Alpha-7A
Alpha-7L

Alpha Continuous Air Monitor

Technical Manual

Thermo Eberline
A Division of ThermoElectron

Alpha-7 Alpha Continuous Air Monitor

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Alpha-7L and Radial-Entry Sampling Head

Table of Contents

Overview

Introduction

The Thermo Eberline Alpha-7 collects airborne particulates and measures the concentrations of alpha-emitting isotopes by continuously passing air though a filter paper using an external vacuum source that may be a regulated air pump or a house vacuum system. The active surface of the filter paper is mounted close to a double-diffused junction detector that measures the alpha emissions. The Alpha-7 determines the energy of the particles using a multi-channel analyzer and a unique library-directed peak-fitting algorithm to accurately separate and quantify concentrations of specific isotopes of interest. Once the isotopes and their activity on the filter paper is known, the Alpha-7 uses the measured volume of air that has passed through the filter paper to calculate the concentration of the isotope in the sampled air and the accumulated dose. The monitor displays the concentration or dose on a high-visibility vacuum fluorescent display. This information is also available using the Alpha-7 Client software or RadNet software over a standard Ethernet or wireless network. The data can be logged in an ODBC compliant format and can be easily viewed and analyzed using *Microsoft Access*. The Alpha-7 is a PC-based instrument with a Pentium class microprocessor running the Windows NT 4.0 operating system.

Physical Specifications

Detector:	Solid state, 490 mm² active area, negative bias
Efficiency:	Pu-239 20% (4 pi)
Sensitivity:	<2 DAC-hours for Pu-239
Sample Rate:	0.5 to 2 CFM (14 to 60 lpm)
Dimensions:	Display Unit: 12.25 ? 11 ? 6.5 inches (H W D) (31.1 ? 27.9 ? 16.5 cm) In-Line Sampling Head: 14.5 x 7.5 x 7.5 inches (H W D) (36.8 x 19.0 x 19.0 cm) Radial-Entry Sampling Head: 9.5 x 8.5 x 9 inches (H W D) (24.1 x 21.6 x 22.9 cm)
Weight:	Display Unit: 10 pounds (4.5 kg) In-Line Sampling Head: 9 pounds (4.1 kg) Radial Sampling Head: 6.5 pounds (2.9 kg)
Connections:	RJ-45 for 10/100-Base-T Ethernet (calibration and/or networking) PS2 Keyboard/Mouse Connector (local control of the Alpha-7) External Video DB15 (local view of the spectrum and for calibration) Screw connections: terminal blocks for analog input, analog output, and double pole, double throw alarm relays. Alpha-7L only, an 11 pin military connector is prewired for a 4-20 mA loop-powered current loop, a 12 volt nominal output indicating Normal operation, and the alarm relay contact outputs.
Power:	90 to 264 VAC, 50/60 Hz, less than 100 Watts
Air inlet:	The Alpha-7 standard configuration utilizes a radial inlet sampling head, which is primarily intended to sample ambient room air. An optional in-line sampling head is available with a 1 inch I. D. pipe inlet with light baffle cap. An optional 1-inch I.D., 1 ¼ inch O. D. adapter is available for compression fitting connection to standard 1 ¼ inch O. D. stainless steel tubing
Analog Inputs:	0 or 4 to 20 mA for a signal proportional to stack flow
Analog Outputs:	A 4 to 20 mA loop powered analog current signal that can be assigned to any one desired measured item. For example, Slow Dose, Slow Concentration, Fast Concentration, Sample Flow Rate, and Stack Flow Rate. The analog output always displays the measurement selected for page 1 of the display.
Relay contacts:	Screw connections for Alarm, Fail and High Activity Alarms. The alarm relay is pre-wired to the military connector.
Pump:	3/8 inch NPT male pipe connection for vacuum supply. Recommended flow rate is1.5 cubic feet per minute (or 42 lpm)
Recommended Filter Paper:	Millipore 5 micron 47mm Black Fluoropore, Catalog number SA1J408V2
Vacuum Drop:	4 inches of Hg at 1.5 cubic feet per minute

Communications

The Alpha-7 uses Ethernet (IEEE 802.3), or optionally WiFi wireless (IEEE 802.11b), communications. The standard Alpha-7 is delivered with an RJ-45 connector and uses 10/100-Base-T Ethernet. The simplest method of communicating with an Alpha-7 is to use a single computer with the TCP/IP protocol drivers, a network card and a standard crossover cable to connect the two. For communications to be established, the Alpha-7, and the computer connected to it, must have compatible IP addresses and subnet masks.

Data transmitted over the Ethernet network to and from the Alpha-7 Client and Alpha-7 Calibration Wizard programs is transmitted using Transmission Control Protocol / Internet Protocol, or TCP/IP. This method of data transmission insures data integrity and receipt. When data is transmitted from the Alpha-7 for RadNet use, it is transmitted as Universal Datagram Packets (UDP), which is “connectionless” and does not insure data receipt, but requires less overhead and minimizes network traffic.

Data is communicated to the Alpha-7 Client program via both polls and broadcasts. Polled data is data requested by the Alpha-7 Client and is typically used for parameter, spectrum and history. Dose and concentration data, which is updated regularly such as isotope readings and status messages, are broadcast from the Alpha-7 to each Alpha-7 Client that is recognized as having established a connection to that particular Alpha-7. Broadcast data is transmitted every fifteen second or every minute and will not always match the actual display at the Alpha-7, which is updated every second.

Software updates are handled through the network connection. The Alpha-7 SBC (Single Board Computer) does not have a floppy disk, removable hard disk, or CD drive. This means that all software maintenance is done through the network connection. While additional hardware (in the form of disk drives, CDs, etc.) can be added, it is not needed for normal operation. If additional hardware becomes necessary, it must be added locally by connecting a keyboard, mouse and monitor to the Alpha-7 itself.

Stand-Alone Configuration

If no Ethernet network connection is available or desired, changing parameters can be accomplished by connecting a SVGA monitor, keyboard and mouse directly to the Alpha-7. These connections are available on the right side of the unit as the user is facing the display. This allows the operator to work using the SBC built into the Alpha-7.

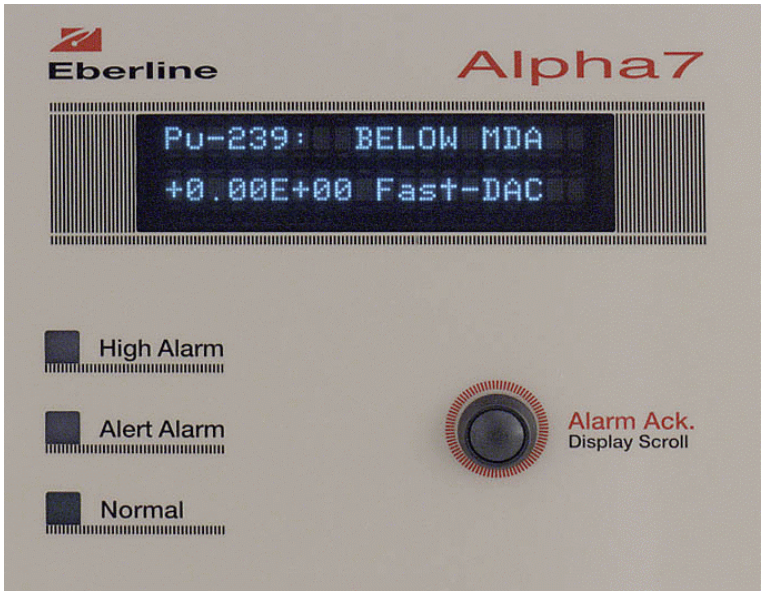
Running the Alpha-7 Client software locally at the Alpha-7 allows the modification of all operating parameters in exactly the same environment that the remote client provides. The Alpha-7 Calibration Wizard can also be run locally in this manner, again providing all the functionality that is available when running remotely. The Alpha-7 Client software comes pre-installed on the Alpha-7. This provides the user with the ability to immediately connect a monitor and keyboard and monitor the status of the instrument. The Alpha-7 Calibration Wizard is installed on Alpha-7A models, but not on Alpha-7L models. Since the Calibration Wizard provides the user with the ability to change critical parameters, its use should be controlled administratively.

CAUTION: Putting the Alpha-7 Calibration Wizard software on the Alpha-7 will give any user with network access the ability to change critical calibration parameters.

Operator Interface

The local operator interface is very simple. A highly visible alphanumeric vacuum fluorescent display is used to display up to 10 pages of information. These pages can be configured to display as much or as little information as desired, including concentrations, dose, flow data, etc. The instrument status is always displayed on Page 0.

To keep the system simple to use, the Alpha-7 does not have the option of displaying a spectrum in the instrument display. Please keep in mind that, if desired, the Alpha-7 can be used with an external SVGA monitor or flat panel display to show the spectrum with the Alpha-7 Client program running in the monitor, or with the Alpha-7 Client running on a network PC connected to the Alpha-7.



A red flashing beacon and a Sonalert audible annunciator are used to annunciate alarms. The Alpha-7 can support both concentration and dose alarms simultaneously. There are three lights - green for ***Normal*** condition, yellow for an ***Alert*** condition and red for ***High Alarm*** . The *High Alarms* can be actuated by either a concentration alarm or dose alarm. The *Alert Alarm* can be actuated only by a concentration alert. The *Normal* light will be lit if there are no abnormal conditions, including failures. A flashing *Normal* light indicates that at least one of the alarms set in the instrument is below the *Minimum Detectable Concentration (MDC)* or *Minimum Detectible Activity (MDA)* for that isotope. The default display units for isotope data are concentration units (e.g. pCi/liter or DAC) but can be factory-configured for dose (e.g. pCi or DAC-h).

Alpha-7L Differences

The Alpha-7L front panel has different lights and labeling than the Alpha-7A. Instead of the *High Alarm* and *Alert Alarm* lights, it has ***Hot Job*** and ***Trouble*** lights. The *Hot Job* light is bright blue in color and indicates that the instrument is configured to alarm on concentration, instead of Dose, for rapid annunciation of large releases. Dose alarming is the default for non-*Hot Job* CAMs. The *Trouble* light is yellow and indicates a problem with the instrument requiring operator attention. The default display units for Alpha-7L isotope data are dose units (e.g. pCi or DAC-h).

Instrument Software

The Alpha-7 is a PC-based instrument running the Windows NT 4.0 operating system. To provide full functionality, Thermo Eberline uses three separate software packages. These are:

A7SERVER.EXE	The primary instrument control software that acquires spectrum data, identifies isotope peaks, calculates activity, concentration and dose, measures the flow and drives the display and alarm annunciators. This program runs automatically whenever the Alpha7 is started. In addition to the measurement and annunciation functions, it communicates with the Alpha-7 Client software by sending the necessary information.
RADNETSVR.EXE	This software queries the A7SERVER software and provides RadNet-compliant information over an Ethernet network. The RadNet client software, which collects and displays the data, is not automatically provided with the Alpha-7. It is available as a separate product from Thermo Eberline.
EBERLOGGER.EXE	The EBERLOGGER.EXE program is the data-logging client that runs locally on the Alpha-7. Alpha-7 Client requests for historical chart data are made

	directly to EBERLOGGER, which gathers the required data from the database, and then returns the data to the requesting program.

In addition, seven other files are required for the Alpha-7 to function. These include six Dynamic Linked Libraries (DLL) files which contain many of the Alpha-7 Client graphic and display functions. The Alpha-7 also requires several database files and templates, including *Isotopes.mdb*, which is the isotope library for the Alpha-7. In addition, there are two text files used to define the RadNet configuration setup parameters for the Alpha-7. These text files will be described in the RadNet Configuration section.

A shortcut to the *startup.bat* file is put in the *Microsoft Windows NT* "Startup" group. The batch file starts automatically when the instrument is powered up starting EBERLOGGER.EXE, A7SERVER.EXE, and if RadNet support is required, RADNETSVR.EXE.

A typical Alpha-7 directory structure follows:

```
Eberline\
    Alpha-7\
        A7CALIB.EXE
        A7CLIENT.EXE
        A7CLIENT.A7C
        A7SERVER.EXE
        RADNETSVR.EXE
        EBERLOGGER.EXE
        CHART.DLL
        DOSE.DLL
        RADNETUI.DLL
        SPECTRUM.DLL
        TREE.DLL
        UDPDLL.DLL
        REGA7.BAT
        STARTUP.BAT
        RNISOTOPES.TXT
        RNLIST.TXT
        ATL.DLL
        DATA\
            ISOTOPES.MDB
            HISTORY\
                A7LOG.MDB
                EMPTY DATABASE\
                    A7LOG.MDB
        UPDATES\
```

Client Software

A7CLIENT.EXE	This is the Alpha-7 Client software that runs on the remote PC (which can also be used on the Alpha-7 itself with a keyboard and mouse attached) to view the information from the Alpha-7 and to configure the measurement parameters on the Alpha-7.
A7CALIB.EXE	This is the Alpha-7 Calibration Wizard software that can be run locally (if it is installed on the Alpha-7) or on a remote PC and is used for the calibration of the Alpha-7. A7CALIB.EXE automates the calibration process by performing a low and high gain test to determine the optimum gain for the instrument to align the energy scale, and then performs an efficiency test to determine the intrinsic detector efficiency. Next, a flow meter calibration is performed by measuring known input flows and automatically adjusting the flow calibration values to match. It then automatically stores these parameters back to the Alpha-7 and prints a calibration report if desired.
TREE.DLL	This library contains the “Tree Control” for the Alpha-7 Client and Calibration Wizard.
SPECTRUM.DLL	This library contains the “Spectrum Control” for the Alpha-7 Client and Calibration Wizard.
DOSE.DLL	This library contains the “Dose Control” for the Alpha-7 Client.
CHART.DLL	This library contains the “Chart Control” for the Alpha-7 Client.
RADNETUI.DLL	This library contains the RadNet properties dialog for the Alpha-7 Client.
A7CLIENT.A7C	This file saves the configuration settings on exit from the Alpha-7 Client. Settings include window sizes, the instrument list, spectrum zoom settings and refresh time, chart settings, and dose control column widths, etc. The file can be deleted if some settings become unresponsive or unworkable. If deleted, the Alpha-7 Client will create a new file on the next exit.

Typical Alpha-7 Client directory structure:

\PROGRAM FILES\
EBERLINE\
A7CLIENT\
A7CALIB.EXE
A7CLIENT.EXE
A7CLIENT.A7C
A7SERVER.EXE
RADNETSVR.EXE
CHART.DLL
DOSE.DLL
RADNETUI.DLL
SPECTRUM.DLL
TREE.DLL
REGA7.BAT
UNINSTA7CLIENT.ISU

Software Updates

The Alpha-7 has the ability to automatically install and register software updates. The user simply copies the updates from the distribution source into the *C:\Eberline\Alpha7\Updates* folder in the Alpha-7 hard drive. When the Alpha-7 is started or re-started, it first checks to see if a software update is available by checking the *Updates*\ folder for any *.exe, *.dll, or *.bat files. If there are updates, it moves the newer files to the active *Alpha7*\ folder, overwriting the existing files. The Alpha-7 *Startup.bat* file then runs the *RegA7.bat* file to update any file registrations that may have changed with the updated files. The Alpha-7 then initializes all the necessary files to start operation again. It is highly recommended that the software running on any PC used as a client for the Alpha-7 be updated at the same time as the software on the Alpha-7. Alpha-7 Client applications that have not been updated may continue to run normally but will not implement any new features or corrections that have been made.

To update client installations, the user may simply run the Alpha-7 Client CD, which will copy all the distribution files onto the installation target and register the files. Alternatively, simply copy the new executable and library files provided for the update (.exe and .dll files respectively) to the current directory for the client software and run the *RegA7.bat* file. This process insures that new features and corrections will be available. This process is also valuable if the user is unsure of the current version on the Alpha-7 in question. The user may copy the files listed above from the Alpha-7 to the client Alpha7 folder (usually *C:\Program Files\Eberline\Alpha7*) and run *RegA7.bat*. This insures compatibility with the existing programs on the Alpha-7. It is highly advisable to update all Alpha-7s and clients whenever an update is available, to take advantage of any new features which may have been added.

NOTE: The *RegA7.bat* file insures that all the files are properly registered with the operating system and relies on the *REGSVR32.EXE* file provided with the Microsoft Windows version running on the client computer. If your computer uses non-standard directories for its Windows software, please contact Thermo Eberline or your system administrator for assistance in obtaining a *RegA7.bat* file customized to correctly update your system registry.

Alpha-7 Hardware

Single Board Computer (SBC)

The Alpha-7 uses a small, PC-compatible single board personal computer (SBC) for the main processing and calculations. Because of the constant advances in SBC technology, and in particular in microprocessors, the single board computer in the Alpha-7 may have different specifications that those listed in this manual. Externally, the SBC is identical in each of its versions. There are no user-serviceable parts inside the case of the SBC.

Display Board

A front panel display board controls the alarm annunciation and relays, analog output and the vacuum fluorescent display. This board is powered by an 8051-family 8-bit microprocessor. It provides the interface for the SBC to the external indicators, the *Alarm Ack.* button and door switches. The communications link with the SBC is via an RS-232 serial communication port. The second port is an RS-485 port and provides the serial communication link between the Display Board and the Multi-Channel Analyzer (MCA) Board.

The front panel Display Board also controls the relays for external signals from the Alpha-7.

On the Alpha-7L, an eleven-pin MIL-spec connector provides access to the loop-powered 4-20 milliamp output and the alarm, trouble and failure relay contacts.

All other relay connections are accessed on screw terminals behind the black cover plate on the left side of the display unit. Terminal definitions may be found in the Drawings section of this manual.

Multi-Channel Analyzer (MCA) Board

The MCA Board is mounted in the remote sampling head enclosure. This board provides all the functions required for multi-channel analysis, including signal conditioning, peak trapping, and analog to digital conversion. The amplitude of each pulse is digitized and the corresponding channel counter incremented to create the spectrum.

A mass flow sensor is used to accurately measure the volume of air passing through the filter, providing the additional information needed to determine concentrations. A separate pre-amplifier board, mounted on the detector itself, provides the interface to the detector. Communications between the Display Board and the MCA Board in the remote head is performed via a high-speed serial communications link over an RS-485 connection. The RS-485 configuration is capable of supporting distances of up to 500 feet using 22 AWG wiring and allows remote placement of the head.

These subassemblies are described in more detail in the Hardware Description section of this manual.

Theory of Operation

Technological Advancements

The Alpha-7 uses peak shape analysis to determine the activity of specific isotopes on the filter paper. This is a new approach replacing the older methods using regions of interest (ROI's) or exponential tail fits. The advantage of the technique is the ability to accurately determine the amount of an isotope interfering with the measurement of the isotopes of interest.

For example, because Pu-239 is on the tail of one of the radon daughters, it is very important to be able to subtract those counts in the Pu-239 region caused by the radon daughters. The older technique relied on factors used to subtract a portion of one ROI from another. The factor was not constant, however, and depended on the age of the filter (as radon daughters were collected and came into equilibrium), dust loading, and detector quality. The new technique used in the Alpha-7 is much more accurate at measuring the interference from the naturally occurring isotopes and performing the background compensation. This method also allows for automatic gain adjustment to constantly insure that the reference peaks are aligned with the proper energy.

The curve fitting is performed using a proprietary peak shape model and iterative algorithm developed by Thermo Eberline specifically for the Alpha-7.

The MDC is calculated from the variance in the curve fit. This provides a better estimation of MDC than the older method using ROI's, which depended on the accuracy of multiple regions of interest. The MDC calculation takes into account both the variability in the measurement of the counts, which is minimized due to the curve fit, and the variability due to the curve fitting process itself.

Spectrum Measurement

Spectrum Acquisition

The Multi-Channel Analyzer (MCA) Board contains a 12-bit digital-to-analog converter (DAC) that provides for energy resolution of up to 4096 channels. The Alpha-7 uses a 512-channel configuration for an energy resolution of approximately 20 KeV/channel. The spectrum counts are kept in an array of four-byte counters which support up to 4.3 billion counts per channel. On start-up or after a filter change, a *Reset Spectrum* message is issued to the MCA Board, followed by a *Start Count* message. Counts will continue to build the spectrum until the next filter change or a manual spectrum reset from the Alpha-7 Client.

Once per second, the A7Server program polls the spectrum from the MCA Board and calculates a "best fit" of individual isotope peaks, where the summation of the peaks provides a minimum "least squares" difference between the actual channel counts and the fitted curve. The individual isotope peak curves are saved and may be viewed from the Alpha-7 Client program by selecting the isotope in the Tree Control. Selecting the instrument icon in the Tree Control provides a view of the overall fit.

The resulting curve fit coefficients provide values that represent the total counts under each isotope peak, along with a derived count variance that is used to determine the minimum detectible activity/concentration for each peak.

Peak Shape Factors

Several factors affect the shape of the individual isotope peaks—thereby, the sensitivity of the instrument:

Detector to filter paper distance—As an alpha particle travels through air, the decay energy of the particle is depleted (i.e. attenuated) by collisions with air molecules. This means that a 6.00 MeV alpha emitted by a Po-218 decay, may reach the detector with only 5.50 MeV. This energy attenuation means that the distance between the detector and the surface of the filter paper has a dramatic effect on the peak width, and thereby, the ability of the instrument to accurately resolve isotopes near the 6.00 MeV Po-218 radon daughter peak. This effect can be noted when comparing the spectrum from the In-Line Remote Head (which has a 4.3mm spacing), and the spectrum from the Radial Entry Remote Head (which has a 6.3mm spacing).

Altitude and Barometric Pressure—Like the detector to filter paper distance effect, the density of the air in the detector/filter gap will change with increases/decreases in barometric pressure due to meteorological conditions or changes in altitude. Less dense air means fewer collisions and less alpha energy loss on arrival at the detector. For this reason, the Alpha-7 must be calibrated at the altitude where the instrument will be installed—preferably during a time of average barometric pressure for the region. In spite of these precautions, some peak broadening may be observed as low or high pressure fronts move through the area.

Filter Paper Type—The type of filter paper used can also affect the peak shape. Rough or paper-type filters have holes and pits where particles can become deeply embedded and

the resulting alpha-emissions experience significant energy loss as they work their way out through layers of dust and filter fibers before finally reaching open air. For best peak shape, use a filter paper with a very smooth surface. Thermo Eberline recommends the 5-micron Teflon-membrane Fluoropore filters (Catalog number SA1J408V2) for their superior performance in peak shape while maintaining a low pressure drop.

Filter Loading—As the accumulation of particulates on the filter progresses, previously deposited particles will become buried by more recent deposits, further degrading the energy reaching the detector. This effect causes peaks of isotopes with longer half-lives to shift towards a lower energy as the emitted alphas can lose significant energy before even reaching open air.

Curve Fitting

General Algorithm

The Alpha-7 utilizes a sophisticated algorithm for determining the concentrations of alpha-emitting isotopes. Whereas, most Alpha-CAM's use a region-of-interest approach for measuring total counts within energy ranges, the Alpha-7 uses information about the peak shape to mathematically separate the spectrum into a combination of individual isotope peaks. The curves from these individual isotope peaks, when summed, produce a "fit" of the total spectrum. The quality of this fit is the primary determinant of the instrument sensitivity. In a radon background, the best sensitivity to mid-energy isotopes will be obtained when the peak shape factors listed above are minimized to produce narrow peaks and the model closely fits the tail shape of the 6.0 MeV Po-218 peak.

Studies of Alpha spectroscopy have yielded several generalized mathematical models to describe the shape of an air-attenuated alpha peak. To represent peaks in the Alpha-7, Thermo Eberline has developed a model which best fits the spectrum data acquired by the Thermo Eberline detector and electronics and easily adjusts to different filter types and detector spacings.

As mentioned above, a new spectrum is acquired every second and peak areas (counts) derived based on fixed peak-shape coefficients. Once every fifteen seconds, the program checks the peak-shape coefficients to make slight adjustments for any changes in the peak shape.

Obviously, the algorithm to determine curve fit is quite numerically intensive and consumes a good percentage of the available processing time of the SBC. Computation time increases exponentially, as the number of peaks that are to be fitted increases. For this reason, it is important to include in the Alpha-7 isotope tree only those isotopes that the user wants to measure or expects to be present in the sampled air.

Peak Shape Training

Since the instrument is normally used at a fixed altitude, with a certain type of filter paper, and in a fairly fixed set of environmental conditions, the peak shape—over the first 24 hours—will rarely change visibly. However, if the MCA electronics or the detector is changed out during maintenance, or if a different filter paper type is installed, the peak shape can change significantly.

The Alpha-7 program incorporates code to "train" itself to the peak shape it typically sees. To allow the instrument to train itself to its typical operating conditions, a 24- to 48-hour trial should be run prior to putting the instrument into use to allow the training algorithm to measure and store the 'typical' shape parameters. The shape parameters will be saved when the total counts are greater than 16,000 and the Fit Ratio (see below) drops below 0.60. If this trial run is not possible, it should be noted that the instrument will still be operational, but may not have the optimal sensitivity it would have if 'trained' properly.

Curve Fit Statistics

The Spectrum Ciew in the Alpha-7 Client provides some indications of the quality of the curve fit. If Statistics are enabled, the upper left corner of the spectrum display will show three values which apply to the fit: Total Counts, ChiSq and Fit Ratio.

Total Counts—indicates the total number of alpha counts in the spectrum. When there are few counts in the spectrum, the curve fitting results are more inconsistent, but as counts increase, the individual peaks become more obvious and the curve fit is accomplished more rapidly and accurately. At 8000 counts in the spectrum, there is usually enough information to begin determining the peak shape coefficients and so the customer may notice gradual changes in the fit at this point. While there is no definite crossover point in the total counts, by the time the spectrum has 80,000 counts, the curve fit should be quite accurate.

ChiSq—is the Chi-squared value that represents the sum of the squares of the deviations between the actual channel counts and the curve fit counts. This value can be expected to increase as the total counts increase.

Fit Ratio—is a calculated value which best describes the quality of the curve fit. The value changes during the life of the filter buildup, usually starting out about 1.5, then dropping over the next day to below 0.6, then gradually increasing again. Values greater than 2.0 are cause for attention and the spectrum should be examined for signs of unlisted isotopes, spectrum noise or unusual filter buildup.

Curve Fitting Difficulties

While the algorithm is quite robust and can adapt to significant changed in peak shape, the curve fitting can fail if not all isotopes being collected on the filter paper are present in the Alpha-7 isotope tree, if the unit has been miscalibrated, or if unusually heavy filter loading has occurred. In this case, the instrument will enter a failed condition with a status of "POOR CURVE FIT." An examination of the spectrum may provide an indication of the cause.

To clear this condition, the user must change the filter, issue a *Reset Spectrum* command from the Alpha-7 Client or, as a last resort, re-calibrate.

Concentration Calculation

Fast and Slow Integration Windows

Each isotope measured by the Alpha-7 uses two integration times, which are independently set for each isotope. This means that a longer time can be used for isotopes expected to have low concentrations and shorter integration times for those isotopes expected to have higher concentrations. These are described as Fast and Slow Window intervals.

The default values are 60 seconds and 30 minutes. In the case of the default values the fast alarms are evaluated each second based on the most recent two 60 second intervals and the slow alarms are evaluated every five seconds based on the most recent two 30 minute intervals.

The MDC for longer window times will be lower because it has better statistics resulting from longer effective count times. The statistical fluctuation will also be less for longer window times.

The Alpha-7 will start monitoring the concentration after two seconds (two fast interval updates) and the flow is above the flow fail limit value specified in the sample flow properties window.

History Arrays

The A7Server program keeps a history array of count rate, variance, flow and volume readings for each isotope, in both one-second detail (for determining fast concentration) and one-minute detail (and slow concentration). A maximum of 20 minutes of one-second detail are retained, while the one-minute detail is limited to 8 hours.

Concentration Calculation Method

The curve fit function produces coefficients for each isotope that correspond to the counts under the peak. In order to calculate a concentration, the counts for each peak are saved—along with the flow rate and volume—in a history array, so that the increase in counts over time can be used to determine the net count rate. For each isotope, two different time intervals are used to determine concentrations and are referred to as the “fast window” and “slow window” times (sometimes called ‘acute’ and ‘chronic’). The peak counts—based on the history values over one and two window times—are used to determine the net count rates. For instance, if the window time is 60 seconds, then the net count rates for the previous minute and also the minute previous to it, are calculated. For long-lived isotopes, the difference in net count rates over the two intervals is proportional to the concentration. Once

the change in net count rate is known, the calibration constant and flow volume are used to derive the concentration in the specified measurement units.

An additional term is included in the concentration calculation to account for the expected count rate losses due to activity that has decayed off during the last interval. For longer half-lived isotopes the term $Net_0 \cdot \lambda$ goes to zero. However, this term is very important for the proper treatment of the short-lived radon daughters.

It should be noted that in situations where the counts under a peak are changing very slowly or not at all, slight variations may occur in the determination of the net count rate, which can result in small negative concentrations. The Alpha-7 reports negative concentrations as "< 0." This is an indication of no appreciable airborne concentration. These effects are minimized by the use of the two different evaluation intervals, with a longer interval providing greater precision in low-level measurements.

Concentration Equation

The concentration equation used for the fast and slow calculation is:

$$Concentration = (Net_1 - Net_0 e^{-\lambda T_{WA}} - Net_0) \cdot \frac{Yield}{Vol_{Sample} \cdot K_{DAC} \cdot Cal \cdot Eff}$$

Where,

T_{WA} = Actual slow/fast window time in seconds[1]

Net_0 = Net count rate from $T - 2T_{WA}$ to $T - T_{WA}$

Net_1 = Net count rate from $T - T_{WA}$ to T

Cal = Calibration constant

Eff = Detector efficiency (4-Pi)

$Yield$ = Isotope Alpha yield

Vol_{Sample} = Sampled volume since filter change

K_{DAC} = DAC conversion factor (equals one if DAC not used)

λ = decay constant, $\lambda = \frac{\ln(2)}{T_{½}}$ where, $T_{½}$ = isotope half-life

A mass flow sensor is used to accurately determine the volume of air collected on the filter paper during the count time.

[1] The actual window time may be shorter than the user-defined window time. When a new spectrum is begun, following a spectrum reset or a filter change, a window time equal to the elapsed time, is used so that a "best guess" concentration value can be calculated. This actual window time will increase until it is equal to the user-defined time. This occurs when the user-defined window time has elapsed since the filter change or spectrum reset. After this point, the user-defined time is used.

Dose Calculation

The Alpha-7 program calculates dose according to the activity collected on the filter paper. Because the Alpha-7 is typically used to continuously monitor the air in a facility, the concept of "worker dose" is dependent upon the portion of time the worker spends in the facility in comparison to the time the Alpha-7 filter has been accumulating activity. For instance, if an Alpha-7 has been sampling air at 1 CFM for 40 hours, and the activity of Pu-239 is 15 dpm, the worker dose is not 2 DAC-h, but is dependent on how much of the 40 hours the worker spent inside the room being monitored. The determination of worker dose must be accomplished administratively by noting the dose readings when the worker enters and leaves the area and calculating the increase in dose.

$$Activity = \frac{Net_1 \times Yield}{T_{WA} \times Cal \times Eff}$$

$$Dose = \left(\frac{Activity}{K_{DAC} \times Flow_{Sample} \times 60}\right)$$

Where,

T_{WA} = Actual slow/fast window time in seconds[1]

Net_1 = Net count rate from $T - T_{WA}$ to T

Cal = Calibration constant

Eff = Detector efficiency (4-Pi)

$Yield$ = Isotope Alpha yield

K_{DAC} = DAC conversion factor (equals one if DAC/DAC-h not used)

Region of Interest Calculation

In addition to measurement of specific isotopes, the Alpha-7 program also supports the definition and calculation of concentration of multiple isotopes within an energy Region of Interest (ROI). The difference between the ROI calculation and the calculations for specific isotopes, is simply in the computation of net counts within the region. These net counts are then assigned to an isotope with a user-defined name, such as "Region" or "MixedU," and treated as if the counts were all under the same peak.

The ROI counts are calculated by summing the counts from isotopes whose peak is within the bounds of the region, then adding the difference in counts between the curve fit and the actual spectrum counts (summed over the ROI).

Error Handling and Exceptions

Due to a number of circumstances, a valid concentration is not always calculated during each one-second interrupt. On entry into the concentration calculation function, the elapsed time since the last calculation is checked to see if any updates were missed. If updates were missed, the last good concentration value is used instead.

Minimum Detectable Concentration Calculation

Uncertainties in Peak Counts

In most ROI-based Alpha-CAM's, the minimum detectible concentration is based on the statistical uncertainty of the background counts that fall within the region, in combination with the uncertainty of any counts in excess of the background. In the Alpha-7, the minimum detectible concentration (MDC) is not directly related to the spectrum counts, but to the uncertainty in the curve fit.

When the curve fit is completed each second, several values are returned which represent the counts under each peak. As described earlier, these values are statistically distributed about the 'true' peak areas and have known probabilities of being within 1-sigma, 2-sigma, etc. of the true area. A characteristic of the curve fit algorithm is that in the course of solving the minimization problem, a "covariance matrix" is calculated which described the errors associated in the solution. This covariance matrix identifies, on its diagonal, the variances of each coefficient—including the peak area coefficients. In other words, the curve fit routine returns the actual variances for the peak areas so that uncertainties due to interfering isotopes (I.e. background) have already been considered.

Although the actual calculation of the covariance matrix is too involved to describe here, an examination of the peak area variances confirm that, for a well-defined spectrum (> 80,000 counts), when the counts due to an interfering isotope greatly outnumber the counts due to the isotope in question, the variance increases. Likewise, when there are very few interfering counts from other isotopes, the variance begins to approach a value equal to the peak area counts.

In the case of a non-well-defined spectrum (< 80,000 counts), the curve fit solution is more uncertain, and therefore, the uncertainties of the peak areas are understandably higher. This means that as more and more counts are accumulated in a spectrum and the peaks become smoother, the peak area uncertainties (hence, the MDCs) actually improve—in spite of interfering counts!

Calculation of the Variance of Net Count Rate

The variances returned from the curve fit routine represent the uncertainties on the total peak counts for each isotope. These values, however, cannot be used directly in the determination of the MDC, since the MDC calculation involves net count differences in the peak area.

