

Protean  
Instrument  
Corporation

WPC-1050

Revision 1.0

# Protean Instrument Corporation

2

Contents	
About This Manual .....	9
Installation Overview .....	10
Unpacking Instructions .....	10
Unpacking the Mobile Cart Crate (Optional) .....	10
Preliminary Preparations .....	13
Inspect the Detector .....	14
Connect the Counting Gas .....	15
Preliminary Procedures.....	17
Printer Testing (Optional) .....	18
Manually Count a Test Source .....	22
Print and Save Factory Plateau .....	24
Installations Without Attached Printer .....	25
Setting the Calendar/ Clock .....	25
Replace the Cabinets and Install the Stacks.....	25
Load Carriers and Test the Sample Changer .....	26
Read the Manual.....	27
WPC-1050 Overview .....	28
Menu Driven Operation .....	28
Pass Code Protection .....	28
Count Function.....	28
Calibration Function.....	28
Control Charts .....	28
Program Function .....	29
Counting Parameters .....	29
Background Parameters.....	29
Efficiency Parameters .....	29
Battery Backup.....	29
Printer .....	30
Computer Connectivity .....	30

# Protean Instrument Corporation

3

International Power Entry.....	30
Limited Warranty.....	30
Sample Loading.....	31
The Five Types of Plates.....	31
Sample Carrier Plates.....	32
End Plates.....	32
Skip Plates.....	32
Routine Plates.....	32
QC Plates.....	32
Prepare Changer.....	33
Selecting Sample Carriers.....	33
The WPC-1050 Console.....	34
The Rear Panel.....	34
Getting Started.....	35
Count a Sample.....	35
Step 1 Define.....	35
Define Counting Routines.....	36
Routine Definition Page 1.....	37
Routine Definition Page 2.....	38
Routine Definition Page 3.....	38
Routine Definition Page 6.....	39
Step 2 Calibrate.....	40
Step 3 Single Sample Count.....	42
Step 3 Batch Count.....	44
Review.....	46
Batch Input.....	47
Edit Batch Input.....	48
Import Batch.....	49
Setup Menu.....	50
Screen Utilities.....	50

# Protean Instrument Corporation

4

Calibrating the Touch Screen .....	50
Backlight Brightness .....	51
Beep Volume .....	52
Program Menu .....	53
Import Settings.....	53
Instrument Parameters .....	54
Auto Count Options .....	55
Query Options .....	55
Restack When Finished .....	56
Auto Start Options .....	56
Cycle Recount.....	56
Cycle Delay .....	56
Printer .....	57
Gas Flow Option.....	58
Set Calendar/Clock.....	59
Setup Pass Codes .....	60
Set Instrument ID .....	61
Define Counting Routines .....	61
Count Routine Definition Page 1.....	62
Naming the Count Routine .....	62
Preset Time .....	62
Minimum Count Time .....	63
Repeats .....	63
Preset Counts .....	63
Specifying the Counting Mode.....	64
Alpha Only .....	64
Alpha and Beta.....	64
Results Storage.....	64
1 Page per Sample.....	64
Automatic Print.....	64

# Protean Instrument Corporation

5

Completing Count Routine Definition Page 1 .....	64
Count Routine Definition Page 2.....	65
Count Routine Definition Page 3.....	70
Count Routine Definition Page 4.....	71
Count Routine Definition Page 5.....	72
Count Routine Definition Page 6.....	73
Calibration Menu .....	75
Plateau Determination.....	76
Acquiring a Plateau .....	77
Viewing a Plateau.....	78
Manual Background/Efficiency Entry.....	79
Radon Efficiency Factors .....	81
Import Control Chart Limits .....	82
Print All Calibration Info.....	82
Control Charts .....	83
Manually Acquiring Control Checks .....	84
Acquiring Control Checks .....	85
Data Menu .....	86
View Count Routine Data.....	87
Routine Data View .....	88
Display Option.....	89
Full Record View .....	89
Page Selection .....	90
Delete Count Routine Data .....	91
View Control Check Data .....	92
Background Control Chart.....	92
Alpha Control Chart .....	95
Beta Control Chart .....	97
Export Data .....	100
Diagnostics Menu.....	102

Trending ..... 103

Acquiring Trending Data ..... 105

Printing Trending Data ..... 107

Manual Count ..... 108

The Data Display ..... 109

Printer Test..... 110

Guarding Against Obsolescence ..... 111

Plateau Data CSV File Format ..... 112

Alpha Control Chart Checks Data CSV File Format ..... 113

Beta Control Chart Checks Data CSV File Format ..... 114

Background Control Chart Checks Data CSV File Format..... 115

Sample Data CSV File Format..... 116

Trend Data CSV File Format ..... 117

Radon Subtraction ..... 120

    Determination of Radon Efficiency Factors ..... 121

    Routine Counting with Radon Subtraction ..... 121

External Control ..... 122

Service Guide Introduction ..... 123

    The Power Supply Subsystem ..... 123

    The Detector Subsystem ..... 123

    The Gas Flow Subsystem..... 124

    The Sample Changer Subsystem..... 124

    The Linear Electronics Subsystem..... 124

    The CPU Subsystem ..... 125

    General Instructions..... 126

    Removing the Cover..... 126

    Opening and Closing the Shield ..... 127

    Removing the Sample Detector ..... 128

    Installing the Sample Detector..... 128

    Power Entry..... 128

Fuse Rating..... 128

Line Voltage Selection..... 128

Checking the Low Voltage Power Supply (LVPS)..... 129

LVPS Voltage Check..... 129

LVPS Replacement ..... 129

Service Guide for Gas Flow Subsystem ..... 130

Low Gas ..... 131

The Gas Filter ..... 131

Gas Tank Precautions..... 131

Operating Environment ..... 131

General Electrical Failures..... 131

Blows Main Fuses..... 131

Failure to Initialize on Power-up..... 132

Intermittent Lockup ..... 132

Trouble Shooting the Linear Channels..... 133

APA-10-D and HV-20-D Status Indicators ..... 133

Beta Background is High? ..... 133

Sample Counts are zero? ..... 134

Performance Changes – Background..... 134

    Gas Quality ..... 134

    Contamination ..... 134

    Electronic Noise ..... 135

Performance Changes – Efficiency..... 135

    Geometry ..... 135

    Gas Quality ..... 135

    Sample Changer ..... 136

    Plateau Settings ..... 136

    Replacing the Entrance Window..... 137

    Detector Contamination ..... 137

Variable Definitions and Equations..... 138

# Protean Instrument Corporation

8

Concepts of Alpha / Beta Counting.....	143
The Alpha / Beta Counter .....	143
Gas Filled Proportional Detectors.....	143
Count Time Requirements .....	144
Low Background Concepts.....	144
Shielding and Background.....	144
The Cosmic Guard and Background.....	145
Low Background Material Selection .....	145
Background Stability .....	146
Absolute Counting Efficiency .....	146
Intrinsic Detector Efficiency.....	146
Counting Geometry and Efficiency .....	147
Sample Self-Absorption and Counting Efficiency.....	148
Calibrated Conversion Factors .....	149
The Control Chart.....	149
WPC-1050 OPTIONS.....	150
WPC-1050 SPARES & ACCESSORIES .....	150
LIMITED WARRANTY .....	151



## About This Manual

This manual provides the information to install, operate, and service the WPC-1050 Alpha/Beta Counting instrument. Also included is a brief introduction to fundamental concepts of alpha/beta counting and instrument architecture. The WPC-1050 is a sophisticated counting instrument that is very easy to use. The operations embedded in the instrument adapt to almost every alpha / beta counting application. At the same time, simple counting tasks remain simple, and can be done with the WPC-1050 quickly and easily.

For additional assistance or information contact us at:  
Protean Instrument Corporation  
231 Sam Rayburn Parkway  
Lenoir City, TN 37771

Phone: (865) 717-3456  
FAX: (865) 717-3456  
[www.proteaninstrument.com](http://www.proteaninstrument.com)

**WARNING: The power plug for this instrument shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument is likely to make the instrument dangerous.**

**WARNING: Opening the cover of this instrument is likely to expose dangerous high voltages. Disconnect the instrument from all voltage sources while it is being opened.**

**WARNING: Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.**

## Installation Overview

This section is intended to provide guidelines for unpacking and installing your WPC-1050 Alpha/Beta Counting instrument. The installation procedures will introduce many of the diagnostic tools provided by the instrument. The intention is to get all hardware connected and verified before embarking on the setup and calibration of the instrument.

### Unpacking Instructions

The standard instrument is shipped in one wooden crate. A second wooden crate will contain the mobile cart option if it was ordered. The crates are identified as follows. Optional printers, computers, etc, are shipped in separate boxes.

Crate 1 (514 lbs) - This crate is identified by its A-frame top and contains the instrument and accessories.

Crate 2 (307 lbs) (Optional) – The large rectangular wooden crate contains the WPC-02 mobile cart option. **Open crate 2 first if it is included with the shipment.**

The following instructions are a guide to unpacking the instrument.

#### Unpacking the Mobile Cart Crate (Optional)

- Identify crate 2 containing the mobile cart and remove the top and one side. If there is no crate 2 ignore this section.
- Remove the cart and tilt to an upright position.
- Place the vinyl mat on top of the cart.
- Instructions for installing the gas cylinder mount and support clamp are included in the appendix of the instruction manual under the WPC-02 option. Set aside the hardware until this is to be performed.

#### WARNING

***If you did not purchase the mobile cart and plan to place the instrument on a table or lab bench take notice. The WPC-1050 weighs approximately 427 lbs. Make sure your table will SAFELY support this weight.***

## Unpacking the WPC-1050 Crate

- Identify crate 1 and remove the 4 lag screws on each corner.
- With a person at each end, lift the A-frame top straight up being careful not to scratch the cabinet cover.

**Important - The lead shield is in the left rear of the instrument as you face its front. Observe the orientation of the rods relative to the instrument as they are packed inside the crate. This is the same orientation which must be used when they are used to lift the instrument. As you face the front of the instrument, the rods will extend longer from the left side and shorter from the right side. This will partially compensate for the unbalanced weight when the unit is lifted.**

- Tag the lift rods as front and rear respectively according to the way they are packed in the crate.
- Remove the clamps securing the lift rods and set the rods aside.
- Remove the turnbuckles securing the instrument to the bottom of the crate.
- Identify and set aside the following contents:
  - Instruction Manual
  - Gas Tank Regulator
  - Power Cord
  - Sample Carriers and Control Plates
  - Sample Carrier Inserts (planchet holders)
- Remove the accessories box from the crate.
- The sample stacks are packed underneath the accessories box. Remove and set aside with the other accessories.
- Lift the front instrument cover and set aside.
- Left the rear instrument cover and set aside.
- Inspect the shipping brace attached to the lead shield. Make sure it is secure.
- Inspect and report any observed damage inside the instrument.

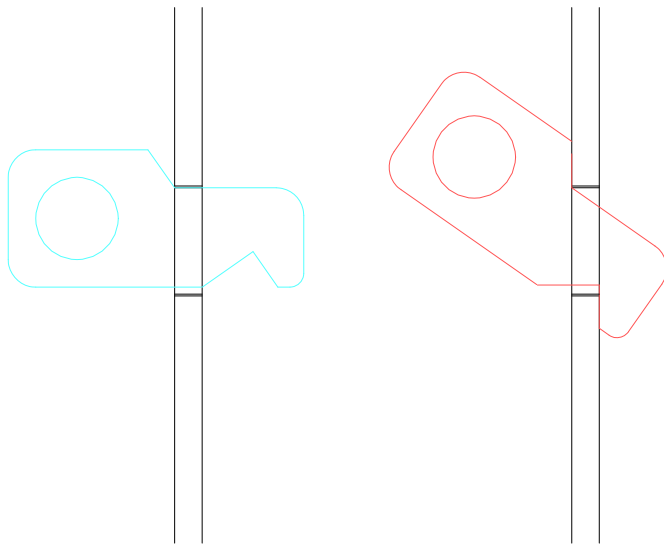
## Removing the WPC-1050 from the Crate

Prepare to remove the instrument from the crate. It is recommended that four people be available (one on each end of the lifting rods) as the instrument weights approximately 410 lbs. Instruct your helpers as to the proper lifting technique. (Lift with your legs – Not with your back!)

*The weight is unequally distributed in the instrument. The offset lengths of the lift rods partially compensates for the imbalance, none-the-less, the man on the rear left will lift about 30% more than the others. It is essential that everyone lift together.*

Insert the lift rod locks into the base holes as shown in the Insertion Position figure below.

