows the user to stop in-progress data acquisition. If data acquisition is not in progress, this menu option will not be available.

If the operator selects the **Stop** menu option, a dialog box will appear (Figure 4).

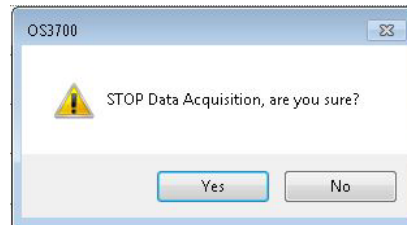


Figure 4. Dialog Box: Confirm Stop Data Acquisition

Note: While the dialog box is displayed, data acquisition will continue in the background.

If the user clicks the *No* button, the dialog box will close, and data acquisition will not be stopped.

If the user clicks the *Yes* button, the routine data acquisition will stop. Any counts that were in progress will end without being completed. The user will be presented with a dialog box (Figure 5).

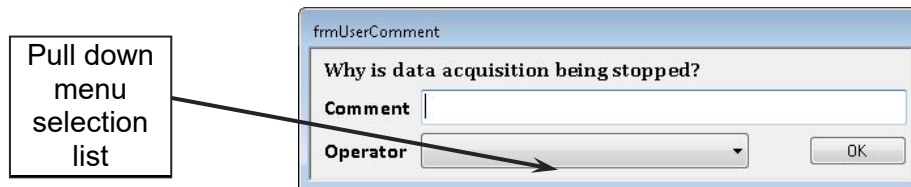


Figure 5. Dialog Box: Enter Comment

In the “Comment” textbox, provide an explanatory reason why data acquisition is being stopped. Select the “Operator” name from the pull-down menu of operator names. Click the *OK* button. The “Comment” and “Operator” name, along with the current date and time, will be written to the Event Log. Commas will be removed from comments.

If a “Comment” is not entered, the default text of “No Comment” will be entered in the Event Log. If an “Operator” is not selected, a default operator of “Misc Staff” will be entered.

Note: Operator names reside in the “RPL_OS3700_ConfigParams_XX” database, “OperatorList” table. This table can be manually edited if names need to be added or removed.

Note: When routine data acquisition is not in progress, a prominent red message, “Data Acquisition Stopped,” will be displayed on the main screen, reminding users that data acquisition is not taking place (Figure 1).

Note: The stack monitoring system computer is equipped with a software monitoring system called “Watchdog.” Watchdog has a heart-shaped icon that displays in the system taskbar when the program is running. By clicking on the icon, an interactive window (Figure 6) will appear where the program can be paused and or resumed. Watchdog monitors both PNNL OS3700 and PNNL OS3300 stack monitoring software for system lockups by verifying that timestamps on the database files are being actively updated. If either software program does not successfully provide a new record in a specified amount of time, Watchdog assumes the system has locked up and executes a hard reboot of the system. All necessary programs are maintained in the startup menu, so the reboot will restart all necessary stack monitoring programs. Because Watchdog triggers on unsuccessful database entries from the software, pause Watchdog before stopping the counting process. Once the interface with PNNL OS3700 is complete, Watchdog will need to be restarted.

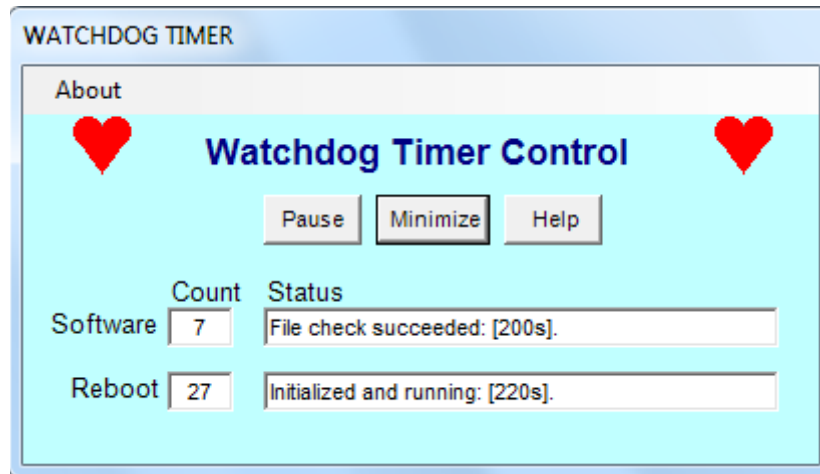


Figure 6. Display: Watchdog Timer

3.2.3 Parameters Menu

The following options are available from the **Parameters** menu (Figure 7):

- Fail Threshold: Displays the “Tritium” and “Channel B” count “Fail Threshold Settings”.
- Preferences: Displays a preferences window for setting source parameters and related values.
- Database: Displays the connectivity information for the SQL databases currently in use.

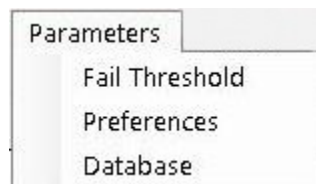


Figure 7. Menu: Parameters

3.2.3.1 Fail Threshold

The **Parameters|Fail Threshold** menu option brings up a dialog box that allows the user to set a minimum count rate for the “Tritium” and “Channel B” channels (Figure 8).

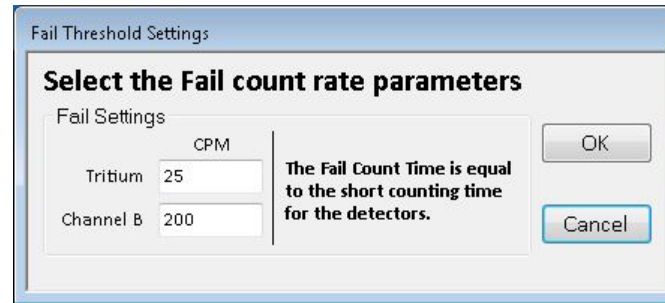


Figure 8. Display: Fail Threshold

The values represent the minimum counts (counts per minute [CPM]) that must be obtained by the electronics to demonstrate the systems are functioning. A failure to meet these count levels will result in a “CAM Function” alarm as well as a “Fail Threshold” alarm in the offending channel (see Section 3.2.4).

Values must be greater than zero CPM for both channels. However, setting these values too high may result in false alarms of the CAM Function. The count time is fixed and equal to the short count time. The “Fail Threshold” settings are checked after every short count time.

When the *OK* button is clicked, both CPM entries are checked for validity. If an invalid value (e.g., non-numeric, zero, or negative number) is entered, a dialog box will appear indicating a problem (Figure 9). If the *OK* button is clicked, the user can correct the value.

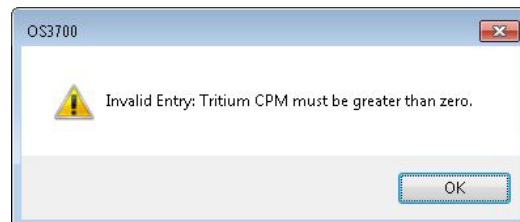


Figure 9. Dialog Box: Invalid Fail Threshold Entry

If the entries are correct, they will be stored to the local SQL database and used in subsequent software operations. A comment will be written to the Event Log describing the changes the date and time the changes were made.

If the *Cancel* button is clicked on the “Fail Threshold” settings screen, the screen will close without the entries being checked. If any entries were changed, they will not be stored to the local SQL database or used in subsequent software operations.

3.2.3.2 Preferences

The **Parameters|Preferences** menu allows the operator to set “Source Parameters” and other options for use within the PNNL OS3700 software (Figure 10).

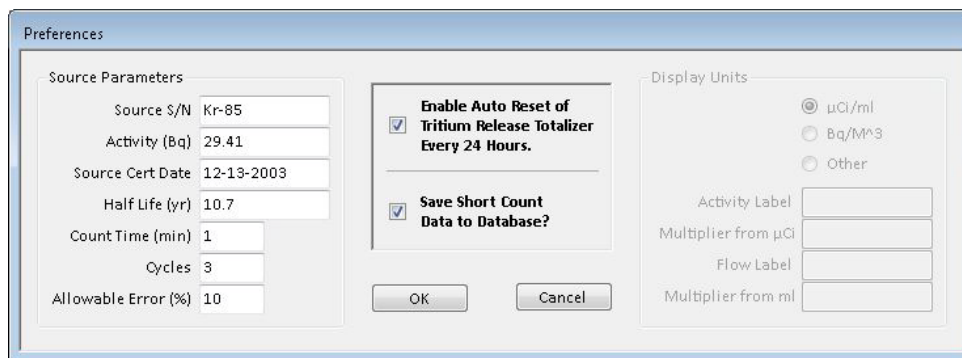


Figure 10. Display: Preferences

The available “Preferences” entries and options are described below.

- “Source S/N”: The serial number of the source used to perform source checks. Any alphanumeric characters can be used to designate the source used in a “Source Check” and “Source Efficiency” measurement.
- “Activity (Bq)”: The activity, in Becquerels (Bq), associated with the source used in a “Source Check” and “Source Efficiency” measurement.
- “Source Cert Date”: The date the source activity was certified. The date must be entered in the form “mm-dd-yyyy”. The source activity is decay-corrected by the software from the source certification date to the date the “Source Check” or “Source Efficiency” measurement is performed.
- “Half-Life (years)”: The half-life, in years, of the source used in performing a “Source Check” or “Source Efficiency” measurement.
- “Count Time (min)”: The count time (in minutes) to be used in a “Source Check” or “Source Efficiency” measurement.
- “Cycles”: The number of cycles to be used in a “Source Check” or “Source Efficiency” measurement.
- “Allowable Error %”: The percent allowable error that is used to determine the “PASS” or “FAIL” criteria in a “Source Check.” Because of the stability of the CAM and as a measure of conservatism, the allowable error is set at 10%. This value is two-thirds of the allowed reference response of $\pm 15\%$ called out in the IEC 60671 standard.
- “Enable Auto Reset”: Enable auto reset (i.e., box checked) causes the software to automatically reset the Tritium and Channel B total activities every day at approximately midnight.
- “Save Short Count Data to Database?”: Save short count data to the database (i.e., box checked) causes the short count data to be written to the database at the end of each short count. If unchecked, only the long count data are written to the database. This setting can be used to manage the size of the database file and should normally be checked.
- “Display Units”: Allows the operator to choose between $\mu\text{Ci}/\text{mL}$ and Bq/m^3 as standard display units or enter conversion factors for customized units. The display units do not affect the units of the data stored in the database, as those units are fixed.

Note: The “Display Units” option has not been fully implemented in the software; therefore, it has been disabled.

When the *OK* button is clicked, all entries are checked for validity. If an invalid value (e.g., blanks, invalid date, non-numeric, zero, or negative numbers) is entered, a dialog box will appear indicating which entry is invalid (e.g., Figure 11). If the *OK* button is clicked, the user can correct the value.

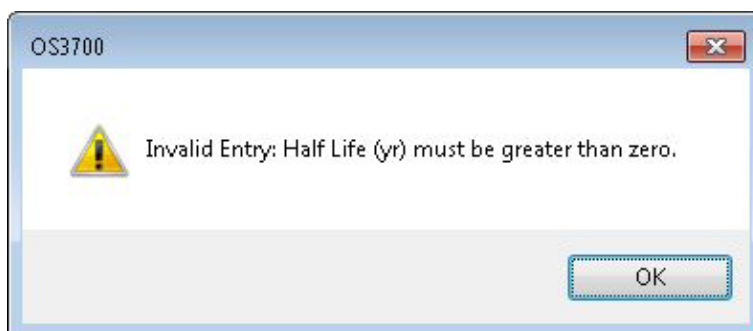


Figure 11. Dialog Box: Invalid Preferences Entry

If the entries are correct, they will be stored to the local SQL database and used in subsequent software operations and calculations. A comment will be written to the Event Log describing each entry that was changed, along with the date and time of the change.

If the *Cancel* button is clicked on the “Preferences” screen, the screen will close without the entries being checked. If any entries were changed, they will not be stored to the local SQL database or used in subsequent software operations.

3.2.3.3 Database

The **Parameters|Database** menu option brings up an information screen. It displays the current connectivity information for both SQL databases currently in use by the software.

When the screen is initially presented, both information blocks will be blank. Click the *Get Information* button to retrieve the “Configuration Parameters” and “Data Storage” strings (see Figure 12).

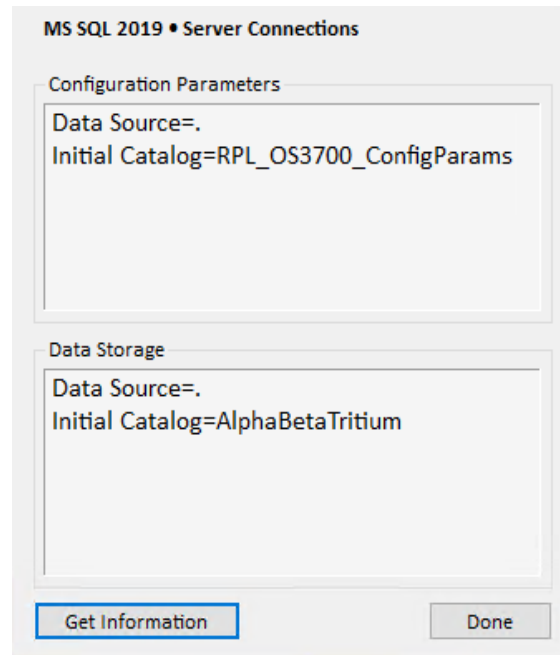


Figure 12. Display: Database Information

The user can exit this screen by clicking the *Done* button.

Note: The SQL database connectivity configuration parameters cannot be setup or modified via the PNNL OS3700 software.

Note: Although not evident in Figure 12, the databases have a numerical designation at the end of their name (e.g., “AlphaBetaTritium_01”) that references what system the database exchanges information with.

3.2.4 Alarms Menu

The following options are available from the **Alarms** menu (Figure 12):

- Settings: Displays the configuration parameter screen for the Alarm Values settings.
- Relay Setup: Displays the configuration parameter screen for the alarm option Relay Setup settings.
- Relay Test: Displays an interactive screen allowing the user to perform an alarm Relay Test in real time by toggling the digital output relays.