Typically, the variance of a difference is simply the sum of the individual variances, but with a continuously growing spectrum, we do not have independent measurements of the peak area. Because each spectrum is dependent on the previous spectrum (i.e. the counts in each channel can never decrease, but are dependent on the counts that had already accumulated in the previous measurement), we use a different approach to calculating the "net" variance.

In repeated measurements of a growing sample, we can determine an average variance by taking the total variance and dividing by the number of samples. In the case of the Alpha-7 spectrum, we take the variance for each peak and divide by the total spectrum counts to get a variance-per-total-count average (V). The sum of the averages at the start and end of a window interval, when multiplied by the increase in total counts over the same interval, yields

the variance of the net counts for that window period. The square root of the sum of the previous and current window variances then produces the standard deviation of the net count increase/decrease in activity (in counts).

What remains is simply to apply the flow, calibration constant and efficiency factors to the standard deviation in counts to convert to the units of concentration. The final MDC calculation, then, is as follows:

$$Variance_0 = Net_{Total0} \cdot V_{2WA} \cdot V_{WA}$$

$$Variance_1 = Net_{Total1} \cdot V_{WA} \cdot V_{Cur}$$

$$Sigma = \frac{\sqrt{Variance_1 \cdot Variance_0}}{T_{WA}} = \sqrt{Variance_0}$$

$$MDC = \frac{K \cdot Sigma \cdot Yield}{Cal \cdot Eff \cdot Vol_{Sample}}$$

Where,

K = false alarm rate factor (i.e. Sigma Factor)

Net_{Total1} = Increase in total spectrum counts in most recent T_{WA}

Net_{Total0} = Increase in total spectrum counts in previous T_{WA}

Region of Interest MDC

The variance for the region of interest is calculated differently. The ROI variance is the sum of the individual variances (per total count) of the isotopes within the region, plus the covariances (per total count) between the isotopes within the region (these can be negative), plus the variance (per total count) due to the difference (in counts) within the region between the spectrum and the curve fit.

$$V = \frac{\sum_{ROIisotopes} V_{iso} \cdot \sum_{ROIisotopes} Covar_{iso} \cdot \sum_{ROIchannels} Spect_{ch} \cdot Fit_{ch}}{Net_{Total1}}$$

This variance is then archived in the history array and represents the V_{Cur}, V_{WA} and V_{2WA} variances in the equations above.

Alarms

Once calculated, the concentration levels are compared against the appropriate alarm levels, and an alarm occurs if the calculated level is equal to or exceeds the alarm level. The fast concentration alarm is used to give rapid alarm response on high (acute) concentrations. The slow is used to accurately measure lower (chronic) concentrations. For both Fast/Slow Window integration times, until one full interval has passed, the alarms will be evaluated based on only elapsed time. Once a full interval has elapsed that particular alarm will be evaluated based on the specified evaluation time.

NOTE: If an alarm is below the currently calculated MDC (Minimum Detectable Concentration) the alarm is temporarily set to the MDC. This helps prevent nuisance alarms caused by poor statistics at very low concentrations combined with very short evaluation intervals.

As the filter loading changes, especially as the radon daughters are collected and during their equilibration, the MDC for each isotope will change, generally decreasing up through a period of twice the evaluation interval selected, then increasing gradually to reflect the impact of the variability associated with the increased total counts. The Normal LED on the front panel will blink as long as any alarm set points are below their respective MDC.

Configuring Your Alpha CAM

Network Setup

NOTE: The Alpha-7 can be operated either as a stand-alone instrument, or as one of multiple instruments on a network. In either case, the Alpha-7 is shipped "network ready" so that it can be configured from a networked PC or laptop computer. If you intend the Alpha-7 for stand-alone operation and will set up the unit using an attached monitor, keyboard and mouse, then you may skip to Local Setup Using A Monitor And Keyboard.

CAUTION: Network setup can be very complicated. For this step of the Alpha-7 setup, you may wish to request the help of your network administrator.

In order to communicate with another computer, either the Alpha-7 settings must be changed to be compatible with the other computer, or the network settings of the other computer must be changed to be compatible with the Alpha-7. To set up the Alpha-7 for use on a TCP/IP network, the following information must be obtained from your network administrator:

Network Setting	Required Setting	Eberline Default Setting	Editable through Calibration Wizard
Computer Name		A7000xxx	Yes
Uses static or dynamic IP address		static	No
TCP/IP Address (or Address Range)		128.0.0.xxx where xxx is listed on the calibration sheet.	Yes
TCP/IP Subnet Mask		255.255.0.0	Yes
Gateway		128.0.0.1	No

The Alpha-7 comes pre-configured from the factory with a static IP Address and Computer Name based on the serial number of the instrument. This data is printed at the top of the calibration sheet for each Alpha-7.

The Alpha-7 Calibration Wizard allows configuration of only the IP Address, Subnet Mask and Computer Name. After conferring with the network administrator, if any additional network settings must be changed, the Alpha-7 setup will require local modification using a monitor and keyboard (see following section).

When performing remote setup from another computer on an existing network, or over a simple two-computer network using a “cross-over” Ethernet cable to directly connect the computer with the Alpha-7, the computer used must have an IP Address and Subnet Mask compatible with the default values in the Alpha-7. Once the any of these parameters have been changed, the Alpha-7 must be restarted for the changes to take effect (see Routine Operation And Maintenance—Power Down).

Local Setup Using A Monitor And Keyboard

For stand-alone use, the Alpha-7 can also be configured by connecting an SVGA-compatible monitor, a keyboard and a mouse (using the supplied Y-adapter) to the PS2-style connector on the Alpha-7 SBC. This is very useful if no network connection is available. These connectors are accessed on the right side of the display unit (see Drawings—Alpha-7 Outline Drawing).

The user can either modify the network parameters using the *Microsoft Windows* methods, or run the Alpha-7 Calibration Wizard locally and use the editing capabilities in the Instrument Properties dialog.

Please note that the Alpha-7 Calibration Wizard may not be installed on the Alpha-7 itself for security reasons. This means that network setup must be performed using the Microsoft Windows Network Properties dialog. Again, the Alpha-7 must be restarted if any changes are made to the network parameters.

Network Setup Using The Alpha-7 Calibration Wizard

For security reasons, critical Alpha-7 setup options must be accomplished through the Alpha-7 Calibration Wizard. This program, which is covered in much more detail in the Alpha-7 Calibration section, enables additional functionality in the Tree Control than is enabled by the Alpha-7 Client program.

Alpha-7L Specific: To run the Alpha-7 Calibration Wizard (*A7Calib.exe*), it will need to be installed in the *Alpha7* folder of the client PC or the instrument itself. The Alpha-7 Calibration Wizard program is not included in the Alpha-7 Client Installation CD. It must be copied from the Alpha-7 Calibration Wizard distribution diskette to the client folder (typically *C:\Program Files\Eberline\Alpha7*).

Run the A7Calib.exe program from the client folder. The initial Wizard Page will appear which can be skipped by clicking Next.

On the Instrument Information and Isotope Configuration page, fill in the *Instrument Name* field and click the *Connect* button. The Tree Control should indicate "Trying…," then display the instrument icon when the connection is completed (this can take up to 90 seconds). Next, right-click on the instrument icon to get the instrument pop-up menu and select *Properties…*

Under the General tab, enter the *Instrument Location* text, the new *Computer Name*, *IP Address* and *Subnet Mask*, then click the *OK* button. To finalize the network changes, right mouse click on the instrument icon again and select *Restart…* The Alpha-7 will do a shutdown and restart. When it finishes restarting, the new network settings will be in effect. At this point the network configuration is complete and you may *Cancel* out of the Calibration Wizard, and, if necessary, reconfigure the network settings of your client computer to be compatible with the new settings of your Alpha-7.

Setup Using The Alpha-7 Client

Most of the remaining instrument setup can be accomplished using the Alpha-7 Client program. This program contains the same Tree Control used to configure the network parameters described under the Alpha-7 Calibration Wizard section. The Alpha-7 Client program is initiated by double clicking on the Alpha-7 Client icon on the *Windows* desktop, or by double clicking on the *A7Client.exe* file in *Windows Explorer*.

Password Access

Two levels of password access are provided in the Alpha-7 Client program. The first level provides the user View-Only access. The second level provides editing capabilities to configure the Alpha-7, but does not allow modification of any information that would effect the instrument calibration. Those modifications are restricted to the Alpha-7 Calibration Wizard, which provides a third level of access via administrative control of the program availability. The Tree Control in the Alpha-7 Calibration Wizard allows unrestricted editing of all Alpha-7 parameters.

When the user starts the program, a password screen will be presented for the user to enter the appropriate password. There are two levels of password access: View-Only and Full Rights.

Entering the **View-Only** password allows the user the lowest level of access to the client program. The user may view the Alpha-7 operating parameters and data but is not allowed to change any values or configuration. In this mode most parameter fields will display the settings, but the edit field will be grayed out preventing user modification. The default View-Only password is blank, which means you can press the *Enter* key or click *OK* with the mouse to enter the client.

Entering the **Full Rights** password allows the user access to configuration parameters for all Alpha-7 instruments that can be accessed from that client computer. These changes include the instrument name, display page settings, isotopes to be measured, and alarm set points. The user is not allowed to change any of the calibration data that might affect the quality of the measurement using this program. The default Full Rights password for all new Alpha-7 Client installations is “eberline”. The password is case-sensitive, so be sure that the *Caps Lock* is off.

The View-Only and Full Rights passwords can be edited by clicking on the *Edit* menu item in the Alpha-7 Client and selecting *Passwords…*. Password editing is limited to users who log on with the Full Rights password. The user may then change both the View-Only and Full Rights passwords.

Care should be taken to properly document the passwords when they are changed. If the passwords should be lost, access to the program can only be regained by uninstalling the program and reinstalling it to restore the default passwords.

Keep in mind that the passwords are independent for each installation of the Alpha-7 Client, and unless the passwords are set the same for multiple installations, the password for one installation will not be accepted at another installation on a different computer.

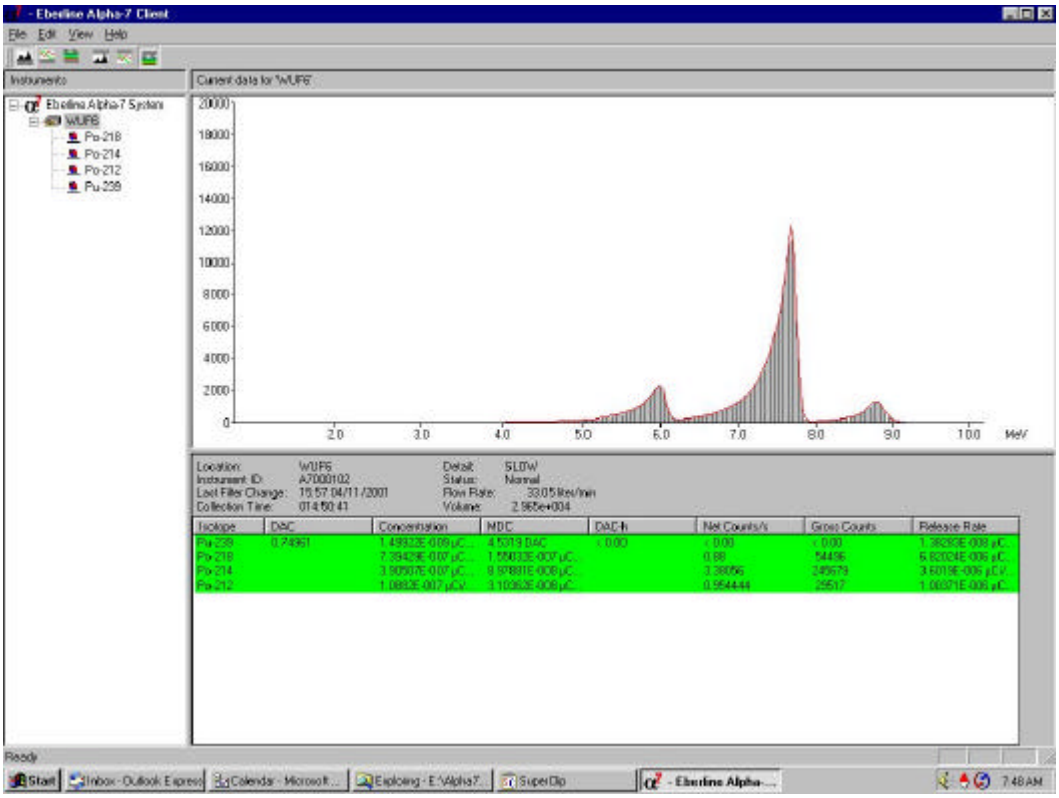
The third level of security for modifying calibration data is provided administratively by restricting access to the Alpha-7 Calibration Wizard software. The calibration software is the only method for modifying the Alpha-7 calibration data and network settings. Data may be modified manually if necessary, but use of the automated calibration wizard is advised for both ease-of-use and accuracy of calibration.

Alpha-7 Client Overview

The Alpha-7 Client program is the primary user interface for the Alpha-7. It provides all of the information access functions and the more common instrument maintenance functions.

There are four main sections to the display - three of which can be displayed at any one time. The four are the **Tree Control** showing the Alpha-7 instruments available on the network, the **Spectrum Control** showing the total counts plotted in a bar chart format by energy, the **Dose Control** showing the DAC, DAC-h and concentrations for the isotopes selected by the user and a strip **Chart Control** which graphically depicts the value for the selected isotopes referenced against the alarm set point for that isotope.

The Tree Control is always shown on the left side of the Alpha-7 Client display. The screen image below shows the Spectrum Control in the upper right portion of the screen and the Dose Control in the bottom right portion. The Chart Control can be selected by using the pull-down menu for View, or by clicking on the appropriate tool icon in the Alpha-7 Client toolbar. The Chart Control, Dose Control, and Spectrum Control may be displayed in either the upper or lower window. The three icons on the left end of the toolbar select the control to be shown in the upper right window, while the three icons on the right end of the toolbar select the format to be displayed in the lower right window. Each of the windows can be resized using normal *Microsoft Windows* drag and drop methods.



The Tree Control is used to select which instrument's data is displayed in the other windows. When either an instrument or one of its isotopes is selected, the controls in the right hand windows will display data for that instrument.

For the, When an isotope is selected in the Tree Control, the Alpha-7 Spectrum Control will show the curve fit for the selected isotope as a red line drawn over the spectrum in the position of the selected isotope. When the instrument is selected (i.e., click on the instrument icon), the entire curve fit (of all isotopes) will be shown drawn in red onto the spectrum.

Isotope Database

The ***Isotopes.mdb*** database provides the isotope references for the Alpha-7. A default database is supplied by Thermo Eberline containing the most common isotopes of interest, including the radon progeny and a mixed-uranium region of interest. The user can add any desired isotopes to the Alpha-7 by adding the necessary data into the *Isotopes.mdb* database. The Alpha-7 will then allow the newly added isotopes to be added to the tree. This database is stored directly on the Alpha-7 in the *Data/* subfolder, and is valid only for the Alpha-7 on which it resides.

Once the database has been edited, it can be copied to any other Alpha-7 to standardize the operation. This must be performed as a manual operation, since the database is not updated automatically by the startup process.

The *Isotopes.mdb* database consists of the following fields:

ID	The entry number in the table, usually generated automatically
Isotope	The isotope name as desired to appear in the Alpha-7 tree and controls, limited to 8 characters
Parent	A check box indicating that this isotope is the start of a user defined decay chain, and will appear in the list as a parent isotope
Energy1 (MeV)	The weighted peak energy of the alpha particle(s) emitted from this isotope[2]
Particulate	A check box indicating that this isotope is particulate in nature and will be collected on the filter paper
Alarms	A check box indicating that the default condition for this isotope is alarms are enabled when added
Reference	A check box indicating that this isotope will be used as a reference for the auto energy alignment function. These are usually the normally occurring radon progeny, but in the case of filtered air, they may include the main isotope of interest
DAC Unity	This value is the conversion factor from uCi/cc, which are the default units for an added isotope, to DAC. If the default units are changed from the client program, the DAC unity value must also be changed to match the new units.
Half-life (sec)	This is the half-life of the isotope in seconds
Daughter1	The first decay product of the isotope
Abundance	The abundance of the first daughter product

[2] The energy of an isotope with multiple decay paths may be calculated by "weighting" each energy by the associated abundance. For instance, the weighted energy of an isotope with two alphas; one of 75% abundance at 4.6MeV, and one of 25% abundance at 4.53MeV, can be calculated as E = 4.6 x 0.75 + 4.53 x 0.25 = 4.5825 MeV.

Beta	A check box indicating whether this daughter was produced by a beta decay, which would not produce a measurable event for the Alpha-7
Stable1	A check box indicating that the result of the decay of the isotope is a stable isotope
Daughter2	The second decay product of the isotope (not currently used)
Abundance2	The abundance of the second daughter product
Beta2	A check box indicating whether this daughter was produced by a beta decay, which would not produce a measurable event for the Alpha-7
Stable2	A check box indicating that the result of the decay of the isotope is a stable isotope
Page	The default local display page for the isotope on the Alpha-7
Logging	A check box indicating the default logging status for the isotope when added
Comments	A text space for a user-definable comment

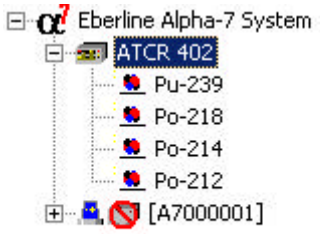
The default energies for the alpha-emitting isotopes in the database are taken from the U.S. Department of Health, Education and Welfare, *Radiological Health Handbook*. For isotopes which had multiple alpha emissions, all emissions that were within plus or minus 3 percent of the normal peak energy were combined together using a weighted average based on the abundance of each energy peak to arrive at an average energy for the peak energy of that isotope. None of the isotopes currently listed in the database have more than one major peak, although the database is configured to support isotopes with multiple alpha peaks.

As of Version 1.6 of the *A7Server* program, second daughters of an isotope are not supported.

Using The Tree Control To Set Up A CAM

Elements Of The Tree Control

The Tree Control is made up of three elements: the System Root icon and description, the Instrument icon and description, and the Isotope icon and name.



The **System Root** is always present in the tree and identifies the network type—in this case an Eberline Alpha-7 System.

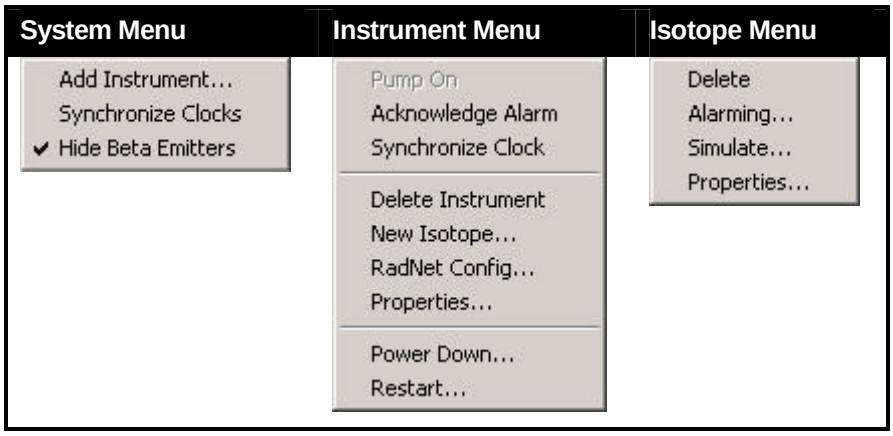
Next is an **Instrument** icon and description. In the example below, there are two kinds of Instrument icons and two types of descriptions. The top instrument is on-line and is indicated by a standard icon with the monitor Location (ATCR 402) listed in the description field. The next Instrument is off-line and is indicated by a "off-line" icon, preceded by a ***Fail Beacon*** icon. The description field is the *Computer Name* assigned to the instrument. Individual instruments must be added manually to the tree. There is no auto-search of a network to identify Alpha-7 instruments.

In addition to the *Fail Beacon* icon, there are ***Alarm Beacon*** (red) and a ***Maintenance Status*** (wrench and screwdriver) icon.

The last element is the **Isotope** icon and name. The list of isotopes in the tree corresponds to the isotopes configured for the Alpha-7 under which they appear. The icons shown in the example represent alpha-emitting isotopes. Beta-emitters, if present in the isotope list of an Alpha-7, will have a different icon to distinguish them from the isotopes of interest. Isotopes are added automatically to the tree when an Alpha-7 reports back the isotope list.

Tree Control Popup Menus

The three elements of the Tree Control each have a popup menu associated with them to provide access to configuration functions. These menus are the System Menu, the Instrument Menu, and the Isotope Menu. To activate each of the menus, place the cursor over the tree element and click the right mouse button.

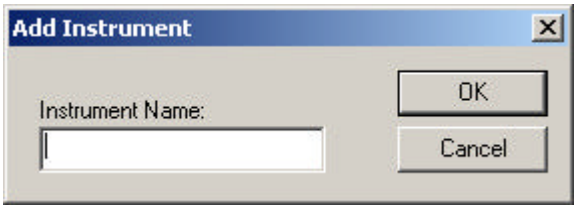


System Menu

Adding Alpha-7s To The Instrument Tree

When the Alpha-7 Client is first installed, the Tree Control will not contain any instrument icons. The Alpha-7 Client will not automatically search a network for Alpha-7 instruments and add them to the tree. The user must add the instruments in his or her network to the Tree Control before the icons will appear. Not all Alpha-7s need be added to the Tree Control. Add only those instruments of interest to the user running the Alpha-7 Client.

Instruments can be added by right-clicking the mouse on the “Eberline Alpha-7 System” entry in the tree, producing the System Menu. When *Add Instrument…* is selected, a dialog box will appear in which the *Computer Name* (or TCP/IP Address) of the Alpha-7 to be added can be typed. Click *OK* and the Alpha-7 Client will add the specified Alpha-7 to the Tree Control and attempt to communicate with it.



When an instrument is added, the *Computer Name* specified will be appear in brackets in the instrument tree with a *Off-Line* icon next to the name. When the Alpha-7 Client attempts to communicate with the Alpha-7, the name will be replaced with the text, “Trying…” while communications are established.

NOTE: For newly added instruments, this attempt may take as much as 90 seconds before returning. Subsequent attempts should take only a second or two.

When communications with the Alpha-7 are established, the icon will change to a colored *Operational* instrument icon and the instrument text will display the *Instrument Location* description. Clicking on the “plus” symbol in front of the icon will expand the instrument tree to display the Isotope List.

If communications with the new instrument cannot be established, the *Off-Line* icon will remain and the *Computer Name* in brackets restored after the communications attempt.

There can be several reasons why the Alpha-7 is not accessible from the client computer. Placing the cursor over the icon or *Computer Name* of the Alpha-7 will provide a “tool tip” which will indicate the cause of the failure. If the “server is not available” tool tip appears, the cause may be that the Alpha-7 is not turned on, is not accessible via the current Ethernet network connection, or is incompatible with the current IP address or subnet mask.

Clock Synchronization

The System Menu can also be used to synchronize all Alpha-7s that are currently communicating with this instance of the client program. Selecting *Synchronize Clocks* will cause all the Alpha-7s in the tree to be set to the same time as currently being used by the Alpha-7 Client computer.

Showing/Hiding Beta Isotopes

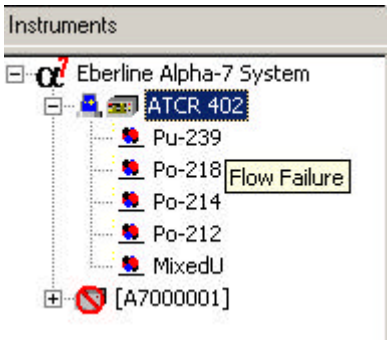
Checking or unchecking the *Hide Beta Emitters* menu selection can change the expanded appearance of the tree. If this item is selected, isotopes with only beta emissions will not be shown in the expanded tree even though they may be naturally occurring daughters of the parent isotope.

Instrument Menu

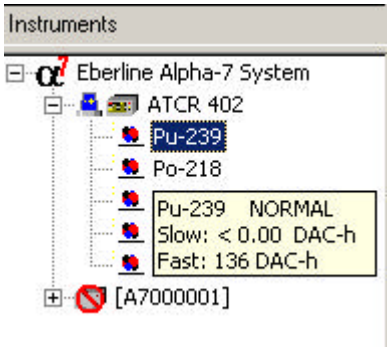
Pump On	Checked if the instrument currently has air flow. Normally grayed-out. Active only during sample flow simulation.
Acknowledge Alarm	Performs the same function as pressing the *Alarm Ack.* button on the Alpha-7 Display Unit.
Synchronize Clock	Synchronizes the clock on this instrument only
Delete Instrument	Deletes the instrument from the tree
New Isotope…	Allows the user to add a new Isotope or Region of Interest to the instrument. See Adding Isotopes and Adding a Region of Interest
RadNet Config…	Presents a dialog to allow configuration of RadNet parameters. Not active if RadNet is not enabled on the Alpha-7
Properties…	This item calls up the Instrument Properties dialog described in the next section.
Power Down…	This function does a remote *Windows* Shutdown of the instrument.
Restart…	This function does a remote *Windows* Restart of the instrument.

Tool Tips

The Tree Control also supports "floating tool tips." For example, putting the cursor over an instrument icon will display the current status of the instrument. In this case the Alpha-7 is out of service (as indicated by the blue icon) because of a Flow Failure. This is shown in the floating box below the monitor in the screen capture shown below.

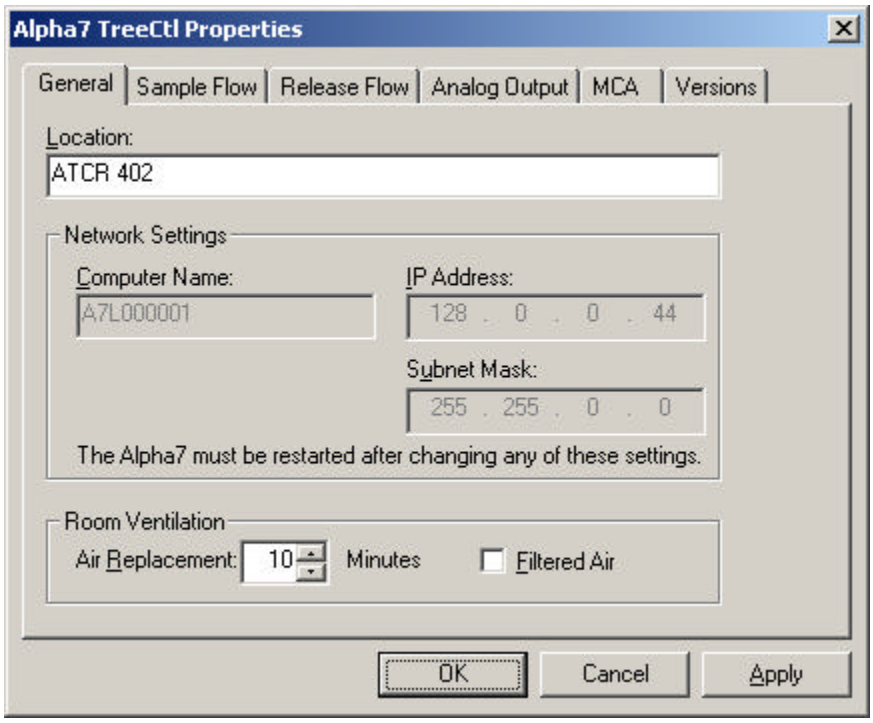


Holding the cursor over one of the isotopes being monitored provides the current isotope status, Fast and Slow readings. This is much faster than changing the display between Fast and Slow tables in the Dose Control.



Alpha-7 Instrument Parameters

To change the measurement parameters for the Alpha-7, right-click on the Alpha-7 that you would like to work with and select *Properties…*.



This dialog box provides information on most of the Alpha-7 general operating parameters. Additional parameters specific for each isotope are addressed in another screen described later in this manual. Editing of most of these parameters is restricted in the Alpha-7 Client program.

Please be cautious in editing these parameters as the changes are made in Alpha-7 that you are working with. In particular, please be very careful about the alarm levels and about changing the units of the measurement. Changing the units should be done only during calibration to ensure that the correct values and conversion factors are used. Values that are grayed-out may only be changed using the Instrument Properties dialog in the Alpha-7 Calibration Wizard.

The tabs are:

General

Sample Flow

Release Flow

Analog Output

MCA

Versions

General Instrument Properties

General is used to specify a location for the monitor as well as the monitor name and IP address.

Location—is a descriptive name for the Alpha-7 which appears in the Tree Control and that can be used to easily recognize the location, purpose or function of that specific unit.

IP Address—is the network address that the Alpha-7 will respond to via the Ethernet connection. This network address comes set from the factory based on Thermo Eberline's testing network and may not be appropriate for the users network (to change, see Network Setup). The last three digits are a function of the serial number, typically 100 plus the last 2 digits of the serial number. The user must modify the network address to conform to the local network where the Alpha-7 is to be used.

Subnet Mask—is set to the appropriate value for the network. If you do not have this information, please contact the person at your facility responsible for network administration. The IP address and subnet mask shown above are for example purposes only and may not be compatible with your network.

Computer Name—refers to the name that has been assigned to this specific Alpha-7 for a network identifier. This name is shown on Page 0 of the Alpha-7 display during normal operation. This same name or IP address is used to communicate with the Alpha-7 Client program. When adding an instrument, the *Computer Name* is the name that is added to the instrument tree.

Room Ventilation - Air Replacement—interval does not affect the measurement. It is used to determine the equilibrium of radon daughters during isotope simulation. Isotope simulation is available for each isotope in the tree and is intended for demonstration or training purposes only.

Room Ventilation - Filtered Air—check box is used to select the time interval over which no counts from the detector will cause an LOW COUNTS failure. If the Alpha-7 is measuring filtered air, the radon background counts may be almost non-existent, hence, fewer counts will be detected. The un-checked (non-filtered air) default interval is 10 minutes. If the box is checked, the time period for a LOW COUNTS failure to occur is zero counts in three hours.

Sample Flow Properties

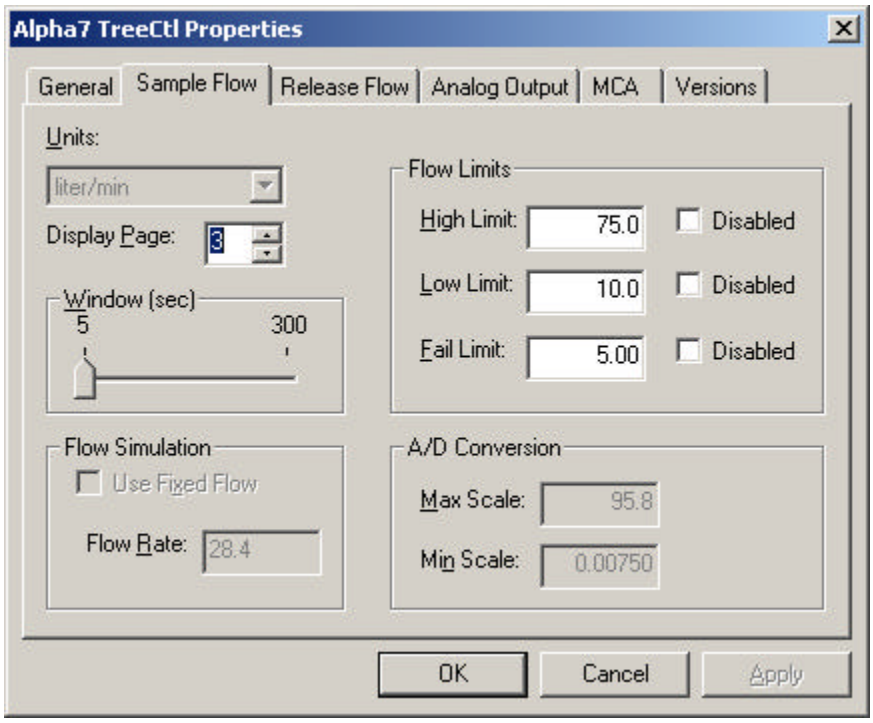
The Sample Flow page is used to enter flow action level limits for the High Flow, Low Flow, and Flow Fail conditions. High/Low Flow statuses may be alarmed conditions or only warnings, depending on the customer-requested factory settings.

High Limit—defines the alarm/warning level where a HIGH FLOW status will be annunciated when the measured flow exceeds the limit.

Low Limit—defines the alarm/warning level where a LOW FLOW status will be annunciated when the measured flow falls below the limit.

Fail Limit—defines the level where a FLOW FAIL status will be annunciated when the measured flow falls below the limit. This is a failure condition and the unit will be taken out of service.

Any individual action level can be disabled using the ***Disabled*** check box.



Display Page*—**entry selects the "page" of the two-line Alpha-7 display on which sample flow data will appear. In the example, the *Display Page* is set to Page 3, which will cause flow data to appear on the third page that is displayed when the Alpha-7 display is scrolled from the General Status Page on Page 0. Note that the flow value displayed is an average. The averaging interval is adjusted using the ***Window (sec) slider immediately below the selection box for the display page. A new flow measurement is made every second, and the display value is then calculated by averaging the last x values together, where x is the number indicated by the slider pointer.

NOTE: The following values may only be edited using the Alpha-7 Calibration Wizard.

***Units*—**are shown in a pull-down list and include m^3/min, m^3/sec, ft^3/min, cm^3/min, and liters/min. The selected units will affect the units of isotope concentration (e.g. flow units of ft^3/min will produce concentration units of pCi/ ft^3, where the isotope units of measure are pCi).

Max Scale and ***Min Scale*—**values in the A/D Conversion windows define the span for the flow readings. The sample flow signal from the mass flow sensor is scaled by these values to indicate the flow measured during calibration. These values are derived during flow calibration and are set automatically by the Alpha-7 Calibration Wizard.

For simulation, or in the event of a failure of the mass flow sensor, the Alpha-7 can be temporarily set for a simulated fixed flow. This is selected using the edit field and check box in the Flow Simulation area in the lower left hand corner of the display.