Simultaneously raise both ends of the lift rod such that the locks engage the cabinet base as shown in the Lifting Position figure below.



Insertion Position

Lifting Position

If you do not have the wheeled cart option, and the instrument is to be moved to another area find a sturdy cart or dolly. **Do not expect to carry the instrument for any distance.**

Remove the instrument from the crate and transport it and all accessories to its installation location.

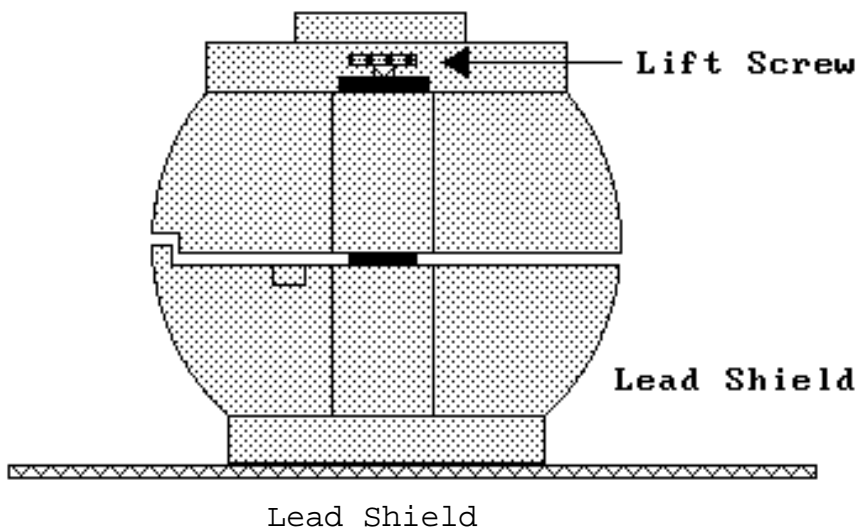
**Preliminary Preparations**

Before applying power and pressing buttons, there are a few preliminary details to consider. The instructions that follow assume that the instrument is positioned in its permanent location in preparation for usage. Do not block the left side from accessibility. When the user performs routine maintenance or otherwise need to access the detectors, the shield rotates and overhangs the left side of the instrument by about six inches. We recommend that the left side be positioned on an unobstructed table edge with enough room for a person to kneel beneath the shield. Allow about six inches in the rear of the instrument for access to peripheral cables and gas connections.

- Remove the instrument cover. The cover is in two pieces a front and a rear. First lift the front cover and set aside. Next lift the rear cover and set aside. The rear cover cannot be removed with the stacks in place.
- Locate and remove the shipping brace on top of the spherical lead shield. Unscrew the top nut on each threaded rod and remove the brace. Loosen the jam nuts at the bottom of each threaded rod. Unscrew and remove each threaded rod. Save these parts for future use. It is our recommendation to install the brace any time the instrument is to be transported.

**Inspect the Detector**

- On top of the shield is a lifting screw identified by its plastic tee handle as seen in the figure below. Turn this screw clockwise as many times as it takes to fully lift the top part of the shield.
- Carefully rotate the top of the shield clockwise until it overhangs the left of the cabinet.
- Look up into the top of the shield and inspect the detector. Make sure the mounting screws have not loosened during shipment. The window is very fragile. Do Not Touch It! If the four mounting screws in the outside ring need tightening, do so carefully with a jeweler’s screwdriver. The lead is soft and over tightening will pull the inserts out of the shield.
- Rotate the top shield counter clockwise back into position over the bottom shield. Turn the lifting screw about four turns counter clockwise to start closing the shield. Make sure gas lines and cables are not pinched during this operation. Just before the two shields come into contact, push the top lightly in a counter clockwise direction to hold it against the stop machined into the back surface of the bottom shield. This insures alignment of the two halves as you continue to close the shield. Continue to turn the lifting screw counter clockwise until the shield is fully closed. Do not completely remove the lifting screw.
- Locate the four plastic plugs in the accessories kit and place in each hole vacated by the lifting rods.



**Connect the Counting Gas**

The accessories kit includes a two-stage gas tank regulator with a supply line and fittings attached. Counting gas is obtained from local suppliers for a small monthly cylinder rental fee and refill charge. The gas is referred to as P-10 counting gas and is a mixture of 90% argon and 10% methane. Other mixtures such as P-5 have been used with only slight changes in performance. Consistency in the mixture and purity are essential to stable operation.

In the USA, gas cylinders are offered in either T-cylinders containing approximately 300 cubic feet of gas or K-cylinders containing approximately 200 cubic feet of gas. T-cylinders are generally a better economical value. A T-cylinder supply will last about 14 weeks of continuous use with windowed proportional detectors.

The following procedure assumes your gas is contained in a cylinder. Should your laboratory be equipped with a manifold gas system, insure that the maximum inlet pressure to the instrument is 10 PSI. Connect the instrument to your manifold using the transparent gas line and quick disconnect fittings included with the tank regulator.

- A new tank of gas is generally pressurized to around 2400 PSI. Do not open the tank valve until the regulator is installed.
- Securely install the regulator on the gas cylinder. Note-Counter Clockwise to tighten.
- Close the regulator valve fully clockwise and set the secondary gas pressure adjustment to minimum (counter clockwise).
- Open the tank valve fully. The primary pressure gauge should indicate in excess of 2000 PSI. Check the regulator to tank couplings for leaks using a suitable liquid bubble solution.
- The gas fitting used to connect to the rear panel of the WPC-1050 has an internal valve. Press and hold the top of this fitting to permit gas flow.
- Open the regulator valve fully counter clockwise.
- Adjust the secondary regulator pressure to 10 PSI and allow the gas to flow for about 15 seconds. This will allow any particles which may have become dislodge from the tank coupling to be purged.
- Close the flow meter valve on the front of the WPC-1050 (fully clockwise).
- Connect the gas supply to the WPC-1050 using the rear panel connection.

**WARNING**

*The ultra-thin detector window is easily stretched or ruptured by excessive gas pressure and/or flow rate.*

- The front panel flow meter should indicate the proper flow rate. (Nominally 60 cc/min).
- Allow the gas to flow into the instrument for one hour before using.

If the gas supply is interrupted, air will enter the guard detector. When this occurs, the instrument should be allowed to purge for at least one hour before attempting to count samples or standards. This provides adequate time for air trapped in the lines or guard detector to be purged from the instrument. If this procedure is not followed, and increase in beta background may be observed during the period of poor gas integrity.

**WARNING: If your main power is not USA standard 120 VAC 60Hz, check the power configuration and fusing before proceeding. Refer to the section titled Service Guide Introduction.**

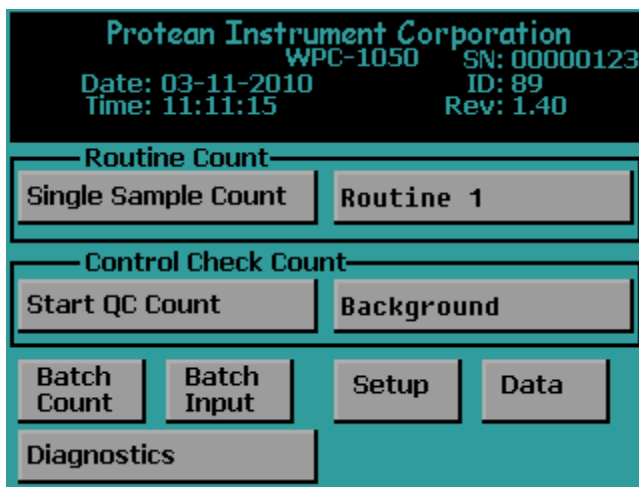
**WARNING: Keep your hands clear from all mechanical assemblies during the following tests.**



Preliminary Procedures

- Attach the power cord to the IEC power entry module on the bottom left of the rear of the instrument. Plug the power cord into the power mains and switch on the power. The power switch is also located in the power entry module above the cord.

The display should then show the Top Menu screen seen below.



**Printer Testing (Optional)**

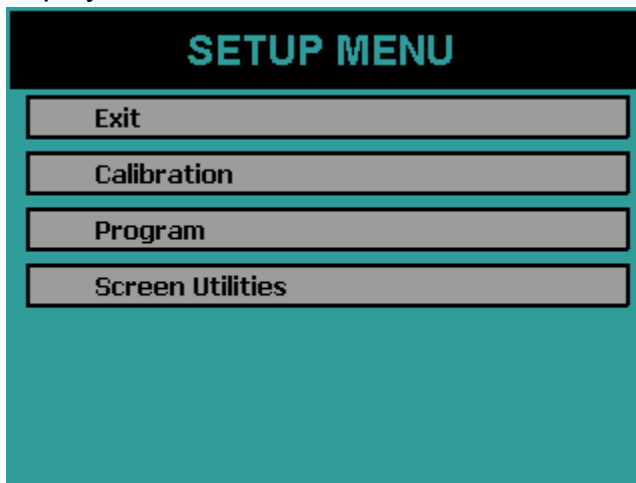
The WPC-1050 prints alphanumeric and graphic information. Graphic commands are kept to a minimum for compatibility purposes. The graphic control commands are compatible with printers that support 9P ESC/P or PCL5 printer command language. We do not maintain detailed instructions for all printer models and brands.

The printer connection is a standard USB interface.

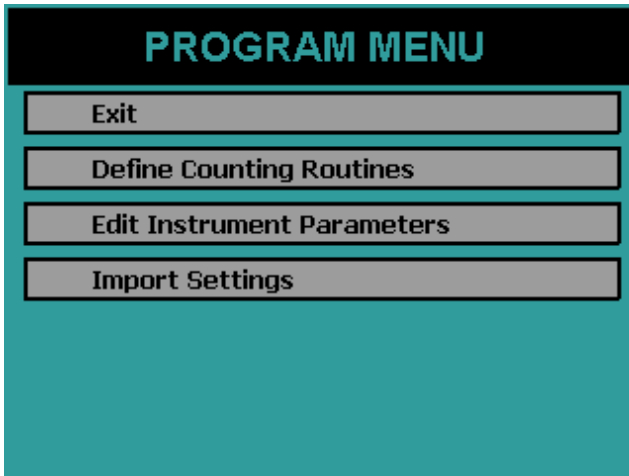
- Connect the printer USB cable to the back of the WPC-1050 USB port.
- Select the correct print driver.

The goal is to test the printer in order to do so the correct printer driver must be selected.

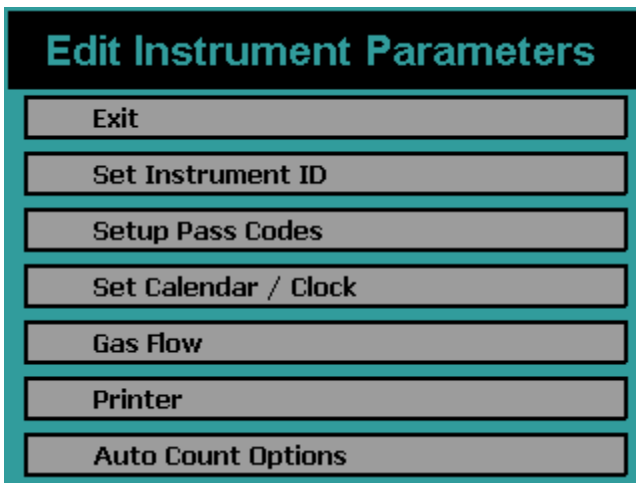
- Press the *Setup* button on the Top Menu screen. The Setup Menu will be displayed as seen below.



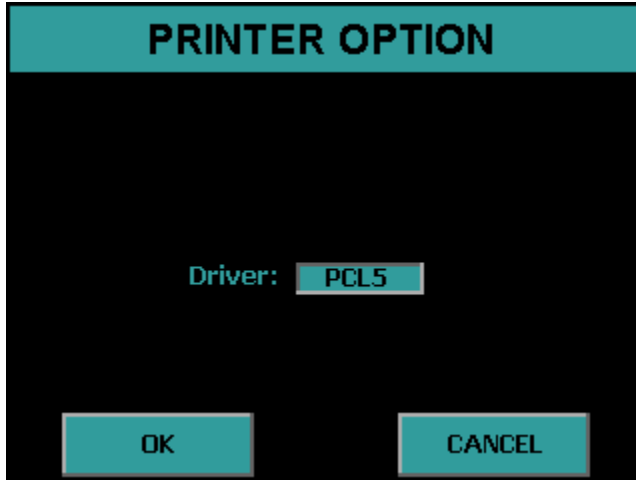
- Press the *Program* button. The Program Menu will be displayed as seen below.