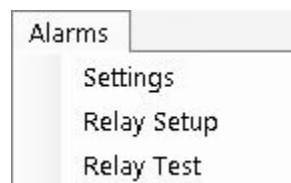


Figure 13. Menu: Alarms

3.2.4.1 Settings

The **Alarms|Settings** menu displays the screen shown in Figure 14. The “Alarm Values” should be entered using site-specific information. Each alarm value is described in Table 1. Some alarm settings may not be enabled for specific software installations; these items will be grayed out.

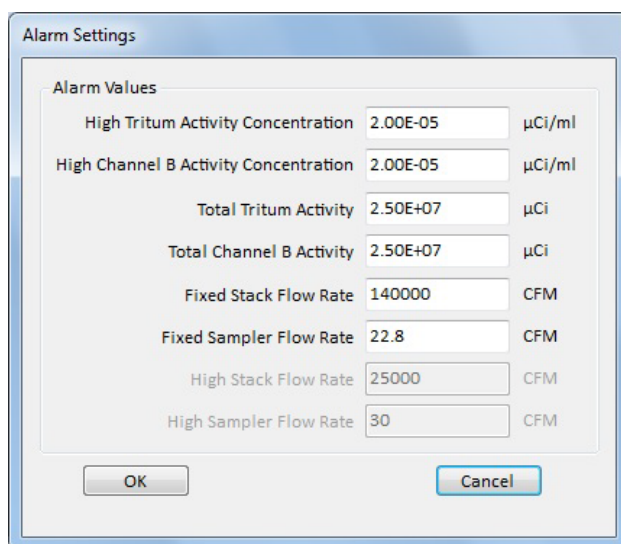


Figure 14. Display: Alarm Settings

Table 1. Alarm Settings

Item	Description	Typical Settings
High Tritium Activity Concentration	Tritium activity concentration (μCi/mL) alarm value for either a short count or rolling average interval.	2.00E-05 μCi/mL
High Channel B Activity Concentration	Channel B activity concentration (μCi/mL) alarm value for either a short count or rolling average interval.	2.00E-05 μCi/mL
Total Tritium Activity	Tritium activity (μCi) alarm level for daily total tritium output through the stack.	2.50E+07 μCi
Total Channel B Activity	Channel B activity (μCi) alarm level for daily total activity output through the stack.	2.50E+07 μCi
Fixed Stack Flow Rate	Flow rate (in cubic feet per minute [CFM]) for fixed flow stack systems. This value is used to calculate the flow total through the stack for any given integration period.	140,000 CFM
Fixed Sampler Flow Rate	Flow rate (in CFM) through the sampler system. Set by site-specific requirements and measurements. See the LB110 manual for more information.	22.8 CFM
High Stack Flow Rate	Not used by the PNNL OS3700 software. This alarm is generated directly by the LB110 or by other instruments independent of the CAM.	165,000 CFM
High Sampler Flow Rate	Not used by the PNNL OS3700 software. This alarm is generated directly by the LB110 sample flow rate control module.	30.0 CFM

When the *OK* button is clicked, all entries are checked for validity. If an invalid value (e.g., blanks, non-numeric, zero, or negative numbers) is entered, a dialog box will appear indicating the entry for which there is a problem (Figure 15). If the *OK* button is clicked, the user can correct the value.

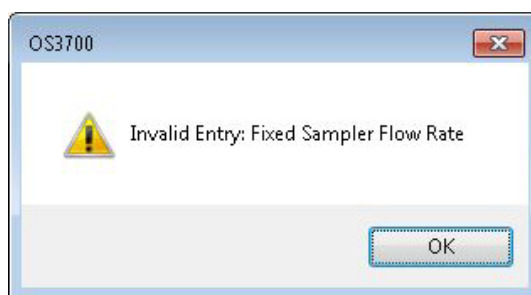


Figure 15. Dialog Box: Invalid Alarm Settings Entry

If the entries are correct, the values will be stored to the local SQL database and used in subsequent software operation. A comment written to the Event Log will describe each entry that was changed and the date and time the change was made.

If the *Cancel* button is clicked on the “Alarm Settings” screen, it will exit without checking if any entries were changed. If any entries were changed, this option will not store them to the local SQL database.

3.2.4.2 Relay Setup

The **Alarms|Relay Setup** menu allows the user to define the relay configuration for the PNNL OS3700 software. Any alarm threshold that is exceeded can generate an alarm output. The “Relay Setup” screen (Figure 16) is used to set alarms associated with the digital output from the PCI-1780U multi-function card or relays. More than one alarm can be output to any PCI-1780U channel, with up to eight channels available. The software uses a logical “OR” function to determine whether an output is generated. Therefore, multiple alarm options can be added to a single relay channel. If any alarm threshold is met, the alarm will be activated.

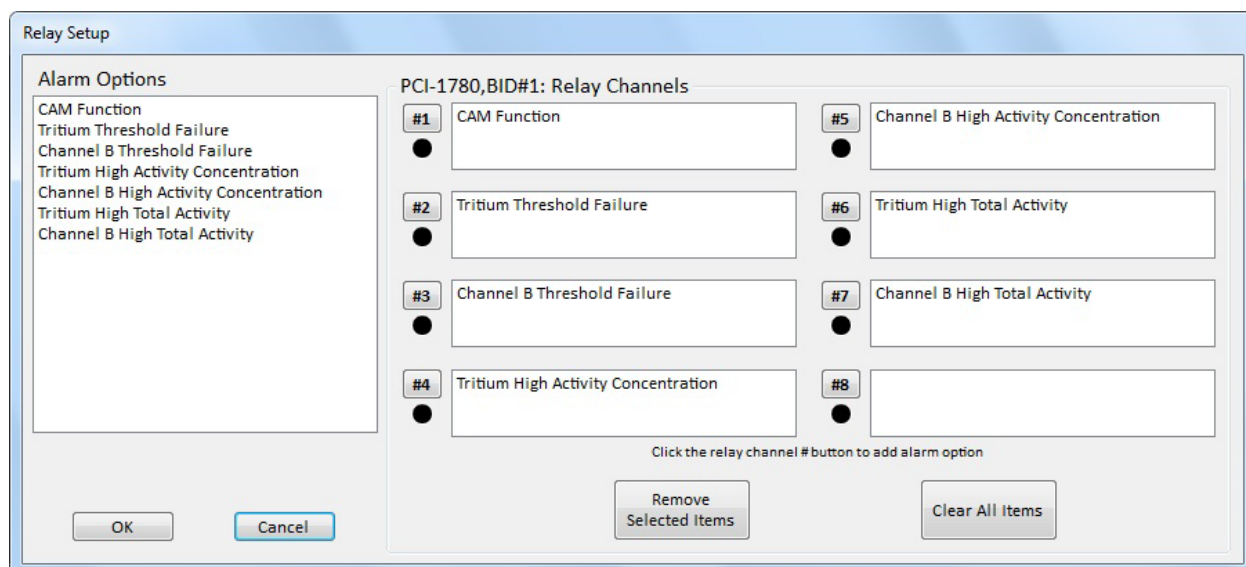


Figure 16. Display: Relay Setup

Note: When an alarm occurs and the software sets the pertinent relay channel (digital output) to “on”, that relay channel will be left in the “on” state, until the data circumstance that caused the alarm is resolved. For example, if the “Channel B Threshold Failure” alarm occurs for a particular acquired data value, the channel relay (#3, in this example) will activate (i.e., turn on) until a subsequent Channel B reading shows that the alarm condition is no longer in effect. If the software continues to acquire data that causes the alarm condition, the alarm channel will stay activated. Once the acquired data shows that the alarm condition has been resolved, the software will deactivate (turn off) that particular alarm channel relay.

Descriptions of the available “Alarm Options” are provided below:

- “CAM Function”: An alarm that occurs when either the Tritium or Channel B threshold failure is not met. For example, in the setup shown in Figure 16, if the Tritium channel does not meet the fail threshold, both relay outputs 1 and 2 will be activated.
- “Tritium Threshold Failure”: An alarm that occurs when the total number of counts in the tritium counter of the PCI-1780U card is less than the fail threshold value set in Section 3.2.3.1.
- “Channel B Threshold Failure”: An alarm that occurs when the total number of counts in the Channel B counter of the PCI-1780U card is less than the fail threshold value set in Section 3.2.3.1.
- “Tritium High Activity Concentration”: An alarm that occurs when the calculated tritium activity concentration for either a short count or rolling average interval exceeds the value set in Section 3.2.4.1. See Section 3.2.6.1 for instructions on enabling rolling average.
- “Channel B High Activity Concentration”: An alarm that occurs when the calculated concentration of Channel B activity for either a short count or rolling average interval exceeds the value set in Section 3.2.4.1. See Section 3.2.6.1 for instructions on enabling rolling average.
- “Tritium High Total Activity”: An alarm that occurs when the calculated daily total tritium activity released exceeds the value set in Section 3.2.4.1.

- “Channel B High Total Activity”: An alarm that occurs when the calculated daily total Channel B activity exceeds the value set in Section 3.2.4.1.

Descriptions of various on-screen controls and their function are provided below.

- “Alarm Options”: A list of all available alarm options that may be assigned to any of the relays. When making assignments for specific relays, one or more options in the list must be selected (highlighted).
- “Relay Channels”: Each of the eight “Relay Channels” (1 through 8) has their own list of alarm options and an assignment button, indicated by the “#” and the relay channel number (e.g., #1). When a relay channel button is clicked, any selected “Alarm Options” will be added to that list. An “Alarm Option” cannot be added to the same “Relay Channel” more than once.
- “Relay Indicators”: Each of the eight “Relay Channels” (1 through 8) has their own round indicator light. If that relay channel is currently “on”, its round indicator light will be red. If that relay channel is currently “off”, its round indicator light will be black.

When the *Remove Selected Items* button is clicked, any selected “Alarm Options” in one or more of the “Relay Channels” will be removed from the relay channel alarm lists.

When the *Clear All Items* button is clicked, all of the “Alarm Option” lists in each “Relay Channel” will be cleared.

When the *OK* button is clicked, all current “Alarm Option” assignments in each “Relay Channel” will be stored to the local SQL configuration database. There are no checks done on the entries. The selected Relay Channel Alarm Option settings will be immediately used within the software for alarming purposes.

When the *Cancel* button is clicked, the “Relay Setup” display screen will close; any changes to the form will not be saved to the local SQL configuration database or be used by the software for alarming purposes.

3.2.4.3 Relay Test

The **Alarms|Relay Test** display (Figure 17) is primarily intended to be used for system diagnostic and testing purposes; the display allows for the manual setting and resetting of alarm channels to test the software’s digital output functionality without needing to create a condition that would lead to an actual alarm situation.

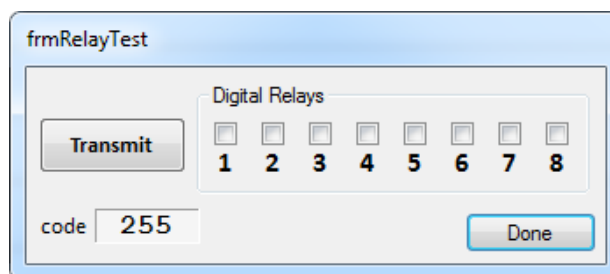


Figure 17. Display: Relay Test

Clicking any one of the eight “Digital Relay” checkboxes (1 through 8) will toggle the relay on and off. When this is done, the software does not send a signal to the digital relay channels to perform that function.

- A “checked” box is used to turn “on” (i.e., set) a particular digital relay channel.
- An “unchecked” box is used to turn “off” (i.e., reset) a particular digital relay channel.

Clicking the *Transmit* button will send the appropriate “byte code” (shown in the lower left of the display; 255 in this example) to the PCI-1780U card. This will set or reset the various “Digital Relays” that have been checked or unchecked.

Clicking on the *Done* button will exit this screen. The software will not attempt to reset any channels when you leave the screen. If any digital relay channels are “on,” the user must reset them prior to leaving this screen, or they will be left “on” by the software.

3.2.5 View Menu

The following options are available from the **View** menu (Figure 18):

- Event Log: Displays a window to view the current or past daily Event Log contents.
- Current Values: Displays a window to view the current calibration data, including background counts and efficiencies.
- Review Data: Displays a window to view past activity concentration data.

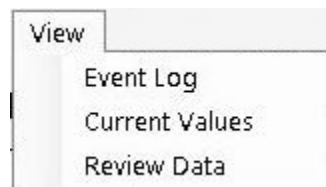


Figure 18. Menu: View

3.2.5.1 Event Log

The **View|Event Log** option is used to display various informational messages written by the software during its operation (Figure 19).

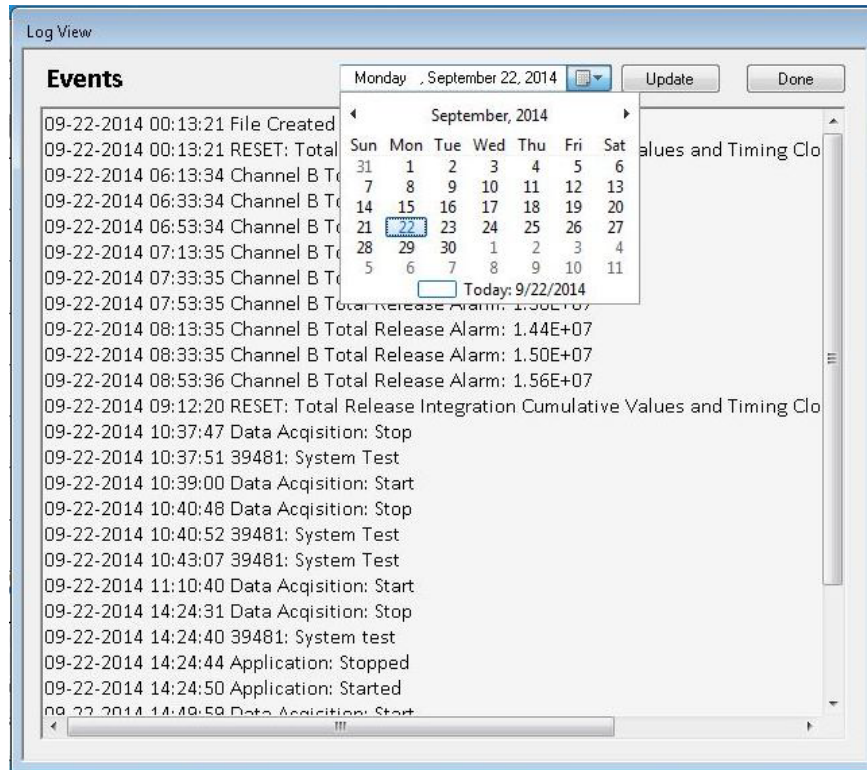


Figure 19. Display: Log View

A new “Event Log” file is written each day and contains messages for that day. “Event Log” contents are displayed with the oldest entries at the top and newest entries at the bottom. The vertical scroll bar on the right of the display can be used to scroll the file contents. If entries are too wide to be displayed, a horizontal scroll bar will appear.