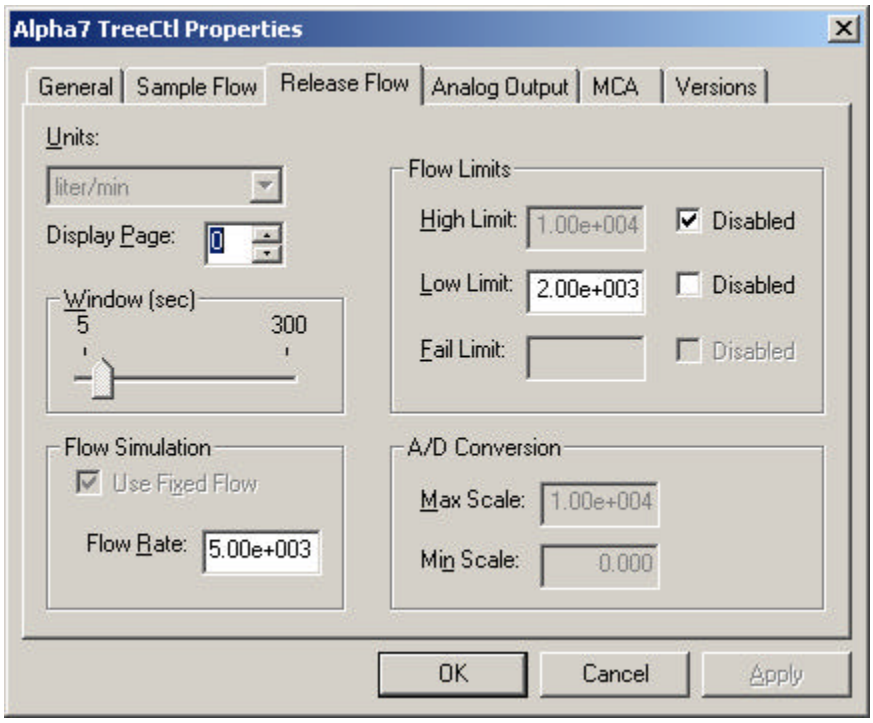
Use Fixed Flow—is a checkbox to enable the use of fixed flow. When this box is checked, the Alpha-7 status will remain in a "flow failed" status until the pump is turned on using the Instrument popup menu provided by right-clicking on the instrument in the directory tree. Clicking on the *Pump On* selection will alternately turn the pump on and off for simulation. A checkmark next to the *Pump On* item indicates that the pump is currently on. This function has no effect on any actual pump associated with the Alpha-7. It does replace the flow sensing with a fixed number so the Alpha-7 does not record the actual flow value from the flow sensor. The *Pump On* control may be performed from the Alpha-7 Client program.

Flow Rate—defines the flow, in the currently selected units, that is simulated when the *Pump On* command is invoked.

Release Flow Properties

The Release Flow allows the Alpha-7 to receive input from an in-line airflow sensor in a stack or duct. This external analog 0 or 4 to 20 mA logarithmic signal is interpreted as being proportional to the flow rate through one duct or stack. The Alpha-7 then uses this signal to correct for the ratio of the sample flow rate to the stack flow rate to accurately determine the activity released from the facility.

The parameters on this page are very similar to those described in the Sample Flow Properties section above. Unlike the Sample Flow Properties, the Alpha-7 does not provide a *Fail Limit* for the stack release flow rate. This parameter is always shown in gray on the display and can never be edited—even with the Alpha-7 Calibration Wizard.



The Release Flow page is used to enter flow action level limits for the HIGH FLOW or LOW FLOW conditions. High/Low Flow statuses may be alarmed conditions or only warnings, depending on the customer-requested factory settings.

High Limit—defines the alarm/warning level where a HIGH FLOW status will be annunciated when the release flow rate exceeds the limit.

Low Limit—defines the alarm/warning level where a LOW FLOW status will be annunciated when the release flow rate falls below the limit.

Any individual action level can be disabled using the ***Disabled*** check box.

Display Page—entry selects the "page" of the two-line Alpha-7 display on which release flow data will appear. In the example, the Display Page is set to Page 0, which will prevent release flow data from being displayed. Note again, that like the Sample Flow reading, any Release Flow value is an average. The averaging interval is adjusted using the ***Window (sec)*** slider immediately below the selection box for the display page.

NOTE: The following values may only be edited using the Alpha-7 Calibration Wizard.

Units—are shown in a pull-down list and include m^3/min, m^3/sec, ft^3/min, cm^3/min, and liters/min. The selected units will affect the units of Release Rate (e.g. flow units of ft^3/min will produce Release Rate units of pCi/ min, where the isotope units of measure are pCi).

Max Scale and ***Min Scale*—**factors for the stack flow rate are edited in the A/D Conversion area. These adjust the indicated flow rate to match the actual flow rate. Since this is a user-provided transducer, there is no automatic calibration function for this input. The *Max Scale* should correspond to the stack flow producing the maximum analog input current (20 or 24 mA), while the *Min Scale* should correspond to the flow producing the minimum analog input of 0 or 4 mA. The user will be required to create a manual procedure which provides a 2 point calibration process, and adjust the *Min Scale* and *Max Scale* values until the desired readings are achieved.

The Alpha-7 also allows the use of an fixed flow rate for facilities that do not have an in-line flow sensor installed. This is selected using the edit field and check box in the Flow Simulation area in the lower left hand corner of the display.

***Use Fixed Flow*—**is a checkbox to enable the use of fixed Stack Flow.

***Flow Rate*—**defines the Stack Flow rate to be used—in the currently selected units.

Analog Output Properties

The Analog Output tab controls the operation of the 4 to 20mA analog signal that is generated by the Alpha-7. This signal is proportional to the magnitude of the analog output value. The analog output value is determined as follows:

- If a Flow Rate (Sample or Release) is selected to appear on Page 1 of the Alpha-7 display, the analog output value will be the current displayed flow rate.

- If an isotope or region is selected to be displayed on Page 1, the analog output value will be the Fast or Slow reading for that isotope or region, depending on a factory-defined output setting. The Fast reading is the default and updates once per second. If the Slow reading is configured to drive the analog output, then remember that the slow readings are calculated only once per minute, so the analog output value will only change once per minute.

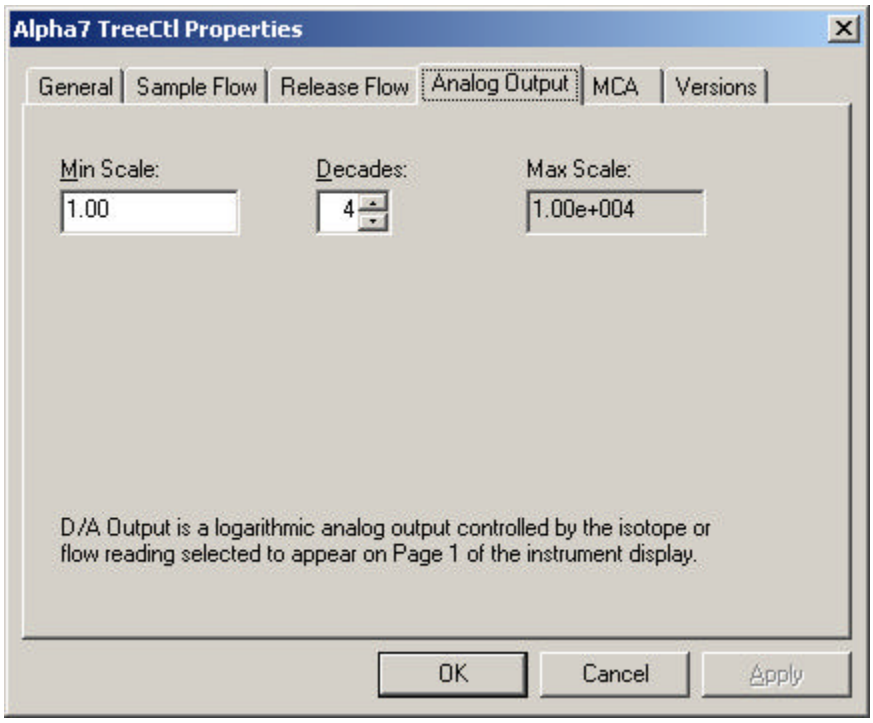
The analog output is a logarithmic signal[3], and units of the output are identical to those selected for the display.

Jumper settings on the Display Board define the range of the analog output and can be set for 0-20 mA, 4-20mA or 4-24mA. The default jumper setting is for 4-20mA output.

***Min Scale*—**is the maximum value which will produce the 4mA minimum output current. Any values less than Min Scale will also cause the 4mA signal to be output.

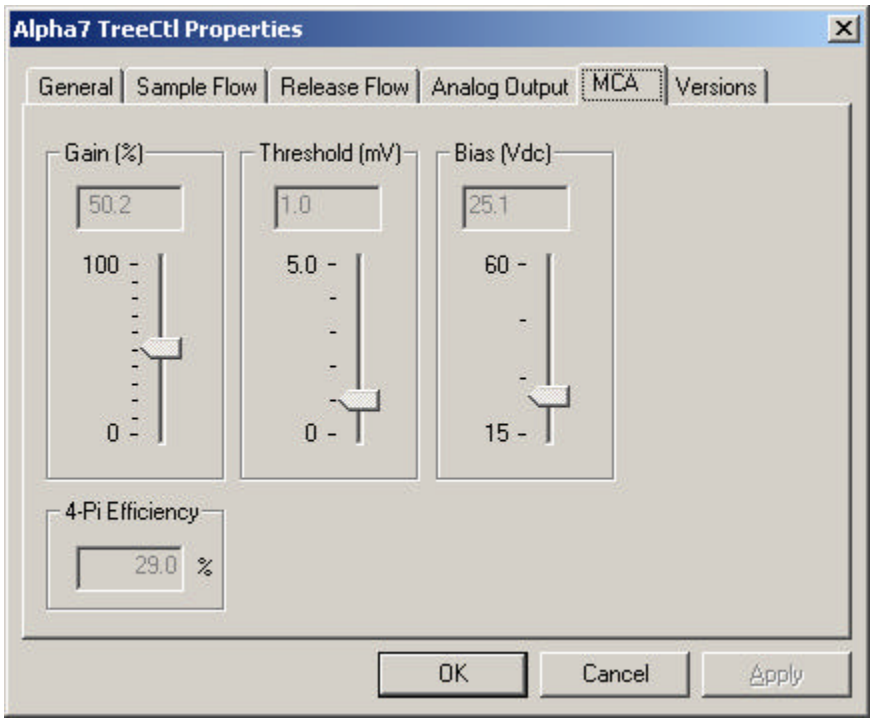
***Decades*—**is an integer value which defines the number of logarithmic decades spanned by the analog output. Once a minimum value and the number of decades is specified, the maximum value, which corresponds to a 20mA output signal, is calculated based on these two operator inputs.

[3] A linear analog output is also a factory-settable option.



MCA Properties

The MCA page is used to examine the gain and threshold settings as well as the detector bias voltage. In the Alpha-7 Calibration Wizard, the edit boxes can be used to enter the values or the slide switches can be moved using the mouse. Once the instrument is calibrated (using the Alpha-7 Calibration Wizard software supplied), these settings should not be changed because any changes may invalidate the calibration.



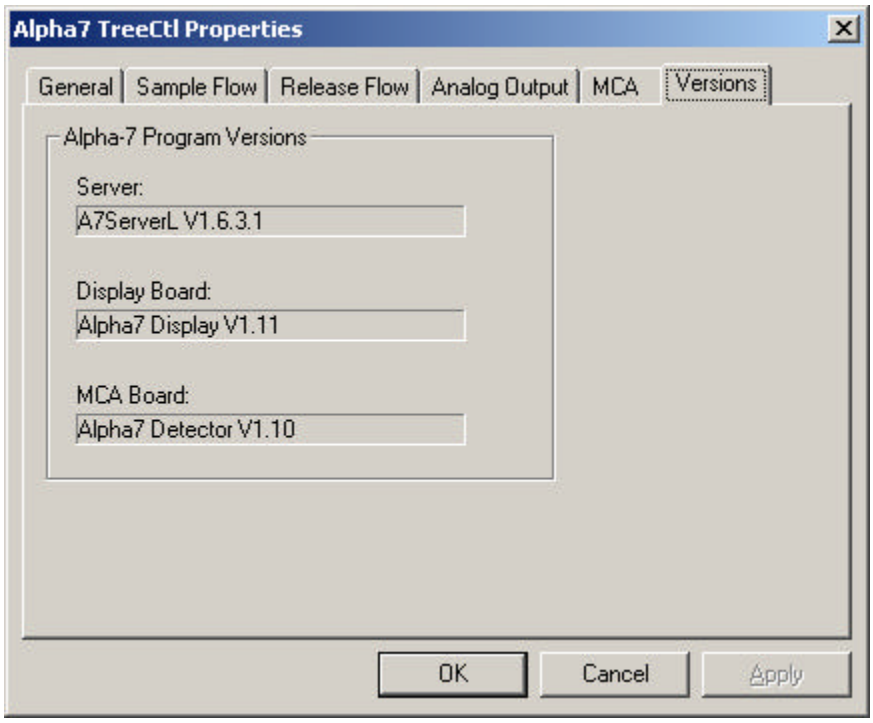
The settings shown are typical values. Small changes to ***Bias*** and ***Threshold*** have relatively little effect, but the ***Gain*** setting is critical. Any gain change will shift an entire spectrum. This in turn may lead to an OUT OF CALIBRATION status and/or poor performance resulting from less than optimum curve fitting of the spectrum. The ***4-Pi Efficiency*** is the intrinsic detector efficiency for the calibration isotope used. This efficiency is dependent upon detector to filter spacing, air density and source geometry. The recommended calibration source is a single alpha-particle emitter in the 5 MeV energy range plated onto a stainless steel disk with a 1 inch (25 mm) active area. ^{239}Pu is the typical calibration isotope used, and is the isotope used in factory calibration.

NOTE: These values may only be edited using the Alpha-7 Calibration Wizard.

For a detailed description of calibration, please refer to the Alpha-7 Calibration section.

Versions Properties

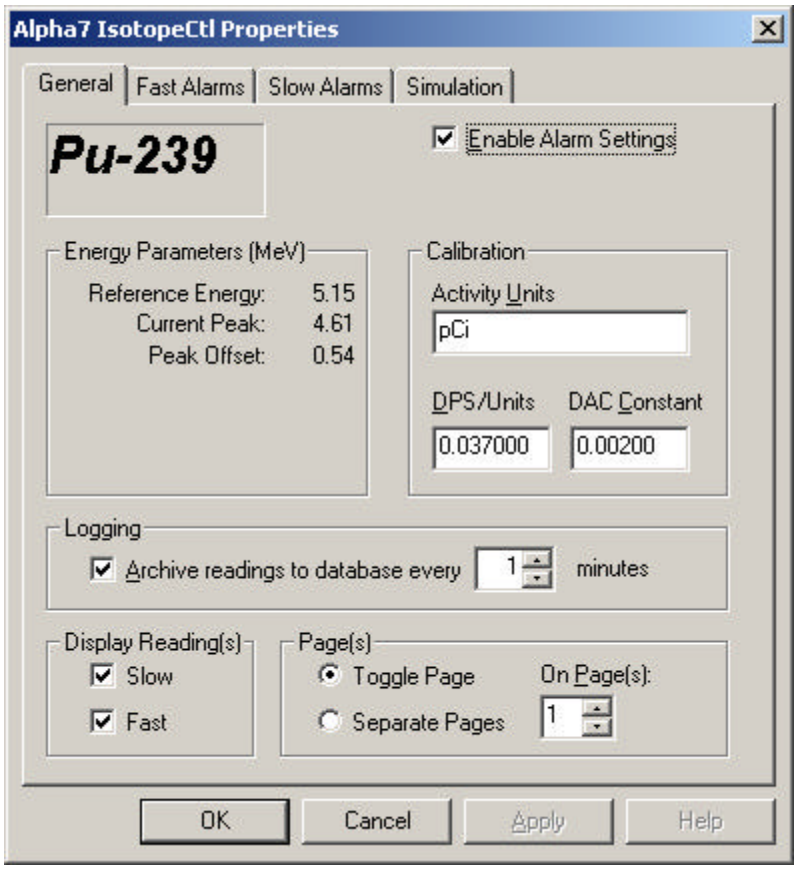
The Versions properties are used to display the software versions used in the Alpha-7. This can be used to quickly determine which software versions are resident. Both the MCA and Display Boards use EPROMS and cannot be updated without a hardware upgrade. The *A7Server* is resident on the hard drive. The properties for Versions is shown below. The Alpha-7 Client version is not shown in this page since it is not an integral part of the Alpha-7 instrument operation.



Alpha-7 Isotope Parameters

Each isotope entered into the isotope tree for a specific Alpha-7 has its own parameter page that configures the operation of the Alpha-7 for that isotope. To change the parameters for any isotope in the Alpha-7 isotope tree, right-click on the Isotope icon that you would like to modify and select *Properties…* from the Isotope Menu.

This dialog box shows the isotope being edited in a window in the upper left corner of the dialog and provides information on the individual isotope parameters.



Exercise caution in editing these parameters. In particular, please be very careful about the alarm levels and about changing the units of the measurement. Changing the units should be done only during calibration to ensure that the correct values and conversion factors are used.

The tabs are:

General

Fast Alarms

Slow Alarms

Simulation

General Isotope Properties

The *Energy Parameters (MeV)* window lists several non-editable isotope parameters. The ***Reference Energy*** defines the actual isotope decay energy as derived from the Isotopes.mdb database. ***Current Peak*** is the energy corresponding to the peak channel in

the spectrum. On a properly calibrated CAM, the difference between these two energies represents the attenuation across the air gap between the filter paper and the detector and is the ***Peak Offset***.

The Calibration parameters consist of the *Activity Units*, the *DPS/Units* conversion factor and the *DAC Unity* constant.

Activity Units—is the text-based units used for isotope activity. The Alpha-7 is an extremely flexible instrument allowing the use of text-based units of measurement. The user may enter any desired units for the Activity units, and then simply enter the conversion factor from DPS to the Activity Units in the *DPS/Units* field. Units of µCi are created by default, but units of pCi are being used in the example above. If units of Bq are used, conversion between DPS and Bq simply uses a conversion factor of 1.0, since one Becquerel is one disintegration-per-second.

DPS/Units—is a conversion factor expressed as disintegrations-per-second per each unit of activity. For example, the display above shows an efficiency of 0.037 *DPS/Unit*. Since the Activity Units are pCi, this translates to 0.037 DPS/ pCi. This factor should only include the conversion for units. The detector efficiency conversion and allowance for the isotope decay abundance is handled automatically.

DAC Unity—is the value for DAC expressed as a divisor of the activity in the selected *Activity Units*. For example, the DAC value for Pu-239 is 2×10^{-12} where the units are µCi/cc. The concentration in air based on the *Activity Units* and the units selected for air flow is divided by this value to calculate the DAC value. This value is used for alarm determination and local display as well as being displayed in the Dose Control and logged (if desired). If the DAC constant is 1.00, the concentration will be displayed using *Activity Units*. In this situation, the alarm determination is also performed in the activity units rather than DAC or DAC-h. If DAC and DAC-h are to be used for alarm determination, logging and display, this value should be set to the conversion factor described above.

Logging—controls the archival of data from this isotope to the *A7Log.mdb Microsoft Access* database. If the ***Archive readings to database*** box is checked, the data for this isotope will be logged into the database at the interval specified in the ***every 1 minutes*** edit box. Data may be logged at different intervals for each isotope.

Enable Alarm Settings—enables alarm level edit fields in the Fast Alarms and Slow Alarms pages of the dialog.

Display Reading(s)—specifies whether to show the readings from this isotope on the front panel display of the Alpha-7. You may display either ***Slow*** readings, ***Fast*** readings or both.

Page(s)—further defines how the display of isotope readings will be performed. If you choose to display only the *Slow* or the *Fast* reading, you may then specify the display page for the reading to appear on in the ***On Page(s)*** field. If both *Slow* and *Fast* readings are checked, then the Alpha-7 can display both readings on one page, toggling the reading every five seconds, or on separate pages. To display both readings on one page, choose ***Toggle Page*** then specify the desired display page in the *On Page(s)* field. To display the readings on separate pages, choose ***Separate Pages*** and specify the page for the *Slow* reading in the *On Page(s)* field. The *Fast* reading will automatically be assigned to the next page.

The Alpha-7 automatically manages the display pages to eliminate blank pages between isotopes and to prevent the selection of the same page for more than one isotope. If there are blank pages between the selected page and the last used page, the information will be displayed on the next blank page. If a page is already in use, the information for the isotope being edited will appear on the next available page. Since the Alpha-7 only displays the data for active pages, this allows the user to scroll continuously through the pages without having blank screens in the middle or the end of the scroll pattern. There is a maximum of 10 pages of information available. The information displayed on any given page can be flow rate or the concentrations of the isotopes. Page 0 is reserved for the name and operational status of the Alpha-7.

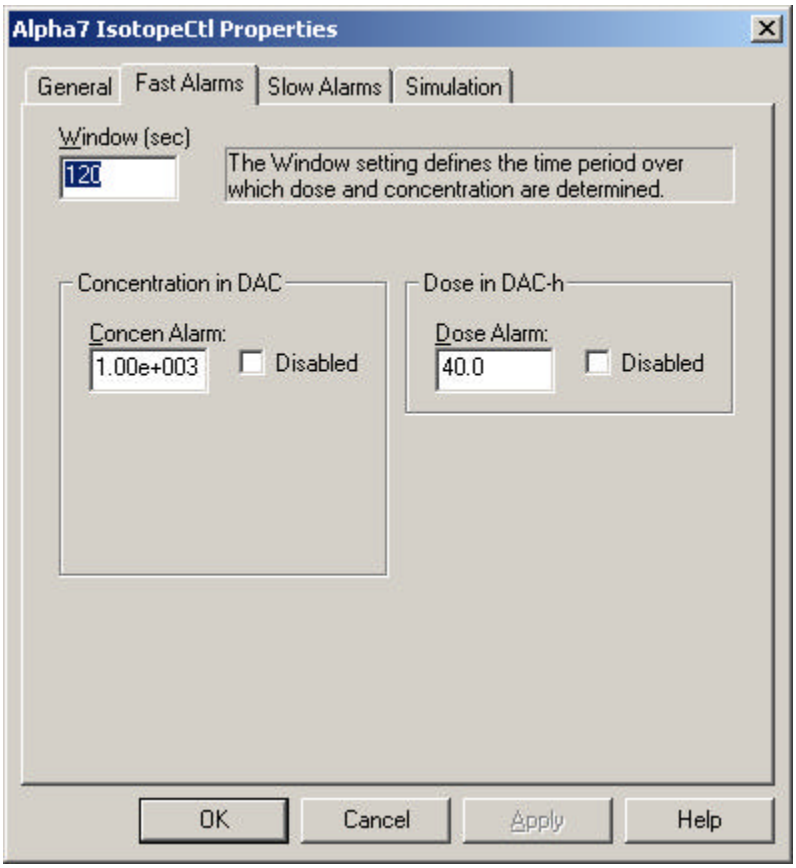
Fast and Slow Alarms Properties

As described in the Theory of Operation section, there are two types of alarms in the Alpha-7: Fast (or Acute) and Slow (or Chronic). The difference between the two is based on the time window over which changes in count rate are observed.

When the Alpha-7 checks for alarms, the current values for the isotope are compared against the slow and fast alarms levels selected by the user. If the current value exceeds an alarm level or the MDC, whichever is higher, the alarm will be annunciated using both the audible and visual indicators. Pressing the *Alarm Ack.* button on the front of the Alpha-7, or remotely acknowledging the alarm from the Alpha-7 Client by right-clicking on the instrument and selecting *Acknowledge Alarm* will silence the audible indicator. If Latching Alarms are enabled at the factory, the visual indicator will remain on until the reading falls below the high alarm set points. If not, the alarm acknowledge will clear the visual indicators and relay as well.

Alpha-7L Specific: Since the Alpha-7L is configured with latching alarms, the beacons and status will continue to show an alarm status until the condition causing the alarm has ceased and the alarm has been acknowledged again at that point.

Corresponding to the two types of alarms are two parameter pages in the Isotope Properties dialog. The pages are similar, but not identical. The differences will be noted below. Also, depending on whether Alert Alarms are active or not (they are disabled on the Alpha-7L), the *Concen Alert* settings will or will not appear.



Window—defines the time window (*Fast Window* is in seconds; *Slow Window* is in minutes) over which the net count rate for the isotope is determined—and similarly, the dose. The difference in two successive net count rates is used to determine concentration. Since the window time affects the calculation of concentration and dose, this value can be edited even if the alarms are disabled.

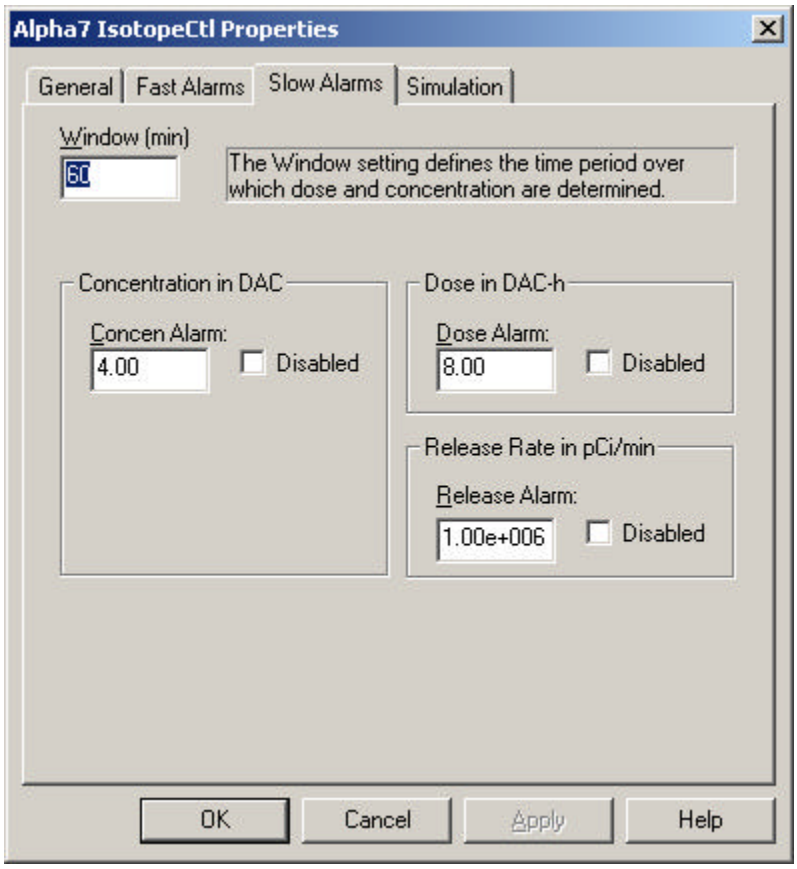
As described in the legend, the window setting is the evaluation time over which the change in count rate is evaluated to determine an increase or decrease in the rate of accumulation. For the fast evaluation window, the limit is from 1 to 300 seconds, and for the slow evaluation window, the limit is from 1 to 120 minutes. The use of this evaluation window will be more fully described in the Theory of Operation section.

Concen Alarm—is the alarm level in the units specified. In the example, the units are DAC. The FAST/SLOW CONCEN condition will be signaled when the measured Fast/Slow Concentration exceeds this level, or the MDC, whichever is higher. Check the ***Disabled*** checkbox to disable checking of this individual alarm.

Concen Alert—is the alert level in the units specified. The FAST/SLOW ALERT condition will be signaled when the measured Fast/Slow Concentration exceeds this level, or the MDC, whichever is higher. Check the ***Disabled*** checkbox to disable checking of this individual alert.

Dose Alarm—is the dose level in the units specified. The FAST/SLOW DOSE condition will be signaled when the measured Fast/Slow Dose exceeds this level, or the MDA, whichever is higher. Check the ***Disabled*** checkbox to disable checking of this individual alarm.

Release Alarm—is used only on the Slow page of the dialog and is the release rate level in the units specified. In the example, the units are pCi/min. The RELEASE RATE condition will be signaled when the measured Slow Concentration times the stack flow rate exceeds this level. The stack flow rate can be based on either a fixed flow rate (check box) or a 4 to 20 mA analog input from a stack flow sensor. Check the ***Disabled*** checkbox to disable checking of the *Release Alarm*.

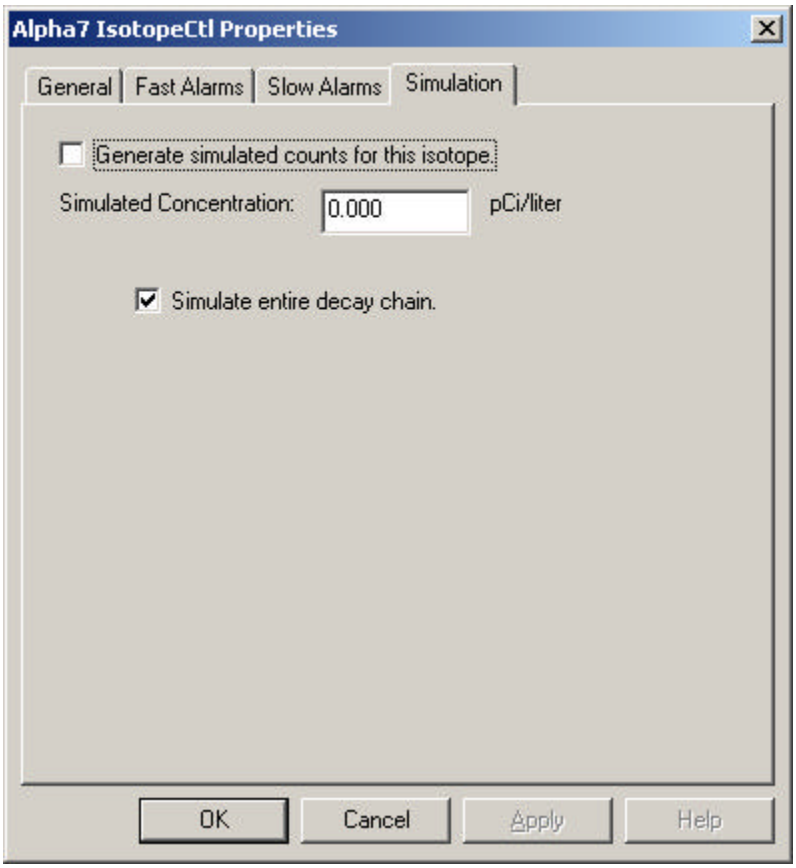


Simulation Properties

A simulation mode is provided for each isotope. This mode can be used for demonstrations and training exercises. This mode generates a spectrum peak for the selected isotope based on the normal spectrum shape and the chosen simulated concentration. Counts grow into the spectrum randomly just as they would in normal operation, and all alarm and measurement

functions are applicable to the simulated counts just as they would be for the real counts from the detector.

CAUTION: Since there is no way for the user to distinguish between simulated counts and real counts without examining the simulation page, caution is advised when using this mode. The simulated counts can generate alarms and activate the alarm relay contacts.



Generate simulated counts for this isotope—activates the simulator for this isotope.

Simulated Concentration—is the concentration level, in the units specified, for which an appropriate count rate will be generated. The simulator may continue to generate simulated counts, even after the *Simulated Concentration* has been set back to zero. Simulated deposits on the filter paper will continue to cause counts, long after the *Simulated Concentration* is reset to zero. The only way to stop the simulation is by unchecking the *Generate simulated counts for this isotope* box.

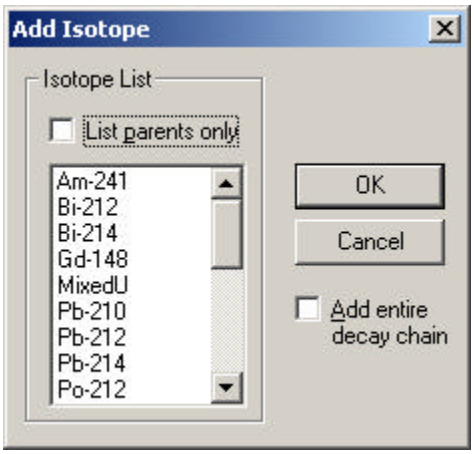
Simulate entire decay chain—causes simulated counts to be generated for all isotope tree daughters of this isotope. Simulated concentration of a decay daughter will be based on the *Simulated Concentration* of the parent and the parent's half-life. To simulate counts only for this isotope, uncheck the box.

CAUTION: Simulating isotope concentrations consumes a significant amount of processing time. Do not create simulations for more than two isotopes at any one time.

Adding Isotopes

The Alpha-7 can be shipped configured with any list of isotopes. It is usually configured with only three radon daughters: Po-218 (RaA), Po 214 (RaC') and Po-212. These isotopes show up in the list of isotopes under each instrument in the Tree Control.

The list of isotopes can be modified by right-clicking on the Alpha-7 instrument icon in the list to bring up the Instrument Menu. Left clicking on *New Isotope...* brings up the Add Isotope dialog box containing a list of available isotopes.



The list shown contains the isotopes defined in the file *Isotopes.mdb* in the *C:\Eberline\Alpha7\Data* folder of the shared drive of the Alpha-7. This is a *Microsoft Access* database, which can be easily modified to add or delete isotopes from the library, or change the definition of existing isotopes in the library. The list itself can be can be restricted by checking the two checkboxes.

List Parents Only—When this box is checked the list of isotopes will show only those isotopes whose "Parent" flag is set in the *Isotopes.mdb* database. With *List Parents Only* checked, the list of isotopes is shorter.