- Press the *Edit Instrument Parameters* button to display the menu seen below.

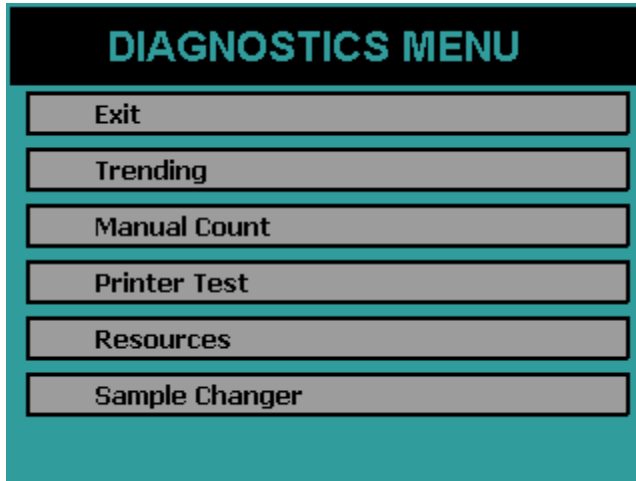


- Press the *Printer* button to display the Printer Option Menu below.



- If connecting a line printer toggle the button to show 9P ESC/P otherwise choose PCL5 for a printer using the PCL5 printer command language. Press *OK* to accept the changes.
- Press *EXIT* until the Top Menu is displayed.

- Press the *Diagnostics* button on the Top Menu.



- Press the *Printer Test* button. The printer should begin to print out a test page similar to the one shown below. If the printed test page appears normal then continue to the next phase of the installation. If the test page does not print correctly verify that the correct print driver is selected and that the printer cable connections are secure.

```
Test Page  
12345678910  
ABCDEFGHIJKLMNPOQRSTUVWXYZ  
abcdefghijklmnopqrstuvwxyz  
Test Graphics Mode
```



**Manually Count a Test Source**

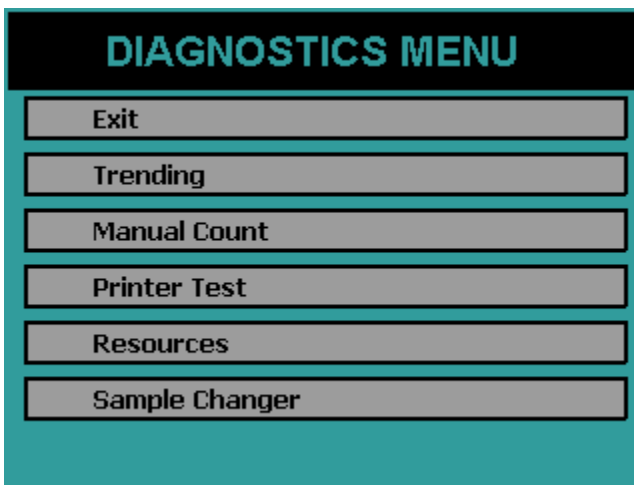
The following items are needed for this test:

- Source (choose a common beta source such as Sr/Y-90)
- Planchet
- Sample Carrier
- Carrier Insert

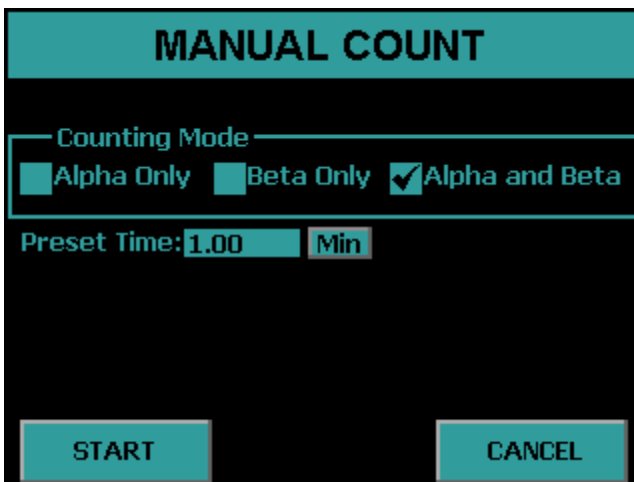
Use a planchet and carrier insert that holds the source as close to the top surface of the carrier as possible.

**The source planchet must not protrude above the plane of the top surface of the carrier.**

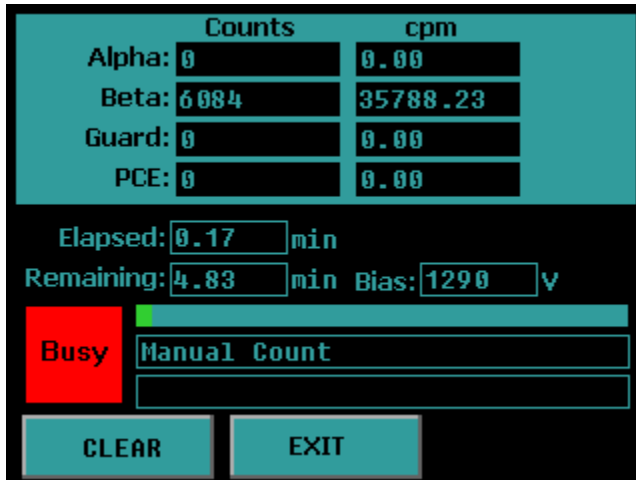
- Press the *Diagnostics* button on the Top Menu.



- Press the *Manual Count* Button. Refer to the Diagnostics section of this manual for a detailed account of the Manual Count routine.



- Select *Alpha and Beta* counting mode and Preset Time of 1 min
- Place the sample on the arm with the label facing the user.
- Press *START* and the arm will pull in and the beta counts will begin to accumulate.



When the preset time expires, accumulation will terminate and the display will remain static until you press the *EXIT* key. The Manual Count utility does not provide a printed output.

Try other test sources if they are available. Typical isotopes used to calibrate and test these instruments are Am-241, Th-230, Po-210, C-14, Tc-99, Cs-137 and Co-60. The first three listed are primarily alpha emitters. Most alpha emitters also decay with some percentage of betas and x-rays which will show in the beta channel of the display.

Put a clean blank planchet into the magazine and count for 10 minutes. Typical results for a 10 minute count at elevations of sea level to 1000 ft are:

- Alpha: 0-2 cpm
- Beta: 5-15 cpm
- Guard: 2000 ±10%

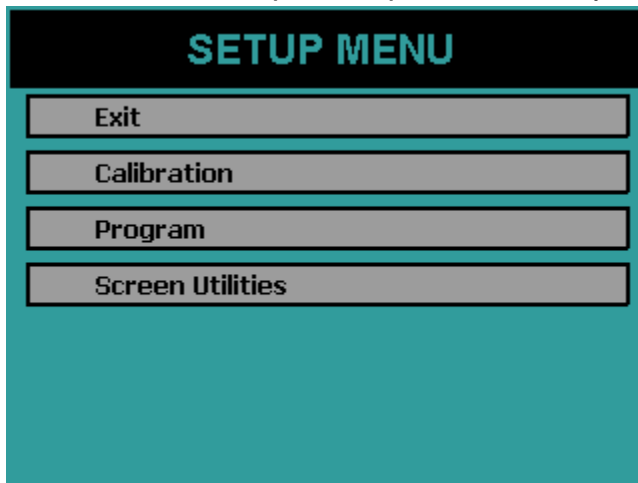
It is normal for these counts to increase 25%-30% at elevations above 5000ft.

Use the manual count routine several times until you become familiar with the procedure.

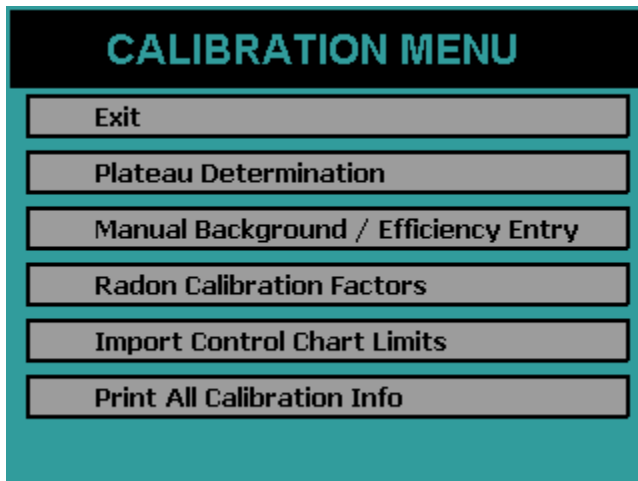
**Print and Save Factory Plateau**

A detector plateau curve is generated on each WPC-1050 during factory tests using Sr/Y-90 beta source. Alpha only and Alpha and Beta operating voltages have been selected from this plateau and all performance tests completed. The plateau data is retained in battery backed memory and available for your inspection. It is recommended that you print the plateau graph and data and maintain this document for future reference. Proceed as follows:

- From the Top Menu press the *Setup* button.



- Press the *Calibration* button.



- Press *Plateau Determination*
- Press the *PRINT* button to print the plateau.

The plateau data which was collected at the factory should be resident in the instrument. The printed report should be saved for future reference. The Calibration section of this manual provides the details for producing your own plateau data.



The plateau can be viewed on the console screen by pressing the *VIEW* button. From the Plateau Data View screen the alpha and beta operating points can be adjusted. **Do Not Adjust** these operating points at this time. Read through the Calibration section before making any adjustments.

## Installations Without Attached Printer

If the WPC-1050 is to be used without an attached printer in this case the plateau report specified in previous tests cannot be printed. In such installations save the plateau to the USB flash drive and copy the PLATEAU.CSV file from the USB flash drive to a safe location. Refer to the Export Data section.

## Setting the Calendar/ Clock

If the calendar/clock information displayed on the Top Menu is incorrect you should now correct it.

- Press the *Setup* button from the Top Menu.
- Press the *Program* button.
- Press *Set Calendar / Clock* button.

## Replace the Cabinets and Install the Stacks

- Replace the rear cabinet. This cabinet simply sets down on the base.
- Locate the left stack. Hold the stack with the brace structure pointed away from you. If the longer of the two vertical sample guides is to your left, you are holding the left stack.
- Hold the stack over the left side of the sample changer with the brace structure pointing to the back of the instrument. Align the slots on the stack with the receptacles on the changer and slide it straight down and into place.
- Locate the lower retaining pin on the stack. This pin has a Teflon block attached. Grasp the block and pull the pin from the magazine.
- Locate the hole on the bridge beneath the right vertical guide of the magazine. The block attached to the pin has a retaining ball on one surface. With this surface pointed down, slide the pin completely in the hole.
- Repeat these steps to install the right stack.
- Set the front cover into place. The back of this cover should interlock with the channel on the bottom of the rear cover.

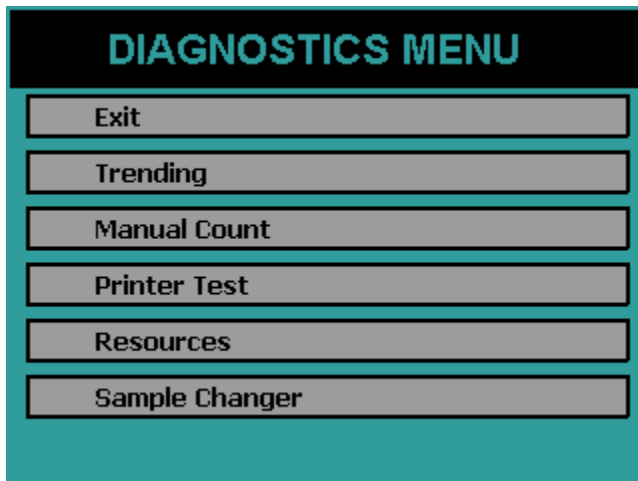
**Load Carriers and Test the Sample Changer**

Now that the stacks are in place the user can fully test the sample changer. First locate the plastic plates shipped with the instrument. Locate the two white plates and the two plates marked as Skip. When loading plates onto the sample changer, orientate them such that you can read the ID label normally as it faces the user. Refer to the Sample Loading section of this manual for further information on the different types of plates.