The current day’s “Event Log” is the default display. To view a different “Event Log” date, click on the “date-picker” control (Figure 19) at the top the display and select the desired date. Then click the *Update* button to load that date’s Event Log contents in the display.

If the selected date does not have an “Event Log” file, the message “File not available” will be displayed, followed by the event log name formatted date string.

Click the *Done* button to close the “Event Log” display.

3.2.5.2 Current Values

The **View|Current Values** option is used to display the current background and efficiency values being used in the software’s calculations (Figure 20).

Current Values		
Background		
	CPM	Calibrated
Tritium	38.28	02-13-2015
ChannelB	976.80	
Efficiency		
	%	Calibrated
Tritium	43.2	02-13-2015
ChannelB	100.0	02-13-2015
Source Efficiency		
	%	Calibrated
Tritium	1.93E-03	02-13-2015
ChannelB	6.09E-02	
OK		

Figure 20. Display: Current Values

The background and efficiency values are determined and stored at calibration time; the “Current Values” form simply displays these stored values for diagnostic purposes. The Tritium and Channel B “Background” and “Efficiency” values are used by the software to calculate the corresponding activity concentrations and total activities from the raw counts. The Tritium and Channel B “Source Efficiency” is used by the software’s “Source Check” utility.

The specific date when that value was derived is in the “Calibrated” column. “Background” values are listed in CPM. “Efficiency” and “Source Efficiency” values are listed in % (percent).

Click the **OK** button to close the “Current Values” display.

3.2.5.3 Review Data

The **View|Review Data** option is used to display a plot of past activity concentration data (Figure 21).

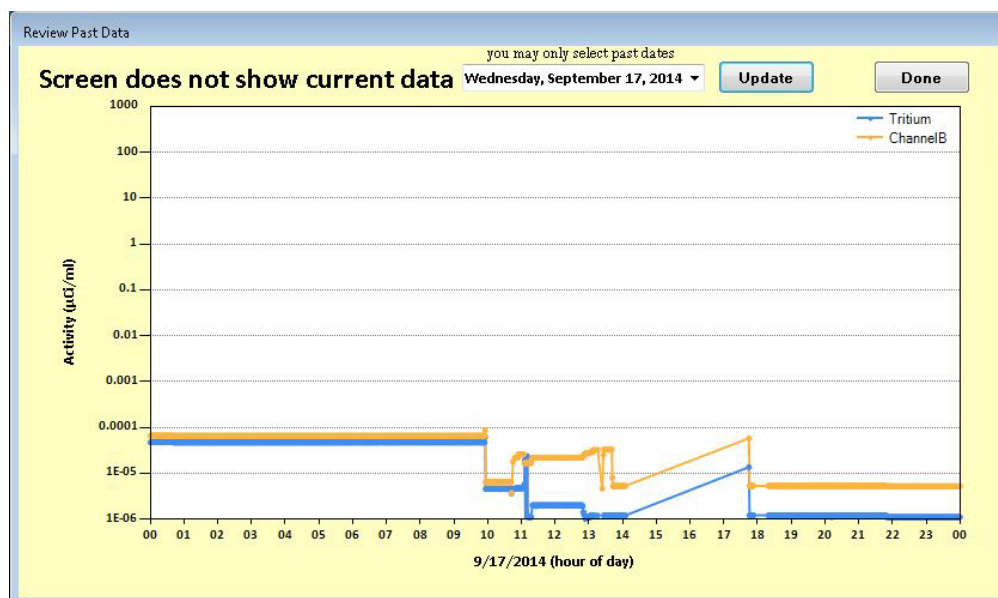


Figure 21. Display: Review Past Data

When the display is initially brought up, no data appears. Use the “date-picker” control to select a past date and then click the *Update* button to plot data from the chosen date. The graph has the same zoom functionality as the main display plotting area. If no data is available for a selected date, it will display a blank rectangle.

The “Review Data” display will not interfere with current data acquisition. As a reminder, the display is colored with a bright-yellow background so that it can be easily distinguished from the current data being acquired and displayed on the software’s main display.

Click the *Done* button to close the “Review Past Data” display.

3.2.6 Utilities Menu

The **Utilities** menu is only available when data acquisition is stopped. The following options are available (Figure 22):

- Count Times: Displays a window for editing the short and long count times and related configuration parameters.
- Source Check: Utility allowing the PNNL OS3700 system efficiency to be verified against calibration values.
- Background: Utility to determine the background readings for the instrumentation.
- Efficiency: Provides a sub-menu of “Efficiency” utility measurement options, including:
 - Source. Utility measurement to determine the instrumentation efficiency per a known source.
 - Tritium. Utility measurement to determine the tritium efficiency per its calibration gas procedure.
 - Channel B. Utility measurement to determine the Channel B efficiency per its calibration gas procedure or allowing the operator to manually enter the efficiency.

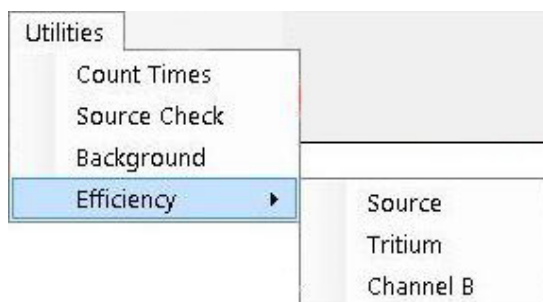


Figure 22. Menu: Utilities

3.2.6.1 Count Times

The **Utilities|Count Times** display (Figure 23) is used to enter the “Short Count Time” and “Long Count Time” or to enable/disable the use of a “Rolling Average” when calculating the “Activity Concentration”.

Figure 23. Display: Count Times

The data entry descriptions are provided below:

- “Short Count Time”: The “Activity Concentration” is calculated at the end of each “Short Count Time”. The “Short Count Time” is an integer number of minutes and must be at least 1 and less than or equal to the “Long Count Time”.
- “Long Count Time”: The “total activity” released since the last reset (normally midnight of the current day) is updated at the end of each “Long Count Time”. The “Long Count Time” is an integer number of minutes and must be equal to or greater than the “Short Count Time” and less than or equal to 200 minutes. The “Long Count Time” must be an even multiple of the “Short Count Time”.
- “Rolling Average”: The “Rolling Average” checkbox enables or disables the use of a rolling average when calculating the “Activity Concentration”.
- “Number of points to Average”: The “Number of Points to Average” is an integer value and is only available if the “Rolling Average” is enabled; the value must be between 2 and 200 and is the number of data points averaged together when calculating the activity concentration using the “Rolling Average”.

The “Short Count Time” is the time period used to determine the Tritium and Channel B activity concentrations, which then are compared to corresponding alarm set points. The “Short Count Time” also is the time period used to compare the raw Tritium and Channel B counts to the instrumentation count fail threshold settings. If the instrumentation does not generate a minimal count level, an alarm is generated. This may mean that the instrument is not working correctly.

The “Long Count Time” is the frequency used to update the estimate of the Tritium and Channel B “Total Activity” released from the stack from some defined start time (usually midnight), which then are compared to corresponding alarm set points.

If any alarm level is exceeded, the “Long Count Time” is set to the “Short Count Time” to update the “Total Activity” released on the software’s main display at a faster rate. This situation continues until all of the alarm levels are cleared (i.e., they are no longer exceeded).

The “Rolling Average” is an alternative method to determine the Tritium and Channel B activity concentrations. When enabled, the Tritium and Channel B “Activity Concentration” on the software’s main display are calculated using a “Rolling Average” of the “Activity Concentration” from each “Short Count Time”, up to the “Number of points to Average” entry.

Note: The “Count Times” display provide the data acquisition card information in the bottom half of the display for the PCI-1780U analog/event counter channels being used by the software. This information is not editable and is only provided as a quality check to assure that the PNNL OS3700 software is using the appropriate input channels.

- “BID#”: Hardware board identifier (internal slot number)
- “Device#”: Internal software driver library reference number
- “Tritium”: Event input channel being used for Tritium counts
- “Channel B”: Event input channel being used for Channel B counts.

3.2.6.2 Source Check

Select the **Utilities|Source Check** menu option to bring up the “Source Check” measurement utility. This utility can be used at any time to verify that the detector’s current source efficiency is within a certain percentage (i.e., an “Allowable Error”) of the “Source Efficiency” measured during the last calibration. Parameters used by this utility are found under the main menu **Parameters|Preferences**. Normally, the “Source Efficiency” is determined during a calibration and the system is checked using the same source throughout the year.

When the **Utilities|Source Check** menu option is selected, the user is presented with three dialog boxes (Figure 24). By clicking the *OK* buttons, the user acknowledges the needed action and confirms the information presented.

If the “Source items” presented in the second dialog are not correct, *Exit* the “Source Check” utility and go to the **Parameters|Preferences** screen and change the source parameters to the correct information. The software uses the source information when calculating the decay-corrected source activity in the “Source Check” utility.

The user is then presented with another dialog box, asking them to provide their name and a brief comment as to why this utility measurement is being performed (Figure 25).

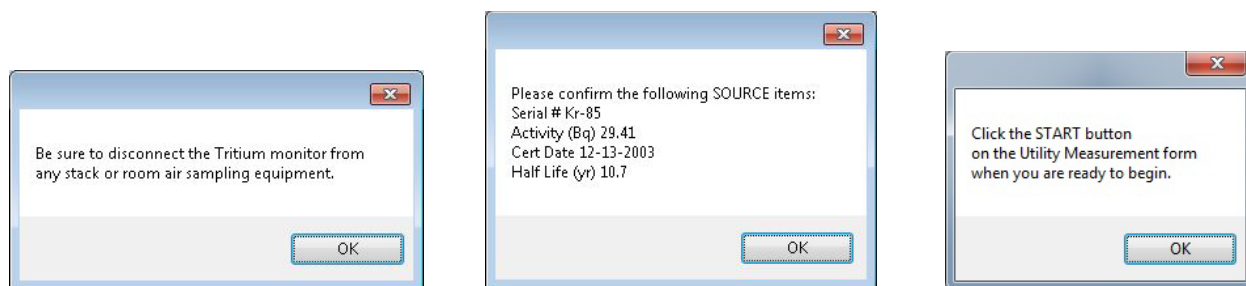


Figure 24. Dialog Boxes: Source Check Utility Measurement – User Confirmation

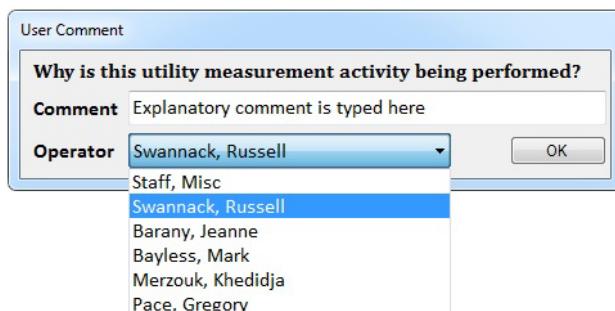


Figure 25. Dialog Box: Source Check Utility – User Comment

After clicking the *OK* button, the comment will be written to the Event Log. Any commas used in a comment will be removed.

Make sure the source has been inserted into the chamber prior to starting the “Source Check” utility. It is recommended to use the same source when making the “Source Check” measurement.

Data entry descriptions for the “Source Check” utility form are listed below, and an example screen is shown in Figure 26:

- “Count Time”: The “Count Time” is the duration of each count cycle. It must be an integer value between 1 and 10 minutes. Note: The “Count Time” is not directly editable from the “Source Check” form. This parameter can be modified from the **Parameters|Preferences** form, if necessary.
- “Cycles”: The “Cycles” is the number of count cycles that will be performed; it must be an integer value between 1 and 10. **Note:** The “Cycles” is not directly editable from the “Source Check” form. This parameter can be modified from the **Parameters|Preferences** form, if necessary.

Click the *Start* button when ready to begin a “Source Check”. The software will proceed to do a “Source Check” for the number of data “Cycles.” The remaining “Count Time” for each cycle can be seen on the “Count Time” display within the main software display.

Click the *Stop* button to stop a “Source Check” that is already in progress. If clicked, the user is asked to confirm this action. Stopping the utility measurement before it has completed is considered to be a “Source Check FAILED” by the software.

Utility Measurement

Source Check

Setup

Count Time minutes

Cycles

Reference Values

Decay-Corrected Source Activity (Bq):	Tritium Background (CPS)	Channel B Background (CPS)
195749.34	0.64	16.28

Cycle	Tritium CPS	Channel B CPS
1	9.00	179.58

Current Average Efficiency (%)

-	Tritium	Channel B
Avg	4.27E-03	8.34E-02
Stored Eff (%)	2.03E-03	6.12E-02

Start

Stop

Exit

Figure 26. Display: Source Check Utility (in progress)

Click the *Exit* button to exit the “Source Check” utility form. The Exit button is only available when the “Source Check” is not acquiring data.