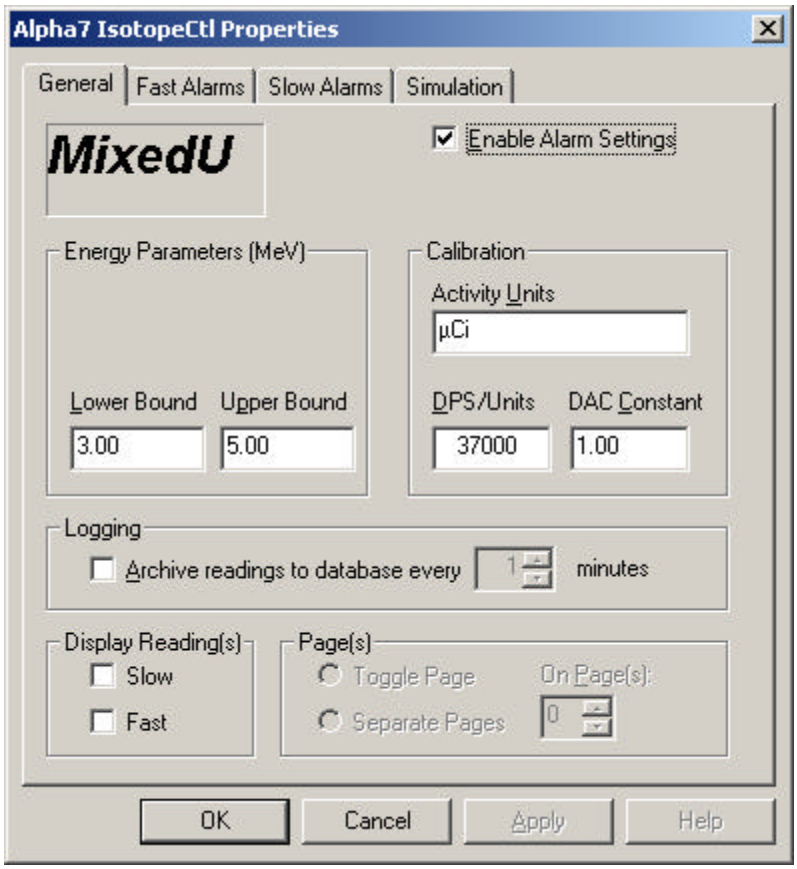
Add entire decay chain—When this box is checked, then when an isotope is added, all decay products of that isotope are also added. With *Add entire decay chain* checked, adding Rn-220 also adds the isotopes Po-216, Po-212, Bi-212, and Po-212.

To add an isotope, click on the desired isotope, and then click on *OK*. Alternately, just double-click on the isotope you want.

NOTE: Since additional computation overhead is created for each isotope listed in the isotope tree, best performance will be achieved when only the isotopes which generate alpha particulates are added to the tree.

Adding a Region of Interest

In addition to the normal isotopes defined in the database, a special case entry may be defined in the *Isotopes.mdb* database to represent regions of interest. A Region of Interest entry is any isotope name in which the peak energy for that isotope is defined as 0 MeV. The ***Region Name*** may be up to 8 characters long. This Region of Interest will then be available from the list in the *Add Isotope…* dialog box described in the previous section. The example dialog above lists the standard ***MixedU*** isotope which is the Region of Interest entry in the supplied database.



In place of the normal Energy Parameters, the Region of Interest limits will be displayed. These limits are user-definable.

Lower Bound—defines the lower end of the region in MeV.

Upper Bound—defines the upper end of the region in MeV.

Counts in the Region of Interest are defined to be the total counts in the region, minus any tail counts from isotopes whose peak is outside the region, but whose tail extends into the region.

The values selected are applicable only to the particular instance of the Region of Interest displayed. If the user adds the same region from an equivalent isotope database to another Alpha-7, the user can set different limits for that Alpha-7.

All other functions normally associated with an isotope will function with the Region of Interest isotope definition with the following exception: There is no simulation available for a Region of Interest. Region of Interest calculations are performed using a different method than normal isotopes. While normal isotopes have a calculated curve fit which is used to determine the total counts for that isotope, Region of Interest isotopes sum all the counts for the channels between and including the defined boundaries, then subtract the counts that intrude into the Region of Interest from all curve-fitted isotopes whose peak energies are outside of the defined Region of Interest. This provides the normal gross count benefits associated with a Region of Interest while providing the additional accuracy of the curve-fitting algorithm for the subtraction of counts from other isotopes that may interfere with the desired Region of Interest.

Removing Isotopes or Regions.

Only isotopes in the first level of the isotope tree may be deleted. The other isotopes that typically represent daughter products of the parent in the first level cannot be deleted.

To remove an isotope that is not grayed out, just right-click on it in the list associated with the desired Alpha-7. Select *Delete...* from the Isotope Menu. Daughter products in the second level of the tree may only be deleted by deleting the parent, then adding the parent back without the daughters.

CAUTION: The Alpha-7 is designed to accurately correct the measurement for the influence of the radon daughters. For this reason, the alpha particulate radon daughters must be included in the list of isotopes and in the list under the Alpha-7 in the display. Radon daughters may be included as progeny of the naturally occurring radon isotopes, or may be added individually without the parent isotopes to limit the number of isotopes being maintained by the Alpha-7. This method is particularly appropriate when some of the isotopes or daughters produce no particulates or produce isotopes that have no alpha emissions. The method of adding individual daughter products is the preferred configuration since it minimizes the complexity of the tree and limits the total number of isotopes tracked by the Alpha-7.

CAUTION: Adding and deleting isotopes can immediately and directly affect the quality of the curve fit of the current spectrum. It is highly recommended that isotopes

only be added or deleted during the calibration process and not during normal operation to insure that the instrument continued to function in a known, controlled configuration.

Using Profiles To Create Standardized Configurations

Profile Overview

Setting up the many parameters of an Alpha-7 can be a complicated task. The effort is multiplied when the CAM system contains many instruments and each instrument's settings must be identical, or if a single Alpha-7 is used for several monitoring tasks requiring different settings that must be swapped frequently. To reduce this effort, the Alpha-7 server program provides capability for configuration "profiles" to automatically configure the settings of an instrument to a saved set of parameters. This means that for a large system, only a single instrument need be set up manually, then the parameters for that unit can be saved in a profile and used to "clone" all the other instruments by simply placing the profile file on the hard disk of each instrument and re-starting the unit. An additional benefit of configuration from a profile is that several different profiles can be created and kept ready to quickly reconfigure an Alpha-7 for different types of applications (e.g. stack monitoring, room monitoring, etc.).

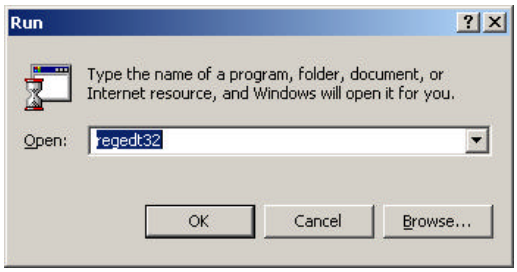
NOTE: Instrument-specific and remote sampling head parameters are not included in the profile so that when a new profile is installed, the instrument-specific parameters (e.g. instrument name, calibration settings, etc.) are not changed.

Creating A Profile

CAUTION: Creating a profile requires a working knowledge of the *Microsoft Windows* Registry Editor. Changes to the *Windows* Registry may render the Alpha-7 inoperable! This step should be performed by an experienced *Windows* user.

To create a profile, first configure the Alpha-7 with the appropriate alarm settings, units, display pages and any other parameters that you want to be saved in the profile. Once the configuration is complete, the settings (saved in the *Microsoft Windows* registry) can be saved to a profile file using the *Microsoft Registry Editor*. This can be done either remotely across a network (from a Windows NT/200/XP computer), or locally if a keyboard, mouse and monitor are attached to the Alpha-7.

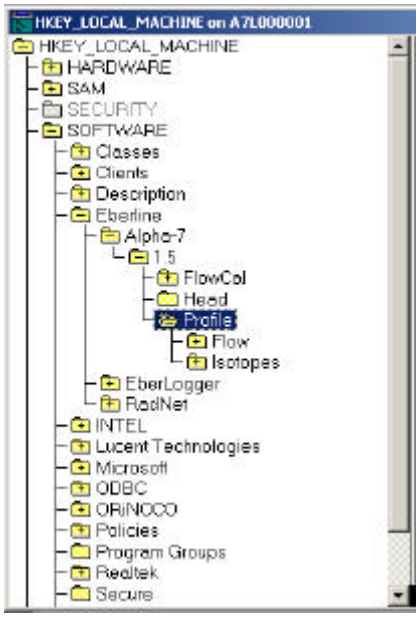
If done remotely, a Remote Administration privilege is required. See your network administrator to make sure the privilege is enabled.



From the *Start* button, select *Run…*, type in "regedt32" and press *OK*.

NOTE: If *Windows* cannot find the program, you can Browse… to it in the System (Win95/Win98) or the System32 (WinNT/Win2000/WinXP) subfolder under the Windows folder.'

When the Registry Editor appears, the registry key windows will be displayed. If you are creating the profile locally, the appropriate screens will already be displayed. If you are running RegEdt32 remotely across a network, select the *Registry* menu then click on *Select Computer…* and type in the name of the Alpha-7 you wish to create the profile from. Select the *HKEY_LOCAL_MACHINE* window and expand the *SOFTWARE/Eberline/Alpha-7/1.5/* key. You will see the Profile key as a subkey under the 1.5 key. Select it then pull down the ***Registry*** menu, select *Save Key…* choose a destination folder where you want to save the profile and give the profile a file name (e.g. "*standard_config*"). The default extension is "*.reg*" but you may add a different extension if you wish.



Loading A Profile

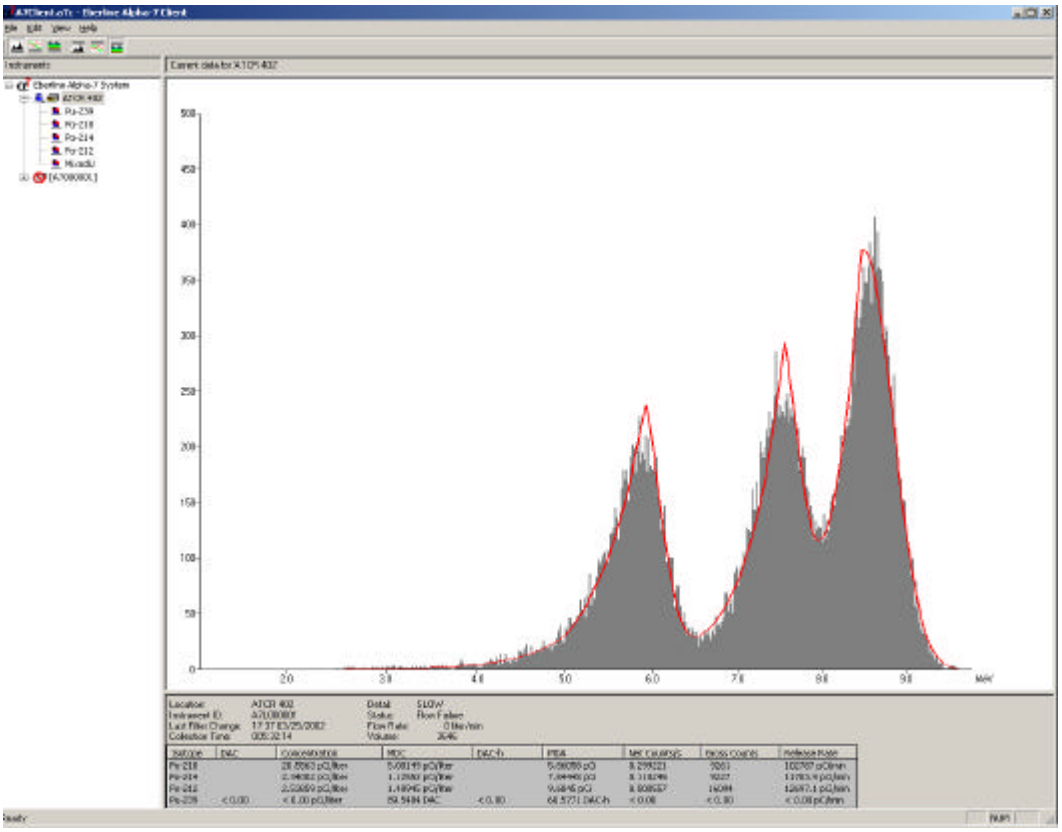
Once a profile is created, to clone those settings to other instruments, start by making a copy of the profile file and renaming it to "*profile.reg*". This name is important, as the Alpha-7 will only recognize a profile with this name.

Next, copy the *profile.reg* file to the *C:\Eberline\Alpha-7* subfolder on each instrument you wish to reconfigure. When the file has been copied, restart the unit—either from the front panel pushbutton, or remotely from the Alpha-7 Client using the Instrument Menu and selecting *Restart…*.

When the Alpha-7 starts up, it looks in the current folder to see if the file *profile.reg* exists. If it does, the program will read its contents, restore the settings in the registry, delete the file, then start up normally.

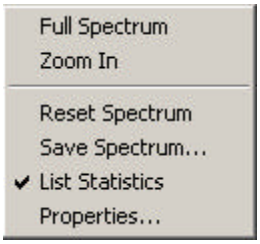
Setting Up the Alpha-7 Client Display

The Alpha-7 Client display is split into three sections. The Tree Control on the left shows the list of Alpha-7's being monitored. The upper and lower portions of the right side of the display can be any combination of two of the following types of display: Chart Control, Spectrum Control, or Dose Control. Each control will reflect the data for the Alpha-7 currently selected from the Tree Control on the left side of the display.



Spectrum Control

The Spectrum Control shows the Alpha-7 spectrum with an overlaid red curve fit for the isotope selected. If no isotope is selected, the curve represents the sum of all the individual isotope curves and fits the entire spectrum. The scale for the spectrum is auto-scaling. Right-clicking anywhere in the spectrum display will present the user with the Spectrum Popup Menu.



The user can select the auto-scaled ***Full Spectrum*** from the list, or choose ***Zoom In*** and drag a box around the area of interest by holding down the left mouse button and dragging the box corner to the desired size. However, if a specific region of the spectrum is of

greater interest, select ***Properties…***. This will allow you to change the scale factors—in both the x- and y-axis.

Reset Spectrum will zero all spectrum counts. This will clear all counts in the spectrum, but since the accumulated activity is still on the filter paper, the integrated sample flow volume or elapsed time since last filter change data will not be reset. Those data are only cleared when a filter change is recognized.

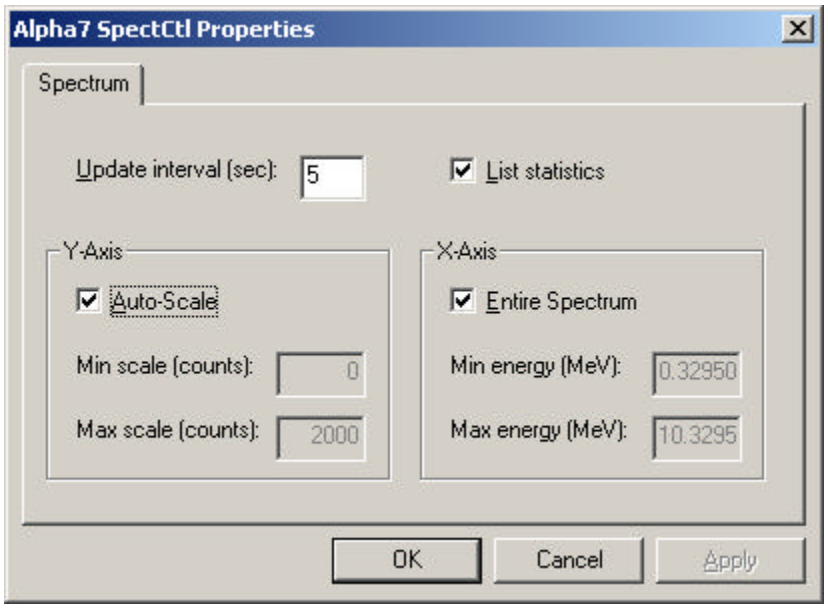
The user may also save the current spectrum in a comma-delimited ASCII text file by selecting ***Save Spectrum…***. The user will be prompted to provide a path and a name for the text file, which will then be saved in the specified location. Saved in the file in three columns are the channel number, channel counts, and curve fit value.

Choose ***List Statistics*** to display curve fit statistics that provide a measure of the quality of the curve fit as well as the total counts in the spectrum. The lower the value for the fit ratio, the better the curve fit. Values below 1.0 are generally considered to be a good fit.

The Spectrum Control can provide additional information on the spectrum through the use of tool tips. If the cursor icon is placed on the spectrum over an individual bar in the spectrum display, a tool tip will appear as a legend with the current channel, the corresponding energy for that channel, and the number of counts in that channel. This tool tip will remain as long as the cursor is in place, and will update automatically as the spectrum is updated.

Spectrum Control Properties

The Spectrum Control properties dialog allows for additional customization of the spectrum display.



Update interval (sec)—defines the frequency with which new spectrums are acquired for display update.

List Statistics—provides the same function as selecting the feature from the popup menu.

***Auto-Scale*—**allows the Y-axis of the spectrum display to update automatically whenever the peak counts in any channel exceed the max scale.

Min Scale and ***Max Scale*—**define fixed limits to the Y-axis when *Auto-Scale* is turned off (unchecked).

Entire Spectrum*—**controls the display of the X-axis. When this box is checked, the entire energy spectrum from 0 to 10 MeV is displayed. When unchecked, the max and minimum energies bounding the X-axis are defined by the ***Max energy and ***Min energy*** values.

Checking both *Auto-Scale* and *Entire Spectrum* performs the same function as selecting *Full Spectrum* from the popup menu.

Dose Control

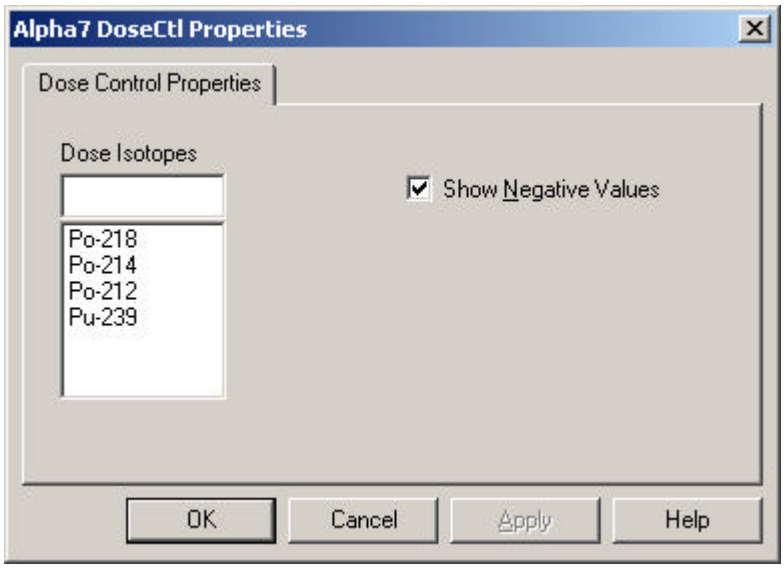
The Dose Control lists individual isotope data in tabular form. The DAC (Derived Air Concentration), DAC-h, concentration in activity per unit volume, net cps, and gross counts for each isotope selected to appear in the Dose Control table.

The Dose Control can display either Fast or Slow values. Right-click on the header section of the control (showing the integrated volume, airflow, Alpha-7 location, etc.) and select either *Fast Readings* or *Slow Readings*.

DAC values are only displayed in the Dose Control window if the *DAC Unity* value is set to a value other than 1.0. Otherwise, the DAC and DAC-h columns will be blank for that particular isotope.

Because a concentration or DAC reading is based on a difference in count rates, there is usually a statistical mean of zero. This means that the DAC or concentration value, in the absence of any meaningful isotope activity, is below zero about as often as it is above zero. In cases when the values are below zero, the value displayed for the concentration will be shown as "< 0.00". The MDC displayed is the minimum statistically valid measurement that can be made by the Alpha-7 under the current conditions for the isotope selected. This value will be displayed in the same units as the concentration.

Dose Control Properties



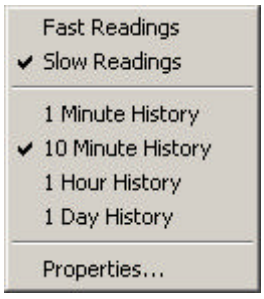
***Dose Isotopes*—**can be added to or deleted from the Dose Control by right-clicking on the header for the control (the area with the legend data) and selecting *Properties…*. A Dose Control Properties dialog will be appear which will allow the user to add or delete isotopes from the control. To add an isotope, type in the isotope name as it appears in the Tree Control and press the *Enter* key. To delete an isotope, click on the isotope to select it and press the *Delete* key.

***Show Negative Values*—**is a checkbox which, when checked, configures the control to display negative readings. The unchecked default is to display "< 0.00" whenever a reading is below zero.

When modifications are finished, click on the *OK* button. Isotopes being added must already have been added to the tree for that instrument. Any isotope that is in the Dose Control but not in the isotope tree for the instrument selected will be shown in the table but will not display any data.

Chart Control

The Chart Control shows the strip chart plot of concentration against time for the isotopes for either *Fast* or *Slow Readings*. This Chart Control requests historical data from the A7Log.mdb database stored in the Alpha-7, and then adds new data to the chart as it is accumulated.



Right-clicking on the title block of the Chart Control will allow the operator to select different resolutions of data. The minimum resolution of the data is 1 minute for archived data based on the Slow evaluation period. Increased resolutions are averages of the next lower resolution for that time interval. Example, 10-minute data is an average of the 10 1-minute intervals contained in that 10

minute period. Resolutions of 1-minute, 10-minute, 1-hour and 1-day are provided in the Alpha-7.

No history is provided for the Fast evaluation interval data, which is updated as it occurs at 5 second intervals when the Fast interval data is selected for the Chart Control.

If another display function is selected, the Chart Control will restart when next selected.

The horizontal axis of the strip chart reflects time, with the newest data displayed on the right hand side of the chart. The vertical axis is represented as the percentage of the alarm setting for each isotope selected to appear on the strip chart. The red line represents the high alarm set point for the selected evaluation interval.

NOTE: If the *Concen Alarm* set point is below the MDC for an isotope displayed in the strip chart, the isotope may exceed the red line without generating a high alarm.

Chart Control Properties

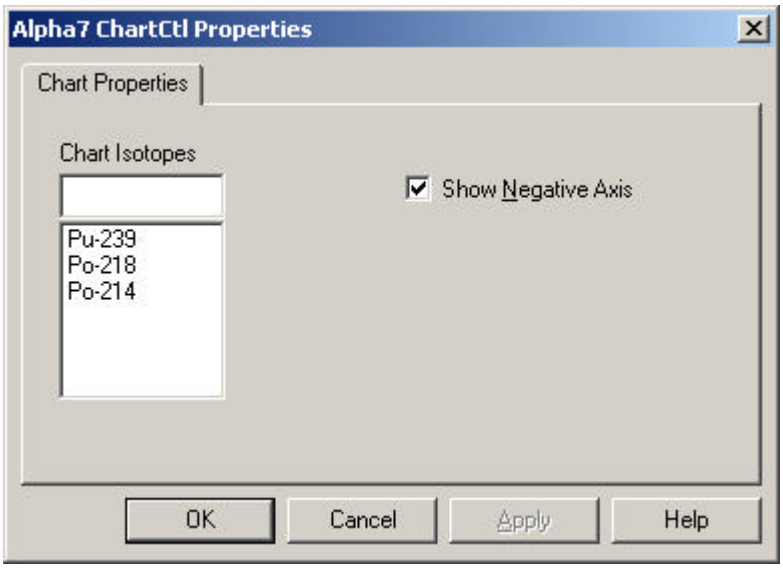


***Chart Isotopes*—**are entered and deleted just like in the Dose Control properties dialog. Type a new Isotope in the edit field and press *Enter* to add an isotope. Select an isotope from the list and press *Delete* to delete an isotope from the chart.

***Show Negative Axis*—**controls the display of a chart region below zero concentration. When checked, a negative Y-axis is displayed.

When modifications are finished, click on the *OK* button. Isotopes being added must already have been added to the tree for that instrument. Any isotope that is in the Chart Control but not in the isotope tree for the instrument selected will be shown in the legend but will not display any data.

RadNet Configuration

RadNet is a non-proprietary data acquisition solution for radiation monitoring instruments that allows various types of instruments from many different manufacturers to be placed in an Ethernet network and viewed over the network using a single piece of software. The Alpha-7 is fully RadNet compliant supporting the transmission of both current readings and spectrum data across a network.

The RadNetSvr.exe Utility

RadNetSvr.exe is a utility program located in the *C:\Eberline\Alpha7* folder that provides the RadNet support in the Alpha-7. It is executed on startup by the Startup.bat file. To minimize overhead on the computer, if no RadNet support is required, the RadNetSvr startup command in the *Startup.bat* file can be commented out as follows:

```
REM start radnetsvr
```

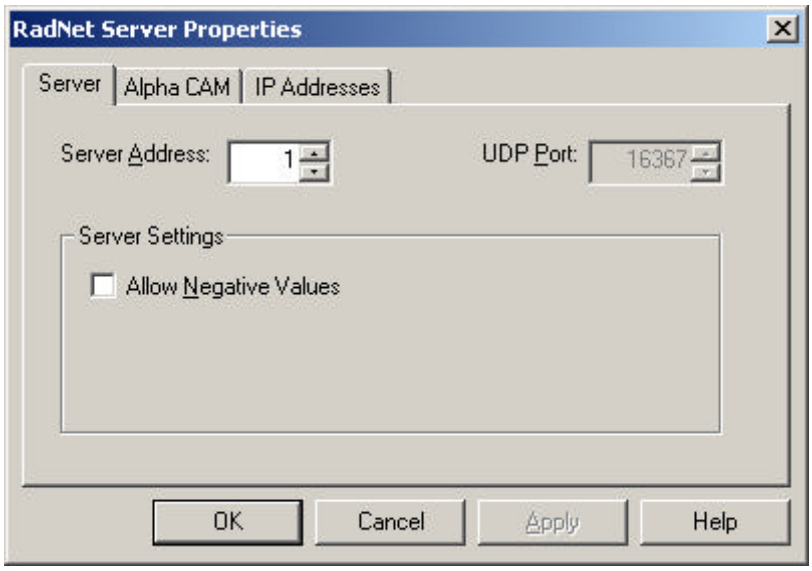
Using the RadNet Server Properties Dialog

The RadNet system is configured using the RadNet Server Properties dialog. From the Instrument tree in the Tree Control, right-click on the appropriate instrument and select *RadNet Config…* to call up the dialog shown.

NOTE: The program *RadNetSvr.exe* must be started and running before the *RadNet Config…* menu is available.

Server Properties

***Server Address*—**is defined on the Server page of the RadNet setup pages. Multiple Alpha-7s can be assigned to the same *Server Address* allowing them to be grouped together by location or function. Both the *Server Address* and the *Alpha CAM Address* (on the Alpha CAM page) range from 1 to 255, allowing in excess of 64,000 possible combinations.

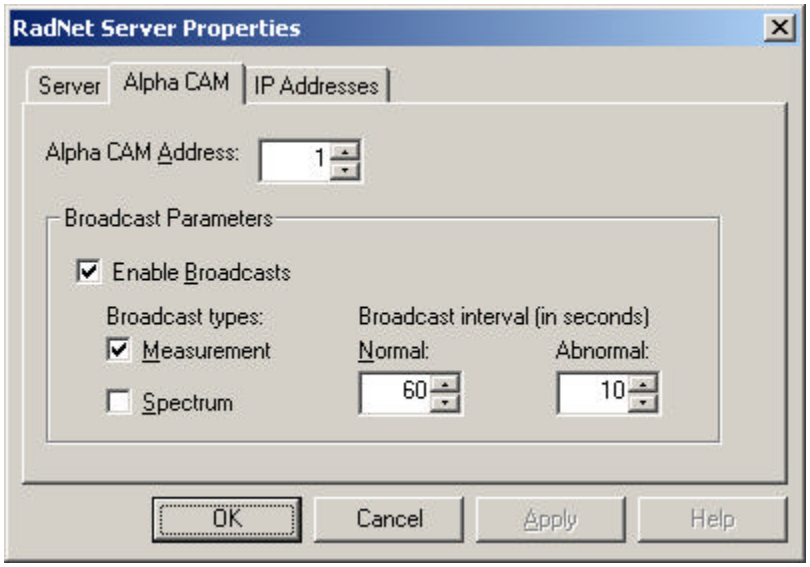


Allow Negative Values—is a setting which allows transmission of negative concentration or dose readings. The default is Off, meaning if any of the data is negative, a zero will be transmitted for that value.

UDP Port—applies to the port number of the UDP transmission and cannot be edited at this time.

Alpha CAM Properties

The Alpha CAM page is for settings that apply to the particular Alpha-7.



***Alpha CAM Address*—**is the second part of a two part address consisting of the *Server Address* and the *Alpha CAM Address*. The range is 1 to 255 and each CAM must have a unique two-part address.

***Enable Broadcasts*—**controls whether the *RadNetSvr* software will transmit data for this instrument. The two types of broadcasts are *Measurement* data and *Spectrum* data. The Server can transmit either or both packet types. The selected data will be broadcast for all isotopes that are listed in the *Rnisotope.txt* file, as described in the RadNet Files section below.

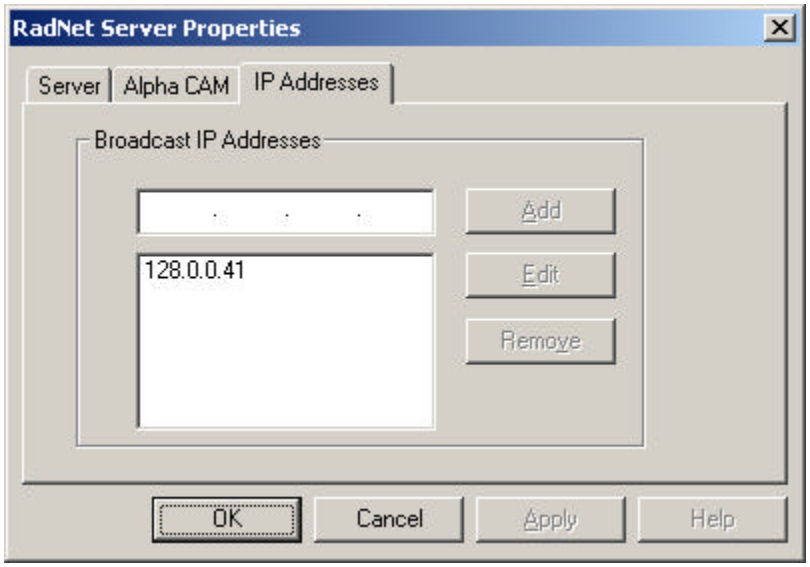
***Measurement*—**is the checkbox which enables periodic transmission of RadNet measurement packets.

***Spectrum*—**is the checkbox which enables periodic transmission of RadNet spectrum packets.

The Broadcast interval settings are to allow different broadcast frequencies for ***Normal*** operation and ***Abnormal*** conditions. Typically the instrument is expected to send data more frequently whenever there is an abnormal condition. The time intervals are set in seconds with a range of 1 to 6000.

IP Addresses Properties

The IP Addresses page lists the addresses and subnets to which the RadNet data will be broadcast. This data is saved in the *Rnlist.txt* file in the *C:\Eberline\Alpha7* folder.



***Broadcast IP Addresses*—**RadNet requires this list contain at least one entry to which the data should be transmitted. The IP address can also be a subnet broadcast address. For example, if you specify address 128.1.0.23 to reach a specific PC, you could specify 128.1.0.255 and reach all of the PC's on that subnet.

To enter an IP address, type the address in the edit field and click the ***Add*** button. The new address will appear in the list.

To Edit an IP address, click the address in the list and click the ***Edit*** button. Edit the values in the edit box. Click the ***Add*** button when you are finished editing.

To remove an address, click the address in the list, then click the ***Remove*** button.

RadNet Files

There are two text files in the *C:\Eberline\Alpha7* folder that are used for RadNet support. One is the ***RnList.txt*** file. This file specifies the IP addresses that the Alpha-7 will broadcast all RadNet messages to. If an IP address is not in this list, the computer with that IP address will not receive any RadNet data. While it is possible to edit this file manually, it is recommended that the user set the broadcast addresses through the RadNet Server Properties dialog discussed in the RadNet Configuration section.

Example:

10.1.4.99
10.3.8.4

The last entry is followed by a carriage return. Broadcasts may be made to a subnet by using "0" as the entry for all monitors on that subnet, such as 10.3.8.0.

The other text file used is ***RnIsotopes.txt***. This file contains a list of isotopes and the conversion constants for each isotope. This list represents the isotopes for which data will be broadcast on RadNet. The conversion constant is the number that the current reading for a given isotope must be multiplied by for the result to be transmitted in the standard RadNet Units of Becquerels/cubic centimeter (Bq/cc). This conversion constant converts the concentration reading from its current form to Bq/cc. The isotope and the constant are separated by a tab or space. The example below assumes that the concentration for both isotopes on the Alpha-7 is being displayed in µCi/cc.

Example:

Pu-239 3.70E+010
Po-218 3.70E+010

NOTE: This file MUST be edited manually using a text editor such as Windows Notepad. After editing this file, the Alpha-7 must be restarted for the changes to take effect.

Database Data Source Configuration

The two *Microsoft Access* databases used by the Alpha-7, *A7Log.mdb* and *Isotopes.mdb* reside in the *Data*\ folder and the *Data**History*\ folder respectively, of the Alpha-7 hard drive. It may be desirable, in some situations, to place the database files on a network file server, instead of on the local instrument.

Since the programs used in the Alpha-7 do not directly access the databases, but instead, rely on a protocol called Open Database Connectivity—or ODBC, for short—a simple redefinition of an ODBC setting can redirect the path to the files. This section describes the procedure for defining the ODBC Data Source to point to a network drive.

Setting Up The File Server

Before changing the Data Source definitions, the new database file(s) must be saved on the file server which the Alpha-7 will reference. Create a folder and copy *A7Log.mdb* from the *Empty Database*\ folder and/or *Isotopes.mdb* from the *Data*\ folder to the new folder(s) on the file server.

Running the ODBC Data Source Administrator

The change of the ODBC Data Sources must be done from the Alpha-7 using an attached keyboard, monitor and mouse. (Connection of a mouse usually requires restarting the Alpha-7.)

From the *Start* menu, select *Settings* the *Control Panel*. Double click on *Data Sources (ODBC)* to run the ODBC Data Source Administrator.

Changing The Data Source

The Alpha-7 Data Sources are listed under the System DSN tab.

Click on either the *Alpha-7 Data* or the *Isotopes* Data Source and click the *Configure…* button. In the dialog that pops up, Click *Select…*, create the Map Drive path to the appropriate file server file, then click *OK*.