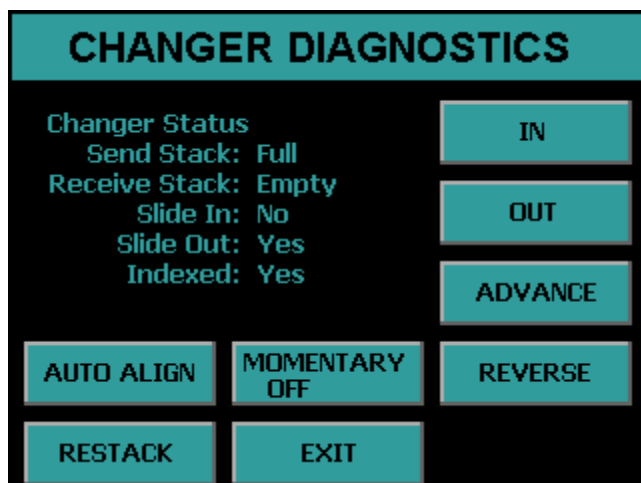
- Lift the access door to the slide on the sample changer.
- Lay one of the End Plates on the slide and slip it to your right inside the right bridge.
- Lay one of the Skip plates on the slide and slip it to your left inside the left bridge.
- Place the second End plate on top of the Carrier plates.

Now the sample changer is ready for test.

From the Top Menu press the Diagnostics Button.



Press the Sample Changer button from the Diagnostics Menu.



Press the *AUTO ALIGN* button to line up the changer. Press the *ADVANCE*, *REVERSE*, *IN* and *OUT* buttons and observe the changer status.

### Read the Manual

The installation of the WPC-1050 is now complete. The user should now have some feel for how to interact with the instrument. Only a few of the many and powerful functions have been used. The next task is to define the count routines from the dozens of options. Then determine calibration factors for each of the counting routines that are defined. Then finally samples will be ready to be counted

## WPC-1050 Overview

The WPC-1050 has many unique features described in detail in subsequent sections of this manual. This section is provided to give you an overview of some of these features.

### Menu Driven Operation

The WPC-1050 can be operated in a stand-alone mode or from a computer. In the stand-alone mode operation menus are displayed on a touch screen LCD display.

### Pass Code Protection

Pass code protection prevents unauthorized entry into the three main operating functions of the WPC-1050:

- Count
- Calibrate
- Program

Pass code protection can be turned off as well. If enabled, up to five unique pass codes can be entered.

### Count Function

Routine Sample counting begins by pressing the *Single Sample Count* or *Batch Count* button from the Top Menu.

### Calibration Function

Calibration of the WPC-1050 consists of setting the detector operating voltages and determining efficiency and background values for the count routines. In most cases control charts are also used to monitor instrument stability.

Each counting routine uses separate background and efficiency calibration data. When a sample is counted, calibration data for the selected counting routine is used for calculating sample activity.

### Control Charts

Once calibration parameters are established, control checks are used to insure that the instrument is stable and the calibration is still valid. The WPC-1050 maintains three control charts. The control chart data may also be the designated source for backgrounds and efficiency values.

**Program Function**

All operations of the instrument are initially defined using the program function through the *Program* button under the Setup Menu. This includes assignments of pass codes as well as defining the specifics of the counting routines and calibration methods.

The WPC-1050 allows up to twelve counting routines to be defined. The routines can be named for easy and meaningful identification. Count routine definitions include routine name, report model, presets, counting mode, counting cycles, background mode, efficiency mode, report units, routine data storage options, printing options, and report models.

**Counting Parameters**

Each count routine has parameters that include the preset conditions and the count mode. The preset conditions include maximum time, minimum time, alpha counts and beta counts. Count mode is either alpha and beta or alpha-only. In the alpha and beta mode the alpha and beta counts are separated by a pulse height discriminator in a single preset time interval. In the alpha-only mode, the sample detector is operated at the alpha plateau voltage where the detector is insensitive to betas.

**Background Parameters**

Background values can be selected using a calibration sample or manually entered. The preset time for a background count is specified as it may be different from the routine sample count time.

**Efficiency Parameters**

Efficiency values can be entered from a calibration sample or manually entered.

**Battery Backup**

The WPC-1050 has a memory backup battery for the 24-hour clock/calendar, operating parameters, calibration files and sample data. The battery is a long life lithium type that has lasted in excess of eight years in the field. The low power consumption of the WPC-1050 makes it an excellent candidate for a UPS (un-interruptible power supply).

## **Printer**

Two printers are supported, a line printer with 9P ESC/P printer control language and a laser page printer with PCL5 control language. Host only based printers are not supported.

## **Computer Connectivity**

The rear panel of the WPC-1050 contains a RS-232 port for connecting to external or remote computers. A software option is available from Protean Instrument Corporation to allow full control of the system from a PC. Simple data transfer is available to copy saved data resident on the instrument to a USB flash drive in CSV (comma separated value) format. The CSV output formats are described in detail in this manual.

## **International Power Entry**

The rear panel power entry module supports a universal IEC line cord attachment. The power entry module can be converted for operation at either 110VAC or 220VAC 50/60Hz.

## **Limited Warranty**

A twelve month limited warranty covers the WPC-1050 with the exception of consumable items and accessories not manufactured by Protean Instrument Corp. In the latter case, the original manufacturer's warranty will prevail. A maintenance program (both on-site and return-to-factory) is available and is highly recommended

## Sample Loading

Throughout this manual many references are made to loading and unloading samples. Let's begin with an orientation of key areas of the sample changer. As you face the front of the instrument there are five key areas.

- The *left stack* or magazine is the send stack.
- The *left bridge* is between the slide and the left stack. The bar code reader is mounted to this bridge and internally it contains a sensor for detecting an *End* plate.
- The *slide* is the center of the sample changer.
- The *right bridge* is between the slide and the right stack. Internally it contains an *End* plate sensor.
- The right stack or magazine is a receive stack for samples as they are processed.

## The Five Types of Plates

There are five types of plates supplied with each instrument. These plates look similar but are coded differently and are treated differently by the instrument. Each plate has a bar code label on its top and an identification label on the front edge. The plates are keyed such that there is only one way to load them in the stacks. The plates are molded using a conductive plastic to minimize static charge.

Locate and examine the sample carriers provided with your instrument. There should be either 50 (or 100 if this option was ordered) sample carriers with appropriate labels attached to the outside edge. Each of these carriers also has a bar code label on top through which the instrument identifies this specific carrier. Blank labels and custom bar codes are available if needed. The identification labels on the outside edge may also be replaced as needed.

There are also four other types of plates supplied with each instrument besides the sample carriers. These four types are called Routine plates, QC plates, Skip plates, and End plates.

The following is a description of the various plates and their usage.

**Sample Carrier Plates**

The sample carrier plates are designed to accept planchets up to 2 inches in diameter and up to 5/16 inches deep. Snap-in inserts are available in three depths. To match the dimensions of the planchets to be used. Standard depths are 1/8, 1/4, and 5/16 inches. Planchets and/or their contents should never be allowed to protrude above the top surface of the sample holder or a sample changer jam or ruptured window will occur. The depth of the planchet should be matched closely to the depth of the sample holder to minimize performance loss.

**End Plates**

End plates designate the beginning and the end of a stack of samples. Two of these plates are included with each instrument. They are unique because of the reflective surface on the back edge of the plate. Sensors in the bridges detect these reflective surfaces. Detection of an End plate by the right bridge sensor indicates the start of a stack of samples or a restacked position. Detection of an End plate by the left bridge sensor indicates the end of a stack of samples.

**Skip Plates**

Skip plates are used to fill the void between the left bridge and the slide so that samples can be removed from the stack.

**Routine Plates**

The WPC-1050 provides 12 unique counting routines. Define and use as many of these routines as needed. A routine tells the instrument how to count and report results for a batch of samples. Routine plates are used to tell the instrument which routine a batch of samples belongs to.

**QC Plates**

Control charts track instrument performance on a day by day basis by counting control standards and comparing the results with historical results. The QC plates are a combination sample (control standard) and routine plate. Whenever they are encountered, the instrument knows which standard is carried and which control chart to update. There are three QC plates initially labeled "QC1" through "QC3".



**Prepare Changer**

First place two Skip plates and then an End plate on the right stack. Next place a Routine plate and then Sample Carrier plates and finally place an End plate on the left stack. Press the Diagnostics button from the Top Menu and then press the Sample Changer button. Press the Reverse button until the Receive stack indicates Empty.

**Selecting Sample Carriers**

Sample carriers are available in 1/8 inch, 1/4 inch, and 5/16 inch depths to accommodate planchets of the same depths. In general, the shallowest planchet and carrier should be used to achieve the highest counting efficiency. Since radiation from the sample follows the inverse square law, a very small change in distance from the detector has a very large effect on the intensity of the radiation seen by the detector. The limiting factor for close sample spacing is the thickness and uneven nature of the sample itself. Smear or swipe samples are often very “wavy”. Although the sample media is very thin, ripples in the media can make the vertical dimension of the sample quite large. The ultra-thin window on the detector can be torn easily from contact with the sample.

## **The WPC-1050 Console**

The WPC-1050 is controlled through a LCD touch screen display. Detailed descriptions of the screen menus are provided later in this manual.

## **The Rear Panel**

The rear panel contains AC power, USB printer interface, gas connector, and a RS-485 connector. The power entry module on the right side of the rear panel contains the power on/off switch. Power supply fuses are located behind the removable plastic panel. Input power range can also be changed from the power connector.

## Getting Started

### Count a Sample

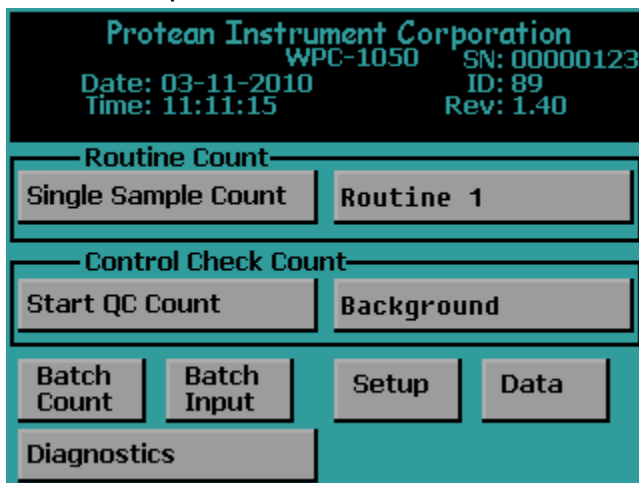
To count a sample three steps must be taken:

1. Define
2. Calibrate
3. Count

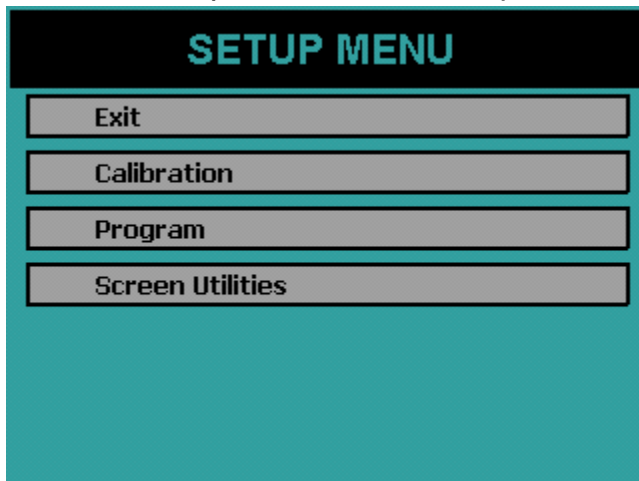
Normally the counting routines are defined and calibrated as part of installation of the system, and when new counting routines are required. On a daily basis only Step 3 the count function is used to count a calibration check source or to count a sample.

### Step 1 Define

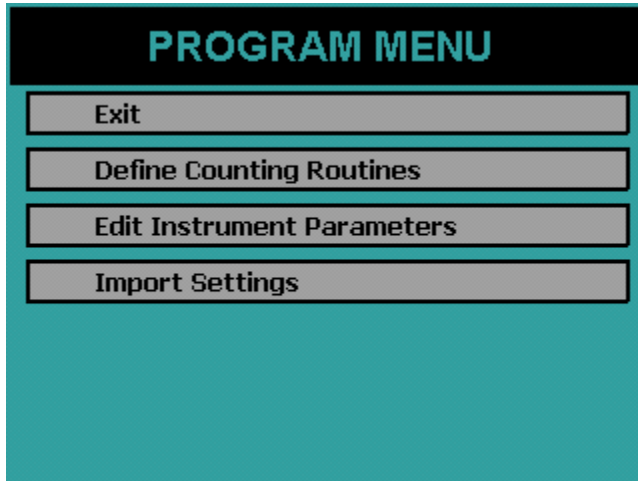
The first step is to define a count routine.