At the end of a data cycle, the “Tritium” and “Channel B” counts per second (CPS) will be displayed in the center grid (Figure 26). The “Current Average Efficiency (%)” will be calculated and displayed in the lower grid for each channel according to Equation 1:

$$\text{Channel Efficiency}(\%) = \frac{\text{Channel (CPS)} - [\text{Channel Background (CPS)}]}{\text{Decay corrected source activity (Bq)}} \times 100 \quad (1)$$

where:

Channel Efficiency(%) is the calculated Tritium or Channel B efficiency

Channel (CPS) is the measured Tritium or Channel B counts

Channel Background (CPS) is the Tritium or Channel B background counts stored in the configuration database

Decay corrected source activity (Bq) is the source activity at the time of the **Source Check**. This value is calculated by the software and is based upon the source information entered on **Parameters|Preferences** form.

Reference “Tritium Background (CPS)”, “Channel B Background (CPS)”, and “Decay-Corrected Source Activity (Bq)” being used by the software to calculate the channel efficiencies are displayed on the form during a “Source Check”.

“Stored Eff (%)” values determined at the calibration time for each channel are displayed immediately below the “Current Average Efficiency (%)”. If the efficiencies are within the “Allowable Percent Error” limit established on the **Parameters|Preferences** form, the software will display a “Source Check PASSED” dialog box at the end of the last measurement cycle. Otherwise, the software will display a “Source Check FAILED” dialog box.

User actions and measurements are written to the Event Log. Reference values, such as the “Decay-Corrected Source Activity” will also be written to the Event Log. At the end of each data cycle, each channel’s counts (in CPS) are written to the Event Log. When the “Source Check” completes, the software writes the calculated average efficiencies for each channel to the Event Log.

3.2.6.3 Background

Select the **Utilities|Background** menu option to display the “Background” measurement utility. This utility is used at calibration time to determine the Tritium and Channel B “Background” counts, which are stored in the software database and used in subsequent calculations of the Tritium and Channel B “Activity Concentration” and “Total Activity” (refer to Section 4.0). The “Background” measurement utility should be run without any radiological sources in the instrument. In addition, the “Background” measurement utility should be run before running any “Efficiency” utility measurements because the channel background values are subtracted from the gross counts in the efficiency calculation (see Equation 1; Section 3.2.6.2).

When the **Utilities|Background** menu option is selected, the user is presented with two dialog boxes (Figure 27). By clicking the **OK** buttons, the user acknowledges the needed action and confirms the information presented.

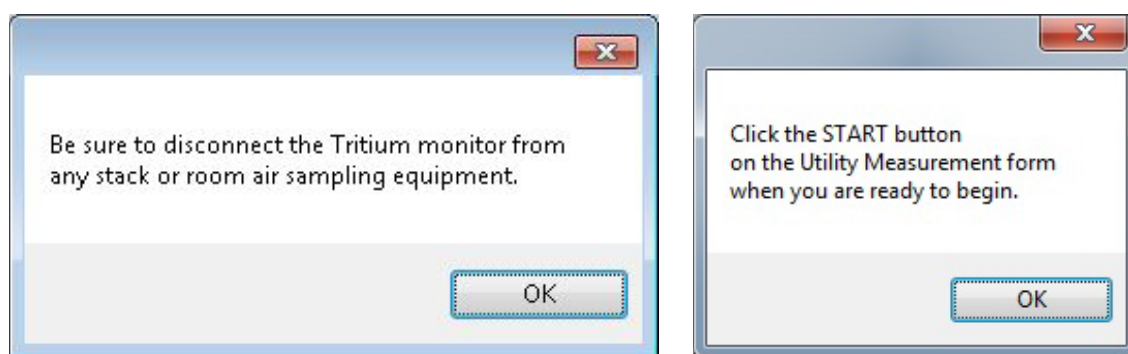


Figure 27. Dialog Boxes: Background Utility – User Confirmations

Data entry descriptions are listed below for Figure 28.

- “Count Time”: “Count Time” is the duration of each count cycle. It must be an integer value between 1 and 10 minutes.
- “Cycles”: “Cycles” is the number of count cycles that will be performed. It must be an integer value between 1 and 10.

Utility Measurement

Background

Setup

Count Time minutes

Cycles

Cycle	Tritium CPS	Channel B CPS
1	4.67	14.18
2	5.28	14.22
3	5.28	14.18

Current Average Counts (CPM)

-	Tritium	Channel B
Avg	304.67	851.67

Start Store Data

Stop Exit

Figure 28. Display: Background Utility (in progress)

To begin a “Background” measurement, enter the “Count Time”, number of measurement “Cycles”, and click the *Start* button. At the end of each measurement cycle, the center grid (Figure 28) will be updated with the current CPS from each channel. The lower grid will be updated with the average CPM from all cycles for each channel.

Click the *Stop* button to stop a “Background” measurement that is in progress. Otherwise, once the “Background” measurement utility completes, the *Store Data* button can be clicked to store the “Current Average Count (CPM)” to the configuration database. Stored values will be used in all subsequent software calculations.

Caution: Storing the “Background” values will void the instrument calibration.

Click the *Exit* button to exit the “Background” measurement utility form. The *Exit* button is only available when the “Background” measurement utility is not acquiring data.

Informational messages are written to the Event Log during the use of the “Background” measurement utility, including the channel counts (CPS) for each data cycle and the average background counts (CPM) for each channel. User interactions, such as stopping a measurement, storing background values, or exiting the utility are also written to the Event Log.

3.2.6.4 Efficiency|Source

Select the **Utilities|Efficiency|Source** menu option to bring up the “Source Efficiency” measurement utility. This utility is used at calibration time to establish the stored source efficiency values for subsequent use in the “Source Check” utility. Refer to the “Source Check” utility (Section 3.2.6.2) for information on how the “Source Efficiency” values are used in a “Source Check”.

When the **Utilities|Efficiency|Source** menu option is selected, the user will be presented with three dialog boxes (Figure 29, in sequence from left to right). By clicking the *OK* buttons, the user acknowledges the needed action and confirms the information presented.

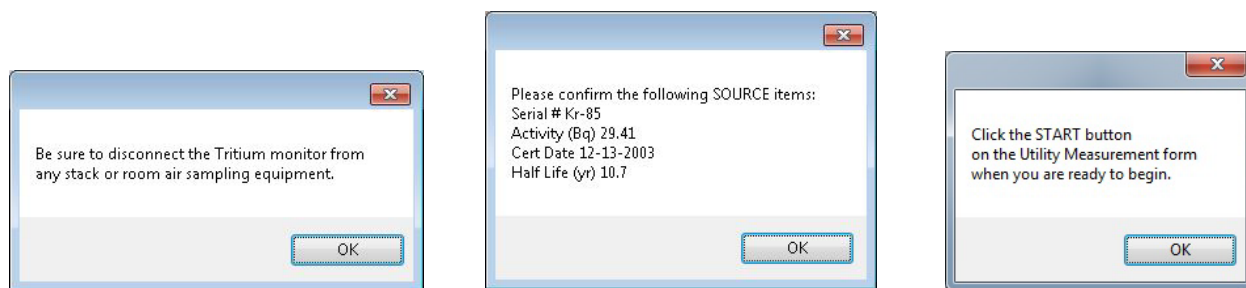


Figure 29. Dialog Boxes: Source Efficiency - User Confirmations

If the “Source items” presented in the second dialog are not correct, click the utility’s *Exit* button and go to the **Parameters|Preferences** screen and change the source parameters to the correct information. The software uses the source information when calculating the decay-corrected source activity in the “Source Efficiency” utility.

A ^{137}Cs gamma test source is used to measure the “Source Efficiency”. Make sure the source has been fully inserted into the LB110 chamber prior to starting the “Source Efficiency” utility.

Data entry and screen button descriptions for the “Source Efficiency” utility form are listed below, and an example form is shown in Figure 30.

- “Count Time”: The “Count Time” is the duration of each count cycle; it must be an integer value between 1 and 10 minutes.
- “Cycles”: The “Cycles” is the number of count cycles that will be performed; it must be an integer value between 1 and 10.

To begin a “Source Efficiency” measurement, enter the “Count Time,” number of measurement “Cycles,” and click the *Start* button. At the end of each cycle, the center grid (Figure 30) will be updated with the current CPS measured in each channel. The lower grid will display the “Current Average Efficiency (%)” from all cycles for both channels.

Informational messages are written to the Event Log during the use of the “Source Efficiency” utility, including the channel counts (CPS) for each data cycle and the average channel efficiencies. User actions, such as stopping a measurement, storing efficiency values, or exiting the utility are also written to the Event Log.

3.2.6.5 Efficiency|Tritium

Select the **Utilities|Efficiency|Tritium** menu option to bring up the “Tritium Efficiency” measurement utility. This utility is run at calibration time to establish the “Tritium Efficiency”, which is stored in the software database and used in subsequent calculations of the Tritium “Activity Concentration” and “Total Activity” (refer to Section 4.0).

When the **Utilities|Efficiency|Tritium** menu option is selected, the user will be presented with three dialog boxes (Figure 31, in sequence from left to right). By clicking the *OK* buttons, the user acknowledges the needed action and confirms the information presented.

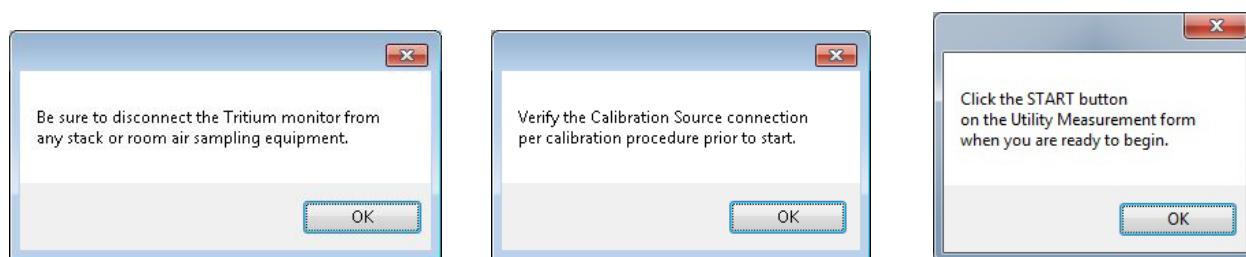


Figure 31. Dialog Boxes: Tritium Efficiency - User Confirm

The user should verify the tritium source gas is properly connected following the calibration procedure prior to beginning the “Tritium Efficiency” utility.

Data entry and screen button descriptions for the “Tritium Efficiency” utility form are described below, and an example screen is shown in Figure 32.

- “Count Time”: The “Count Time” is the duration of each count cycle; it must be an integer value between 1 and 10 minutes.
- “Cycles”: The “Cycles” is the number of count cycles that will be performed; it must be an integer value between 1 and 10.
- “Source Gas Concentration”: The “Source Gas Concentration” is the concentration of the tritium source gas used in the calibration; it must be a positive decimal value in units of $\mu\text{Ci/L}$.

To begin a “Tritium Efficiency” measurement, enter the “Count Time,” the number of measurement “Cycles,” the “Source Gas Concentration,” and click the *Start* button. At the end of each cycle, the center grid (Figure 32) will update with the current CPS measured in each channel. The lower grid will display the “Current Average Efficiency (%)” from Tritium channel. Although the “Tritium Efficiency” measurement utility will acquire counts (CPS) for both channels, it will only calculate the “Current Average Efficiency (%)” value for the Tritium channel; the Channel B CPS values are provided as a reference.

Utility Measurement

Tritium Efficiency

Setup

Count Time minutes Source Gas Concentration $\mu\text{Ci/liter}$

Cycles

Reference Values

Source Gas Activity (CPS)	Tritium Background (CPS)	Channel B Background (CPS)
228.0	0.64	16.28

Cycle	Tritium CPS	Channel B CPS
1	97.40	2.83
2	94.15	3.15

Current Average Efficiency (%)

-	Tritium	Channel B
Avg	4.17E+01	not calculated

Start Store Data

Stop Exit

Figure 32. Display: Tritium Efficiency Utility (in progress)

Click the *Stop* button to stop a “Tritium Efficiency” measurement that is in progress. Otherwise, once a “Tritium Efficiency” measurement is complete, the *Store Data* button can be clicked to store the efficiency values in the configuration database. Stored values will be used in all subsequent “Activity Concentration” and “Total Activity” calculations (see Section 4.0).

Caution: Storing the “Tritium Efficiency” value will void the previous instrument calibration.

Click the *Exit* button to exit the “Tritium Efficiency” utility form. The *Exit* button is only available when the “Tritium Efficiency” utility is not acquiring data.

Reference values being used by the software to calculate the “Tritium Efficiency” (Equation 1; Section 3.2.6.2) are displayed on the form during a “Tritium Efficiency” measurement; these values include:

- “Source Gas Activity (CPS)”: The “Source Gas Activity” is the corresponding counts (CPS) calculated by the software for the user-entered “Source Gas Concentration” ($\mu\text{Ci/L}$).
- “Tritium Background (CPS)”: The “Tritium Background (CPS)” is the background tritium counts stored in the configuration database; this value is subtracted from the gross “Tritium (CPS)” counts in the efficiency calculation.
- “Channel B Background (CPS)”: The “Channel B Background (CPS)” is the background Channel B counts stored in the configuration database; this value is subtracted from the gross “Channel B (CPS)” counts in the efficiency calculation.

Informational messages are written to the Event Log during the use of the “Tritium Efficiency” utility, including the channel counts (CPS) for each data cycle and the average channel efficiencies. User interactions, such as stopping a measurement, storing efficiency values, or exiting the utility, are also written to the Event Log.

3.2.6.6 Utilities|Efficiency|Channel B

Select the **Utilities|Efficiency|Channel B** menu option to bring up the “Channel B Efficiency” measurement utility. This utility is run at calibration time to establish the “Channel B Efficiency”, which is stored in the software database and used in subsequent calculations of the Channel B “Activity Concentration” and “Total Activity” (refer to Section 4.0).