The Data Source is now set to access the file server database. Change the other Data Source, if necessary, and restart the Alpha-7 for the changes to take effect.

Filter Paper Considerations

With both the In-Line Head and the Radial Entry Head, the recommended filter paper for use with the Alpha-7 is a 47-mm diameter Millipore Fluoropore Teflon-membrane filter with a 5 µm pore size.

Particle collection tests performed at the Lovelace Respiratory Research Institute in Albuquerque, NM have shown essentially 100% collection efficiency for 10 µm diameter particles with a flow rate of 1 CFM.

The design also permits the substitution of 2-inch filters. The Fluoropore filter has a smooth Teflon membrane collection side (which prevents the spectrum-broadening associated with deep burial of deposits in a porous paper providing a high-resolution Alpha energy spectrum) and a fibrous support side, which improves pressure-drop characteristics. Install the filter with the white Teflon side UP.

NOTE: Improper Fluoropore filter installation will result in a relatively poor spectrum if the filter is installed with the support side facing the detector. For easy recognition, the support side of the filter is a dark gray color.

Attaching A Vacuum Source

The operating sample flow range of the Alpha-7 is 0.5 CFM to 2.0 CFM (14 lpm to 57 lpm). Recommended flow rate is1.5 cubic feet per minute (or 42 lpm). The flow source can be either a vacuum pump or house vacuum system.

Radial Entry Sampling Head Connection

The Alpha-7 radial inlet sampling head, which is primarily intended to sample ambient room air is fitted with a 3/8 inch NPT male pipe connection for vacuum supply.

In-Line Sampling Head Connections

The in-line sampling head is available with a 1 inch I.D. pipe inlet with light baffle cap. An optional 1-inch I. D., 1 ¼ inch O. D. adapter is available for compression fitting connection to standard 1 ¼ inch O. D. stainless steel tubing

Routine Operation and Maintenance

Status Conditions

The Alpha-7 has an extensive list of possible status conditions. These statuses may be both isotope-level statuses and/or instrument-level statuses. The instrument-level status is present at all times on Page 0 of the Alpha-7 display, and as a Tool Tip on the Tree Control under the Alpha-7 Client whenever the cursor passes over the instrument icon in the tree. Isotope-level statuses are indicated on the isotope display page, or from Tool Tips when the cursor passes over an isotope icon in the Alpha-7 Client Tree Control.

The following tables list the annunciator behavior for the different status types possible on an Alpha-7, as well as the list of all possible statuses and how they are typed. Because the behavior is different for an Alpha-7L than it is for an Alpha-7A, please familiarize yourself with the status list for your appropriate version of Alpha-7.

Status Descriptions

Normal	Unit is operating normally with no alarm, failure or maintenance conditions.
Below Fast MDC	The minimum detectible concentration is above the fast alarm set point.
Below Slow MDC	The minimum detectible concentration is above the slow alarm set point.
Below Fast MDA	The minimum detectible activity is above the fast dose set point.
Below Slow MDA	The minimum detectible activity is above the slow dose set point.

Filter Change	A filter change was sensed because the filter door was opened.
Isotope Change	An isotope was added or deleted from the isotope list by an operator.
Filter Dirty	Sensitivity has decreased because of dust loading or radon background. The alarm set point is again below the MDC for at least one isotope.
Door Open	The filter door switch has sensed the door opening.
Calibrate	Unit is being calibrated.
Check Source	Check Source Mode has been commanded on the unit.
Low Flow	The Sample or Release flow is below the Low Limit.
High Flow	The Sample or Release flow is above the High Limit.
Slow Alert	The Slow Alert Limit has been exceed on at least one isotope.
Fast Alert	The Fast Alert Limit has been exceed on at least one isotope.
Slow Alarm	The Slow High Alarm Limit has been exceed on at least one isotope.
Fast Alarm	The Fast High Alarm Limit has been exceed on at least one isotope.
Slow Dose	The Slow Dose Limit has been exceed on at least one isotope.
Fast Dose	The Fast Dose Limit has been exceed on at least one isotope.
Release Alarm	The Slow Release Alarm Limit has been exceed on at least one isotope.
Calib Due	The calibration expiration date is in less than seven days.
Out of Calib	The calibration on this unit has expired.
Flow Fail	The Sample or Release flow is below the Fail Limit.
Poor Curve Fit	The defined isotopes cannot be fit to the given spectrum.
Display Comm	Communications with the Alpha-7 Display Board have failed.
MCA Fail	Communications with the Alpha-7 MCA Board have failed, or the remote head has been disconnected.
Door Timeout	The filter door has been left open for more than five minutes.
Low Counts	No counts have been received from the detector in 10 minutes[4].
MCA EEPROM	The stored *SmartHead* parameters failed the CRC error check.
Off Line	Unit is initializing.

Alpha-7A Status Annunciations

Annunciator	Instrument Status Condition

[4] If the instrument is configured for "Filtered Air," this timeout period is 3 hours.

	NORMAL	ALERT ALARM	HIGH ALARM	MAINT.	FAILED
Normal LED	ON BLINK[3]	ON	ON	OFF	OFF
Alert Alarm LED	OFF	ON	OFF	OFF	OFF
High Alarm LED	OFF	OFF	ON	OFF	OFF
Alarm Beacon	OFF	OFF	ON	OFF	OFF
Sonalert	OFF	ON OFF if Acked	ON OFF if Acked	OFF	OFF

Alpha-7A Status Conditions

STATUS	CONDITION		STATUS	CONDITION
Normal	NORMAL		Slow Alarm	ALARMED
Below Fast MDC	NORMAL		Fast Alarm	ALARMED
Below Slow MDC	NORMAL		Slow Dose	ALARMED
Below Fast MDA	NORMAL		Fast Dose	ALARMED
Below Slow MDA	NORMAL		Release Alarm	ALARMED
Filter Change	NORMAL		Calib Due	FAILED
Isotope Change	NORMAL		Out of Calib	FAILED
Filter Dirty	NORMAL		Flow Fail	FAILED
Door Open	MAINTAINANCE		Poor Curve Fit	FAILED
Calibrate	MAINTAINANCE		Display Comm	FAILED
Check Source	MAINTAINANCE		MCA Fail	FAILED
Low Flow	ALARMED		Door Timeout	FAILED
High Flow	ALARMED		Low Counts	FAILED
Slow Alert	ALARMED		MCA EEPROM	FAILED
Fast Alert	ALARMED		Off Line	FAILED

Alpha-7L Status Annunciations

Annunciator	Instrument Status Condition				
	NORMAL	ALARMED	MAINTAINANCE	TROUBLE	FAILED
Normal LED	ON BLINK[5]	ON	OFF	OFF	BLINK
Trouble LED	OFF	OFF	OFF	ON	BLINK
Hot Job LED	OFF/ON[6]	OFF/ON[4]	OFF	OFF/ON[4]	BLINK
Alarm Beacon	OFF	ON	OFF	OFF	OFF

[5] Normal LED blinks when any concentration/dose alarm setting is below the MDC/MDA

[6] LED is ON if Alpha-7 is configured as a Hot Job CAM (i.e. dose alarms disabled), OFF otherwise.

Sonalert	OFF	ON OFF if Acked	OFF	OFF	OFF

Alpha-7L Status Conditions

STATUS	CONDITION		STATUS	CONDITION
Normal	NORMAL		Slow Alarm	ALARMED
Below Fast MDC	NORMAL		Fast Alarm	ALARMED
Below Slow MDC	NORMAL		Slow Dose	ALARMED
Below Fast MDA	NORMAL		Fast Dose	ALARMED
Below Slow MDA	NORMAL		Release Alarm	ALARMED
Filter Change	NORMAL		Out of Calib	FAILED
Isotope Change	NORMAL		Flow Fail	FAILED
Door Open	MAINTAINANCE		Poor Curve Fit	FAILED
Calibrate	MAINTAINANCE		Display Fail	FAILED
Check Source	MAINTAINANCE		MCA Fail	FAILED
Filter Dirty	TROUBLE		Door Timeout	FAILED
Calib Due	TROUBLE		Low Counts	FAILED
Low Flow	TROUBLE		MCA EEPROM	FAILED
High Flow	TROUBLE		Off Line	FAILED

Alarms

When a radiological alarm is determined, the Alpha-7 will annunciate the alarm in several ways: by turning on the red alarm beacon, the audible Sonalert, the red alarm LED on the front panel (Alpha-7A only), and by energizing the alarm relay contact.

Whether the alarm annunciations are automatically cleared when the condition is cleared depends on whether the instrument is configured for “latching alarms.” If the instrument is configured for latching alarms (Alpha-7L uses latching alarms), the alarm indications will remain, until the operator acknowledges the condition, even if the condition which caused the alarm no longer exists.

The audible Sonalert can be silenced with the ***Alarm Ack*** button on the front of the Alpha-7. Alternately, right-clicking on the instrument in the Tree Control in the Alpha-7 Client brings up the Instrument Menu at left, in which a left click on ***Acknowledge Alarm*** performs the same function. Acknowledging the alarm only silences the Sonalert audible warning. The alarm beacon will continue flashing until the Alpha-7 no longer measures a value that exceeds the alarm set point for any isotopes.

Alarm Logging

In addition to the visual and audible indications, the EberLogger utility creates a log of the alarm condition, and 30 minutes after the event, will archive a table of the spectrums for six hours leading up to the alarm, and thirty minutes after. For details, see the Data Logging section.

Filter Changes

The Alpha-7 uses standard 47 mm filter media. The two types of sampling head assemblies require different procedures for changing the filter paper, however, in both cases, the filter is placed on the filter support, which consists of a stainless steel micro-perforated screen. Next a retaining apparatus is placed over the filter to hold the filter in position and to create pressure against the O-ring, which prevents flow leakage around the edges of the paper.

Filter papers should be changed according to the filter type, dust-loading conditions, radon background, alarm settings and required sensitivity. Testing has indicated that, under "normal" conditions, the filters should be replaced at least once per week. In this case, "normal" conditions consists of the recommended filter, a flow rate of 1CFM (28.3 lpm), moderate radon levels (approx 0.5 pCi/l) and moderate dust levels. In a filtered-air environment, it is possible that filter papers may be changed less frequently than once per week.

To prevent any light induced counts, an internal switch is present in both head types which turns off the detector bias voltage when the user starts to open the detector door. When the filter door is opened, the instrument detects this condition with the switch and begins a "filter change timeout." If the filter door is re-closed in less than 10 seconds[7], the operator is prompted to press the acknowledge button to confirm a filter change. If the acknowledge button is not pressed, operation resumes from where it was interrupted.

[7] The default filter change timeout is ten seconds. This timeout can be changed by Eberline field service personnel, or at the factory to provide for a longer interval for filter inspection without forcing a spectrum reset.

If the filter door is closed after remaining open for more than 10 seconds, the Alpha-7 resets the spectrum and the integrated volume, and restores the detector bias voltage.

If the filter change requires less than the filter timeout, make sure to acknowledge the filter change by pressing the *Alarm Ack.* button when prompted with the message:

Was filter changed?
If Yes, press Ack.

After the filter change, verify that the Alpha-7 display briefly shows the FILTER CHANGE status message to confirm that the procedure was completed successfully. If the display continues to indicate the DOOR OPEN message, check for complete closure of the door or cartridge lock. Failure to recognize the closure probably indicates that the retaining knob was not fully tightened.

CAUTION: When using the recommended Fluoropore filter papers, be sure to make sure new filters are installed properly with the black fiber backing face down.

Radial Entry Sampling Head

In the radial entry sampling head, the filter holder is attached to the radial head via a hinge pin, and is secured at the top by a retaining screw. In the field, the technician unscrews the retaining screw using the attached knob, and folds down the filter holder assembly. This process exposes the detector face and provides access to the detector surface for cleaning when necessary.

To replace the filter paper, unscrew the door latch, open the door and remove the filter retaining ring. Remove the old filter paper, center the new paper on the pedestal and place the retaining ring back onto the filter assembly, pressing firmly so that the O-ring seals properly against the back of the filter paper.

Examine the detector face for dust or deposits and clean if necessary.

Close the filter holder assembly and screw the knob down finger tight. Observe the Alpha-7 display to verify that the FILTER CHANGE message is displayed.

In-Line Sampling Head

The in-line sampling head uses a sample filter cartridge for very efficient filter change operations. This method allows the maintenance personnel to carry pre-loaded filter cartridges and swap the old cartridge for the new one in a matter of a few seconds.

To replace the filter, release the cartridge locking knob and remove the filter cartridge. Lift the stainless steel lid and remove the old filter paper. Place the new filter paper over the double O-ring seal and carefully lower the cover to hold the filter paper in place.

Return the cartridge and close the locking mechanism, observing the Alpha-7 display to verify that the FILTER CHANGE message is displayed. If the filter was replaced in under 10 seconds, the display will prompt the operator top press the *Alarm Ack.* button to confirm that a filter change occurred.

Alpha-7 Local Display

Display Pages

The Alpha-7 local display supports up to ten pages of information on its two-line vacuum-fluorescent panel. Isotope and flow readings may be displayed on Pages 1 through 9 as defined by the customer (see Alpha-7 Isotope Properties: Display Page). Page 0 is reserved for the display of the Instrument Name, Instrument Status and the amount of accumulation time on the filter paper in hours and minutes.

Since the data for the isotope displayed on Page 1 is output to the analog output, the primary measurement isotope is defined to display on Page 1. Sample flow is usually placed on a subsequent page, since it is often useful to know what the flow rate is.

It is not required that all ten display pages have isotope of flow data assigned to them. In fact, limiting the pages displayed will improve the performance of the Alpha-7. An example of a four-page display scheme with Page 1 the active page is shown below:

Page 0	**A7000109** **NORMAL 118:43**
Page 1	**Pu-239: NORMAL** **1.63 DAC-h**
Page 2	**Pu-239: NORMAL** **17.2 DAC-h Fast**
Page 3	**Sample: NORMAL** **28.3 liters/min**

The Alpha-7 automatically manages the display pages to eliminate blank pages between isotopes and to prevent the selection of the same page for more than one isotope.

Scrolling

The user can scroll through the display pages by pushing the ***Alarm Ack.*** button. When the last page is reached, pressing the button once more will cause Page 0 to be displayed again.

Display Timeout Feature

If no scrolling is done for a specified timeout period (the factory default is two minutes), the display will automatically return to either Page 0 or Page 1 depending on the instrument status. For all normal instrument statuses (see Status Conditions section), the display will automatically return to Page 1 after the timeout period. However, if the unit is in a failed status, the display will return to Page 0, showing the failed instrument status.

Response Check And Challenge Test

Check Source Mode (Alpha-7A Only)

The user first inserts the check source into the source holder and inserts the source holder into the Alpha-7 in place of the filter paper holder. The vacuum may be enabled or disabled according to user preference, since the vacuum buildup will be on the backside of the source and will not affect the detector. The check source mode is then entered by holding down the *Alarm Ack.* button until the “CHECK SOURCE” reading appears (approximately seven seconds). Once the check source mode is entered, the *Alarm Ack.* button should be released since after approximately 10 seconds it will cause the instrument to shut down.

When check source mode is entered, the gross counts for the entire spectrum will be displayed as a weighted average count rate in counts per second. The user then waits for the count rate to stabilize, and can record the count rate at that time.

Opening the filter holder lock—as is done when removing the source holder from the Alpha-7—will force the Alpha-7 to exit the check source mode. The filter holder can then be reinserted to start a new measurement.

Response Check and Challenge Test Mode (Alpha-7L Only)

The Alpha-7L supports an enhanced source check mode which tests several functions in addition to a source count rate test.

The Response Test:

- Displays the Sampling Head Part Number
- Displays the Calibration Due Date
- Compares the current configuration against a set of saved settings, flagging any discrepancies

The Challenge Test:

- Prompts for the operator to insert the check source
- Checks for a source-caused alarm
- Checks for the source dose to be within the acceptable range
- Posts the test results
- Prompts the operator to remove the source
- Returns to normal operation

To begin the Response Test, press and hold the *Alarm Ack.* button until the RESPONSE TEST MODE message is displayed. Release the *Ack.* button, then when the message “Press Ack. To cont.” is displayed, press the *Ack.* button again momentarily to begin the test.

During the test, the *Alarm Ack.* button will advance to the next step, or confirm prompts or questions.

The Challenge Test source isotope and acceptance range is defined in the *Windows Registry*. The default isotope is Pu-239 and any dose in the range 1 – 90,000 DAC-h will pass the range test. To change the defaults, edit the following registry values in the ***HKEY_LOCAL_MACHINE\SOFTWARE\Eberline\Alpha-7\1.5\Profile*** key:

Source—is the name of the source isotope.

Source High DAC-h—is the upper limit of acceptable dose reading.

Source Low DAC-h—is the upper limit of acceptable dose reading.

After the test is completed, a record will be created in the ***Response Test Log.mdb*** database (in the *C:\Eberline\Alpha7\Data* folder) documenting the results of the test. As with the other database files, this table can be viewed using *Microsoft Access*.

Power Down (Turning the Alpha-7 Off)

The Alpha-7 is a Windows NT based computer system. It requires the same care in shutting down as any Windows-based computer. The power down operation can be performed locally, from the front panel of the Alpha-7, or remotely, using the Alpha-7 Client program.

Remote Power Down

To turn the instrument off from a remote PC running the Alpha-7 Client, right-click on the instrument in the Tree Control of the Alpha-7 Client. This will bring up the Instrument Menu shown at left. Select either ***Power Down...*** or ***Restart...***

These two messages have the same meanings as with the standard *Windows Shutdown…* command. A message will appear on the Alpha-7 display indicating when it is safe to turn the instrument off using the power switch on the left side of the Alpha-7.

If you are running the Alpha-7 Client program locally using a monitor and keyboard, an additional ***Shutdown…*** menu item will be listed at the bottom of the menu. *Shutdown* will stop only the *A7Server* program allowing you update the software or perform database management without conflict with the *A7Server* program.

Local Power Down

You can also turn off the machine locally by pushing and holding the *Alarm Ack.* button on the front panel for approximately 15 seconds. The message "*Local shut down? If Yes, press Ack.*" will appear. When the message appears, release the *Ack.* button and the press it again momentarily to complete the shutdown sequence.

When the unit is ready to be powered down, a message saying it is safe to turn the instrument off will appear.

NOTE: Either the CHECK SOURCE MODE or RESPONSE TEST MODE message will be appear after holding the *Alarm Ack.* button down for 8 seconds. Continue holding the button for an additional five seconds until the "Local shut down?" message appears.

Alpha-7 Calibration

Calibration of the Alpha-7 is accomplished by use of the Alpha-7 Calibration Wizard program[8], *A7Calib.exe*. The Alpha-7 Calibration Wizard may be run from any network computer that has the Alpha-7 Client installed. Since the calibration does require the changing of sources and flow rates, it is recommended that the client computer be located within easy access of the Alpha-7 being calibrated.

While the Alpha-7 Client program provides the means to change the isotope and alarm configuration of an Alpha-7, it does not allow calibration information to be changed. The Calibration Wizard provides the method for setting the amplifier threshold and bias voltage, and for calibrating the MCA gain and energy offset, the detector efficiency, and the sample flow min/max scale values. In addition, after connection to an Alpha-7 is established, the Calibration Wizard contains a full-functionality Tree Control that provides all the setup and configuration screens for the instrument operation without any of the parameters being "grayed out". This makes the calibration program extremely powerful and therefore its use should be controlled administratively to limit unauthorized changes to Alpha-7s which could affect the confidence in the measurement.

The calibration process consists of a series of steps that determine the amplifier gain, detector efficiency, and min/max scale values to produce accurate sample flow readings. The steps are normally used in series, but individual steps may be skipped if the user desires. The program allows the instrument to automatically determine and select the correct gain and then calculate the efficiency for a known source. This section is intended to provide you with a quick reference to the calibration process and calibration screens.

[8] Alpha-7L Specific: This program is not installed when the Alpha-7 client program is installed on a client computer, but can be released on a controlled basis.

Smart Head Technology

The Alpha-7 incorporates *Smart Head* technology, which means that calibration parameters are saved, not in the Alpha-7 display unit itself, but in the remote sampling head. This powerful capability means that a calibrated remote head can be connected to any Alpha-7 display unit and put into immediate service. All calibration parameters, including gain and efficiency information, the head serial number, a property ID, and the next calibration due date, are downloaded to the sampling head at the end of the calibration. This means that the calibration of several remote heads can be performed in the shop using a single Alpha-7 display unit and hot-swapping the sampling heads when the procedure is completed. Calibration can be performed on the sampling head only. There is no need to bring the entire Alpha-7 into the shop to do a calibration.

Smart Head Parameters

The following table lists the calibration parameters saved in the sampling head after calibration:

Parameter	Description	Value is
Bias Flag	True = positive bias detector False = negative bias detector	Set at factory
Gain	Amplifier gain value	Calculated
Alpha Threshold	Amplifier upper threshold value	User editable
Beta Threshold	Amplifier lower threshold value (unused)	
Bias Voltage	Detector bias voltage	User editable
Efficiency	Detector 4-Pi efficiency	Calculated
Offset MeV	Energy offset in MeV	Calculated
Air Gap	Detector to filter air gap	Set at factory
Flow Max Scale	Sample flow max scale	Calculated
Flow Min Scale	Sample flow min scale	Calculated
Cal Date	Date and time of last calibration	Calculated
Cal Due	Date and time of calibration expiration	User editable
Serial No.	Eberline-assigned remote sampling head serial number	Set at factory
Property ID	Customer-assigned property ID	User editable
Source Description	Description of calibration source used	User defined
Source Activity	Calibration source activity	User defined
Technician	Name of technician performing calibration	User defined

Hot-Swap Capability

The Alpha-7 supports hot-swapping of sampling heads. This means that the sampling head can be disconnected from a running Alpha-7 and the same head, or a different sampling head, reconnected at a later time. The Alpha-7 will sense when the head has been disconnected and post an MCA COMM status (MCA communications failure) message. When a head is reconnected, the Alpha-7 will determine whether the head is *Smart Head*-compliant, and if so, download the new parameters from the head—continuing operation with a new (reset) spectrum. Of course, the head can also be disconnected and reconnected with the Alpha-7 powered down.

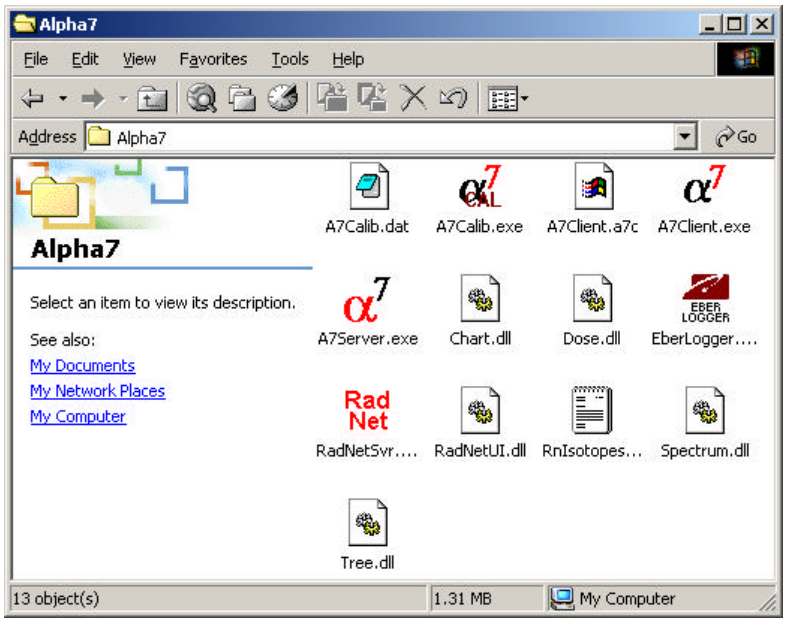
Parameter Error Checking

To insure data integrity, the *Smart Head* parameters are error-checked when they are stored and read back from the sampling head using a CRC-32 check word.

In the event that an error is detected, the Alpha-7 will post a MCA EEPROM status. The customer should then attempt to recalibrate the head to clear the condition. If the condition does not clear after re-calibrating, then the sampling head should be returned to the factory for repair.

Running the Alpha-7 Calibration Wizard

In the *C:\Eberline\Alpha7* folder on the Alpha-7 (or the *C:\Program File\Eberline\Alpha7* folder on the PC you are using to calibrate the Alpha-7) you will find the Alpha-7 Calibration Wizard file *A7Calib.exe*. A screen capture of the folder is shown below. Please note that the Alpha-7 Client program and the Alpha-7 Calibration Wizard software use similar icons.



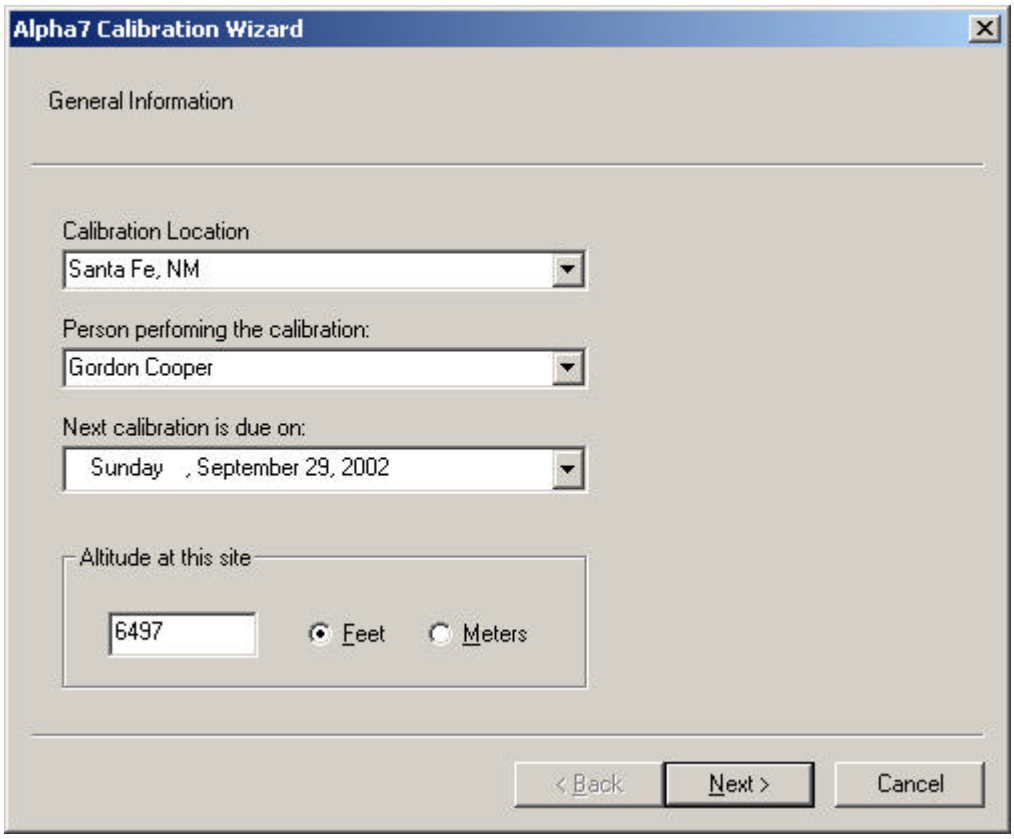
Double-click on the ***A7Calib.exe*** icon to run the Wizard.

General Information Page

When you start the Alpha-7 Calibration Wizard, the first screen prompts you to enter:

Calibration Location—is important for calibration report documentation purposes.

Person performing the calibration—is the name of the operator/technician performing the calibration. For names that are not in the pull-down list, new names can be added to the edit field and will appear in the pull-down list the next time the Alpha-7 Calibration Wizard is run. This means that if you have several people doing calibrations, that you do not need to type in the information each time. Once it has been entered, the next time you just pull down the list and choose the correct name.



Next calibration is due on—is the calibration expiration date. The default date is 180 days from the computer date setting at the time of the calibration. To change the due date, pull down the calendar display and select the desired date. The Alpha-7 will post a warning status of CALIB DUE seven days before the expiration date.

Altitude at this site—The elevation is the critical component of this page. The Alpha-7 uses a correction factor based on the approximate air density at the elevation where the calibration will take place. Because of the relatively short range of alpha particles in air, the elevation plays a large part in where the gain should be set in order to display the alpha energies correctly. Please note that the Alpha-7 does offer the choice of specifying the elevation in feet or meters. Given that there is a factor of three between them, ensure that the correct altitude units are used.

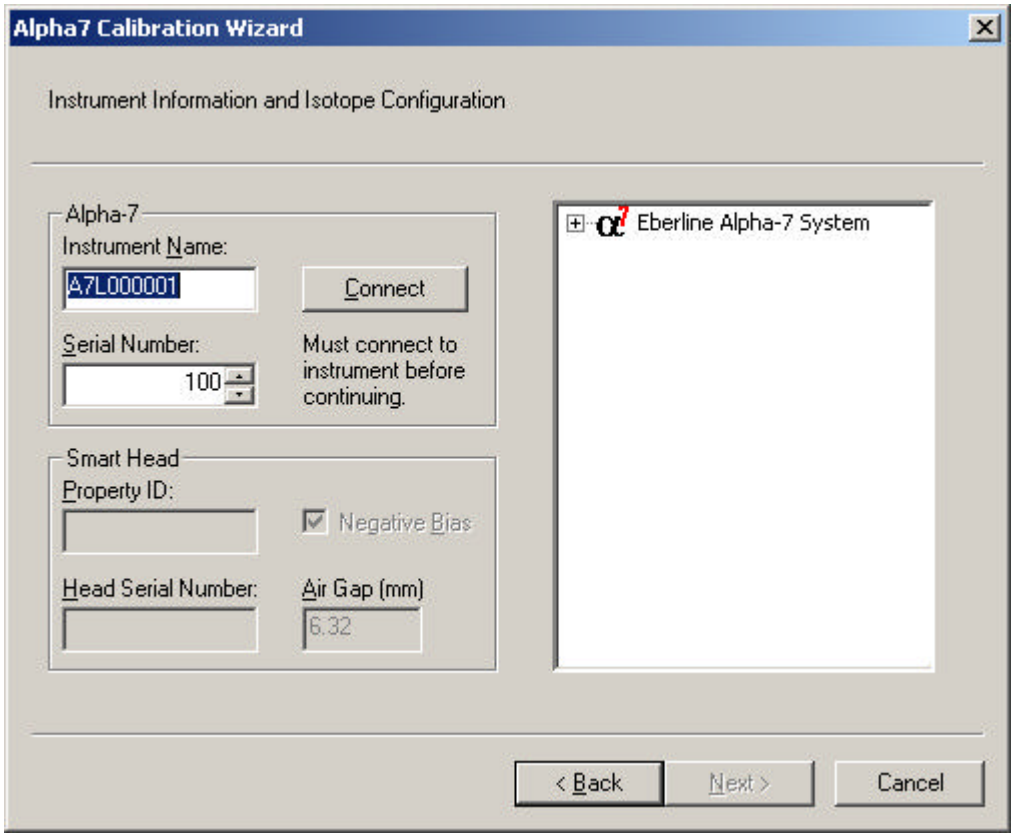
When the parameters have all been verified, click the *Next* > button to advance to the next screen.

Instrument Information and Isotope Configuration Page

Next, you must enter the ***Instrument Name*** of the Alpha-7 and its Eberline ***Serial Number***.

Serial Number –this field accepts any text and shows up on the calibration report.

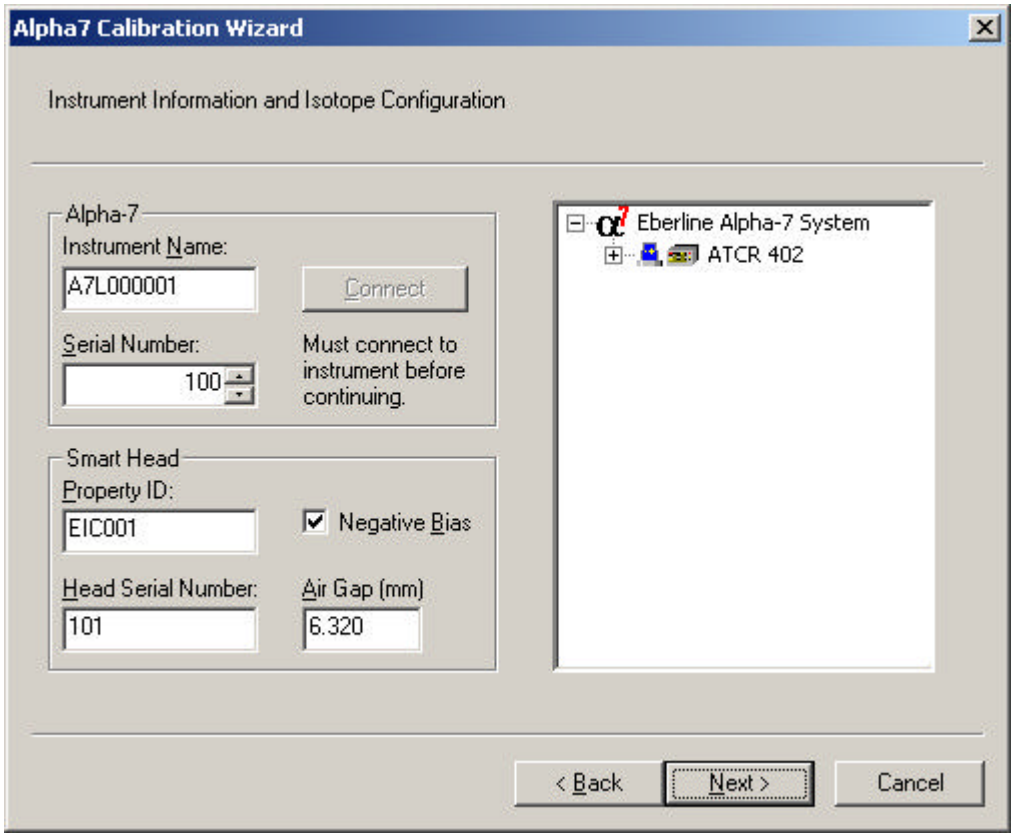
Instrument Name—is the name by which the Alpha-7 can be contacted over the network. If you have changed the name of the Alpha-7 (using the Alpha-7 Client) then you must put the new name in this field. For example, the name shown above is A7L000001. This is the factory default name for serial number 001. The *Instrument Name* is displayed on Page 0 of the Alpha-7 display. Enter the assigned *Instrument Name* in this field.