Press the *Setup* button from the Top Menu to access the Setup Menu.

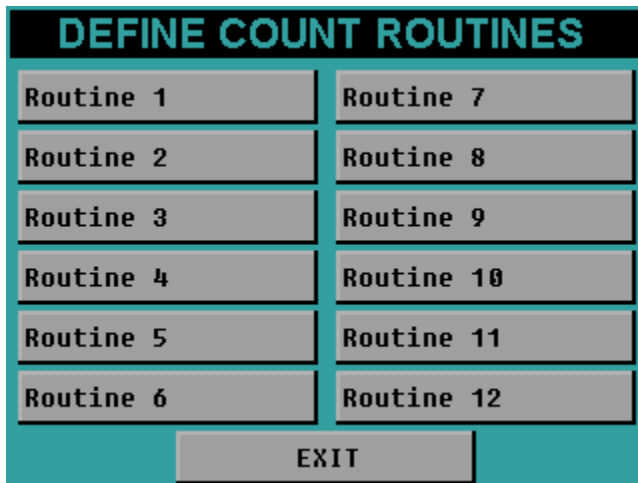


Press the *Program* button from the Setup Menu.



**Define Counting Routines**

When you press *Define Counting Routines* the next screen lists twelve routines to edit. Press the *Routine 1* button to edit this routine.



Routine Definition Page 1

COUNT ROUTINE DEFINITION	
Routine Name:	Routine 1
Preset Time:	1.00 min Repeats: 0
Min Count Time:	0.00 min
Counting Mode	Preset Counts
<input type="checkbox"/> Alpha Only	Alpha: 0
<input checked="" type="checkbox"/> Alpha and Beta	Beta: 0
Results Storage:	Internal
1 Page Per Sample:	No Automatic Print: No
<div style="display: flex; justify-content: space-around;"> <span>NEXT</span> <span>DONE</span> </div>	

**Set the following parameters:**

Preset Time: 1 min

Min Count Time: 0 min

Repeats: 0

Counting Mode: Alpha and Beta

Alpha Preset Counts: 0

Beta Preset Counts: 0

Results Storage: Internal

1 Page Per Sample: No

Automatic Print: No

Now press the *NEXT* button to go to the next routine definition page.

Routine Definition Page 2

**COUNT ROUTINE DEFINITION**

Report Model

- Standard Report
- Standard Report (High Alpha-Only Recount)
- Standard Report (Radon Subtraction)
- Flag Concentration
- Flag Concentration (High Alpha-Only Recount)
- Flag Concentration (Radon Subtraction)

PREV      NEXT      DONE

Select the Standard Report Model.  
Press the *NEXT* button to go to the next routine definition page.

Routine Definition Page 3

**COUNT ROUTINE DEFINITION**

Input Units      Report Units

<input type="checkbox"/> ml	<input type="checkbox"/> pCi	per	
<input type="checkbox"/> l	<input type="checkbox"/> uCi	<input type="checkbox"/> ml	<input type="checkbox"/> cm2
<input type="checkbox"/> m3	<input type="checkbox"/> Bq	<input type="checkbox"/> l	<input type="checkbox"/> 100cm2
<input checked="" type="checkbox"/> ft3	<input checked="" type="checkbox"/> dpm	<input type="checkbox"/> m3	<input type="checkbox"/> Sample
<input type="checkbox"/> cm2		<input checked="" type="checkbox"/> ft3	<input type="checkbox"/> None
<input type="checkbox"/> None			

Format:

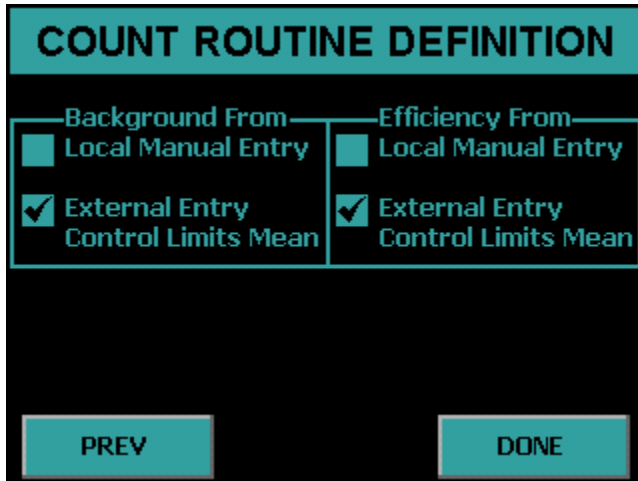
PREV      NEXT      DONE

Set the following parameters:

- Input Units: None
- Activity: dpm
- Per: None
- Format: Normal

Press *NEXT* button to go to the next routine definition page. Note during this setup pages four and five are skipped.

**Routine Definition Page 6**



**Set the following parameters:**

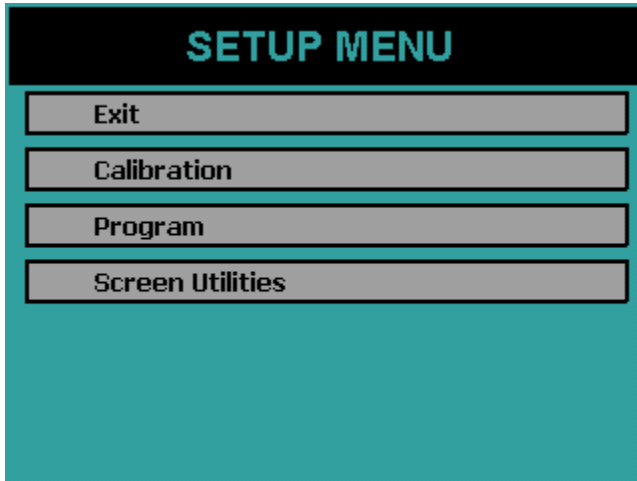
Background From: Local Manual Entry

Efficiency From: Local Manual Entry

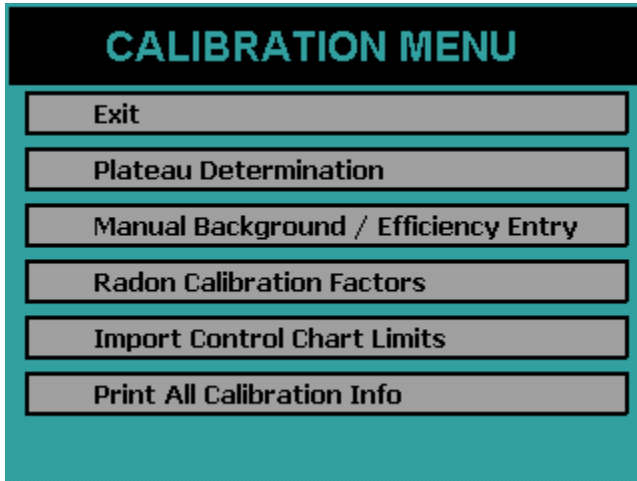
Press the *DONE* button to complete the routine definition.  
Step 1 Define is now complete

**Step 2 Calibrate**

Now press *EXIT* until the Setup Menu is displayed.

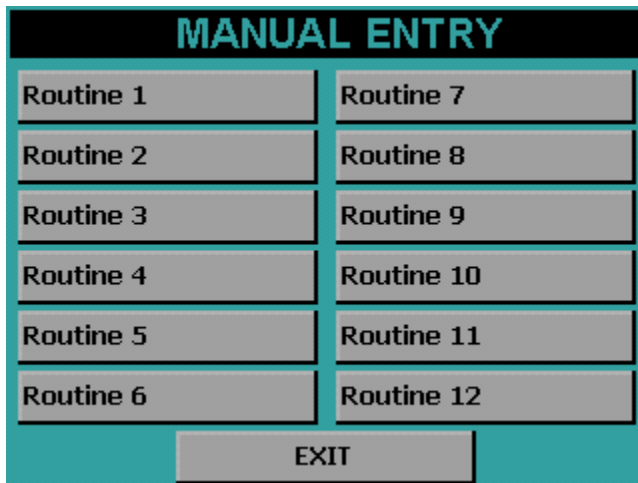


Press the *Calibration* button on the Setup Menu.

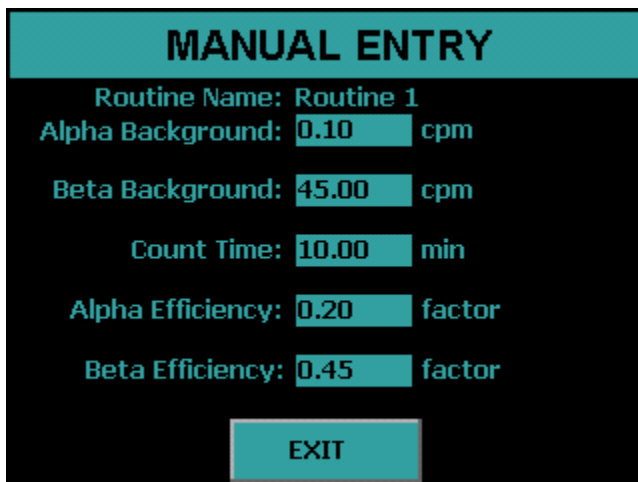


Press the *Manual Background/Efficiency Entry* button from the Calibration Menu.





Press the *Routine 1* button to enter the calibration factors for Routine 1.



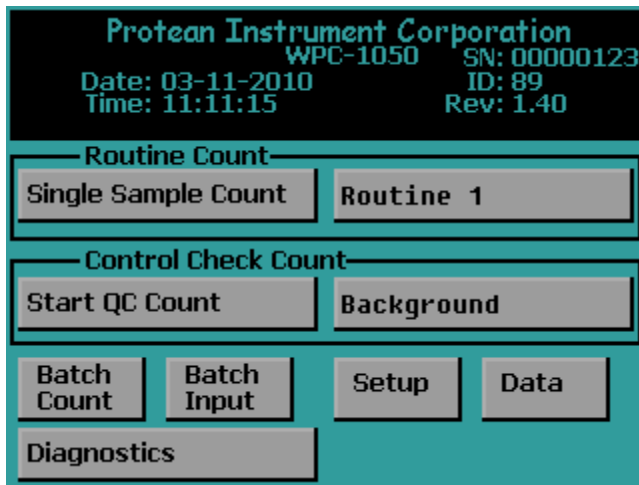
Enter the following calibration factors:

- Alpha Background: 0.10 cpm
- Beta Background :45.00 cpm
- Count Time: 10.00 min
- Alpha Efficiency: 0.20
- Beta Efficiency: 0.45

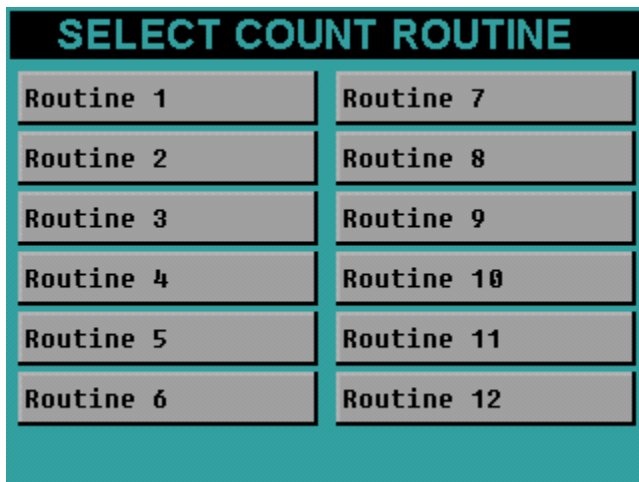
Now press the *EXIT* button.  
Step 2 Calibration is now complete.

Step 3 Single Sample Count

Press the *EXIT* button until the Top Menu is displayed.  
The next step is to start a count with the routine that was defined and calibrated.