When the **Utilities|Efficiency|Channel B** menu option is selected, the user is presented with the following dialog box (Figure 33):

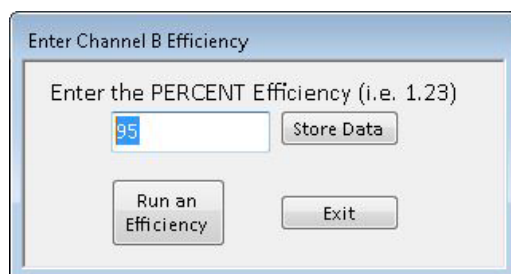


Figure 33. Dialog Box: Enter Channel B Efficiency

This screen allows the user to manually enter the “Channel B Efficiency” or *Run an Efficiency* measurement. To manually set the value, simply “Enter the Percent Efficiency” as a decimal value, within the range of 0 to 100. Then, click the *Store Data* button to store the entered value in the configuration database for use in subsequent software calculations.

Caution: Storing the “Channel B Efficiency” will void the previous instrument calibration.

To run a “Channel B Efficiency” measurement, click the *Run an Efficiency* button. The user will be presented with three dialog boxes (Figure 34, in sequence from left to right). By clicking the *OK* buttons, the user acknowledges the needed action and confirms the information presented.

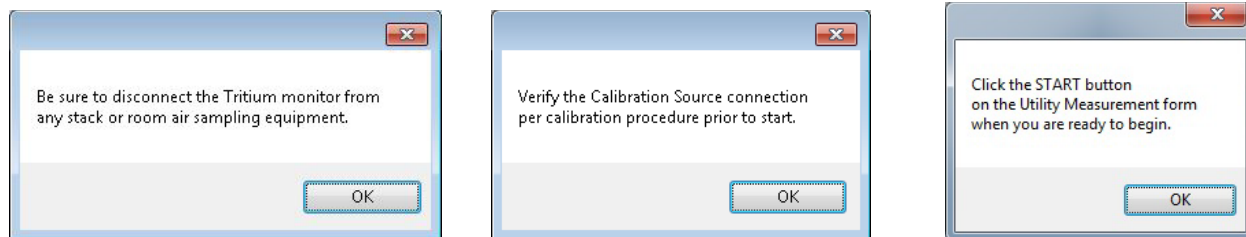


Figure 34. Dialog Boxes: Tritium Efficiency – User Confirm

The user should verify the Channel B source gas is properly connected following the calibration procedure prior to beginning the “Channel B Efficiency” utility.

Data entry descriptions for the “Channel B Efficiency” utility form are listed below, and an example screen is shown in Figure 35.

- “Count Time”: The “Count Time” is the duration of each count cycle. It must be an integer value between 1 and 10 minutes.
- “Cycles”: The “Cycles” is the number of count cycles that will be performed. It must be an integer value between 1 and 10.
- “Source Gas Concentration”: The “Source Gas Concentration” is the concentration of the Channel B source gas used in the calibration. It must be a positive decimal value in units of $\mu\text{Ci/L}$.

To begin a “Channel B Efficiency” measurement, enter the “Count Time,” the number of measurement “Cycles,” the “Source Gas Concentration,” and click the Start button. At the end of each measurement cycle, the center grid (Figure 35) will update with the current CPS from each channel. The lower grid will display the Channel B “Current Average Efficiency (%)”. Although the “Channel B Efficiency” utility will acquire counts (CPS) for both channels, it will only calculate the “Current Average Efficiency (%)” value for Channel B; the Tritium CPS values are provided as a reference.

Click the *Stop* button to stop a “Channel B Efficiency” measurement that is in progress. Otherwise, once a “Channel B Efficiency” measurement is complete, the *Store Data* button can be clicked to store the efficiency values in the configuration database. Stored values will be used in all subsequent “Activity Concentration” and “Total Activity” calculations (see Section 4.0).

Caution: Storing the “Channel B Efficiency” value will void the previous instrument calibration.

Click the *Exit* button to exit the “Channel B Efficiency” utility form. The *Exit* button is only available when the “Channel B Efficiency” utility is not acquiring data.

Utility Measurement

Channel B Efficiency

Setup

Count Time minutes Source Gas Concentration $\mu\text{Ci/liter}$

Cycles

Reference Values

Source Gas Activity (CPS)	Tritium Background (CPS)	Channel B Background (CPS)
228.0	0.64	16.28

Cycle	Tritium CPS	Channel B CPS
1	94.08	240.15

Current Average Efficiency (%)

-	Tritium	Channel B
Avg	not calculated	9.82E+01

Start Store Data

Stop Exit

Figure 35. Display: Channel B Efficiency Utility (in progress)

Reference values being used by the software to calculate the “Channel B Efficiency” (see Equation 1; Section 3.2.6.2) are displayed on the form during a “Channel B Efficiency” measurement; these values are listed below.

- “Source Gas Activity (CPS)”: The “Source Gas Activity” is the corresponding counts (CPS) calculated by the software for the user-entered “Source Gas Concentration” ($\mu\text{Ci/L}$).
- “Tritium Background (CPS)”: The “Tritium Background (CPS)” is the background tritium counts stored in the configuration database; this value is subtracted from the gross “Tritium (CPS)” counts in the efficiency calculation.
- “Channel B Background (CPS)”: The “Channel B Background (CPS)” is the background Channel B counts stored in the configuration database; this value is subtracted from the gross “Channel B (CPS)” counts in the efficiency calculation.

Informational messages are written to the Event Log during the use of the “Channel B Efficiency” utility, including the channel counts (CPS) for each data cycle and the average channel efficiencies. User interactions, such as stopping a measurement, storing efficiency values, or exiting the utility are also written to the Event Log.

3.2.7 About Menu

The **About** menu displays a screen with basic information about the PNNL OS3700 software, including the software version number (Figure 36).

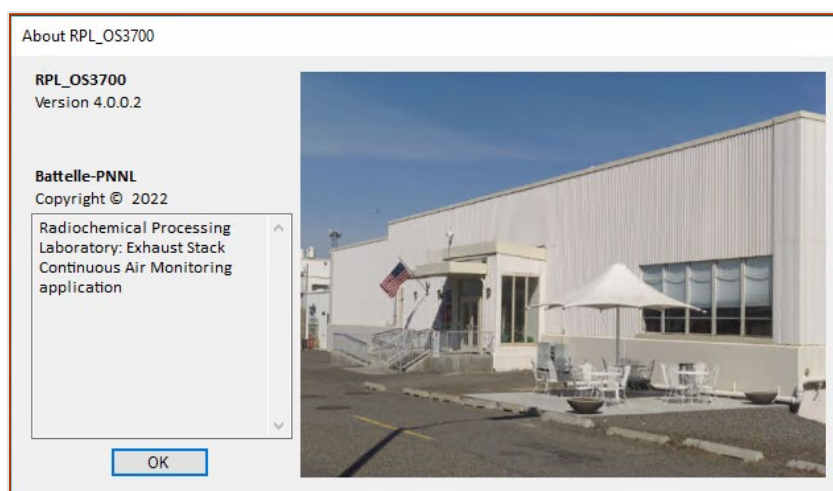


Figure 36. Display: About

3.3 Detector Plateau

There is no automated detector plateau utility within the PNNL OS3700 software. To manually run a detector voltage plateau, follow the steps described below:

1. Enter the desired count time for the plateau measurement as both the “Short Count Time” and the “Long Count Time” shown in Section 3.2.6.1, Count Times. Plateaus are usually run for short periods of time, such as 1 to 5 minutes. Confirm that “Rolling Average” is disabled in the Count Times window.
2. Set the voltage on the LB110 front panel to the lowest desired voltage (e.g., 100 V).
3. Insert a hard check source or a gas source into the front of the LB110.
4. Start the acquisition by selecting **Acquire|Start** and wait for the long count time to be completed.
5. Using the MS SQL Management Studio, open the local SQL “AlphaBetaTritium_XX” database for the PNNL OS3700 software; select the table: “TritiumRawData”.
6. Go to the database table and record the values from the “TritCounts” and “ChanBCounts” field entries. These are the total counts that were just registered (no background subtraction) from the two channels of the LB110.
7. Increase the voltage on the front panel of the LB110.
8. Select **Acquire|Stop** from the menu.
9. Repeat steps 4–8 for the number of voltage steps desired.

The raw data should be plotted as counts in the Tritium Channel and Channel B versus the voltage setting. The voltage should be selected so it is in or near the center of the plateau region for both channels. See “Radiation Detection and Measurement” (Knoll 2000) for more information.

3.4 Real-Time Operation

When the PNNL OS3700 software is in real-time data acquisition mode, the system display is as shown in Figure 37. This screen has several features, which are described in the following subsections.

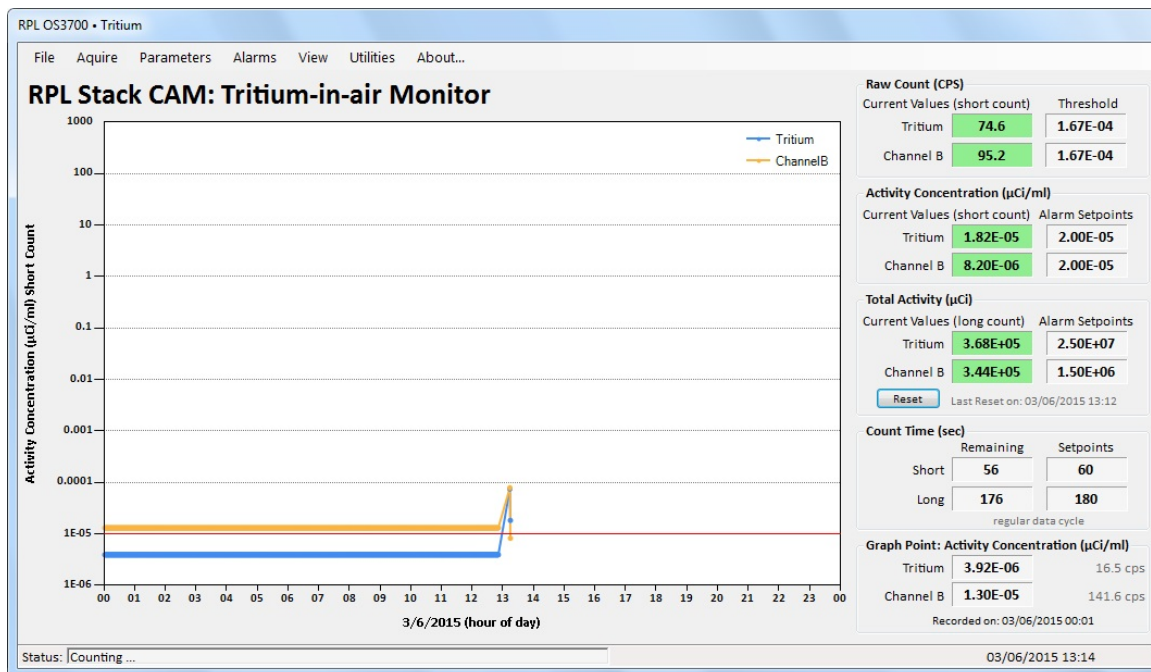


Figure 37. Main Display: Data Acquisition (in progress)

3.4.1 Restrictions

When the PNNL OS3700 software data acquisition is in progress, the following restrictions are in effect:

- The various configuration parameter screens may be reviewed to check their current values; however, none of the configuration parameter values can be modified.
- None of the software Utilities can be selected (i.e., they may not be run while data acquisition is in progress).
- The **File|Exit** menu selection is not available until data acquisition is stopped.
- Other items of note include:
 - Only one user-selected menu option screen may be displayed at a time. To exit a screen while data acquisition is in progress, click the screen’s *Cancel* button.
 - When any user-selected menu option screen is displayed, data acquisition will continue in the background.

3.4.2 Data Graph Display

When the software is started, the “Activity Concentration ($\mu\text{Ci}/\text{mL}$) Short Count” data for the current date will be loaded from the local SQL database and plotted in the data graph display (middle of the main screen).

Two data lines are presented on the graph: blue for Tritium and orange for Channel B. Each measurement is represented by a round dot marker on the line. Each measurement point will be connected with a solid line of the same color.

The vertical (Y-Axis) is a logarithmic scale that has a range that scales to the dataset being plotted; it represents the “Activity Concentration ($\mu\text{Ci}/\text{mL}$) Short Count.” Horizontal grid lines have been added to assist in reviewing the data.

The horizontal (X-Axis) is a single day, hourly time scale that starts at midnight ([00 hr] current day) and ending at midnight ([00 hr] next day). Each increment represents one hour of the current day.

Note: To review historical data, select the **View|Review Data** menu option. This option is available even if data acquisition is in progress. A new screen will appear with a data graph area that has similar functionality to the software’s main data graph.

3.4.2.1 Interactive Zoom

Data points on the graph may be zoomed in on by defining a rectangular region of interest to view. To define the viewing rectangle, use the left mouse button and click the upper-left region of interest. Then, hold the left mouse button and drag it to the opposite corner of the data graph to define the viewing rectangle (Figure 38). When the left mouse button is released, the viewing area will be shown (Figure 39).

Note: The zoom-in feature can be used multiple times to refine the viewing area.

Depending upon the size of the viewing rectangle, scroll bars may appear on either (or both) graph axes. The scroll bar controllers will be sized according to the area of the viewing rectangle relative to the original data graph. Each axis will rescale based on the values within the user-defined viewing area.

Click on the arrow buttons at either end of a scroll bar to scroll to the end of the graph.

At the top-end of the vertical scrollbar and bottom-left of the horizontal scrollbar is an un-zoom button. Click this button to return the data graph to the previous zoom level for that axis.