Once the *Serial Number* and *Instrument Name* fields have been entered, click the *Connect* button to connect the Calibration Wizard to the Alpha-7.

If the address is incorrect, you will see the following message displayed. Click the *OK* button, correct the name and try to connect again.

Once connected, the page will change to look like the example below with the instrument showing up in the Tree Control and the *Smart Head* fields enabled.



At this point, you can edit the remaining Smart Head fields.

Property ID—is the customer-assigned ID for the sampling head being calibrated. It can be ant text up to sixteen characters in length.

Head Serial Number—is the Eberline-assigned serial number for the remote sampling head.

Air Gap—is the detector to filter spacing in millimeters. The default is factory-set and should not be changed unless the detector to filter paper geometry is modified.

Negative Bias—is the detector bias setting. Most Alpha-7s are shipped with negative bias detectors to reduce the attraction of dust to a positively-charged detector surface. This setting is for documentation purposes only.

After verifying all the above settings are correct, the user may modify instrument and/or isotope parameters through the Tree Control.

Modifications using the Tree Control

Under the Alpha-7 Client, many of the edit fields are grayed out within the Tree Control dialogs. When used within the Alpha-7 Calibration Wizard, the Tree Control allows broader editing capability of Alpha-7 parameters and most of the edit fields allow editing. Some of these fields which are applicable to the calibration of the sampling head are:

- Alpha Threshold setting
- Detector Bias voltage
- Release Flow A/D Min/Max Scale

NOTE: Other fields which are enabled, pertain to the Alpha-7 display unit and must be set by connecting to the actual instrument—not the display unit used to calibrate remote sampling heads.

Some of the instrument fields for which editing is enabled are:

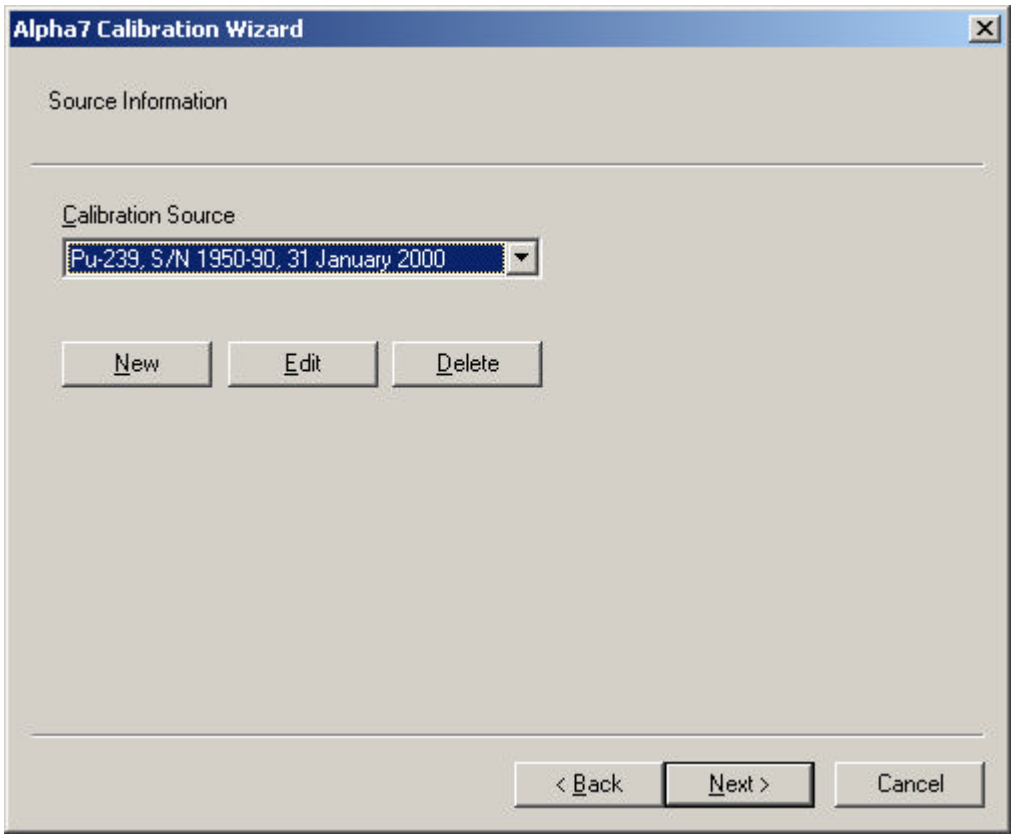
- Sample and Release Flow Units
- Fixed Flow
- Fixed Flow Rate
- Network Settings (TCP/IP Address, Mask, Computer Name)

When all Tree Control modifications have been completed, click the *Next >* button to proceed to the next screen.

Source Information Page

The next Wizard screen is the *Source Information* page. This page is for specifying the source used in the gain and efficiency calibration steps.

The ***Calibration Source*** field is a drop down list of all the sources that have been defined. Pull down the list and select the source to be used for the calibration. If the source is not in the list, it will have to be added.



Source Considerations

The ***Calibration Source*** must be one of the isotopes which the Alpha-7 is monitoring. Note that you can add the isotope using the Tree Control available on the previous Calibration Wizard page and then remove it after the calibration. The isotope only needs to be present in the Alpha-7 isotope tree during the calibration.

The source used should have a peak shape as sharp as possible. Thermo Eberline recommends that a stainless steel source be used since the energy response is superior to plated nickel sources. Nickel sources tend to have a broader and lower energy peak than a stainless source and can cause calibration errors in the *Gain* setting.

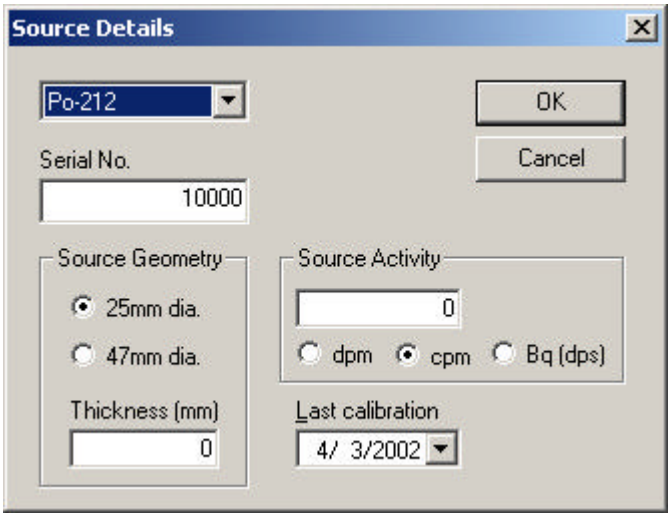
Since the time required to perform the gain and efficiency calibration is dependent on the source activity, a source activity of greater than 50,000 dpm is recommended—preferably an activity in the range 100,000—200,000 dpm. See the Options section for a list of Eberline Calibration Sources.

Note that the Alpha-7 uses a one inch (25 mm) diameter detector and the Calibration Wizard produces much better results when using 25 mm diameter active-area sources (usually plated on a 47 mm disk) than when using a source plated over the entire surface of the 47 mm disk. This source geometry best represents the particle deposition pattern on the filter paper in normal operation. When a larger active diameter is used, the particles outside of the 25 mm center of the source have to travel farther than those inside the 25 mm center and as such show up in the spectrum at lower energies - providing a broader and lower energy peak than will actually be obtained using the filter paper. The filter paper is 47 mm diameter but the collection diameter is only 25 mm.

Entering New Source Information

If the source to be used is not in the *Calibration Source* list, it will have to be added.

To add a new source, click the ***New*** button to enter the *Source Details* dialog shown below. Choose the source isotope from the drop-down list. Note, all isotopes in the Alpha-7 isotope database are listed, not just the isotopes in the isotope tree.



Serial No.—is an unique identifier which appears on the back of the source or on the source container.

Source Geometry—defines the size of the plated area of the source. The recommended plated area diameter is 25 millimeters.

Thickness—is the distance in millimeters by which the detector to filter air gap is reduced when using the source. In most cases, the air gap will not change when using a source and this value should be zero.

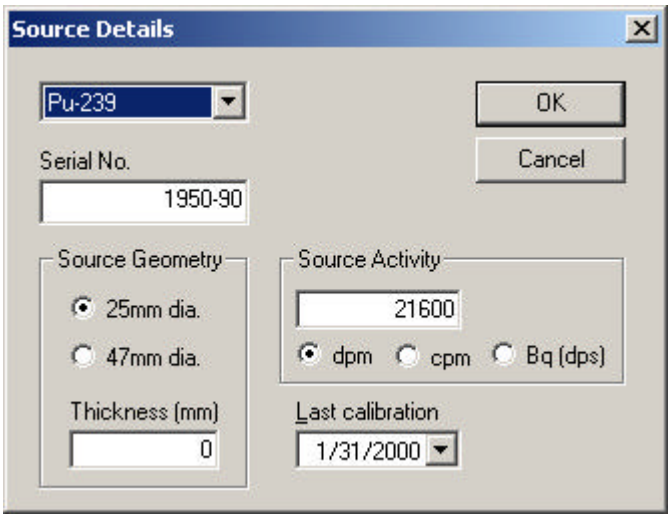
Source Activity—is the activity listed by the source manufacturer, or by the latest recalibration of the source. Be sure to select the units of measure of the source activity in dpm, cpm, or Bq (dps).

Last Calibration—is the date the source activity was last calibrated. Shorter-lived isotopes lose significant activity over time and must be recalibrated frequently. Source isotopes of long half-life (e.g. Pu-239) do not usually require recalibration.

When all the *Source Details* have been entered, click the *OK* button to save the information and return to the Source Information page. This information is then saved on the hard disk allowing the source information to be entered once and then reused.

Editing Existing Source Information

If you click on the ***Edit*** button, you will see the same *Source Details* dialog as when adding a new source, however, the source information for the selected source will be already entered in the fields.

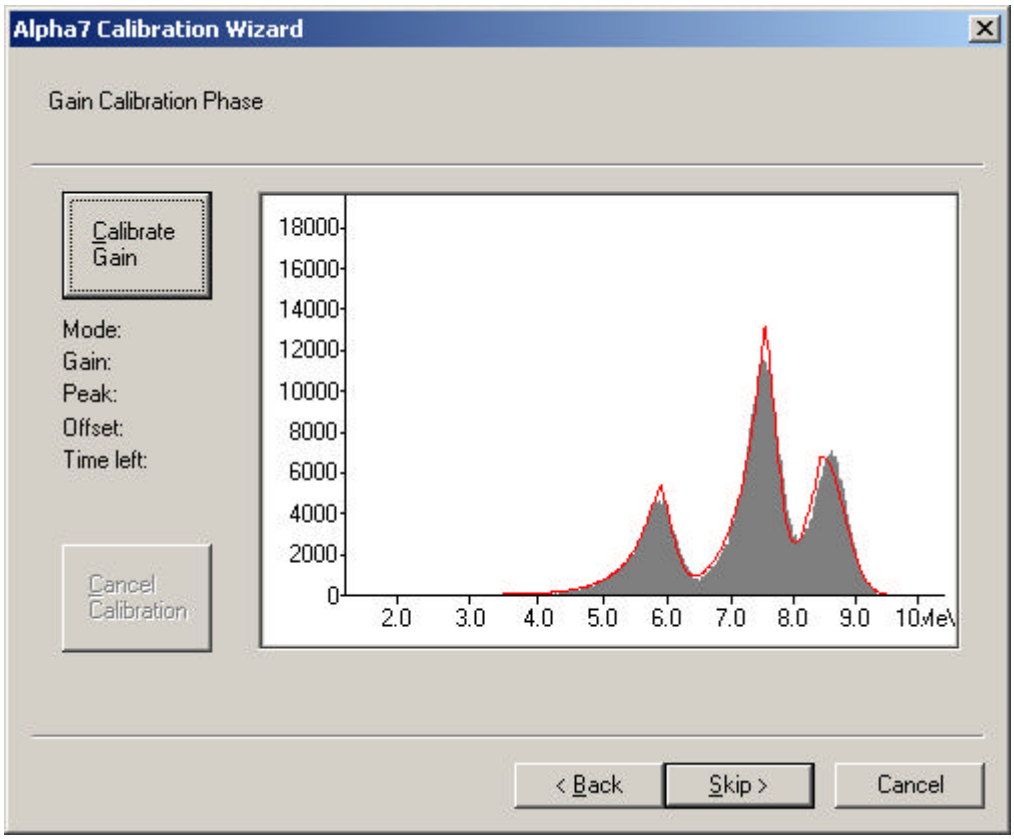


After the source information is edited, click the *OK* button to save the changes and return to the *Source Information* page.

Once the *Calibration Source* field is correct, and the *Source Details* are correct, click the ***Next >*** button to proceed to the next page.

Gain Calibration Phase Page

The Gain Calibration Phase page shows the current spectrum in the Alpha-7. The display is shown below.



You should now TURN OFF THE PUMP and put the calibration source into the source holder and insert it into the Alpha-7. The spectrum display will reset and you will see the new spectrum accumulating at the energy for the calibration isotope.

Once the source is in the Alpha-7, you click on the large ***Calibrate Gain*** button at the left side of the display near the top. This will place the Alpha-7 in CALIBRATE status and begin the gain calibration step.

NOTE: At any time in this process, you can stop the process using the "Cancel Calibration" button and return to the previous screens. This is useful if for example you notice you are using the wrong source.

The Alpha-7 Calibration Wizard will set the gain to a relatively low number and you will see the source peak start to grow in at the left side of the spectrum. Once the Alpha-7 has enough counts for an accurate estimate of the peak location, the Wizard will reset the spectrum and increase the gain to perform the high gain test. The source peak will now grow in at the right side of the spectrum.

Once the Alpha-7 Calibration Wizard has determined the peak locations at the low gain and high gain settings, it will calculate the gain required to place the peak in the appropriate spectrum channel, given the known energy of the source isotope and the energy offset due to the attenuation across the air gap at the defined altitude. It will then set the gain and offset energy to the calculated values, reset the spectrum. The source peak should now begin to grow in at the correct energy location.

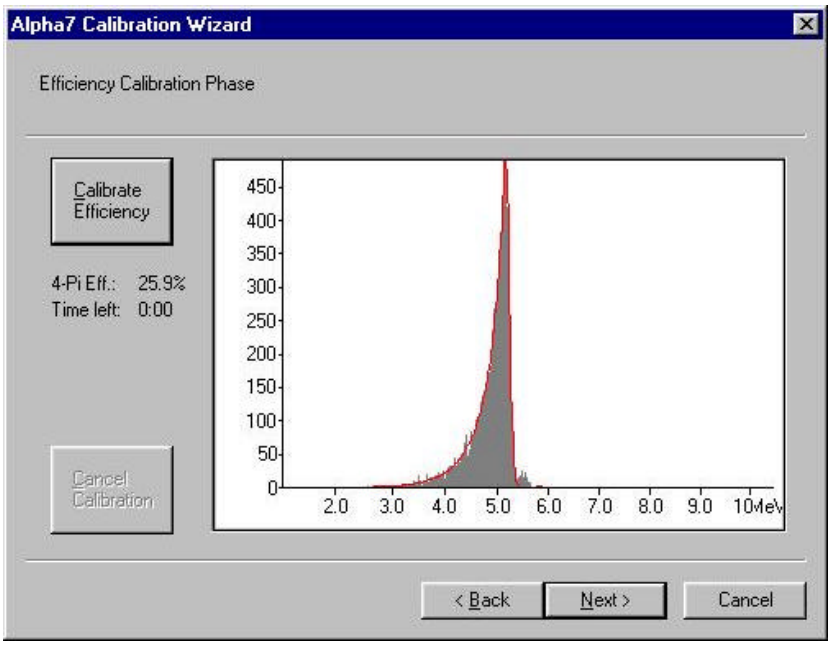
NOTE: If you wish, at this point you may repeat the gain calibration by clicking the *Calibrate Gain* button again. You may repeat this process until satisfied with the results.

The ***Skip >*** button, which was displayed when the page was initially displayed, now reads ***Next >***. Click the *Next >* button to advance to the *Efficiency Calibration Phase* page.

Efficiency Calibration Phase Page

In the *Efficiency Calibration Phase*, the ratio of the detected source activity, to the known source activity is calculated. This *4-Pi Efficiency* value allows the Alpha-7 to scale the measured activity and concentration levels to estimates of the actual activity and concentration levels.

Since this phase is based on curve fit results—and not the actual gross count rate—a very accurate curve fit must be determined. The spectrum must accumulate a significant number of counts to produce an accurate fit, which is why a calibration source with a higher count rate shortens the time required for this step.



Click on the ***Calibrate Efficiency*** button to start the data collection which will compute the intrinsic detector efficiency based on the source emission rate. At the end of the data collection, the Alpha-7 checks the efficiency against the expected range of15% to 30%. You will get an error message if the measured efficiency is outside of this range—usually indicating a bad detector or that the *Source Activity* units were incorrectly specified in the *Source Details* dialog.

At the completion of this phase, the Wizard will display the calculated *4-Pi Efficiency*, and wait for operator input. At this point, repeat the efficiency calibration again, if necessary, or proceed to the next page.

NOTE: At any time in this process, you can stop the process using the "Cancel Calibration" button and return to the previous screens. This is useful if for example you notice you are using the wrong source.

When the ***Next >*** button is enabled, click on it to proceed to the Low flow measurement phase.

Flow Calibration Page– Low Flow Measurement

After the Alpha-7 Calibration Wizard has completed the efficiency calibration, the next phase is the flow calibration. Remove the source and replace the filter paper in the holder.

At this point, the user is required to connect a pump or other source of vacuum to the outlet connection of the Alpha-7, in series with a calibrated mass flow meter so that an accurate known flow rate can be established. The Alpha-7 measures *mass flow*, which is independent of the ambient air pressure in which the instrument is used. It is a measurement of the flow based on the mass of the actual air molecules passing through the Alpha-7.

When calibrating the flow measurement of the Alpha-7, it is critical that the reference value also be stated as mass flow, whether measured by an external mass flow meter or by any alternate method which is then corrected manually for mass flow. This insures the use of the proper reference, which is critical to the linearity and accuracy of the Alpha-7 flow measurement.

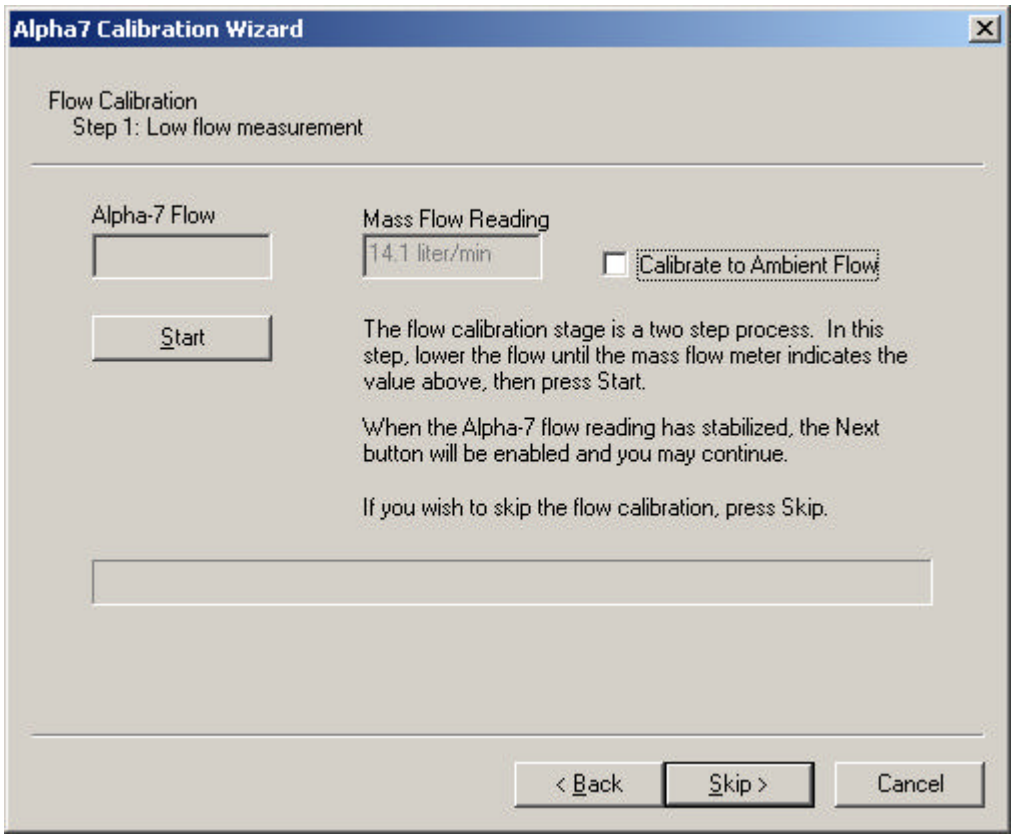
The Alpha-7 calibration wizard performs a two point flow calibration, with the first point at a point on the low end of the desired range of the flow and the second at a point on the upper end of the desired range. The flow calibration is automatic, with no external or manual adjustments to the Alpha-7 required. Flow to the mass flow sensor is controlled by a non-adjustable precision orifice, which uses the differential pressure across a fixed venturi to force flow through the sensor.

The ***Calibrate to Ambient Flow*** checkbox should be checked if flow readings in ambient flow (corrected for altitude) are desired. Selecting this feature can significantly affect the flow readings and the calculation of concentration and dose rates at higher altitudes—based on the actual vs. sea level barometric pressure—and result in proportionally lower levels!

NOTE: Mass flow must still be used in the calibration procedure. This checkbox does not indicate that the input flow rate is in ambient units.

As shown in the screen below, the low flow calibration phase requires a flow rate of 0.5 cubic feet per minute (CFM)—or its equivalent in the selected sample flow units—as shown in the *Mass Flow Reading* window. Adjust the flow as directed on the instructions in the window and click the ***Start*** button. The progress bar will indicate the time remaining in the measurement.

NOTE: The amount of time required to take the flow measurement is based on the sample flow Window time, since the Window time is used to determine the number of samples used in the flow rate average. Reduce the Window time to reduce the time required for flow calibration.



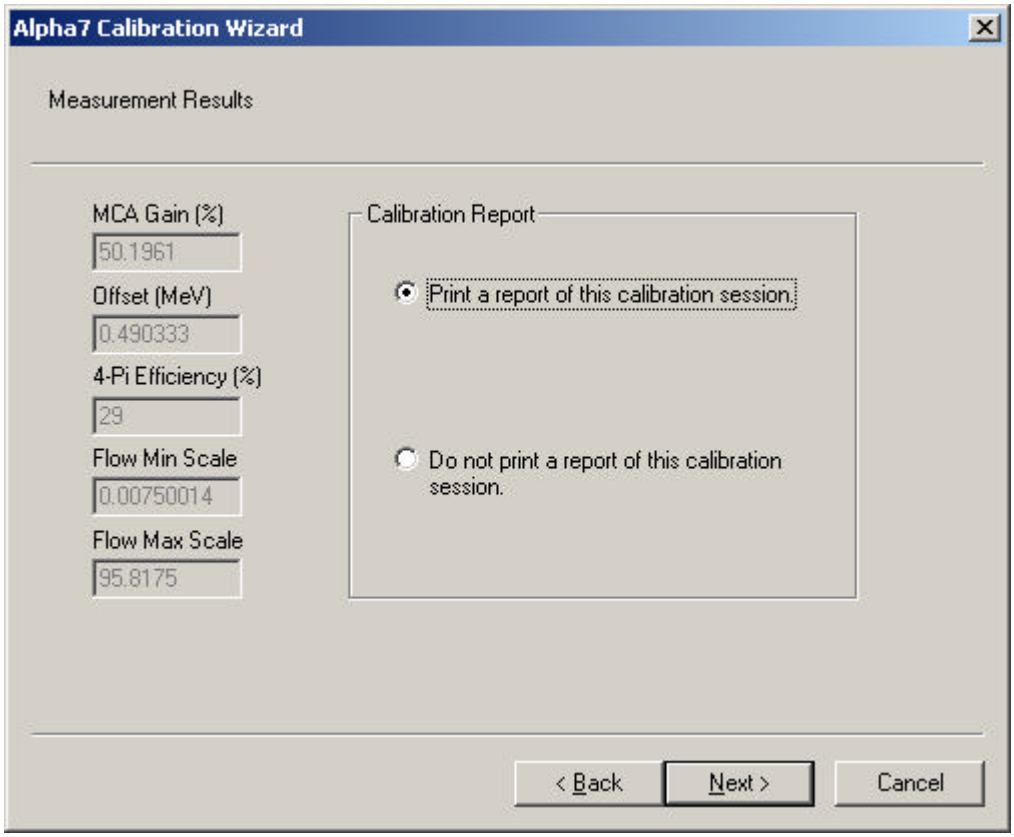
Click the ***Next >*** button when the measurement is completed to advance to the High Flow Measurement page.

Flow Calibration Page– High Flow Measurement

The *High Flow Measurement* page is very similar to the *Low Flow Measurement* page. Again, adjust the flow to match the value in the *Mass Flow Reading* window (1.5 cubic feet per minute), and click the Start button. Wait for the flow measurement to complete and the *Next* > button to be enabled. When the *Next* > button is clicked, the Wizard will calculate the correct *Min Scale* and *Max Scale* flow calibration values and save them for use in the Alpha-7. These values are displayed on the *Measurement Results* page.

Results Page

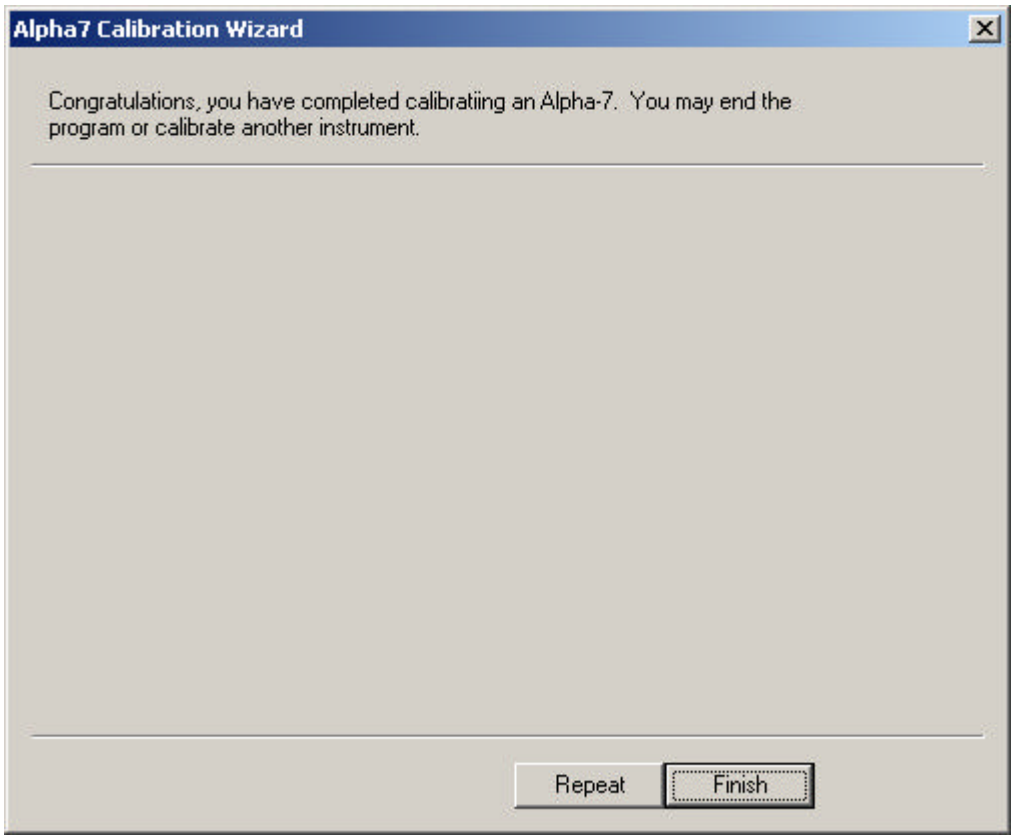
The *Measurement Results* page shown below displays all the calibration parameters that have been determined by the Alpha-7 Calibration Wizard. From this page, you can choose to print out calibration report, or to skip the report. The summary of the parameters derived during the calibration is shown at the left side of the display.



Click the *Next* > button to advance to the final page.

Completion Page

The final screen of the Alpha-7 calibration process and stores all of the new parameters into the Alpha-7. Clicking “Cancel” will abort the calibration and leave the existing parameters as found in the Alpha-7. The calibration wizard may also be used to generate an as-found calibration report by simply skipping all the steps in the calibration and printing out the report at the end of the process.



At this point you can ***Finish*** running the Wizard program or click ***Repeat*** to calibrate another Alpha-7.

Data Logging

History Database– A7Log.mdb

The Alpha-7 has extensive data logging capabilities that are designed to archive readings for later retrieval and analysis. The Alpha-7 uses two databases in its normal operation. Both databases are ODBC-compliant and can be viewed using *Microsoft Access* or other database software that can read a Microsoft Access database. Any version of *Microsoft Access*, from *Access 97* forward, can read the database files.

The Alpha-7 ***EberLogger.exe*** program stores history for status changes, spectrums, and logged isotopes in a database called ***A7Log.mdb*** in the *C:\Eberline\Alpha7\Data\History* folder.

Creating A Link To The A7Log Database

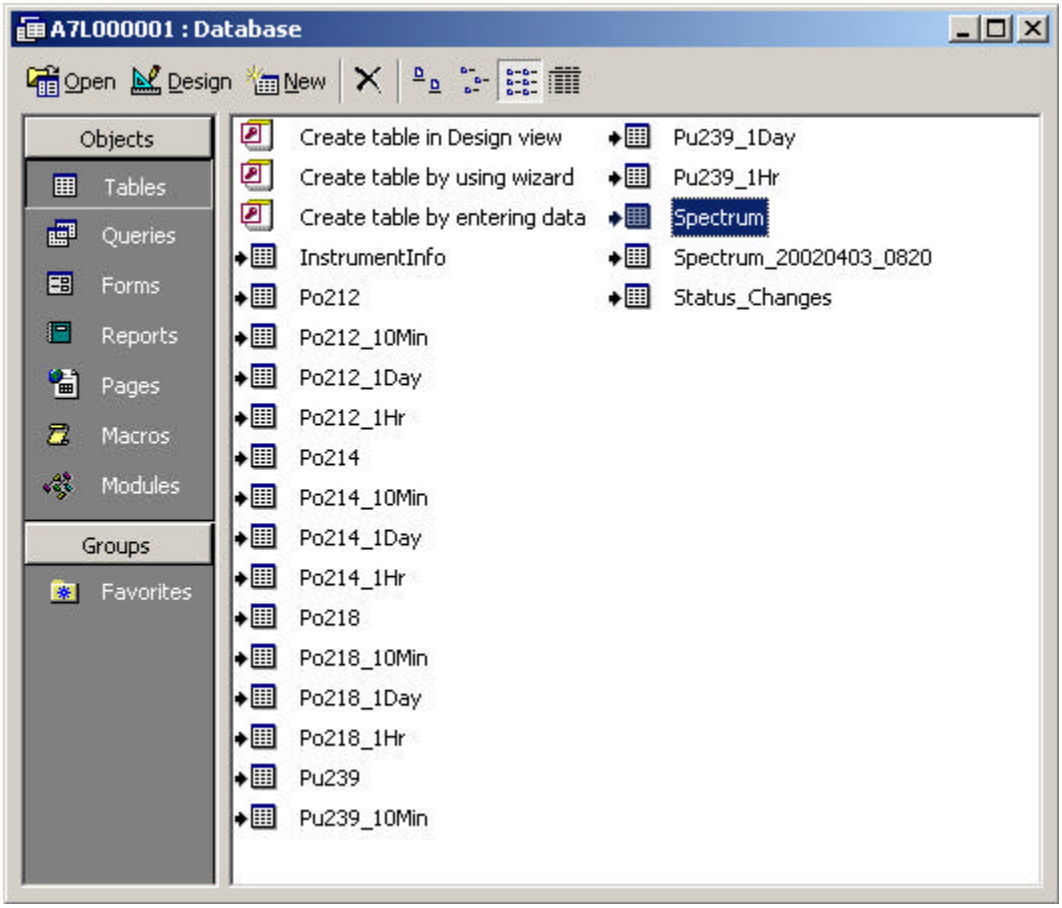
Because the database is locked by the Alpha-7 Server program, it cannot be directly loaded while the *A7Server* program is running. Instead, a remote user running *Microsoft Access* can create a new database and link to the tables in the *A7Log.mdb* database.

?? Create a new blank database

?? Under the *File* menu, select *Get External Data > Link Tables…*

?? Locate the Alpha-7 shared folder and then find the *A7Log.mdb* file in the *History* folder

?? When the *Link Tables* dialog displays, choose *Select All*, then click *OK*



The linked tables should now appear in the new database window. Save the new linked file for future convenience. Opening the database the next time will automatically link to the Alpha-7 database—and, any new data.

Instrument Information Table

A ***InstrumentInfo*** table is contained in the *A7Log.mdb* database which contains information to identify the Alpha-7 logging the data. This table contains only one record. The *InstrumentInfo* fields are:

Instrument—is the Instrument Name

Location—describes the Alpha-7 location description

HeadSN—is the Eberline serial number of the remote sampling head

PropertyID—is the user-assigned property number of the remote sampling head

LastCal—is the date of the last calibration of the remote head

NextCal—is the calibration expiration date

Status Table

In addition to the isotopes, a record is kept of up to thirty-one days of Alpha-7 status changes in chronological order. Records older than the maximum number of log days are deleted from the table. The name of the status table is ***Status_Changes*** and it contains six fields:

UTC—is the time at which the status change occurred.

Status—is the new status.

The following fields can be blank if the alarm change was an instrument-level status change. They will contain values if a new alarm occurred or if an existing alarm was cleared.

Isotope—identifies the isotope which caused the status change.

Reading—contains the latest isotope reading corresponding to the isotope-caused status change.

AlarmLevel—indicates the alarm level which was exceeded to cause the alarm.