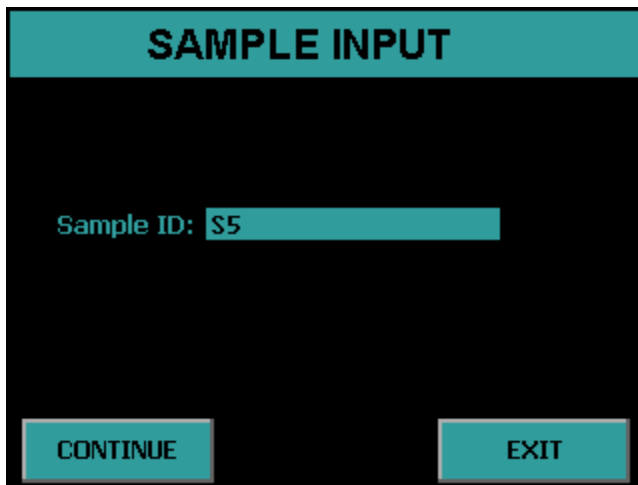
On the Top Menu confirm Routine 1 is selected and displayed. If Routine 1 is not selected then press the button to the right of the *Single Sample Count* button to display the Select Count Routine menu.



Press the *Routine 1* button. The menu will revert back to the Top Menu. Confirm the Routine 1 count routine is selected.

Press the *Single Sample Count* button from the Top Menu.

The sample changer will now pull the slide out so that the user may insert a sample carrier. The next screen to appear is the data entry screen. This routine only requires or allows for a Sample ID. To change the Sample ID press the Sample ID field. Type the new Sample ID and press *Enter*.

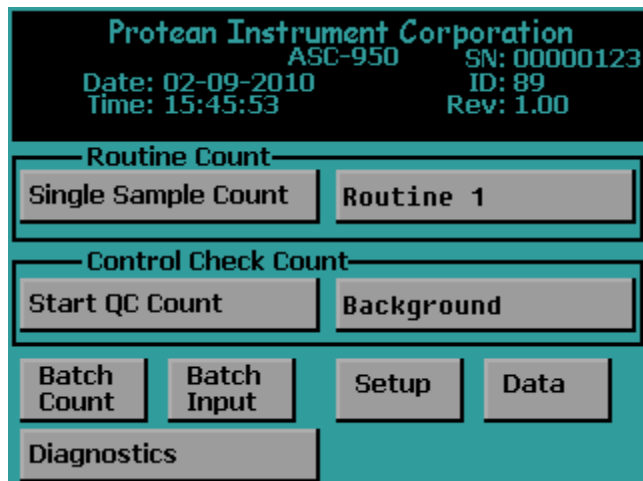


Now press the *CONTINUE* button to insert the sample carrier and begin a sample count. The sample changer will pull the slide in and the acquisition screen appears and displays the Sample ID and Routine Name. The first column lists the cpm. The second column provides the Activity shown in units defined in the count routine. In this case the report units are in dpm. The elapsed and remaining time as well as the current bias voltage is also displayed. Pressing the EXIT button before the count is finished aborts the count.



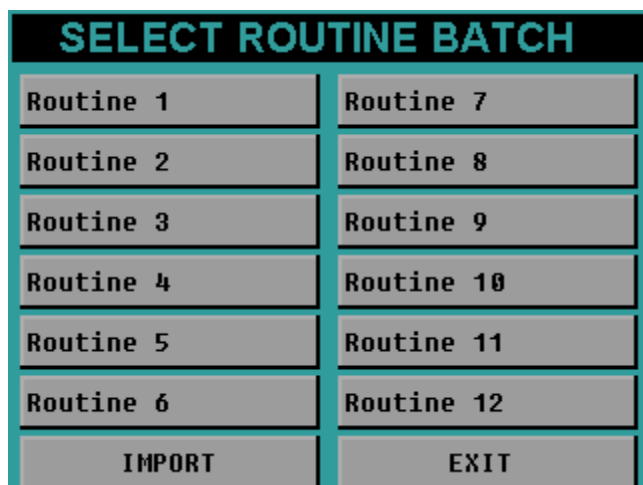
## Step 3 Batch Count

Like the Step 3 Single Sample Count we will perform the sample count but instead utilize the sample changer. Press the EXIT button until the Top Menu is displayed.



Verify that the sample changer is in the restacked position (Receive Stack is empty). Now place the Routine 1 plate onto the bottom of the left stack. Next place a Sample Carrier 1 onto the left stack. Now place the Skip plate and then the End plate onto the left stack.

Press the Batch Input button.



Press the Routine 1 button to select the batch file for Routine 1.

The Edit Batch Input screen will appear.

Carrier #	Sample ID	Input (---)
S1	S1	0.00
S2	S2	0.00
S3	S3	0.00
S4	S4	0.00
S5	S5	0.00
S6	S6	0.00
S7	S7	0.00
S8	S8	0.00
S9	S9	0.00
S10	S10	0.00

Buttons: Erase All, -, ID, Input, +

Buttons: PREV, EXIT, PAGE, NEXT

On this screen are three columns of Carrier #, Sample ID, Input. Since we are using Carrier 1 observe the assigned Sample ID for Carrier 1. If the user wishes to change the ID first make sure it is selected. A input is selected when it is highlighted in white. To select an input press the + and – buttons or simply press the input to select it. With the input selected press the *ID* button to edit the Sample ID. Enter the new ID and press the *Enter* button. Refer to the Batch Input Section of the manual for further information regarding editing batch files. Now press the *EXIT* button to display the Top Menu.

Now press the *Batch Count* button to start a stack directed count. The sample changer will begin to exercise and the barcode reader will scan the barcodes of the carriers. Once the Routine plate is scanned by the barcode reader the Routine 1 parameters are loaded. Next the Carrier 1 is scanned and the Sample ID from the batch file is loaded. Once the Carrier 1 is located under the detector the count will begin just like in the case of the Single Sample Count. Once the count is finished the sample changer will restack all of the carriers if the Restack option is selected Yes otherwise a restack will not occur.

**Review**

The three most important functions in a counting instrument have just been performed, define a counting routine, calibrate a counting routine, and use a counting routine. With slight variations, the same three steps are taken for every sample counted. Normally the counting routines are defined and calibrated once or as required. The calibration step is performed on a periodic basis or when the calibration checks indicate it is needed. Calibration should always be checked after any maintenance on the detector, detector window, or detector amplifier.

The next section covers all of the menus and a detailed discussion of all of the options that are available to the user

## Batch Input

To access the Batch Input press the *Batch Input* button from the Top Menu. The Batch Input is where the Sample ID and Input are associated with a Carrier number for a Batch Count.

After pressing the Batch Input button the user is given the option of selecting a routine batch. There are twelve batch files that are available for editing each with 200 inputs.

SELECT ROUTINE BATCH	
Routine 1	Routine 7
Routine 2	Routine 8
Routine 3	Routine 9
Routine 4	Routine 10
Routine 5	Routine 11
Routine 6	Routine 12
IMPORT	EXIT

**Edit Batch Input**

After pressing one of the Routine batch files the following screen appears where the batch file may be viewed and edited.

Carrier #	Sample ID	Input (---)
S1	S1	0.00
S2	S2	0.00
S3	S3	0.00
S4	S4	0.00
S5	S5	0.00
S6	S6	0.00
S7	S7	0.00
S8	S8	0.00
S9	S9	0.00
S10	S10	0.00

*PREV* – Press this button to go to a previous page of inputs.

*NEXT* – Press this button to go to the next page of inputs.

*PAGE* – Press this button to go to a particular page of inputs.

*Erase All* – Press this button to erase a batch file and set to the default.

*ID* – Press this button to change the selected Sample ID.

*Input* – Press this button to change the selected Input.

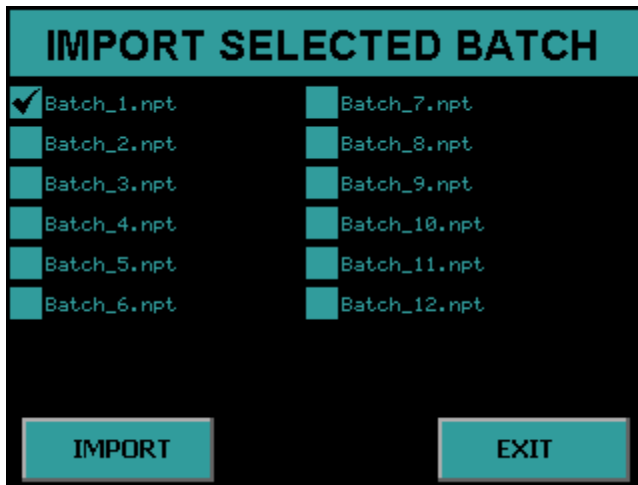
+ - Press this button to select the next input.

- - Press this button to select the previous input.



**Import Batch**

Pressing the *IMPORT* button from the Select Routine Batch screen gives the user the option to import a batch file that was created using the Companion Software. The batch files are saved onto a USB flash drive and then inserted into the USB port on the front of the instrument.



The user then selects a batch from the IMPORT SELECTED BATCH screen and presses the *IMPORT* button. The import will begin and once finished press the *EXIT* button to return to the Top Menu. The user can now view the imported batch file by pressing the Batch Input button from the Top Menu and selecting the appropriate Routine.

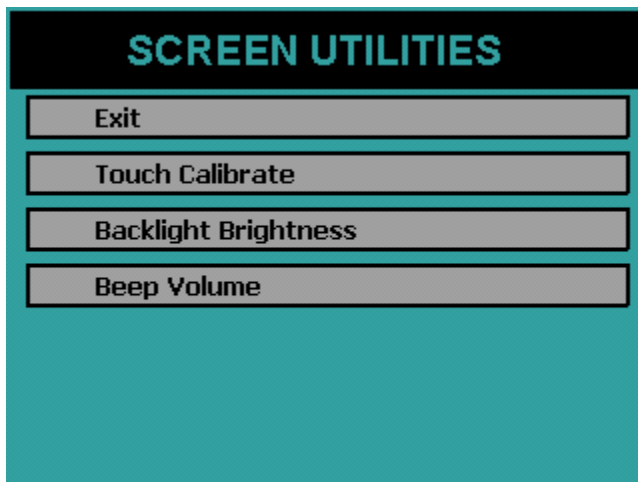


### Setup Menu

To access the Setup Menu press *Setup* from the Top Menu. Under the Setup Menu you have the *Calibration* button where the calibration functions are accessed. The *Program* button is where you program the count routines and instrument parameters. The *Screen Utilities* is where you define the beep volume, backlight brightness and calibrate the touch screen.

### Screen Utilities

To access the Screen Utilities Menu press the *Screen Utilities* button on the Setup Menu.

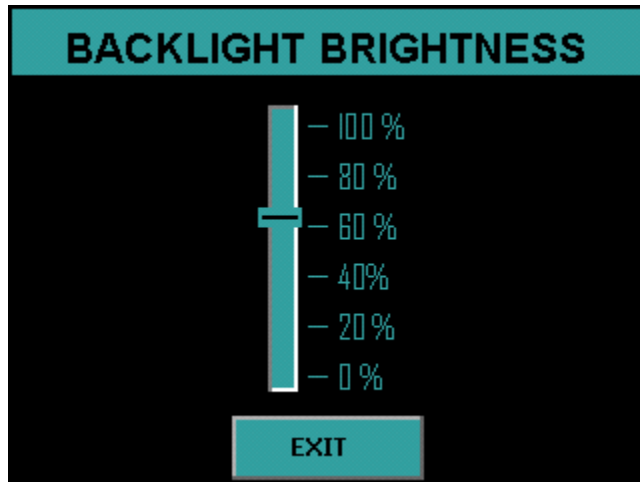


### Calibrating the Touch Screen

Sometimes it may be necessary to calibrate the touch screen when it becomes apparent that the area of the screen touched does not activate a button. To calibrate the touch screen press the *Touch Calibrate* button and follow the on screen instructions. If the *Touch Calibrate* button is accidentally pressed, wait for the built-in timeout to activate after five seconds and abort the operation

**Backlight Brightness**

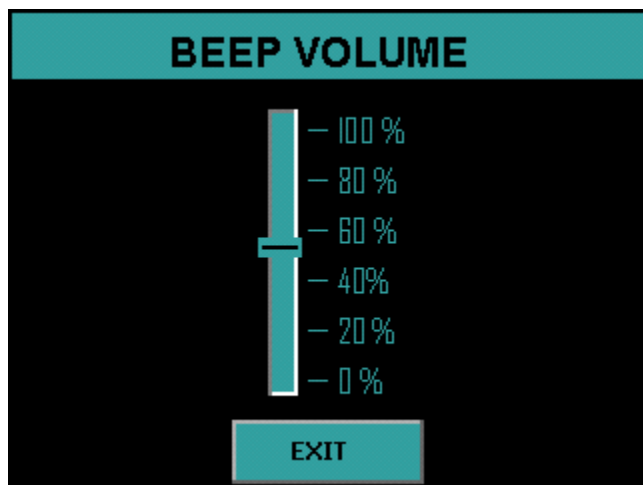
Depending on the lighting of the room you may want to change the brightness of the display. To activate the Backlight Brightness Menu, press the Backlight Brightness button on the Screen Utilities Menu.