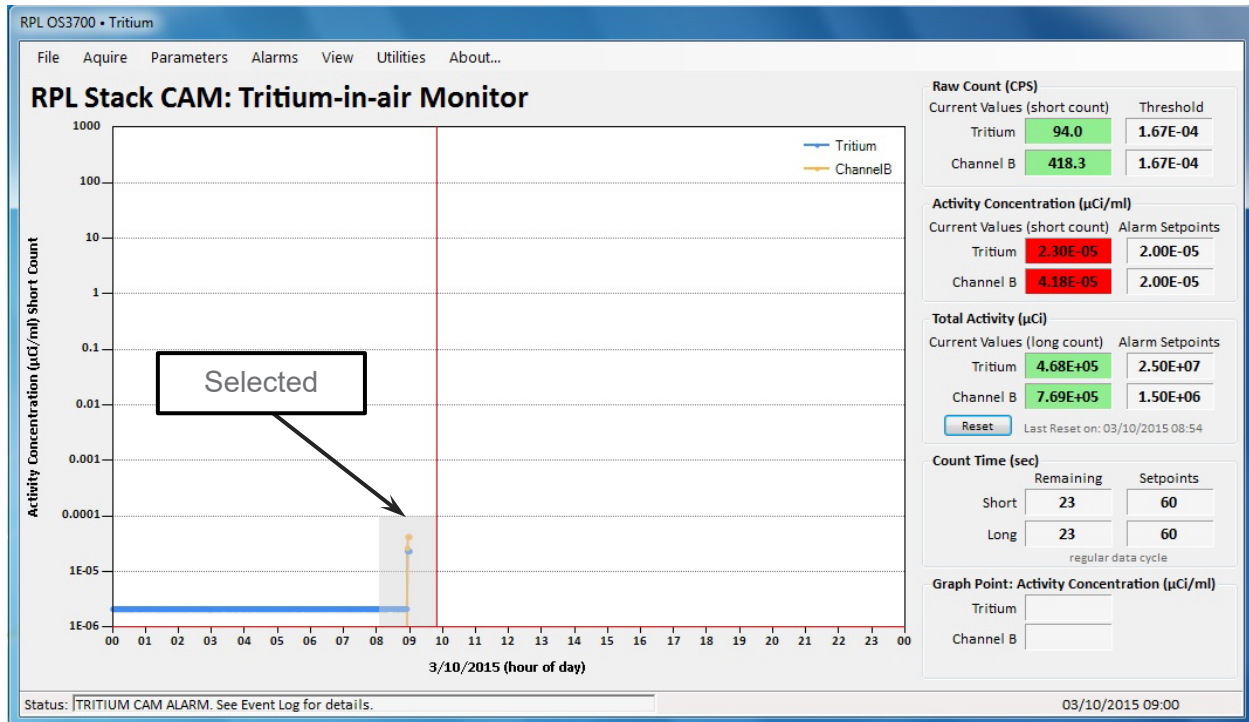


Figure 38. Main Display: Graph Zoom Area Selection Example

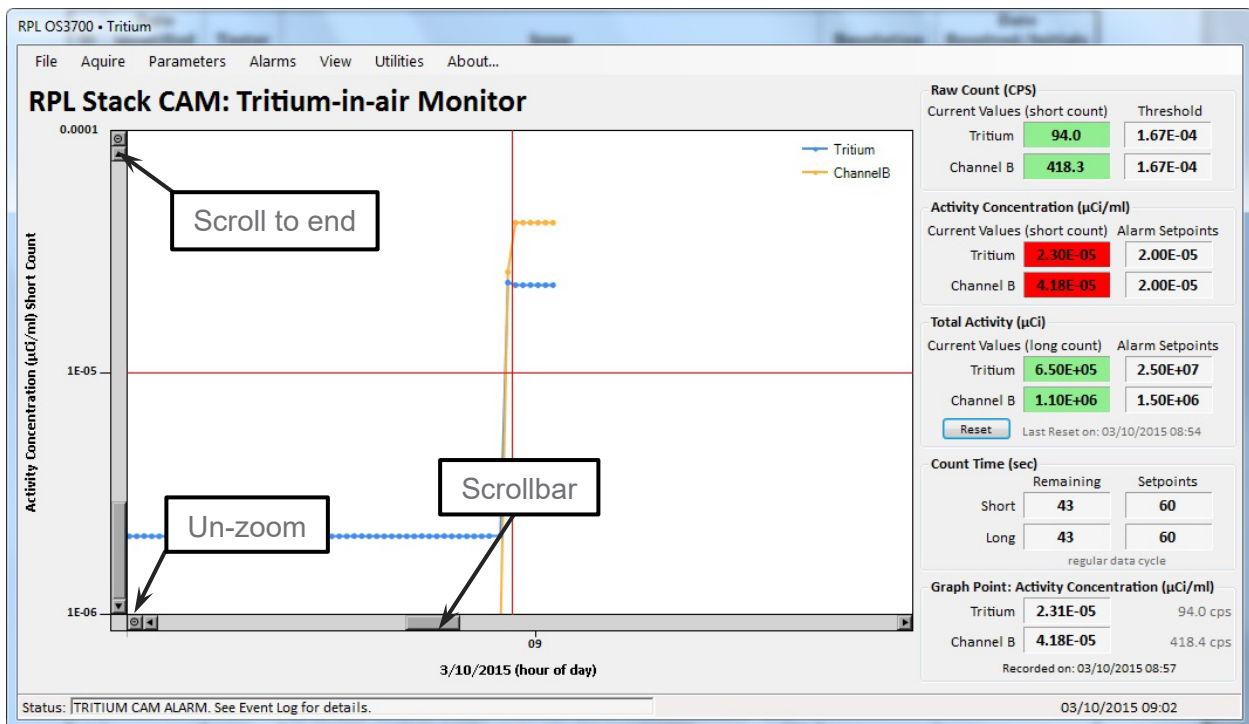


Figure 39. Main Display: Graph Zoom Area Selection Result

3.4.2.2 Graph Point Values

The “Activity Concentration ($\mu\text{Ci}/\text{mL}$) Short Count” value can be displayed for a graph point by clicking on a location immediately to the left of the desired graph point. The selected point’s “Activity Concentration ($\mu\text{Ci}/\text{mL}$)” and corresponding counts “CPS” will be displayed for the “Tritium” and “Channel B” channels in the lower-right corner of the main software display (Figure 40). The date and time the values were recorded will also be displayed.

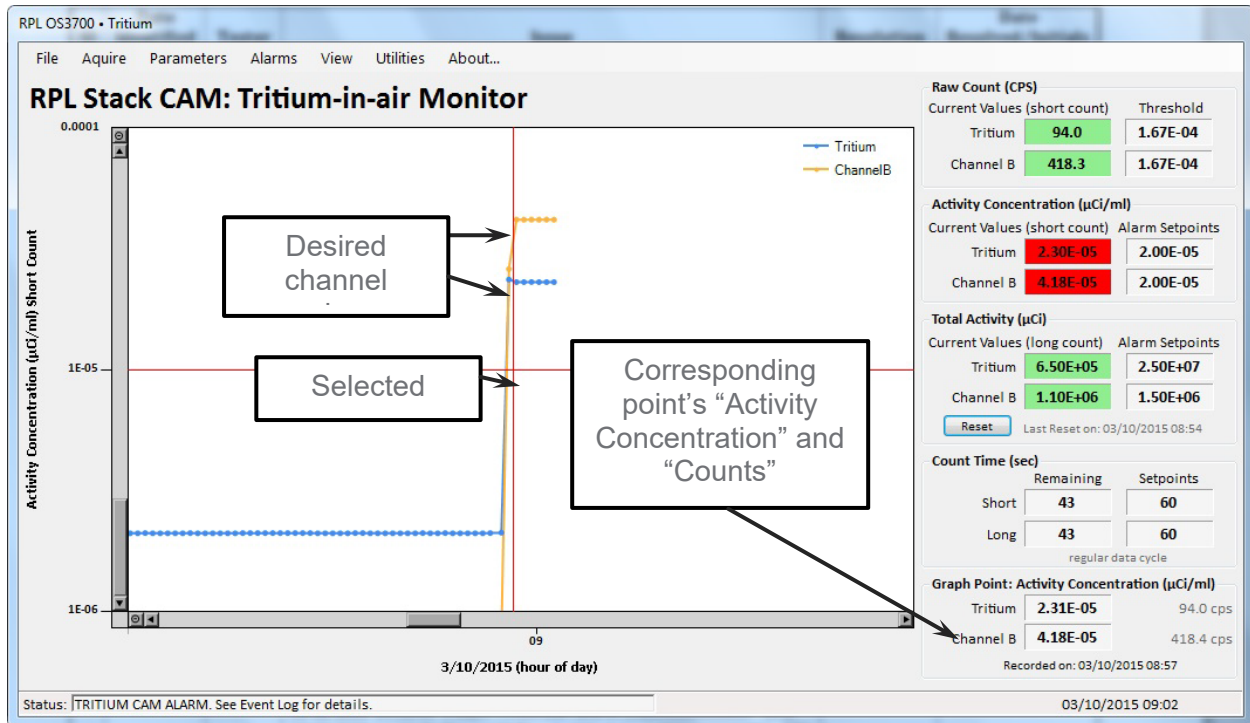


Figure 40. Main Display: Point Selection Result

3.4.3 Display Values

The right-panel of the main software displays several values, including “Raw Count (CPS)”, “Activity Concentration ($\mu\text{Ci}/\text{mL}$)”, “Total Activity (μCi)”, and “Count Time (sec)”. The following sections describe each of these values.

3.4.3.1 Raw Counts (CPS)

The “Raw Counts (CPS)” displays the “Current Values” and “Threshold” counts for the “Tritium” and “Channel B” channels. “Current Values” are the gross counts (CPS) from each channel over the “Short Count” interval. “Threshold” values are the minimum counts (CPS) required in each channel to indicate normal operation of the CAM; threshold values are set under the “Parameters|Fail Threshold” menu (see Section 3.2.3.1).

When the software is first started, the “Current Values” will be blank until the first “Short Count” period has elapsed.

If the “Current Value” CPS of either channel is less than the “Threshold” CPS for a given “Short Count” period, the “Current Value” display box will be red. Otherwise, the box will be green.

Note: Because of natural background radiation, there should always be some minimal count in the “Current Values” for both channels if the CAM is functioning correctly.

Note: Alarms can be configured to actuate if either channel’s “Current Value” CPS is less than the “Threshold” CPS for a given “Short Count” period. See Section 3.2.4.2 to set up the software’s alarming feature.

3.4.3.2 Activity Concentration ($\mu\text{Ci}/\text{mL}$)

The “Activity Concentration ($\mu\text{Ci}/\text{mL}$)” displays the “Current Values” and “Alarm Setpoints” for the “Tritium” and “Channel B” channels. “Current Values” are the activity concentrations ($\mu\text{Ci}/\text{mL}$) calculated by the software from the raw counts in each channel over a “Short Count” or “Rolling Average” interval. The “Current Values” are compared to the “Alarm Setpoints” for alarming purposes; “Alarm Setpoints” are set under the “**Alarm|Settings**” menu (see Section 3.2.4.1).

When the software is first started, the “Current Values” will be blank until the first “Short Count” or “Rolling Average” interval has elapsed.

If either channel’s activity concentration “Current Value” exceeds the “Alarm Setpoint” for a given “Short Count” or “Rolling Average” period, the “Current Value” display box will be red. Otherwise, the box will be green.

Note: Alarms can be configured to actuate if either channel’s activity concentration “Current Value” exceeds the “Alarm Setpoint” for a given “Short Count” or “Rolling Average” interval; see Section 3.2.4.2 to set up the software’s alarming feature.

3.4.3.3 Total Activity (μCi)

The “Total Activity (μCi)” displays the “Current Values” and “Alarm Setpoints” for the “Tritium” and “Channel B” channels. “Current Values” are the total activity (μCi) released in each channel since the last automatic or manual “Reset.” An automatic reset (to 0.0 μCi in both channels) can be configured to occur at midnight for the current day (see Section 3.2.3.2) or manually by clicking the *Reset* button. In either case, the software displays the date/time when the values were “Last Reset” immediately below the “Current Values.” The “Current Values” are compared to the “Alarm Setpoints” for alarming purposes. “Alarm Setpoints” are set under the “**Alarm|Settings**” menu (see Section 3.2.4.1).

When the software is first started, the “Current Values” will display the total activity (μCi) released in both channels for the current day.

If either channel’s total activity “Current Value” exceeds the “Alarm Setpoint” for a given “Long Count,” the “Current Value” display box will be red. Otherwise, the box will be green.

Note: Alarms can be configured to actuate if the total activity “Current Value” exceeds the “Alarm Setpoint” for a given “Long Count” for either channel. See Section 3.2.4.2 to set up the software’s alarming feature.

Note: The total activity “Current Values” update at the end of a “Long Count.” However, if the CAM is in alarm mode, the total activity “Current Values” will update at the end of each “Short Count” for faster data integration.

3.4.3.4 Count Times (seconds)

The “Count Times (sec)” displays the “Remaining” and corresponding “Setpoint” times for the “Short” and “Long” count intervals. The “Short” count “Setpoint” defines the frequency at which the channel “Raw Counts (CPS)” and “Activity Concentrations ($\mu\text{Ci}/\text{mL}$)” update. The “Long” count “Setpoints” defines the frequency at which the channel “Total Activity (μCi)” is updated. The “Short” and “Long” counts “Setpoints” can be set under the **Utilities|Count Times** menu (see Section 3.2.6.1).

Note: The “Long” count will automatically set to the “Short” count when the CAM is in alarm model. When the alarm condition clears, the “Long” count will automatically return to the “Long” count “Setpoint”.

3.4.3.5 Graph Point Activity Concentration ($\mu\text{Ci}/\text{mL}$)

The “Graph Point: Activity Concentration ($\mu\text{Ci}/\text{mL}$)” value can be displayed for a graph point by clicking on a location immediately to the left of the desired graph point in the main display. The selected point’s “Activity Concentration ($\mu\text{Ci}/\text{mL}$)” and corresponding counts “CPS” will be displayed for both the “Tritium” and “Channel B” channels. The date and time the values were recorded will also be displayed. Refer to Section 3.4.2 for more information on using the graph display.