Units—is the units of measure to be applied to the *Reading* and *AlarmLevel*.

Isotope Tables

Within *A7Log.mdb*, the isotope data is logged into separate tables based on the isotope name and the resolution of the data. For example, the 10-minute data table for Pu-239 is "Pu239_10Min." The resolutions are 1-minute, 10-minute, 1-hour and 1-day.

Data is logged in a first-in-first-out fashion, with 240 entries for the 1-minute data, 144 entries for the 10-minute, 168 entries for the 1-hour data, and 31 entries for the 1-day resolution. The total size of the database is then limited by the total points accumulated during one month and the number of isotopes being logged.

The four separate data resolutions are defined as follows:

Resolution	Calculation	Example Table
1-Minute	Snapshot of on-the-minute reading	Pu239
10-Minute	Average of ten 1-Minute averages	Pu239_10Min
1-Hour	Average of six 10-Minute averages	Pu239_1Hr
1-Day	Average of twenty-four 1-Hour averages	Pu239_1Day

Each entry in an isotope data table is time-stamped. The time stamp is usually in Universal Coordinated Time (UTC)—also known as Greenwich Mean Time, or Zulu time—to avoid any ambiguity in the log time for the data, allowing the data from any time zone to be properly interpreted. For customers who request a time stamp in Local Time, a factory configuration setting can produce time stamps based on the Local Time in the Alpha-7.

Each isotope table includes columns for:

UTC—This is the time stamp of the data in Universal Coordinated Time (or, optionally, in Local Time).

Status—This field holds the isotope-level status—not to be confused with the instrument-level status which holds the highest priority status of all the isotopes, and, instrument statuses.

FastConcen—This field holds the fast concentration.

FastMDC—This field holds the fast minimum-detectible-concentration level.

FastDose—This field holds the fast dose accumulated since the filter change.

FastMDA—This field holds the fast minimum-detectible-activity.

SlowConcen—This field holds the slow concentration.

SlowMDC—This field holds the slow minimum-detectible-concentration level.

SlowDose—This field holds the slow dose accumulated since the filter change.

SlowMDA—This field holds the slow minimum-detectible-activity.

ReleaseRate—This field holds the slow stack release rate value.

SampleFlowRate—This field holds the sample flow rate

Volume—This field holds the total sampled air volume since the last filter change.

For each isotope, the units of the values in the database are the same as the units specified in the Alpha-7 for concentration, dose, flow and volume. If the DAC Unity constant for an isotope is not equal to one, the output values will be in DAC or DAC-h rather than the radiological base-units.

Spectrum Table

In order to provide data on the spectrum history, a table of spectrum snapshots is kept for analysis. The ***Spectrum*** table contains six hours and thirty minutes of spectrum data. Spectrums are saved every minute and include two records: one of the raw spectrum data; and one of the fitted curve data.

Because of database table limitations, the 512-channel spectrums are condensed into 256-channel spectrums, which, while losing some detail, makes the database smaller. In addition, the first twelve channels are also omitted since they are below the threshold and never contain meaningful data.

The fields in the Spectrum table are:

UTC—is the time stamp of the spectrum records. Because each UTC filed must be unique, the Raw Spectrum record is stamped one second prior to the Fit Spectrum record.

Status—is the instrument status at the time of the spectrum archival.

Type—indicates whether the record is the Raw Spectrum data or the Fit Spectrum. The spectrums are archived in pairs: Raw, then Fit.

Total—is the total spectrum counts

Ch12…Ch510—is the combined counts for two channels. For example Ch12 is the counts for channel 12 and channel 13; Ch510 is the counts for channel 510 and channel 511.

Spectrum Backup Tables

In the event an operator is not present for thirty minutes or more after an Alpha-7 alarm or failure, thirty minutes after the alarm or failure, a backup copy of the *Spectrum* table is saved.

The backup table is saved with the name ***Spectrum****_yyyymmdd_hhmm* is a time stamp indicating the backup time, where yyyy is the year, mm is the month, dd is the day of month, hh is the hour and mm is the minute. For example, the spectrum backup which occurred at 2:17 PM on March 19, 2002 would be saved as *Spectrum_20020319_1417*.

The backup table has the same fields as the *Spectrum* table.

Starting A New History Database

In the event that the user wishes to start with an empty database, a database template is included in the ***History\Empty Database*** folder. The user must shutdown the *Alpha-7 Server* and *EberLogger* programs, which may be using the database and prevent access by external programs. The user may then copy the A7log.mdb from the *History/Empty Database/* folder to the *History* database to create a blank database for the Alpha-7 to use. If no database is available in the *History* folder, data will not be logged.

Disabling Data Logging

Data logging may be disabled by preventing *EberLogger.exe* from executing during the startup process. The *Startup.bat* batch file executes *EberLogger* during initialization of the Alpha-7. Disable logging by commenting out the line as follows:

REM start eberlogger

Troubleshooting

This section is intended as a brief outline of possible solutions to common configuration problems. Many initial setup problems are associated with network incompatibilities. Solutions to networking problems are outside the scope of this manual and the user should consult their Network Administrator for help in solving the communications or Network Security problems.

Curve Fit Problems

Symptom	Possible Cause	Solution
All or most fit peaks do not line up with spectrum peaks	Missing radon daughter isotope causes nearby peak to shift to best fit the spectrum	Identify and add the missing radon daughter to the isotope tree
	Calibration offset or gain is off	1. Check for correct altitude during calibration
		2. Calibration source is coated or annealed resulting in shifted peak. Use stainless steel source
		3. Source Thickness parameter should be zero

Single fit peak does not line up with spectrum peak	Missing isotope	1. Check actual peak energy and compare to other possible isotopes for the monitoring environment. 2. Po-216 (5.3 MeV) is sometimes needed in the isotope tree.
Peaks are in correct location but peak shape does not match fit curve	Insufficient “training” or filter type has changed	Allow Alpha-7 to “train” itself to the peak shape with a clean filter until 80,000 counts and Fit Ratio < 0.60
	Fluoropore filter installed with fiber-backing toward detector	Install Fluoropore filter papers with fiber-backing (black side) down.
Peaks look good initially but drift off after several days	Dust loading causes peak smearing	Change filter paper more often.
Unknown counts in low energy channels	Low Threshold	Raise Threshold to at least 1mV or 2.5 MeV
	Light leak	Check door switch to verify that detector voltage is off when door is opened.
Peaks much broader than examples in manual	Non-Fluoropore filters have broader peaks	Use Fluoropore filters
	Peaks will be broader at Sea Level, than in Santa Fe, NM (elev. 6500 ft)	None

Alarm Problems

Symptom	Possible Cause	Solution
Alpha-7 is false alarming	Po-212 is set as a *Reference* isotope	Check Isotopes.mdb database for a Reference checkmark on Po-212. Clear the checkmark, save the database, delete Po-212 then re-add the isotope.
	Insufficient "training" or filter type has changed	Allow Alpha-7 to "train" itself to the peak shape with a clean filter until 80,000 counts and Fit Ratio < 0.60
Will not alarm on check source	Low activity check source was not inserted before filter change was sensed. Sensitivity increases for up to 2 Slow Window times after a filter change.	Insert the source rapidly (in < 10 seconds) to avoid filter change detection.
Concentration alarm goes away on check source test.	Check source is a fixed-activity event resulting in a spike in Concentration. It is normal for the alarm to clear after there is no longer a change in count rate.	Check for Dose Alarm instead of Concen Alarm.

Status Conditions

Symptom	Possible Cause	Solution
Status does not clear	Latching statuses	Press the Alarm Ack. button or *Acknowledge Alarm* from remote Alpha-7 Client
POOR FIT status	See Curve Fit Problems	
OUT OF CALIB status	Calibration has expired	Run Calibration Wizard

FILTER DIRTY status	Alarm level is too low for the filter change frequency	Raise alarm level or change filters more frequently
	Heightened radon levels due to meteorological disturbance	Change filter paper
LOW COUNTS status	Detector failure	Use check source to determine if detector is counting.
	Very low radon levels	Set *Filtered Air* checkbox to lengthen timeout duration.
MCA EEPROM status	New MCA Board or uncalibrated remote head	Calibrate head. If problem persists, change out MCA Board.
DOOR FAILURE status	Detector door left open	Close door completely
	Door switch is not closing	Replace door switch

D/A Output Problems

Symptom	Possible Cause	Solution
D/A Output does not track the reading on Page 1	Factory setting for *Output Slow Reading* does not match reading on Page 1	*Output Fast Reading* is the default. Make the Fast reading display on Page 1.
No output on D/A	Display Board configured for current loop	Check Display Board configuration
	D/A output scale does not match range of readings	Verify *Min Scale* and *Decades* match the current units and range of display values.

Logging Problems

Symptom	Possible Cause	Solution
Error message when trying to open A7Log.mdb	File is locked by A7Server.exe	Use New database and link to Alpha-7 database tables. (See Logging section)
No logging of data	EberLogger is commented out in *Startup.bat*	Check *Startup.bat* and uncomment "start eberlogger" command.
	Database is missing	Verify *A7Log.mdb* is in the *Data\History* folder. If not, copy the file from the *Empty Database* folder.
	Data Source points to different file or location	Check the Data Source setting (see Logging section)
	Alpha-7 date/time is much older than data in database	Check date/time of data in database and in Alpha-7. Resynchronize clock and/or delete data from *A7Log.mdb* if necessary.

RadNet Problems

Symptom	Possible Cause	Solution
RadNet readings do not match displayed readings	Conversion to Bq is not correct for the units	Check *RnIsotopes.txt* file to make sure conversion constant for isotope is correct.
	RadNet Client supports only one logged isotope	Specify one isotope to log.

Hardware Description

Remote Sampling Head Hardware

Detector and Preamp Board

The alpha sensitive detector used in the Alpha-7 is a 490 mm^2 diffused junction detector. Negative bias detectors are standard to reduce contamination on the detector face. The detector is mounted on the preamplifier board. Jumpers on the MCA Board control the bias voltage polarity and sets the amplifier pulse output polarity positive-going for input to the flash converter. The front surface of the negative bias detector is at ground potential, and it is at positive bias potential for the positive bias detectors.

MCA Board

The MCA Board performs continuous 4096-channel data acquisition, which is binned down to 512 channels, and supplies that data to the SBC via the RS-485 link on the Display Board. It also samples the sample flow and stack flow analog input signals and converts them using two A/D converters. The SBC requests a complete spectrum from the MCA Board once each second.

The MCA Board uses flash converter and computer-adjustable-gain amplifiers. The detector bias voltage supply section is a computer-controlled DC-DC converter, which supplies up to 60 Vdc positive and negative (polarity jumper selectable). A two channel 10-bit A/D converter is used to monitor the sample and stack flow signals. An on-board mass flow sensor is used for monitoring sample flow through the sampling head.

The MCA Board also supports computer-adjustable-gain, bias voltage and threshold, allowing the *Alpha-7 Calibration Wizard* to align and scale the spectrum properly. A two-point energy calibration is provided in the *Alpha-7 Calibration Wizard* to set the span of the spectrum and to compensate for peak offset due to filter-to-detector air gap.

The photograph shows the:

?? sampling assembly with the mass flow sensor (connected to the clear tubing)

?? MCA Board - attached to the sampling assembly

?? CAM mechanism for closing the door located underneath the vertical tube.

Mass Flow Sensor

The Alpha-7 uses a hot wire anemometer to measure the airflow that passes through the monitor. This mass flow measurement technique is independent of pressure and temperature, making it more accurate than a rotameter. The regulations for alpha air monitoring are typically expressed in terms of ambient volumetric flow rates, however, requiring a correction for density altitude at the measurement location.

Display Board

The display board provides the interface between the SBC and the vacuum fluorescent display and the alarm annunciation. This includes the relays for alarms and failures, the lights for high alarm, alert alarm (Hot Job and Trouble on Alpha-7L units) and normal, as well as the Sonalert audible annunciator and the red beacon on top of the Alpha-7.

The SBC provides output information to the display board once each second . The display board then drives the 2x20 character vacuum fluorescent display with the commands from the SBC and drives alarm lights, horn, relays and drives the 0-20, 4-20 or 4-24 mA (as defined by a jumper on the board) D/A output. The interface between the SBC and the display board is a 115,200 baud serial port.

The interface between the Display Board and the MCA Board is a 115,200 baud RS-485 serial port. Messages from the A7Server program are “passed through” the display board, out the RS-485 port and on to the MCA board. Responses from the MCA board are again passed through, back to the SBC.

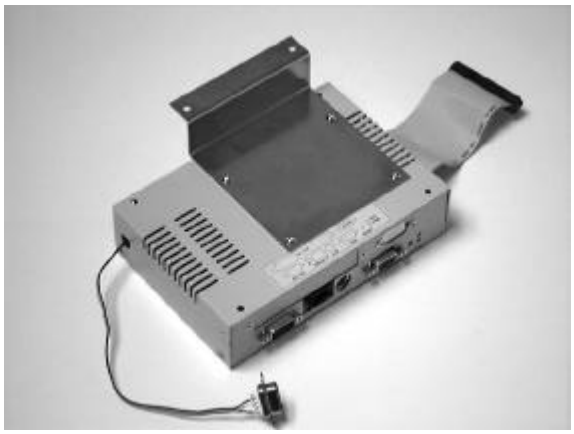
Alpha-7A Details

Connections are available on the display board for the concentration/dose alarms, concentration alert, and normal relays, and also for the analog signals for the analog output of concentration or flow.

Alpha-7L Details

Connections are available on the display board for the concentration/dose alarms, trouble, and failure relays, and also for the analog signals for the analog output of concentration or flow.

Internal Single Board Computer (SBC)



The PC used is a single board computer (SBC) with a 233 MHz Pentium class processor (Cyrix GXM-233) and 64 MB of SODIMM SDRAM. The SBC has on-board support for local-bus SVGA graphics (industry standard DB15 connector), 16-bit Ethernet communications (100-Base-T using an RJ45 connection), and a single 9-pin mini-DIN connector (PS2 type) for keyboard and/or mouse. An IDE hard drive (size varies, > 3 GB) is used for the software.

The Windows NT 4.0 operating system is installed with full support for plug and play devices. Optional support for PCMCIA cards is also offered.

While computers are constantly being upgraded, and Thermo Eberline will use the latest technology as it becomes available, the single board computer used in the Alpha-7 currently has the following specifications:

Processor	233 MHz Pentium class; Cyrix GXM-233
RAM	One 144-pin SODIMM socket accepting up to 128 MB SDRAM. Typically the Alpha-7A will have 64 MB installed
Hard Disk	EIDE Hard drive interface supporting up to 2 EIDE devices. The PC supports BIOS auto-detect.
Serial Port	The SBC is supplied with one RS-232 serial port and one RS-232/RS-422/RS-485 port. One RS-232 port (COM 2) is used to communicate with the Display board. The other port (COM 1, DB-9 connector) is available through the side panel.
Video	CRT resolutions up to 1280 ? 1024 @ 256 colors

Ethernet	PCI 10/100 Mbps 100 Base-T RJ-45 Ethernet, compatible with the IEEE 802.3 protocol.
WiFi (optional)	IEEE 802.11b wireless Ethernet (WiFi) output using off-the-shelf PCMCIA cards

The following features are available in the SBC but are not implemented in the current Alpha-7 are:

- Audio support
- FDD - support for up to 2 floppy disk drives
- Parallel - a single parallel port supporting SPP/EPP/ECP parallel modes
- infrared communications port
- USB support; support for solid state disks
- support for a flat panel display
- support for the PC/104 expansion format

Stack Inlet and Sampling Collection Efficiencies

The In-Line Sampling Head allows the same configuration to be used for either room air monitoring or sampling from stacks or ducts. The unit was tested with 10 µm aerodynamic diameter aerosols and 100% collection efficiency was measured.

The Radial-Entry Sampling Head is used for room air monitoring. The unit was tested with 10 µm aerodynamic diameter aerosols and 100% collection efficiency was measured at 1 CFM flow rate.

Self-Diagnostics

Hardware Self-Diagnostics

When the Alpha-7 is first powered up, the Display Board tests each of the alarm and the status lights, the beacon, and the Sonalert.

Software Self-Diagnostics

During the normal operation, the Alpha-7 Server software constantly (once each second) calculates the MDC (Minimum Detectable Concentration) and MDA (Minimum Detectable Activity) and compares it to the alarm levels for concentration and dose. If the sensitivity is not sufficient to measure the proscribed levels, the Alpha-7 flashes the *Normal* light, reports an isotope status of BELOW MDC/MDA, and on the Dose Control report in the Alpha-7 Client highlights the isotope in white. When the MDC is below the alarm level, the isotope row is highlighted in green.

Each time a curve fit is performed on the spectrum, a goodness-of-fit parameter is evaluated. If the quality of the fit is “bad” for 20 consecutive measurements, then the POOR FIT status is posted and the unit goes into a failed condition.

As the spectrum becomes more defined over time, the MDC and MDA levels will improve. However, as the filter begins to load, the minimum-detectable levels will reach a minimum then begin to rise again. Once the MDC or MDA rises above the proscribed alarm level, and the filter has accumulated for at least 24 hours, a FILTER DIRTY status will be posted.

Options

Radial Head Sampling Head

Order Part No. **ALPHA7 OPT2**

In-Line Head Sampling Head

Order Part No. **ALPHA7 OPT3**

In-Line Head Filter Tray Assembly

Order Part No. **YP11653044**

In-Line Head Source Holder

Order Part No. **YP11653054**

In-Line Head Sample Line Adapter

Adapter, air inlet tube – Alpha-7 requires 1.25 inch Swagelok fitting to mate to 1 inch stainless sample lines.

Order Part No. **ZP11653053**

Remote Head Communications Cable

This cable, for connecting the Alpha-7 to a Remote Sampling Head, is available in a three and ten-foot lengths and is compatible with both the Radial-Entry Head and the In-Line Head.

3-ft Cable: Order Part No. **CA-134-03FT**

10-ft Cable: Order Part No. **CA-134-10FT**

Fluoropore Filters

This is the recommended filter for use in the Alpha-7. Millipore 5µm Fluoropore filters with black backing. Box of 100.

Order Part No. **FIFP15**

Plutonium Calibration Source

Pu-239 Alpha standard, 1-7/8 In. diameter stainless steel disk with 1-Inch active area. Activity of 20,000 to 45,000 CPM (0.009 to 0.02 µCi). Certificate of Calibration traceable to NIST is supplied.

A specific license from the NRD is required, either by the customer or by the shipper. The customer must have a license.

Order Part No. **DNS-17SP**

Thorium Calibration Source

Th-230 Alpha standard, 1-7/8 In. diameter stainless steel disk with 1-Inch active area. Activity of 20,000 to 45,000 CPM (0.009 to 0.02 µCi). Certificate of Calibration traceable to NIST is supplied.

A specific license from the NRD is required, either by the customer or by the shipper. The customer must have a license.

Order Part No. **DNS-17ST**

PCMCIA Adapter

This option provides and adapter which mounts on the SBC to support PCMCIA cards. Currently, the only card supported by the Alpha-7 is the Orinoco Gold wireless Ethernet card for use in wireless Alpha-7 networks.

Order Part No. **Alpha7L OPT1**

Spare Parts

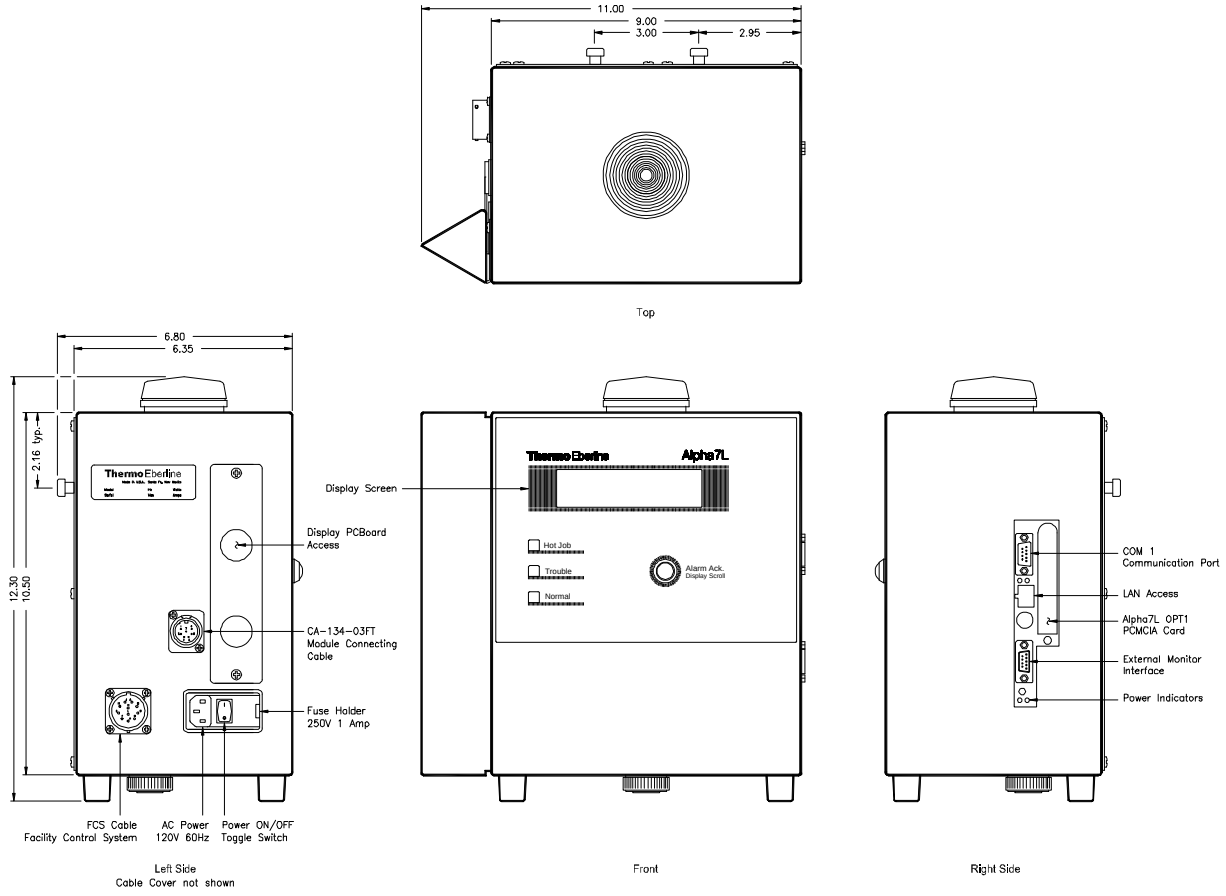
Alpha-7 Spare Parts Listing May 2001

Item	Part Number	Description	Location
1	ADSS2	SC628W Sonalert	Bottom plane of Alpha-7 case
2	CYDE8N	CYDE8N 490 mm2 diffused junction detector, configured for negative bias	Inside in-line detector housing
3	FGBR3	5/16 Hose ? 1/8 MPT	
4	FGBR68	Hex Coupling 1/8 FPT	
5	FGPL40	1/8MPT ? 1/8 Hose Elbow	
6	FGPL53	#10-32 ? 1/8 Hose Orifice, .016 dia.	
7	FGPL60	1/8 MPT x 10-32 UNF Reducer Fitting	
8	FUST2	Fuse, 1 A, 250V, 5 x 20 mm	
9	LPAS32	Strobe Light, Red, 12 VDC	On top of Alpha-7 case
10	MEVE263	Wide Input Power Supply	
11	MMBZ35	Hole Plug - 3/4 Inch - Black Plastic	
12	MMRU78	Bumper	
14	MMTU1	1/8 ID ? 1/4 OD Clear PVC Tubing	
15	MMTU2	5/16 ID ? 9/16 OD Clear PVC Tubing	
16	OPDE5	Optical Sensor, 0.125 Gap	
17	ORBN2010	2-010 BUNA N OR Neoprene O-Ring	
18	ORBN2025	2-025 BUNA N OR Neoprene O-Ring	
19	ORBN2027	2-027 BUNA N OR Neoprene O-Ring	
20	ORBN2031	2-031 BUNA N OR Neoprene O-Ring	Filter holder
21	ORBN2033	2-033 BUNA N OR Neoprene O-RING	
22	ORBN2132	2-132 BUNA N OR Neoprene O-Ring	
23	ORBN2132	2-132 BUNA N OR Neoprene O-Ring	

Item	Part Number	Description	Location
24	ORBN2227	2-227 BUNA N OR Neoprene O-Ring	
25	SGCO57	Compression Spring - .30 OD, .63 Long	
26	VEIN49	3.5 in. Hard Disk Drive, EIDE, >3 GB	
27	VEIN82	Single Board PC, GXM-233 processor, 64 MB SODIMM RAM	
29	YP11649054	Alarm Ack Switch Harness	
30	YP11653044	47MM Filter Tray Assembly	
31	YP11653072	Alpha-7 Display Board	
32	YP11653082	Alpha-7 Preamplifier Board	
33	YP11653092	Alpha-7 MCA Board	
34	YP11653094	Display Power Harness, Alpha-7	
35	YP11653095	Computer Power Harness, Alpha-7	
36	YP11653099	Sonalert Harness, Alpha-7	

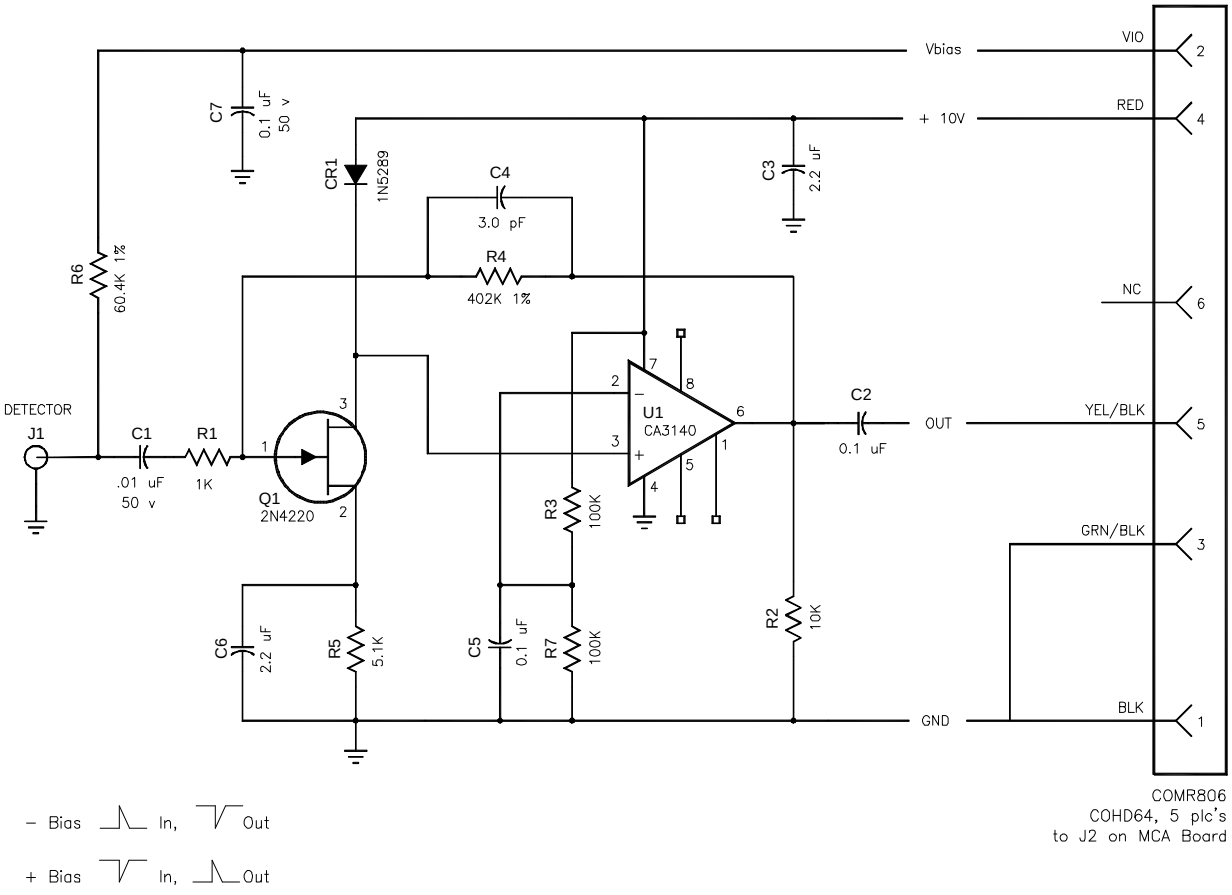
Drawings

Alpha-7 Outline Drawing



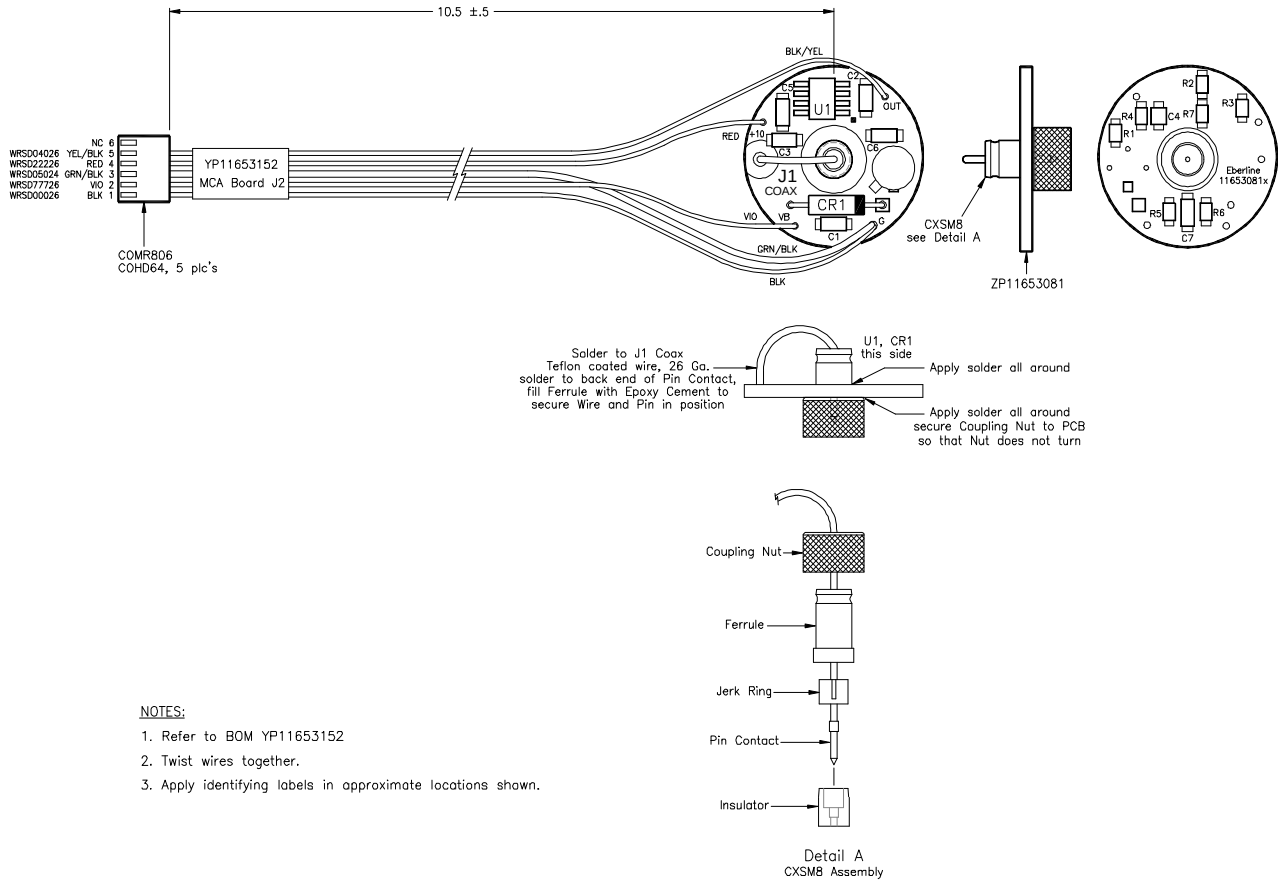
Central Module Outline, Alpha7L, 11653165A

Preamplifier Schematic



PreAmp Board Schematic, Alpha7L, 11653080A

Preamplifier Assembly

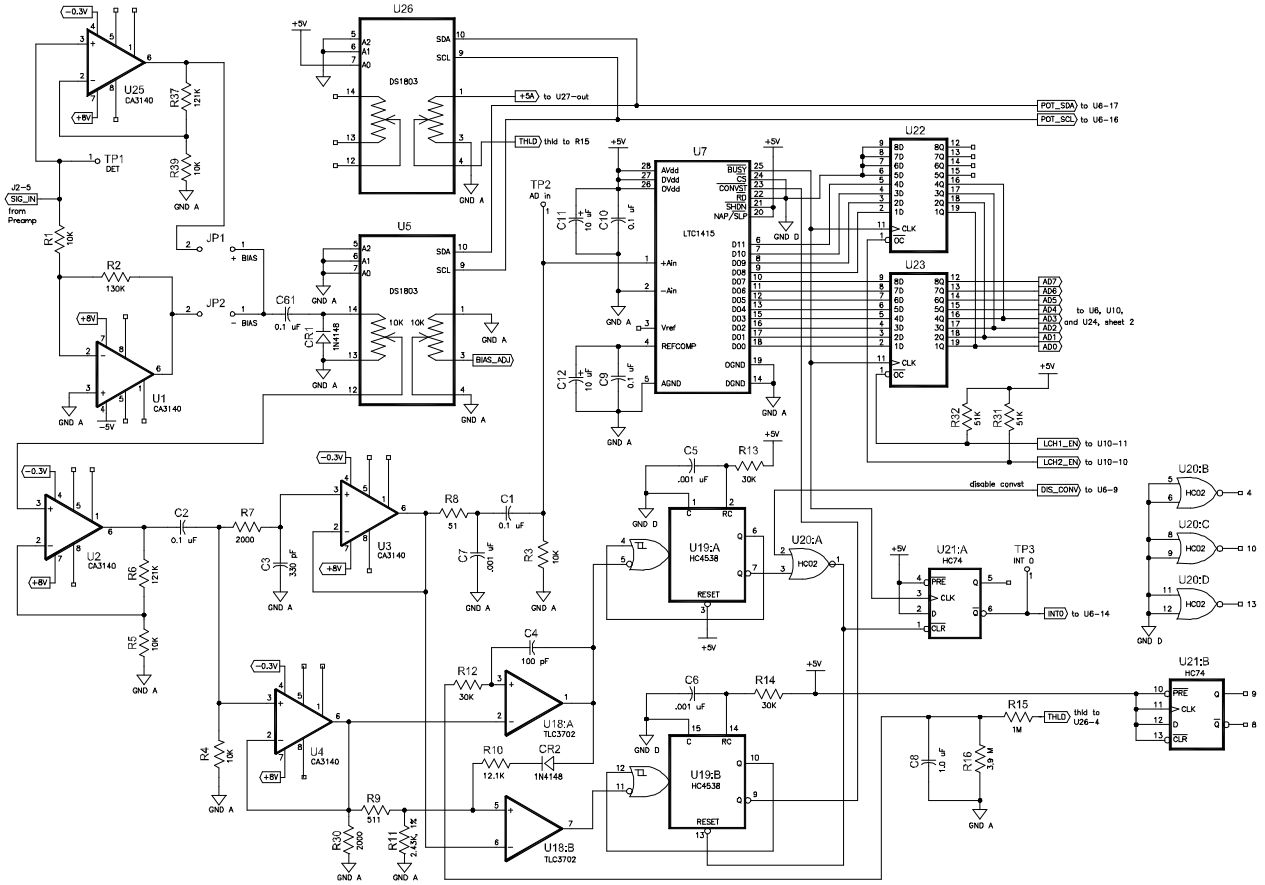


NOTES:

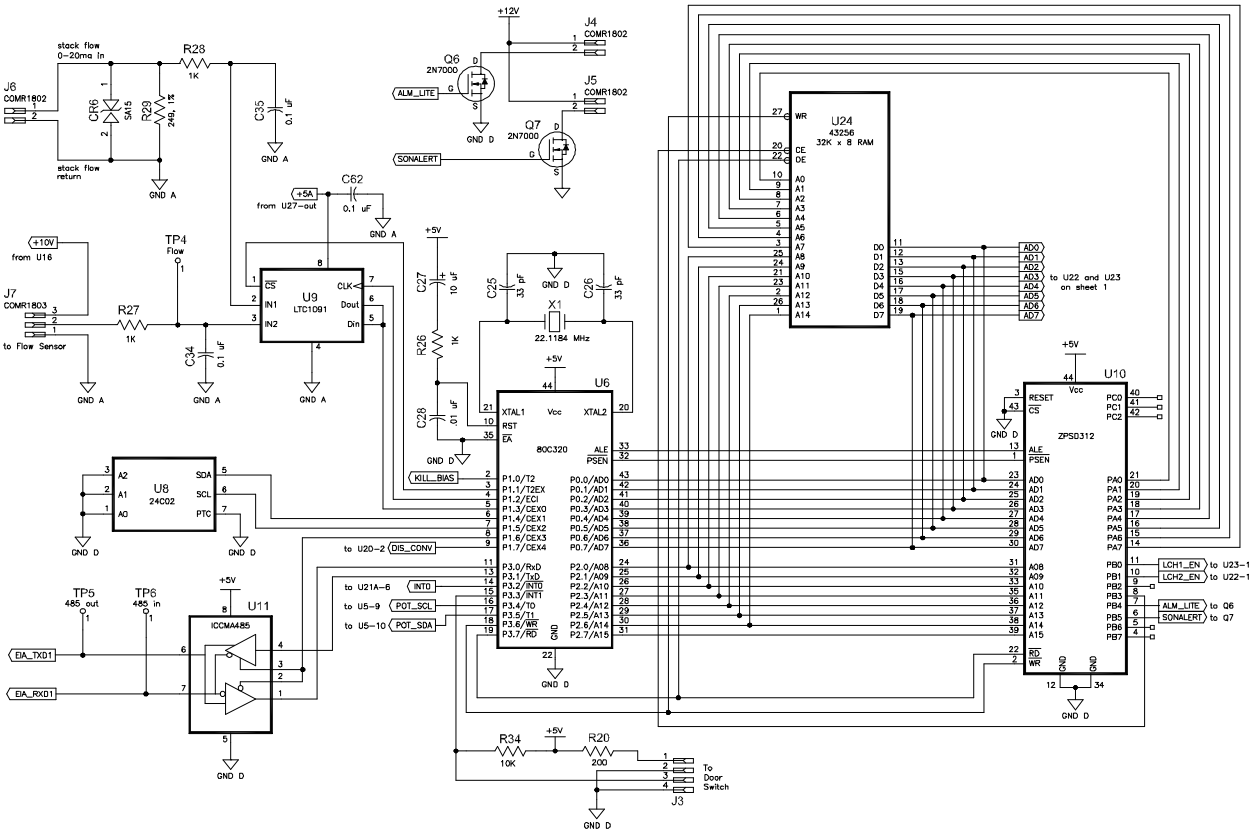
1. Refer to BOM YP11653152
2. Twist wires together.
3. Apply identifying labels in approximate locations shown.