Press a location on the slider and the backlight brightness is updated. Press *EXIT* to save the changes

**Beep Volume**

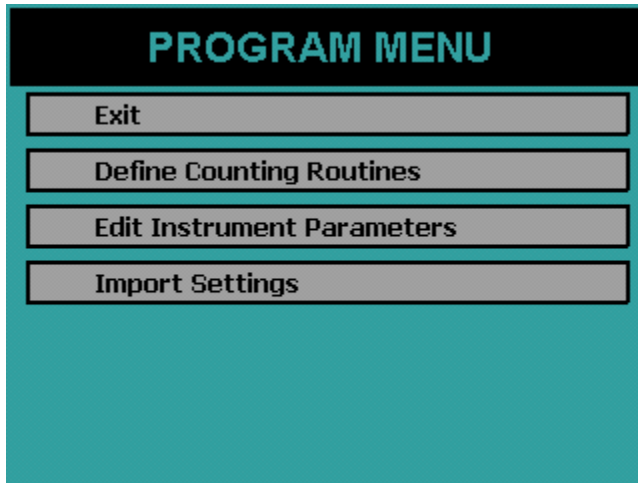
The sound volume of the system can be adjusted through the Beep Volume menu. To activate the Beep Volume menu press the *Beep Volume* button on the Screen Utilities menu.



Press a location on the slider and the instrument will beep with the current volume setting. Press *EXIT* to save the change

### Program Menu

To access the Program Menu, select the *Program* button on the Setup Menu. The Program Menu is where the count routines and instrument parameters are defined. The settings can also be imported from a USB flash drive through the Program Menu.



### Import Settings

Instead of entering count routine settings and instrument parameters through the instrument menus the WPC-1050 offers the option of importing these settings from a USB flash drive. This USB flash drive has a CONFIG.XML file located in a folder named with the serial number coordinating with the instrument to be updated. Select the *Import Settings* button on the Program Menu. Insert the USB flash drive and press *IMPORT*. See the companion software manual for information on how to create the CONFIG.XML file.

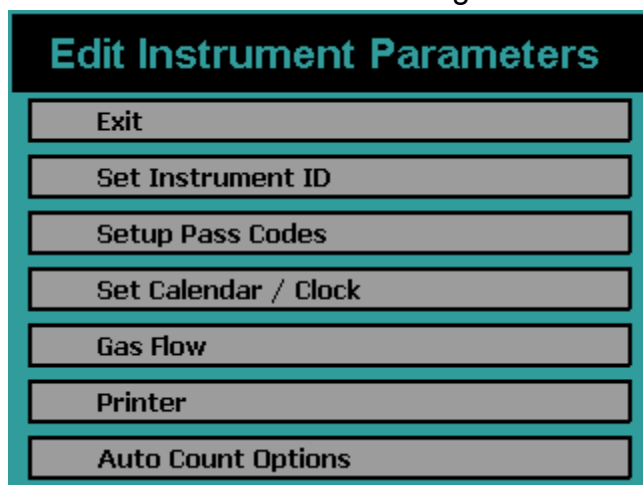


The next screen will display Finished to indicate that the settings have been imported successfully.



### Instrument Parameters

The Edit Instrument Parameters Menu is accessed by pressing the *Edit Instrument Parameters* button from the Program Menu.



### Auto Count Options

Activate the Auto Count Options Menu by pressing the *Auto Count Options* button. The Auto Count Options are only valid for a Batch Count. They are not used for a Single Sample Count.

**AUTOMATIC COUNT OPTIONS**

Restack When Finished:  No

**Query Options**

Query when memory is full:  Yes

Query when QC Check fails:  Yes

**Auto Start Options**

Enable Auto Start:  No

Auto Start Time: 10:10

Auto Start Date: 10-10-2000

Cycle Recount: 0      Cycle Delay: 0 min

OK      CANCEL

### Query Options

There are two query options available, Query when memory is full and when a QC Check fails.

If *Query when memory is full is selected Yes* then when Routine data exceeds 200 records then the stack directed count is stopped and the user is notified and has the option of continue and delete the oldest record or abort the count.

If *Query when memory is full is selected No* then when Routine data exceeds 200 records then the oldest record for this routine is automatically deleted and the count continues.

If *Query when QC Check fails is selected Yes* then when a QC Check is above 2 standard deviations then a recount is performed and if the check fails the second time the user is notified and has the option to continue or abort the count.

If *Query when QC Check fails is selected No* then when a QC Check is above 2 standard deviations then a recount is performed and if the check fails the count continues anyway.

**Restack When Finished**

Select *Yes* if the user wants all samples returned to the Send Stack when the batch is finished. Select *No* if the user wishes for all of the samples to remain in the Receive Stack when the batch is finished.

**Auto Start Options**

The Auto Start Options gives the user the capability to start a Batch count at a defined date and time. The Auto Start must be enabled by selecting *Yes* for *Enable Auto Start* and then the instrument must be on the Top Menu when the *Auto Start Time* and *Date* has been reached for the Batch count to begin.

To disable the Auto Start select *No* for *Enable Auto Start*.

To set the Auto Start Date and Time press each field. Note the time is in 24 hour format.

**Cycle Recount**

The Cycle Recount tells the instrument the number of times to count a batch of samples. A Cycle Recount of 0 indicates only count a batch of samples once. A Cycle Recount of 1 indicates counting a batch of samples twice. To change the Cycle Recount press the field and enter a number and press *Enter*.

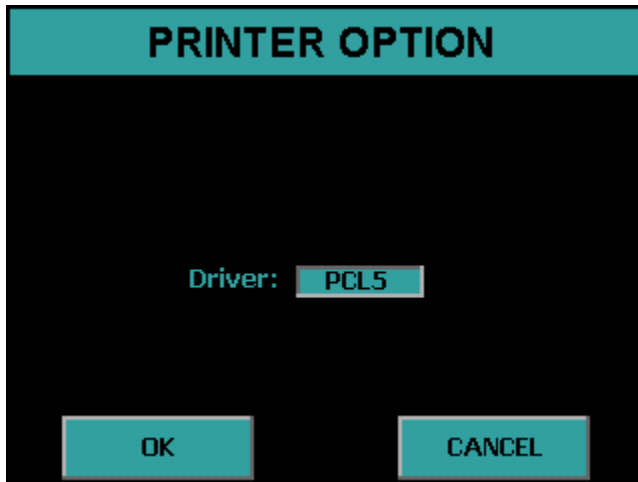
**Cycle Delay**

The Cycle Delay tells the instrument the delay in minutes between a Cycle Recount.



**Printer**

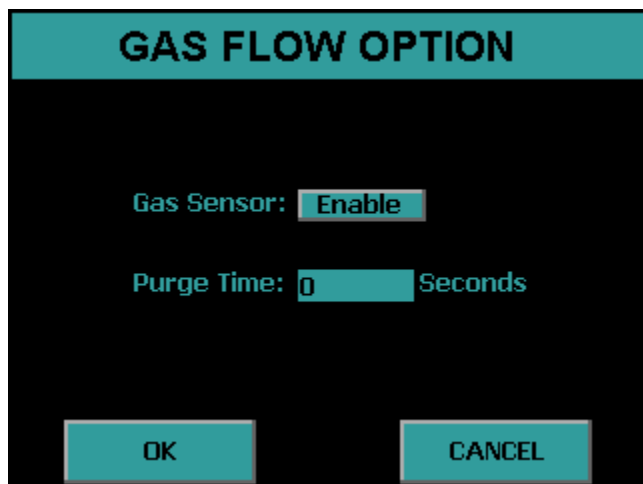
Activate the Printer Option Menu by pressing the *Printer* button. Press the button to select the printer driver. PCL5 is the driver for a printer with PCL5 command support. 9P ESC/P is the driver for a printer with 9P ESC/P command support. Press *OK* to save the setting.



**Gas Flow Option**

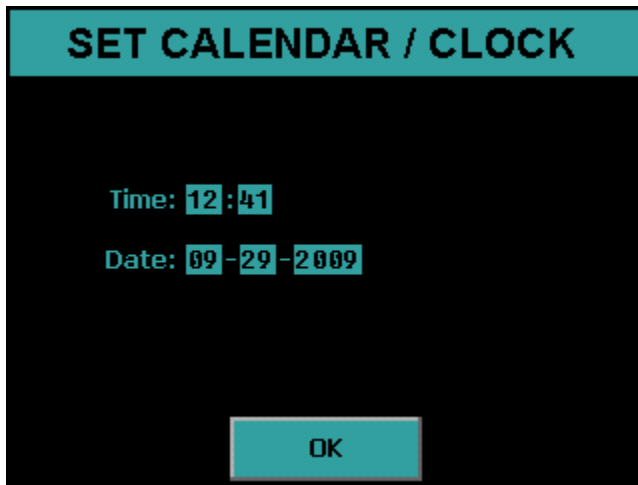
Activate the Gas Flow Option Menu by selecting the *Gas Flow* button on the Edit Instrument Parameters Menu. Press the *Enable* and *Disable* button to enable and disable the gas sensor. The WPC-1050 includes a gas flow sensor which is connected to the gas outlet of the sample detector. Sensing gas flow at this point insures integrity of the gas flow system. The option to disable the sensor is for the unlikely event that the sensor needs repair or replacement.

The purge time is the amount of time after the flow sensor detects good gas flow to wait before beginning a count. This time is entered in seconds.



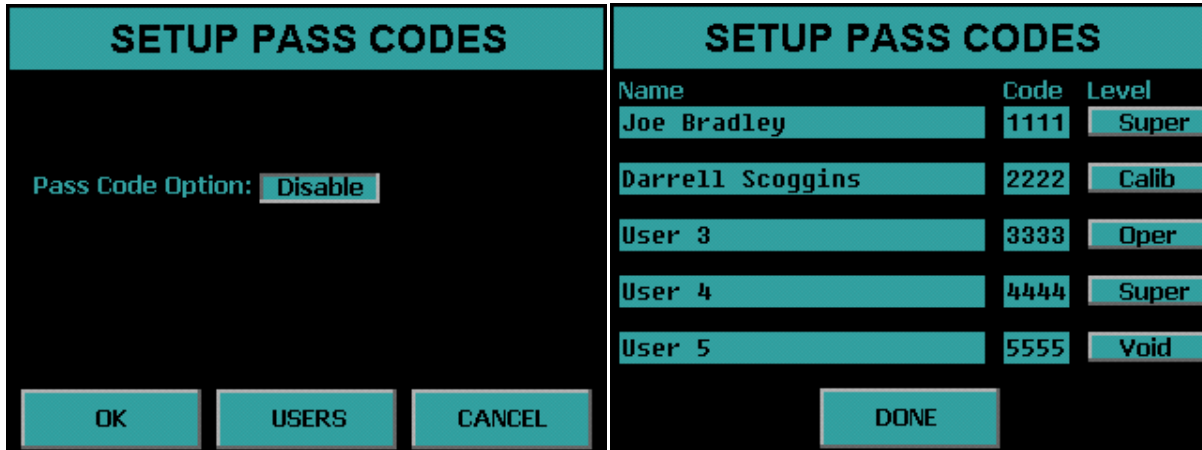
**Set Calendar/Clock**

Activate the Set Calendar/Clock Menu by selecting Set Calendar/Clock from the Edit Instrument Parameters Menu. Press each field to set the time and date. Press *OK* to save the settings.



**Setup Pass Codes**

Activate the Setup Pass Codes by selecting *Setup Pass Codes* from the Edit Instrument Parameters Menu. Press the button to enable and disable pass code protection. Press *USERS* to access the User Information menu and setup User Name, Pass Code, and Permission Level. Press *OK* to save settings.