3.4.3.6 Status Bar

At the bottom of the software is a “Status Bar” that displays various status indicators. During routine data acquisition, the “Status Bar” will display the word “Counting.” If the software is not acquiring data, the “Status Bar” will display the word “Idle.” If the CAM is in alarm mode, the “Status Bar” will display the words “TRITIUM CAM ALARM: See Event Log for details.”

The “Status Bar” also displays the current system clock date and time (month/day/year hours:minutes).

4.0 Calculations

Calculations the software performs during data acquisition and utility measurement options are described in this section.

4.1.1 Activity Concentration ($\mu\text{Ci/mL}$)

The “Activity Concentration ($\mu\text{Ci/mL}$)” in the LB110 sample chamber is calculated at the end of each short count. The measuring air contents in the LB110 counter tube is 260 mL (Berthold Technologies 2009); this value is pre-set in the software. The P-10 to sample air mixing ratio is 4:1 (pre-set P-10 flow rate of 800 mL/min and sample air flow rate of 200 mL/min [Berthold Technologies 2009]). The “Activity Concentration” is calculated by dividing the number of counts in each channel by the count time to determine CPS. The background is subtracted, and these background-corrected values are divided by the efficiency of the detector and sample volume and then converted from Bq to μCi . The result is the “Activity Concentration ($\mu\text{Ci/mL}$)”.

The following equations document how the Tritium and Channel B “Activity Concentrations ($\mu\text{Ci/mL}$)” are calculated.

Counts accumulate on the PCI-1780U card throughout the “Long Count Time” period. Therefore, to calculate the Tritium and Channel B “Gross Counts” for a “Short Count Time” period, the previous short count time period’s count value must be subtracted from the current short count time period’s count value (Equation 2):

$$Gross_Counts_{(Trit\ or\ ChanB)_i} = Total_Counts_i - Total_Counts_{i-1}\ for\ i \geq 2 \quad (2)$$

where:

$Gross_Counts_{(Trit\ or\ ChanB)_i}$ is the Tritium or Channel B gross counts.

$Total_Counts_i$ is the total number of counts acquired by the software from the PCI-1780U card for the i^{th} short count time period.

i is the current short count time period.

At the beginning of each long count, the PCI-1780U card counter is reset to zero (0). Therefore, no subtraction is required for the first short count (i.e., $i = 1$) in a long count.

Next, the background-correct activity (CPS) is calculated for Tritium (Equation 3):

$$Trit_{bkg} = \frac{Gross_Counts_{Trit}}{Count_Time_{sec}} - \frac{background_{Trit}}{60} \quad (3)$$

and Channel B (Equation 4):

$$ChanB_{bkg} = \frac{Gross_Counts_{ChanB}}{Count_Time_{sec}} - \frac{background_{ChanB}}{60} \quad (4)$$

where:

$Trit_{bkg}$ and $ChanB_{bkg}$ are the Tritium and Channel B background-corrected activity (CPS).

$Count_Time_{sec}$ is the short count time (seconds).

The $background_{Trit}$ and $background_{ChanB}$ terms are the Tritium and Channel B background counts (stored in the database in units of CPM; the value is divided by “60” to put in CPS).

Finally, the activity concentration ($\mu\text{Ci/mL}$) is calculated for Tritium (Equation 5):

$$Trit_{conc} = \frac{Trit_{bkg}}{Efficiency_{Trit} * Volume_{samp} * 37,000} \quad (5)$$

and Channel B (Equation 6):

$$ChanB_{conc} = \frac{ChanB_{bkg}}{Efficiency_{ChanB} * Volume_{samp} * 37,000} \quad (6)$$

where:

$Trit_{conc}$ and $ChanB_{conc}$ are the Tritium and Channel B activity concentration ($\mu\text{Ci/mL}$).

$Efficiency_{Trit}$ and $Efficiency_{ChanB}$ are the Tritium and Channel B efficiencies.

$Volume_{samp}$ is the sample volume (260 mL).

37,000 is a conversion factor to convert from Becquerel (Bq) to micro-curies (μCi).

Efficiencies are determined at calibration via their respective measurement (see Sections 3.2.6.5 and 3.2.6.6).

4.1.2 Total Activity (μCi)

The “Total Activity (μCi)” is the total activity released through the stack since midnight of the current day or since the last manual reset. The value is updated at the end of each long count. To calculate the “Total Activity”, the activity released during each long count is determined; it is found by multiplying each short count activity concentration (Equations 5 or 6) by the volume of air that flows through the stack during that short count time period. The resulting short count activities are summed over the long count to yield the long count activity (Equation 7). Finally, the long count activities are summed to determine the “Total Activity” released through the stack since last reset (Equation 8).

The activity (μCi) released over a long count is given by:

$$Activity_j = \sum_{i=1}^{LC_j} Conc_i * Flow_i \quad (7)$$

where:

$Activity_j$ is the activity (μCi) released over the j^{th} long count.

LC_j is the current j^{th} long count time period.

$Conc_i$ is the concentration ($\mu\text{Ci/mL}$) calculated over the i^{th} short count time period (Equations 5 or 6).

$Flow_i$ is the flow (mL) through the stack for the i^{th} short count time period.

The “Total Activity (μCi)” released since the last reset is given by Equation 8.

$$TotalActivity = \sum_{j=reset}^{current} Activity_j \quad (8)$$

where:

TotalActivity is the “Total activity (μCi)” release since the last reset.

Typically, the “Total Activity” is reset to 0.0 μCi at midnight for the current day. However, the potential exists for an operator to manually “Reset” the time for the “Total Activity” calculation at some other time within the current day (see Section 3.4.3.3).

5.0 Databases

The PNNL OS3700 software uses two databases: “AlphaBetaTritium_XX” and “RPL_OS3700_ConfigParams_XX”. Database “AlphaBetaTritium_XX” is described in Section 5.1. It has several tables that are used to store measured and calculated data. Database “RPL_OS3700_ConfigParams_XX” is described in Section 5.2. It contains several tables that are used to store configuration settings for software operation.

5.1 Database AlphaBetaTritium_XX

The “AlphaBetaTritium_XX” database uses the following tables for storing measured and calculated data from the PNNL OS3700 software:

- **TritiumIntegrationLog:** Contains the integration parameter information, such as the starting and ending date and time of each integration period.
- **TritiumQATable:** Contains the current and historical QA calibration data used by the PNNL OS3700 software. The newest record is the last record. It is used in software calculations of activity concentration and total activity. Each time a parameter is changed (e.g., storing a value using a software utility), a new record is generated with the date and time of the change.
- **TritiumRawData:** Contains the long count time data, including the date and time stamp, raw count data, flow totals, as well as the calculated activity concentrations and long count activity.
- **TritiumShortCountData:** Contains the short count time data, including the date and time stamp, raw data, calculated activity concentrations, and flow totals.

Each of these tables, including the field names, field descriptions, units, and datatypes, are described in the following subsections.

5.1.1 Table TritiumIntegrationLog

The “TritiumIntegrationLog” table contains the integration parameter information, including the starting and ending date and time of each integration period (Table 2).

Table 2. Table “TritiumIntegrationLog” Fields

Field Name	Field Description	Unit	Type
IntegrationLog	Unique identifier. The newest record is the last number. This record is generated each time the “Total Activity” is reset. This can occur automatically at midnight (if configured to occur from within the software) or manually if the “Reset” button is clicked on the main software display. The value in this field is generated automatically.	NA	Integer
StartDate	Date/time stamp when the “Total Activity” period begins.	NA	Date/Time
EndDate	Date/time stamp when the “Total Activity” period ends.	NA	Date/Time

5.1.2 Table TritiumQATable

The “TritiumQATable” contains both current and historical QA calibration data used by the PNNL OS3700 software (Table 3).

Table 3. Table “TritiumQATable” Fields

Field Name	Field Description	Unit	Type
TritQAID	Unique identifier for correlating the QA calibration data with the measured counts and calculated concentrations and activities. The value in this field is automatically generated. Records are added sequentially, so the newest record is the last number.	NA	Integer
TritiumEff	Tritium efficiency.	%	Real
TritumBKG	Tritium background count rate.	CPM	Real
ChanBEff	Channel B efficiency.	%	Real
ChanBBKG	Channel B background count rate.	CPM	Real
TritCalDate	Date/time the tritium efficiency was stored.	NA	Date/Time
ChBCalDate	Date/time the Channel B efficiency was stored.	NA	Date/Time
BKGDate	Date/time the tritium and Channel B backgrounds were stored.	NA	Date/Time
ChkSrcEffTrit	Source efficiency in the tritium channel.	%	Real
ChkSrcEffChB	Source efficiency in the Channel B channel.	%	Real
ChkSrcEffCalDate	Date/time the tritium and Channel B source efficiencies were stored.	NA	Date/Time

5.1.3 Table TritiumRawData

The “TritiumRawData” table contains the measured and calculated data for the long count time period, including the date and time stamp, raw count data, flow totals, as well as the calculated activity concentrations and long count activity (Table 4).

Table 4. Table “TritiumRawData” Fields

Field Name	Field Description	Unit	Type
RawIndex	Unique identifier. The newest record is the last number. The value in this field is automatically generated.	NA	Integer
TritConc	Average long count tritium activity concentration.	μCi/mL	Real
ChanBConc	Average long count Channel B activity concentration.	μCi/mL	Real
TritInt	Tritium activity out of the stack for the long count time period.	μCi	Real
ChanBInt	Channel B activity out of the stack for the long count time period.	μCi	Real
CAMStatus	Status indicator for the CAM. This field is currently not being used; always a “0” value.	NA	Real
StackFlowRate	Average long count stack flow rate, either measured or fixed value.	CFM	Real
StackFlowTotal	Calculated long count stack flow total.	m ³	Real
SampleFlowRate	Average long count sample flow rate through LB110 measuring chamber.	mL/min	Real
SampleFlowTotal	Calculated long count sample flow total.	mL	Real
RawDate	Date of the record.	NA	Date/Time
RawTime	Time of the record.	NA	Date/Time
TritCounts	Total gross tritium counts for the long count period.	NA	Real
ChanBCounts	Total Channel B gross counts for the long count period.	NA	Real
CountTime	Total long count time for the record.	Seconds	Real
TritQAID	Integer identifier of the QA record in the “TritiumQATable” being used in the long count calculations.	NA	Integer

5.1.4 Table TritiumShortCountData

The “TritiumShortCountData” table contains the measured and calculated data for the short count time period, including the date and time stamp, raw data, calculated activity concentrations, and flow totals (Table 5).

Table 5. Table “TritiumShortCountData” Fields

Field Name	Field Description	Unit	Type
RawIndex	Unique identifier. The newest record is the last number. The value in this field is automatically generated.	NA	Integer
TritConc	Short count or rolling average tritium activity concentration.	μCi/mL	Real
ChanBConc	Short count or rolling average Channel B activity concentration.	μCi/mL	Real
TritInt	Total tritium activity; this field is “0”, as it is not calculated during the short count time period.	μCi	Real
ChanBInt	Total Channel B activity; this field is “0”, as it is not calculated during the short count time period.	μCi	Real
CAMStatus	Status indicator for the CAM. This field is currently not being used; this field is always “0”.	NA	Real
StackFlowRate	Short count stack flow rate, either measured or fixed value.	CFM	Real
StackFlowTotal	Calculated short count stack flow total.	m ³	Real
SampleFlowRate	Short count sample flow rate through LB110 measuring chamber.	mL/min	Real
SampleFlowTotal	Calculated short count sample flow total.	mL	Real
RawDate	Date of the record.	NA	Date/Time
RawTime	Time of the record.	NA	Date/Time
TritCounts	Total gross tritium counts for the short count period.	NA	Real
ChanBCounts	Total Channel B gross counts for the short count period.	NA	Real
CountTime	Total short count time for the record.	Seconds	Real
TritQAID	Integer identifier of the QA record in the “TritiumQATable” being used in the short count calculations.	NA	Integer

5.2 Database RPL_OS3700_ConfigParams_XX

The “RPL_OS3700_ConfigParams_XX” database uses the following tables for storing configuration settings for operation of the PNNL OS3700 software:

- AlarmOptions: Contains the list of “Alarms Options” used on the **Alarms|Relay** Setup menu form.
- frmAlarmSettings: Stores the “Alarm Values” entered on the **Alarms|Settings** menu form.
- frmCountTimes: Stores the “Count Times” information entered on **Utilities|Count** Times menu form.
- frmFailSettings: Stores the detector “Fail Thresholds” entered on the **Parameters|Fail** Threshold menu form.
- frmPreferences: Stores software preferences entered on the **Parameters|Preferences** menu form.
- frmRelaySettings: Stores the alarm relay settings entered on the **Alarms|Relay** Setup menu form.

- HardwareParams: Contains hardware information displayed on the **Utilities|Count Times** menu form.
- OperatorList: Stores the software usernames that are used to document certain operations within the PNNL OS3700 software.

Each of these tables, including the field names, field descriptions, units, and datatypes, are described in the following subsections.

5.2.1 Table AlarmOptions

The “AlarmOptions” table contains a list of “Alarms Options” that are displayed on the **Alarms|Relay Setup** menu form (Table 6).

Table 6. “AlarmOptions” Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
aoText	Alarm option text to display on the form.	NA	String

5.2.2 Table frmAlarmSettings

The “frmAlarmSettings” table stores the “Alarm Values” entered on the **Alarms|Settings** menu form (Table 7).

Table 7. Table “frmAlarmSettings” Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
asTrit_HighLevel	Tritium activity concentration alarm setting (short count).	µCi/mL	Real
asChanB_HighLevel	Channel B activity concentration alarm setting (short count).	µCi/mL	Real
asStack_FixedFlowRate	Fixed stack flow rate.	CFM	Real
asSampler_FixedFlowRate	Fixed sampler flow rate.	CFM	Real
asStack_HighFlowRate	High stack flow rate.	CFM	Real
asSampler_HighFlowRate	High sampler flow rate.	CFM	Real
asTrit_IntegralActivity	Tritium daily total activity alarm setting.	µCi	Real
asChanB_IntegralActivity	Channel B daily total activity alarm setting.	µCi	Real
asChangeClock	Date/time of record change.	NA	Date/Time

5.2.3 Table frmCountTimes

The “frmCountTimes” table stores the “Count Times” information entered on **Utilities|Count Times** menu form (Table 8).