PreAmp Board Assembly, Alpha7L, 11653152A

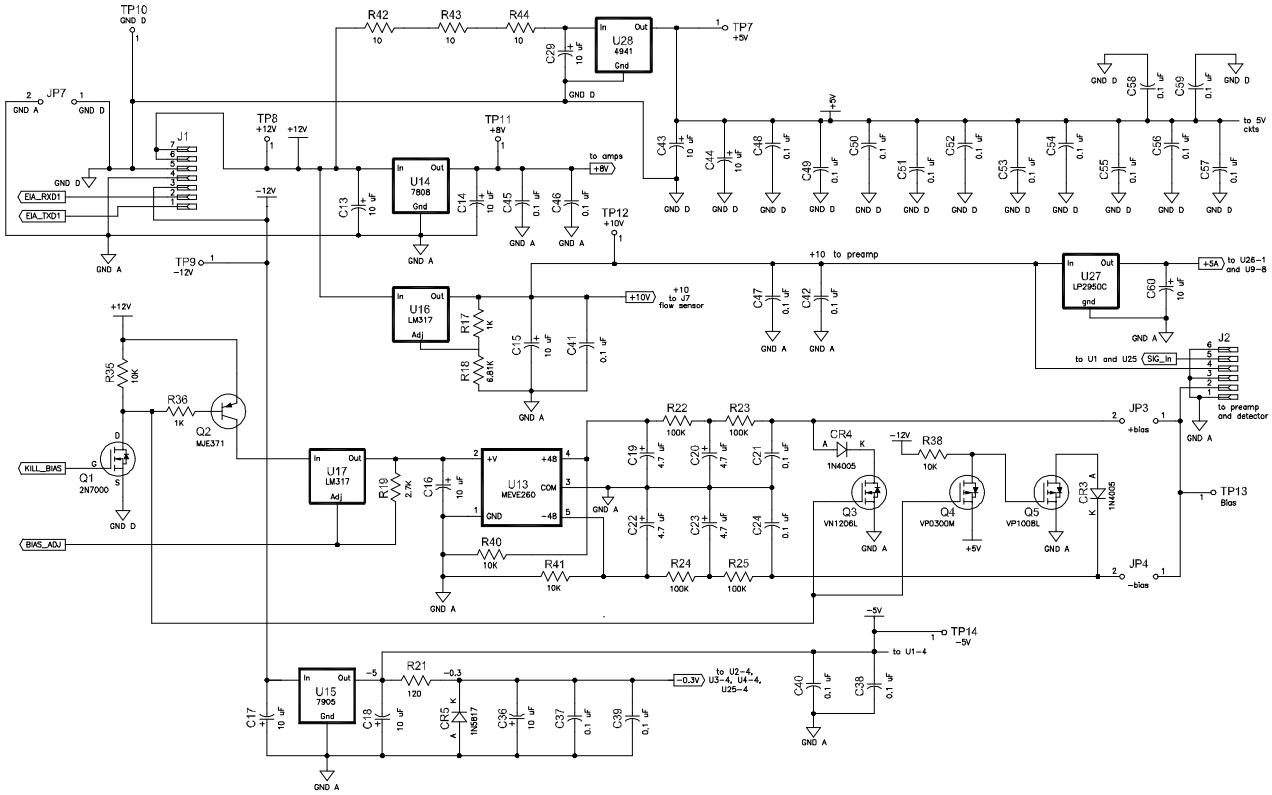
MCA Board Schematic



MCA Board Schematic, Alpha7L, 11653134A sheet 1 of 3

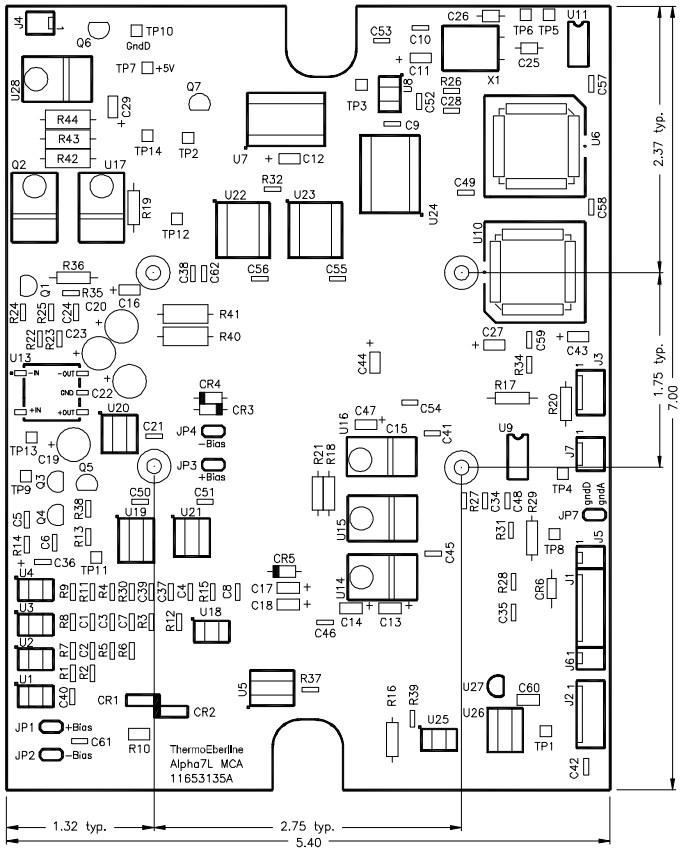


MCA Board Schematic, Alpha7L, 11653134A sheet 2 of 3



MCA Board Schematic, Alpha7L, 11653134A sheet 3 of 3

MCA Board Component Layout



Completed Board Primary Side

NOTES:

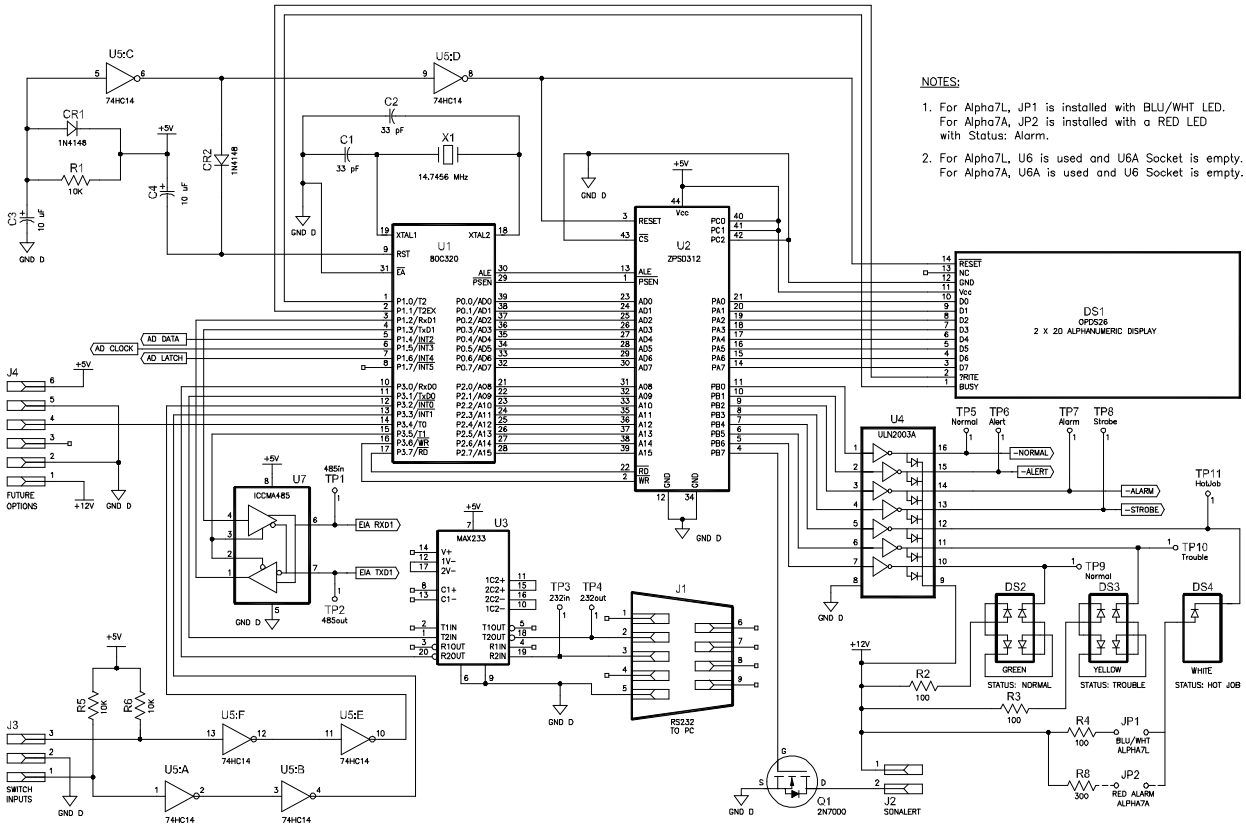
Refer to BOM YP11653136.

Refer to 11653134.dwg for schematic diagram.

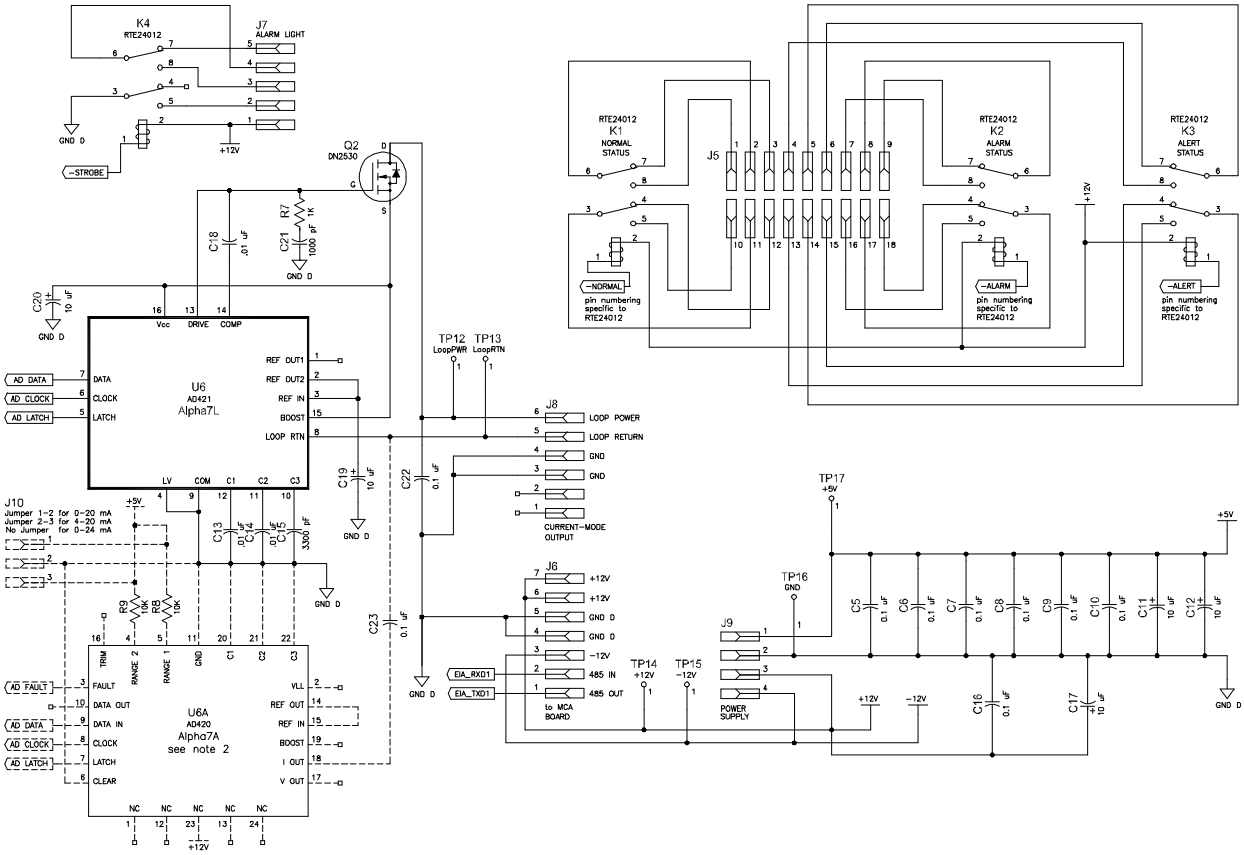
Designations shown are for reference only.

MCA Board Assembly, Alpha7L, 11653136A sheet 1

Display Board Schematic

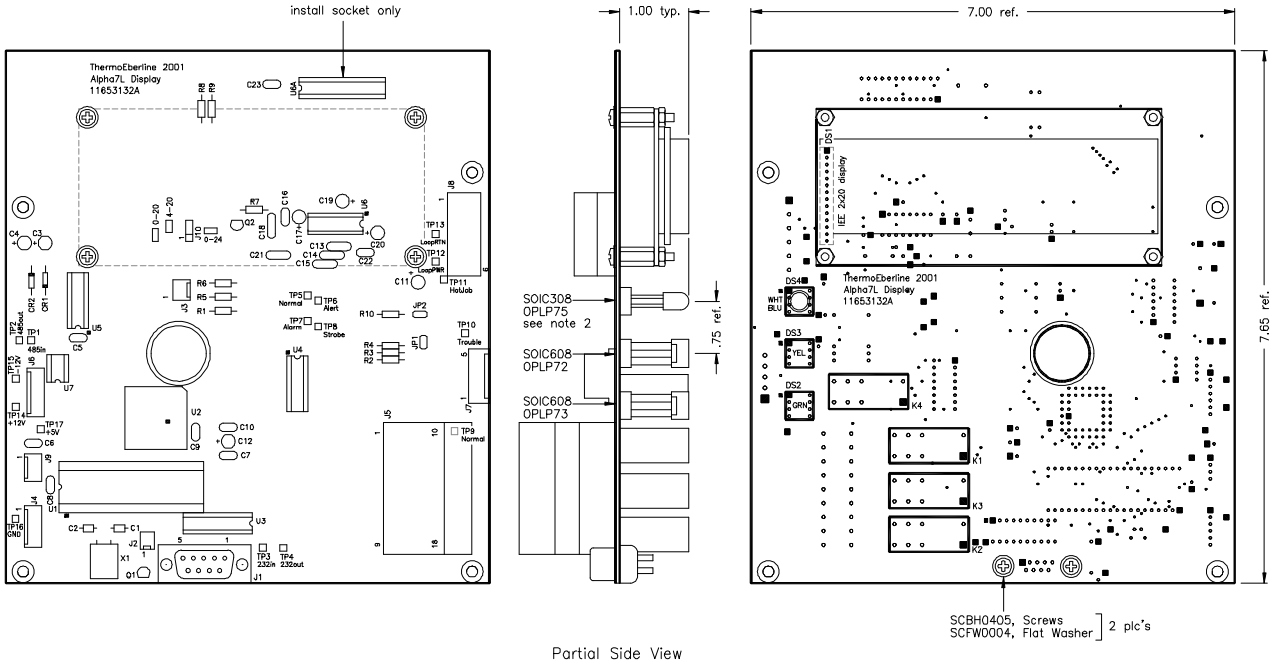


Display Board Schematic, Alpha7L, 11653131A sheet 1 of 2



Display Board Schematic, Alpha7L, 11653131A sheet 2 of 2

Display Board Component Layout



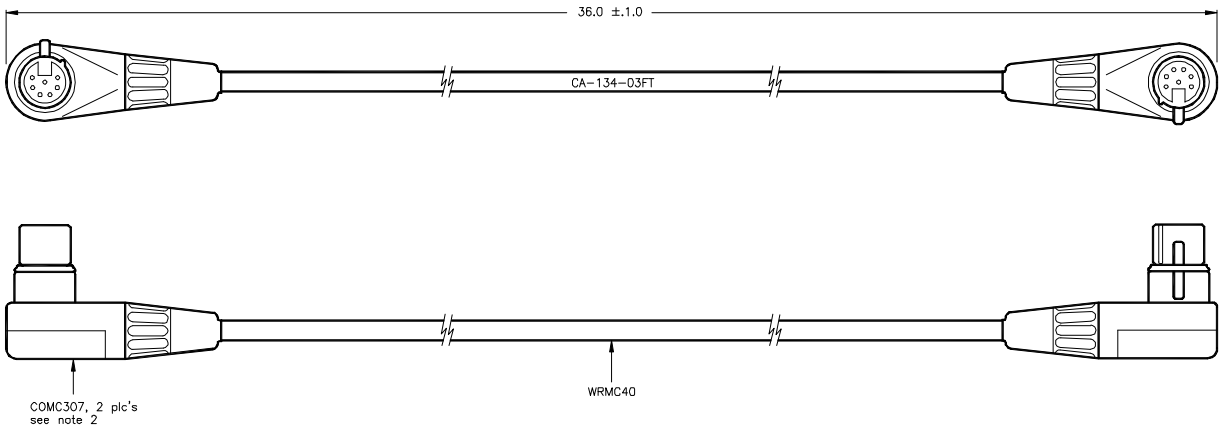
NOTES:

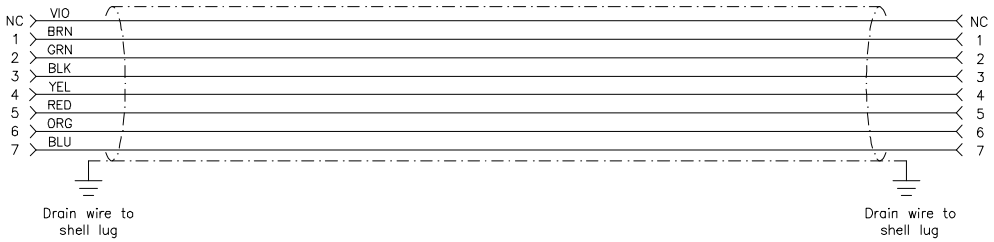
1. Refer to BOM YP11653133.
2. OPLP75, LED Anode to pin 2 and Cathode to pin 8. firmly secure pins in position to hold LED's position.
3. All IC are socketed.
4. U6A IC not installed in Alpha7L.

ATTENTION
ESD SENSITIVE DEVICE
HANDLING PRECAUTIONS REQUIRED

Display Board Assembly, Alpha7L, 11653133A

Alpha-7 Remote Head Communications Cable





NOTES:

1. Refer to BOM CA-134-03FT.
2. Observe opposite orientation of Connector head, COMC307.

CA-134-03FT Module Connecting Cable, Alpha7L, 11653145A

RAP-1 Vacuum Pump

The model RAP-1is a compact, portable system containing an oilless vacuum pump, motor and air flow regulator. The Thermo Eberline airflow regulator is designed to maintain a constant pressure drop across an in-line orifice by controlling a variable bypass valve into the pump. The orifice is adjustable, permitting flow rate adjustment from near zero up to the maximum pump flow velocity. This flow control system permits the pump to operate at a minimum pressure drop at all times which provides cooler pump operation to extend the lifetime.

Some RAP-1 operating curves are shown below. The top line is the pump operating curve. The curves below the pump operating curve show how the sample inlet flow varies with intake vacuum for two different regulated settings. After the regulator is set at a particular inlet flow rate, the sample flow rate follows a similar curve, decreasing as intake vacuum increases.

RAP-1 Specifications

Physical Specifications

Pump type	Oilless, carbon vane
Motor	1/4 HP, 115 Vac, 60 Hz, 6 A (220 V, 50 Hz version available)
Vacuum	19 inches at sea level
Flow rates	See figure 1
Size	17.75 inches long by 7 inches wide by 9.25 inches high (45.1 ? 17.8 ? 23.5 cm)
Weight	33 pounds (15 kg)

Available Accessories

PURK3	RAP-1 Pump Repair Kit
RAP1R RK1	Regulator Repair kit
RAP1 RK2	Pump and Regulator Repair Kit

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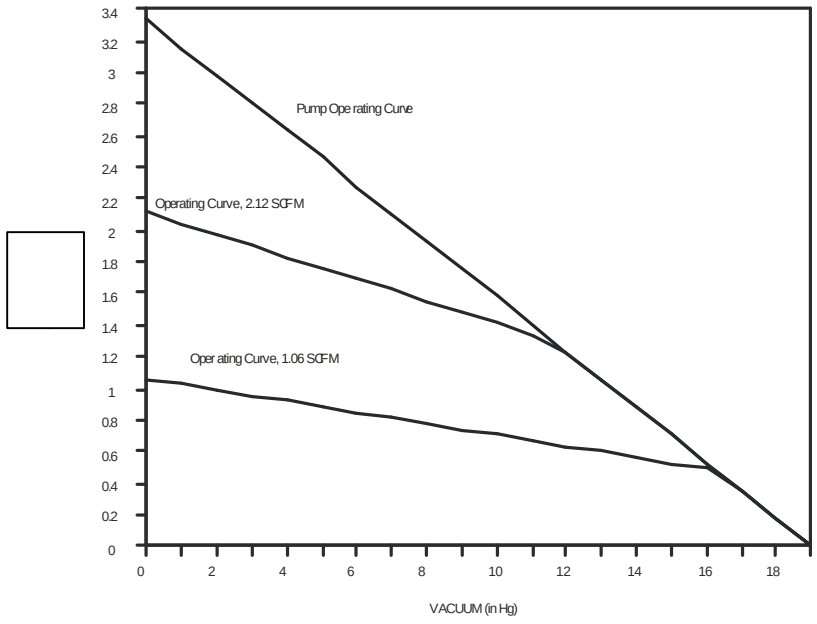
PERFORMANCE CURVES, RAP-1 PUMP



Operating Instructions For RAP-1/RAS-1

The Thermo Eberline Model RAP-1 consists of a vacuum pump and an airflow regulator. The RAS-1 is essentially a RAP-1 with an airflow indicator, vacuum gauge and a filter paper holder added.

To use the RAP-1, remove the two dust caps on the regulator portion of the pump, one located on the fitting marked AIR IN, the other located on the jar assembly of the bypass air inlet. Connect a line or hose to the fitting on the regulator marked AIR IN. The desired airflow may then be set by adjusting the screw in the side of the regulator body marked FLOW ADJUST. To increase the flow, turn the screw counterclockwise and to decrease flow, turn it clockwise.

To use the RAS-1, remove the dust plug located on the jar assembly of the bypass air inlet. Remove the plastic cover from the filter paper holder. Remove the paper clamp by turning the outer ring counterclockwise. Remove the holder and replace the clamp by turning the outer ring clockwise. Turn on the pump and observe the flow rate on the flow meter. If an adjustment is desired, change the flow as described in the paragraph above. The observed airflow reading vs. the actual airflow will differ except under ideal conditions, which are rarely encountered. The actual flow can be obtained by multiplying the flow rate on the flow meter by the square root of the absolute pressure at the inlet to the flow meter (this is the sum of the atmospheric pressure minus the vacuum as read on the gauge) divided by 29.92 inches Hg (atmospheric pressure at sea level).

When using the RAP-1 and RAS-1, do not attempt to control airflow with an external valve in the line. This will defeat the function of the regulator and will cause the pump to work at maximum power, which will, in turn, cause it to run hotter and shorten the pump life. Do not close off the AIR BY-PASS line of the regulator.

Theory of Operation For RAP-1 Regulated Air Pump

The performance curves for the RAP-1 pump/regulator are shown in Figure 1. The regulator can be set for small sample flow rates with negligible head loss added to the system. This is accomplished by the introduction of bypass air into the stream. The bypass air allows the pump to operate at its maximum capacity. The additional air that is drawn through the bypass port causes the pump to run cooler and thus increases the life of the pump. As indicated in Figure 1, the sample flow rate will remain fairly constant over the wide range of external head losses (increasing vacuum) that would be caused by plumbing, filter loading, or elevation above sea level.

A cross section of the regulator is shown in Figure 2. The following explains briefly how the bypass valve on the regulator works.

Air flow into the sample air inlet passes through the variable orifice, causing a pressure drop across that orifice. Each side of the orifice is vented to corresponding sides of the diaphragm, so that the pressure drop positions the diaphragm across the orifice.

Attached to the diaphragm is the bypass valve. With the adjusting screw set to the position for the desired sample flow, the pump draws air from both the sample and bypass inlets. As the sample flow decreases (as would be the case when the filter paper loads up with particles) the pressure drop across the orifice decreases. This results in a repositioning of the diaphragm as the force of the spring is now more than the force created on the diaphragm by the pressure drop on the orifice. The spring pressure on the diaphragm causes the bypass valve to close slightly allowing less air to flow into the bypass inlet. Since the pump is operating at the maximum flow as the bypass flow decreases the sample flow increases, returning to near the preset flow rate. Thus for a given sample flow rate (as set by adjusting the orifice) as the sample flow rate is changed, the diaphragm moves to open or close the bypass inlet. This increases or decreases the bypass flow, which in turn decreases or increases the sample flow, reestablishing the preset value.

As with most regulators systems, the RAP-1R is not ideal. As the sample flow decreases (as measured by increased vacuum at the sample inlet) the adjustment of the regulator to reestablish the sample flow rate leaves the flow slightly lower than the original value. Refer to the performance curves, which show two sample flow rates. As the vacuum increases the flow value moves along a path shown by the typical values of 60 and 30 lpm. If it is desired to maintain a flow value + or - a given tolerance, one recommendation is to start the flow at the desired value + the tolerance. As the filter loads up, the flow will decrease to the value - the tolerance. This provides an average flow rate of the desired value over the period of filter loading.

Maintenance

A. Vane Replacement: The hard carbon vanes should be replaced after 6,000 hours of service. All four vanes should be replaced at the same time. In order to replace the four vanes, remove the inlet and outlet filters on the muffler box of the pump. Next, remove the 5 bolts from the muffler box.

When removing the muffler box, take a look at the gasket sandwiched between it and the end rotor shield plate. Replace the gasket if necessary. Next, remove the 6 bolts on the rotor shield plate. Use compressed air to clean out the pump chamber especially if a vane has broken. Do this prior to inserting new vanes. Remove the four vanes behind the shield plate,

noting their edge curvature orientation. Put the new vanes in the same way. Re-torque the six bolts on the end rotor shield plate with a torque not exceeding 100 in-lbs.

Sometimes when a vane breaks a piece will wedge between the top of the rotor and the body, opening the top clearance. The top clearance should be .002 inches. This can be checked with a feeler gauge. The rotor should be turned while checking this clearance so that all points on the circumference of the rotor will clear. To reduce the top clearance to .002 inches, tap LIGHTLY on the top of the body with a miniature hammer.

DO NOT at any time remove the rotor. DO NOT loosen bolts on either the body or mounting bracket, because this will destroy the preset clearance between the rotor and these parts.

B. Cleaning: If the pump is permitted to run with a dirty filter or no filter at all, excessive dirt, foreign particles, moisture and possibly even oil (from vapors in surrounding air) could accumulate in the chamber. Any of these could cause the vanes to act sluggish or even break.

Flushing the pump (see below) should take care of these situations, but if not, remove the end plate for further examination.

C. Flushing: This is accomplished by removing the filter assemblies and adding several teaspoons full of *cleaning solvent at the intake while the pump is running. Repeat the flushing procedure again and, after all the solvent has passed through the pump, replace the filters. Flush the pump several times a year.

To clear the filter and muffler felts, brush off excess dirt, lint, etc. Wash in cleaning solvent[9] and dry before installing.

[9] Recommended Solvent: Gast Flushing Solvent, part number AH255. Flush unit in a well-ventilated area. Use eye protection and keep your face away from the exhaust port. Do not use a flammable cleaning solvent, such as kerosene.

Model RAP-1 Parts List

Item	Part Number	Description	Use
1	PUVA1	Pump	
2	PUHD43	Filter Felt	For Pump
3	PUHD44	Gasket	For Pump
4	PUHD45	Muffler	For Pump
5	PUHD46	Vanes	Hard Carbon, For Pump, buy in quantities of 4
6	PUDH24	Jar Assembly	Bypass Air Water Trap
7	PUHD3	Jar	For Water Trap
8	PUHD5	Filter Felt	For Water Trap
9	PUDH26	Jar Gasket	For Water Trap
10	RAP1R	Regulator	
11	ZP10552007	Diaphragm	For RAP-1R
12	ORTF2008	2-008 O-Ring Teflon, 3/16" id5/16" OD	For RAP-1R
13	ORBN2007	O-Ring, Buna-N or Neoprene, Parker 2-007, 5/32" id x 9/32 O.D. for RAP	

Model RAP-1/RAP-1R Repair Kits

1. Pump Repair Kit, Thermo Eberline Part No. PURK3 contains:

Description	Quantity	Thermo Eberline Part No.
Filter Felt	2 ea	PUHD43
Gasket	1 ea	PUHD44
Vanes	4 ea.	PUDH46

2. RAP-1R Repair Kit, Thermo Eberline Part No. RAP1R RK1, contains:

Description	Quantity	Thermo Eberline Part No.
Neoprene O-Ring	1 ea	ORBN2007
Diaphragm	1 ea	ZP10552007
Teflon O-Ring	1 ea	ORTF2008

3. RAP-1 Repair Kit, Thermo Eberline Part No. RAP1 RK2, contains:

Description	Quantity	Thermo Eberline Part No.
Pump Repair Kit	1 ea	PURK3
RAP-1R Repair Kit	1 ea	RAP1R RK1