Table 8. Table “frmCountTimes” Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
ctShort	Short count time.	minutes	Integer
ctLong	Long count time.	minutes	Integer
ctRollAvgFlag	Rolling average flag used in the short count concentration activity calculation. A “0” means no rolling average is used, whereas a “1” means a rolling average is being used.	NA	Integer
ctNumPtsAvg	Number of points to average in the short count concentration activity.	NA	Integer
ctChangeClock	Date/time of record change.	NA	Date/Time

5.2.4 Table frmFailSettings

The “frmFailSettings” table stores the detector “Fail Thresholds” entered on the **Parameters|Fail Threshold** menu form (Table 9).

Table 9. Table “frmFailSettings” Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
fsTritium_CPM	Tritium fail setting.	CPM	Real
fsChannelB_CPM	Channel B fail setting.	CPM	Real
fsChangeClock	Date/time of record change.	NA	Date/Time

5.2.5 Table frmPreferences

The “frmPreferences” table stores software preferences entered on the **Parameters|Preferences** menu form (Table 9).

Table 10. Table “frmPreferences” Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
prefSrcSN	Source identifier for the source used in the “Source Check” utility.	NA	String
prefSrcActivity	Activity of the source used in the “Source Check” utility.	Bq	Real
prefSrcCertDate	Source certification date of the source used in the “Source Check” utility.	NA	Date
prefSrcHalfLife	Source half-life of the source used in the “Source Check” utility.	Years	Real
prefSrcCountTime	Count time used in the “Source Check” utility.	Minutes	Integer
prefSrcCycles	Number of cycles used in the “Source Check” utility.	NA	Integer
prefSrcAllowError	Allowable error used in the “Source Check” utility.	%	Real
prefAutoResetFlag	Flag to enable the auto reset of the daily tritium and Channel B total activities. A “0” means no daily reset is performed, whereas a “1” means a daily reset is performed.	NA	Integer

Field Name	Field Description	Unit	Type
prefSaveShortCountFlag	Flag to enable short count data to be written to the short count table "TritiumShortCountData" in the "AlphaBetaTritium_XX" database.	NA	Integer
prefChangeClock	Date/time of record change.	NA	Date/Time

5.2.6 Table frmRelaySettings

The "frmRelaySettings" table stores the alarm relay settings entered on the **Alarms|Relay Setup** menu form (Table 11).

Table 11. Table "frmRelaySettings" Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
rsRC01_AlarmOptions	Relay setup alarm option #1. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC02_AlarmOptions	Relay setup alarm option #2. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC03_AlarmOptions	Relay setup alarm option #3. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC04_AlarmOptions	Relay setup alarm option #4. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC05_AlarmOptions	Relay setup alarm option #5. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC06_AlarmOptions	Relay setup alarm option #6. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC07_AlarmOptions	Relay setup alarm option #7. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsRC08_AlarmOptions	Relay setup alarm option #8. String of identifier numbers corresponding to the "pkID" of the selected alarms(s) in the "AlarmOptions" table.	NA	string
rsChangeClock	Date/time of record change.	NA	Date/Time

5.2.7 Table HardwareParams

The "frmHardwareParams" table contains hardware information displayed on the **Utilities|Count Times** menu form (Table 12).

Table 12. "HardwareParams" Fields

Field Name	Field Description	Unit	Type
pkID	Unique identifier. The value in this field is automatically generated.	NA	Integer
hwPM_BoardPCI	Hardware board identifier (internal slot number).	NA	Integer
hwPM_ChIn_Tritium	Event input channel being used for tritium counts.	NA	Integer
hwPM_ChIn_ChannelB	Event input channel being used for Channel B counts.	NA	Integer
hwPM_DigOut_Port	Port number.	NA	Integer
hwPM_DigOut_Pulse	Pulse number.	NA	Integer
HWPm_ChangeClock	Date/time of record change.	NA	Date/Time

5.2.8 Table OperatorList

The "OperatorList" table contains hardware information displayed on the **Utilities|Count Times** menu form (Table 13).

Table 13. Table "OperatorList" Fields

Field Name	Field Description	Unit	Type
olPayroll	Payroll identifier for user.	NA	String
olFirstName	First name of user.	NA	String
olLastName	Last name of user.	NA	String

6.0 Process

The data starts with the accumulation of counts in the AdvanTech PCI-1780U multi-function data acquisition card. The calculation of the activity concentration and total activity is described earlier in this manual (Section 4.0). The process is described below:

1. The PCI-1780U counters are cleared.
2. The PCI-1780U card begins acquiring counts.
3. At the end of the pre-set short count time, the software retrieves the number of counts in the Tritium and Channel B channels along with the count time. These values are stored for later use in the software and for the database tables.
4. The Tritium and Channel B activity concentrations are calculated for the current short count time.
5. The short count data is stored to the database if the "Save Short Count Data to Database" option is enabled.
6. The concentrations are checked against alarm settings.
7. The count time is incremented by short count time.
8. Steps 2 through 7 are repeated until either an alarm condition occurs (at which time the long count time is made equal to the short count time), or the long count time is reached.
9. The Tritium and Channel B total activity is updated at the end of the long count time and the final short count time activity concentrations are calculated.
10. Data are stored to the database and plotted to the screen.
11. The process continues until the user terminates the program or the computer is shut off.

An example calculation is provided below.

The short count time is equal to 1 minute and the long count time is equal to 3 minutes. The stack flow rate is fixed at 140,000 ft³/min.

The QA data are shown in Table 14.

Table 14. Initial QA Data Set

QATableID	TritEff	TritBKG	ChanBEff	ChanBBKG
1	50.0%	18.0 CPM	85.0%	42.0 CPM

The following set of short count data (Table 15) is used to step the reader through the example.

Table 15. Example Data Set (short count)

Short Count Period	Tritium Counts	Channel B Counts	Time (seconds)
1	35	150	60
2	75	295	60
3	150	460	60

The following data (Table 16) would appear in the “TritiumRawData” or the “TritiumShortCountData” tables.

Table 16. Database Records from Example Data

Raw Index	Tritium Counts	Channel B Counts	Time (seconds)
1	35	150	60
2	75	295	120
3	150	460	180

Table 17 shows the accumulation of short count data and the calculation of the activity concentration ($\mu\text{Ci/mL}$) for the three cycles in the example.

Table 17. Calculated Data from Example

Count Time (minutes)	Tritium Counts	Chan B Counts	Tritium Net Rate (CPS)	Chan B Net Rate (CPS)	Trit Activity Conc. ($\mu\text{Ci/mL}$)	Chan B Activity Conc. ($\mu\text{Ci/mL}$)
1	35	150	0.28	1.80	5.82E-08	2.20E-07
1	75	295	0.95	4.22	1.98E-07	5.16E-07
1	150	460	2.20	6.97	4.57E-07	8.52E-07

For this example, the short count data table and long count data table will contain data from Table 18 and Table 19, respectively.

Table 18. Tritium Short Count Data Table Results from Example

RawIndex	TritConc	ChanBConc	TritInt	ChanBInt	CAMStatus	StackFlowRate	StackFlowTotal	SampleFlowRate	SampleFlowTotal	RawDate	RawTime	TritCounts	ChanBCounts	CountTime	TritQAID
1	5.82E-08	2.20E-07	0	0	0	140,000	3964.4	260	260	8/21/01	13:34:46	35	150	60	1
2	1.98E-07	5.16E-07	0	0	0	140,000	3964.4	260	260	8/21/01	13:35:50	75	295	60	1
3	4.57E-07	8.52E-07	0	0	0	140,000	3964.4	260	260	8/21/01	13:36:54	150	460	60	1

Note. Headings used here are field names in the "TritiumShortCountData" table.

Table 19. Tritium Raw (long) Count Data Table Results from Example

RawIndex	TritConc	ChanBConc	TritInt	ChanBInt	CAMStatus	StackFlowRate	StackFlowTotal	SampleFlowRate	SampleFlowTotal	RawDate	RawTime	TritCounts	ChanBCounts	CountTime	TritQAID
1	2.38E-07	5.29E-07	2.8274E+03	6.2954E+03	0	140,000	3,964.4	260	780	8/21/01	13:36:54	260	905	180	1

Note. Headings used here are field names in the "TritiumRawData" table.

7.0 Software Maintenance

The following sections provide detail on software maintenance, including development requirements, reloading the software, and maintenance and troubleshooting.

7.1 Software Development Requirements

Troubleshooting, questions, or requests for modification of the source code for the PNNL OS3700 software should be directed to PNNL at the following address:

Pacific Northwest National Laboratory
 Environmental Protection and Regulatory Programs
 Environmental Radiation Task Lead
 P.O. Box 999, Mail Stop J2-25
 Richland, WA 99352

7.2 Maintenance Schedules and Procedures

There are six relay outputs controlled by the software. These relays are controlled by a connection to the 25-pin D connector on the back of the PNNL breakout box. These outputs (numbers 1 through 6) are programmable from the software. Two additional digital outputs are present on the 25-pin D connector but are not currently used by the software. If any of these relays do not operate correctly (i.e., sends alarms when there is no alarm or fails to alarm when the level is reached), follow the steps described in Table 20.

Table 20. Relay Output Troubleshooting Checklist

Step	Procedure	If there is a problem, take this next step.
1	Check the ribbon cable connection at the PCI-1780U card on the rear of the computer.	Reconnect if loose. Repair damaged connector (e.g., bent or broken pins).
2	Check electrical terminations at the breakout box.	Reconnect loose cables. Repair damaged connector.

If the checklist fails to remedy the problem, contact the manufacturer for further assistance.

7.3 Errors and Resolutions

Errors and Resolutions are documented in Confluence: <https://confluence.pnnl.gov/>.

Search for “stackcam errors resolutions”.

7.4 Defect Reporting

Contact the TechDesk to report any issues and they will get it routed to the correct team for resolution.

<https://techdesk.pnnl.gov/>

(509) 375-6789

8.0 References

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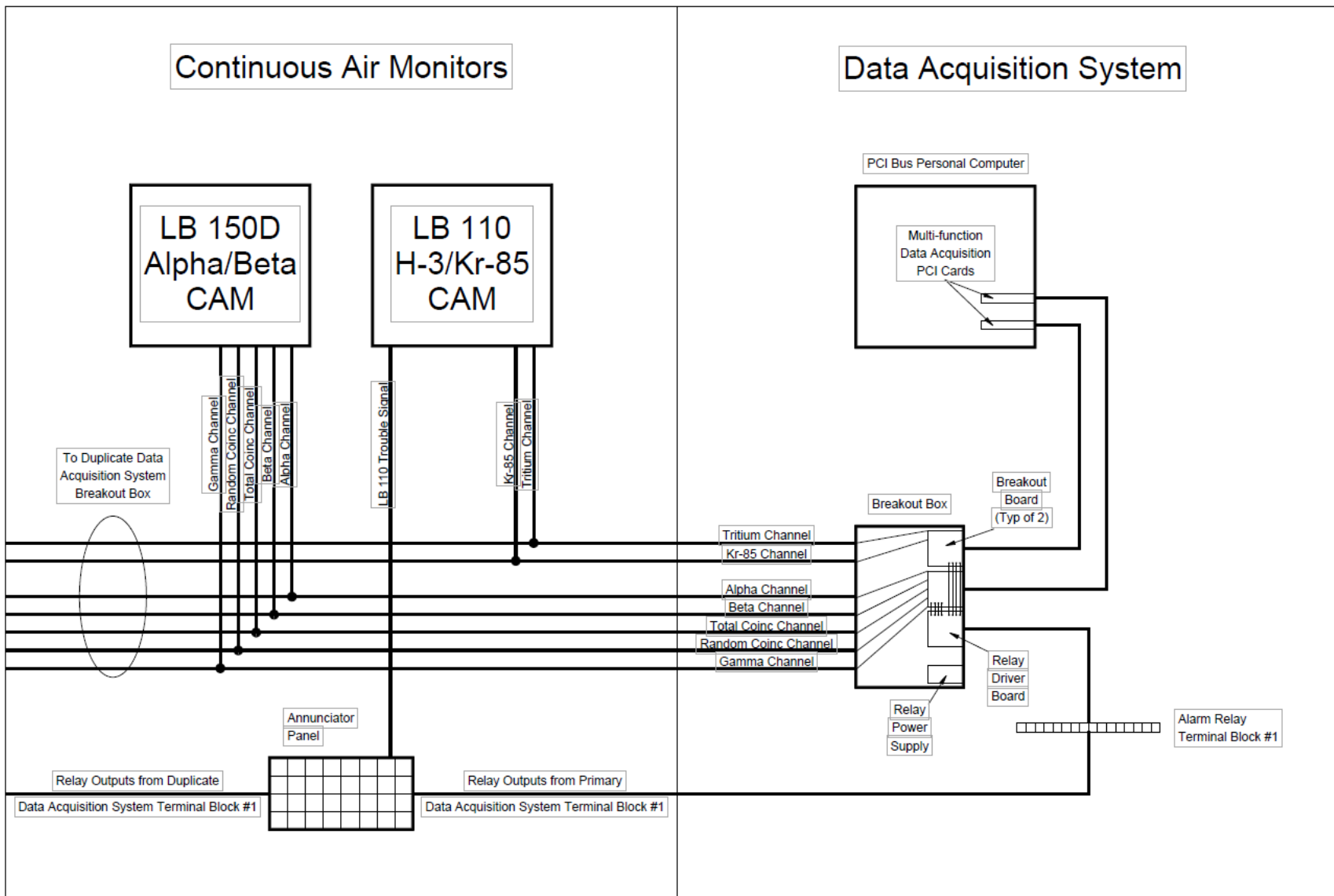
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Appendix A – System Design



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