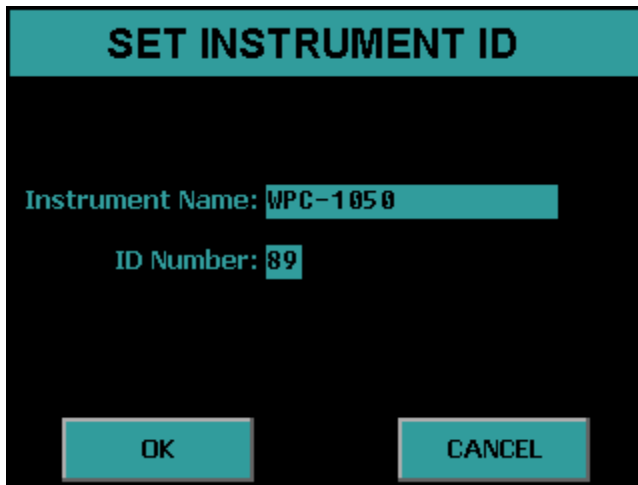
Press the *Name* field to change the user name. Press the *Code* field to change the pass code. Press the *Level* button to select the permission levels.

Four permission levels can be selected:

- **Super** – This user is granted access to all features of the instrument.
- **Calib** – This user is granted access to the Calibration Menu but not the Program Menu.
- **Oper** – This user cannot access the Calibration Menu or the Program Menu.
- **Void** – This user is disabled and cannot log in.

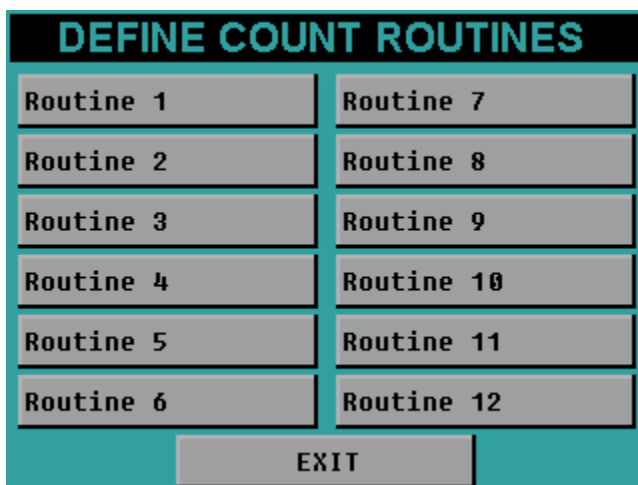
**Set Instrument ID**

Press the *Set Instrument ID* button from the Edit Instrument Parameters Menu to set the Instrument ID. Press the *Instrument Name* field to change the Instrument Name. Press the *ID Number* field to change the ID Number. Press *OK* to save the settings.



**Define Counting Routines**

Press the *Define Counting Routines* button from the Program Menu. When you press Define Counting Routines the next screen lists twelve routines to edit. Press the routine button which you would like to edit.



Count Routine Definition Page 1

**Naming the Count Routine**

The name which will appear in the menus for the Count, Data, and Calibration functions should be defined. This name will identify to the operator the type of samples to be counted using the defined routine. The name will also appear in the printed report.

**Preset Time**

The preset time specifies one of several conditions which can terminate an acquisition. This field defines the maximum amount of time for sample analysis. For most applications, this will be the only preset condition that is used. Therefore this time equates to the amount of time each sample is analyzed. The length of time is usually selected to meet a desired sensitivity or minimum detectable activity requirement. How much time is needed should be determined by the worse case efficiency and background values.

The preset time is set by pressing the *Preset Time* field and entering the time. The minimum preset time must be greater than 0.01 minute.

### Minimum Count Time

The minimum count time should be used only if the user desires to specify preset conditions other than just preset time such as count presets. Otherwise a minimum count time of zero is acceptable.

The minimum count time is related to the preset conditions. The preset time is only one condition that may be specified to terminate an acquisition. For instance, a preset time of one minute could be specified along with a count preset of 10,000 counts. This would cause an acquisition to terminate when either 10,000 counts are accumulated or when the elapsed time reaches one minute – which ever comes first. The Minimum Count Time field allows the user to specify a minimum time to analyze the sample, even if the preset conditions have been met. For instance, assume a minimum count time of one-half minute was specified along with the previous preset conditions. In this example, all samples would be analyzed for a minimum of one-half minute. After the minimum time has elapsed, the system will monitor the number of accumulated counts. Once 10,000 counts are accumulated, the acquisition will be terminated. However, if the elapsed time reaches one minute, then the acquisition will be terminated regardless of the number of counts accumulated.

The Minimum Count Time is set by pressing the *Minimum Count Time* field and entering the time. A Minimum Count Time of zero disables this feature.

### Repeats

It is sometimes desirable to count a sample for a series of short intervals rather than for a single long interval. This method allows determination of decay times or possible interference from a nuclide with a short half life. The WPC-1050 provides for a sample to be recounted up to 99 times. The Repeats is set by pressing the *Repeats* field and entering the value. A repeat value of 0 disables this feature.

### Preset Counts

Preset Alpha and Preset Beta Counts can be entered which will terminate the acquisition if the entered value is reached. If a minimum count time is entered then the Preset Counts values are not evaluated until after the minimum count time has elapsed.

**Specifying the Counting Mode**

The WPC-1050 provides two different methods of alpha/beta activity determination, Alpha Only and Alpha and Beta. These methods dictate how the instrument determines whether a detected event was the result of an alpha particle or a beta particle entering the sample detector.

**Alpha Only** – In the Alpha Only mode the voltage on the detector is lowered to the point where only an alpha particle possesses adequate ionizing energy to produce a detectable pulse. No beta information will appear on the resulting report.

**Alpha and Beta** – This mode operates the detector at the beta operating voltage where both alpha and beta events can be detected. These events are characterized as either alpha or beta depending on the pulse height of the associated event. The resulting report will show both alpha and beta count information.

**Results Storage**

This field allows you to choose where the count routine data is stored. If Internal is selected the count routine data is stored in internal memory only. If external is selected, the count routine data is stored both in internal memory and directly to the USB flash drive. There is a limit of 200 records for each routine if storing to internal memory. If external is selected, the count routine data is stored in internal memory and directly to the USB flash drive.

**1 Page per Sample**

This option is only valid when using the PCL5 driver (page printer). When you select Yes only one record per page is printed. Otherwise the page is not printed until the page is full. When using a line printer (9P ESC/P driver) this option is ignored. To enable or disable the 1 Page per Sample toggle the Yes/No button.

**Automatic Print**

This field controls whether or not data is automatically printed after each acquisition. To enable or disable the automatic printing toggle the Yes/No button.

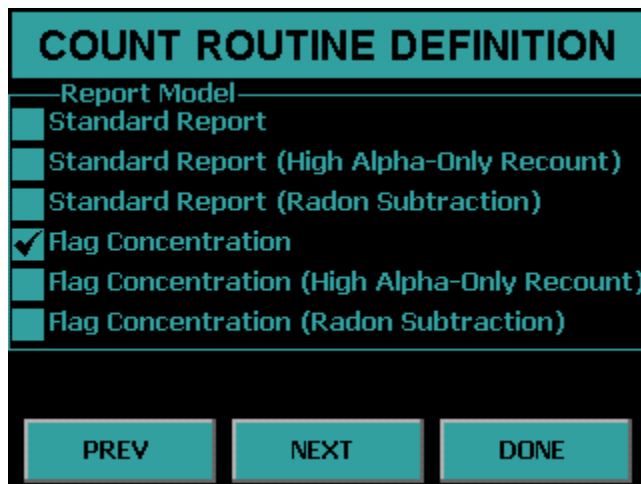
**Completing Count Routine Definition Page 1**

Once all settings are properly adjusted, press the *NEXT* button to proceed to the Second Count Routine Definition Page. If no further settings are required press the *DONE* button.



**Count Routine Definition Page 2**

The second Routine Definition page allows you to select the report model to use with the count routine. The report model selection will define the appearance of the final printed report and the calculations to be performed after a sample is counted. The available choices are described below.



**Standard Report** – This report shows the calibration factors along with the Sample ID, Alpha and Beta cpm, and Activity in the report units specified in the routine definition.

**Standard Report (High Alpha-Only Recount)** – This report is the same as the Standard Report except that an alpha limit must be specified. If that limit is reached then a recount in Alpha-Only Counting Mode is performed.

**Standard Report (Radon Subtraction)** – This report is the same as the Standard Report except that Activity contributed by Radon is subtracted.

**Flag Concentration** – This report is the same as the Standard Report except that alpha and beta warning limits can be set and indicated on the report.

**Flag Concentration (High Alpha-Only Recount)** – This report is the same as the Flag Concentration except that an alpha limit must be specified. If that limit is reached then a recount in Alpha-Only Counting Mode is performed.

**Flag Concentration (Radon Subtraction)** – This report is the same as the Flag Concentration except that Activity contributed by Radon is subtracted.

Note: Report Models Standard Report (Radon Subtraction) and Flag Concentration (Radon Subtraction) require the counting mode to be Alpha and Beta.

Standard Report

An example of a Standard Report can be seen below.

MPC-900  
10/01/2009 14:56:17  
Routine Name: Routine 1  
Alpha MDA = 18.49 dpm      Beta MDA = 56.60 dpm

Alpha Background: 0.20      Alpha Eff. Factor: 0.23      Count Time: 1.00  
Beta Background: 55.00      Beta Eff. Factor: 0.50      Background Count Time: 10.00

Sequence Number	Sample ID	Input 1	Alpha CPM	Beta CPM	Alpha dpm/l	Beta dpm/l
1	S1	1.00	1358.00	361.00	5903.48	612.00

.....

Counted by: \_\_\_\_\_ Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_

Flag Concentration

An example of a Flag Concentration report can be seen below.

```
MPC-900
10/01/2009 14:56:17
Routine Name: Routine 1
Alpha MDA = 18.49 dpm      Beta MDA = 56.60 dpm

Alpha Background: 0.20      Alpha Eff. Factor: 0.23      Count Time: 1.00
Beta Background: 55.00      Beta Eff. Factor: 0.50      Background Count Time: 10.00

Sequence Number   Sample ID      Alpha CPM      Beta CPM      Alpha dpm      Beta dpm
1                 S1            1358.00        361.00        5903.48        612.00
**** LIMITS WARNING Alpha Level 1 Beta Level 1 ****
```

---

Counted by: \_\_\_\_\_ Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_

Standard Report (High Alpha-Only Recount)

An example of a Standard Report (High Alpha-Only Recount) can be seen below.

```
MPC-900
10/05/2009 10:56:10
Routine Name: Routine 1
Alpha MDA = 19.01 dpm   Beta MDA = 57.46 dpm

Alpha Background: 0.10      Alpha Eff. Factor: 0.20      Count Time: 1.00
Beta Background: 45.00     Beta Eff. Factor: 0.45      Background Count Time: 10.00

Sequence Number   Sample ID      Input ml      Alpha CPM      Beta CPM      Alpha dpm/ml      Beta dpm/ml
1                 S1            1.00         74.00         61.00         369.50         35.56
**** Alpha Only Recount ****
2                 S1            1.00         100.00        -----        499.50         -----
```

-----

Counted by: \_\_\_\_\_ Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_

Flag Concentration (High Alpha-Only Recount)

An example of a Flag Concentration (High Alpha-Only Recount) can be seen below.

```
MPC-900
10/05/2009 10:56:10
Routine Name: Routine 1
Alpha MDA = 19.01 dpm      Beta MDA = 57.46 dpm

Alpha Background: 0.10      Alpha Eff. Factor: 0.20      Count Time: 1.00
Beta Background: 45.00      Beta Eff. Factor: 0.45      Background Count Time: 10.00

Sequence Number   Sample ID      Input ml      Alpha CPM      Beta CPM      Alpha dpm/ml      Beta dpm/ml
1                 S1            1.00          74.00          61.00          369.50          35.56
**** LIMITS WARNING Alpha Level 2 ****
**** Alpha Only Recount ****
2                 S1            1.00          100.00         -----         499.50          -----
**** LIMITS WARNING Alpha Level 2 ****
```

---

Counted by: \_\_\_\_\_ Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_

Count Routine Definition Page 3

Count routine definition page 3 allows for the selection of units for the reported results.

The screenshot shows a software interface titled "COUNT ROUTINE DEFINITION". It is divided into several sections:

- Input Units:** A list of units with checkboxes: ml, l, m3, ft3 (checked), cm2, and None.
- Report Units:** A sub-section with two columns:
  - Activity:** pCi, uCi, Bq, dpm (checked).
  - per:** ml, l, m3, ft3 (checked), cm2, 100cm2, Sample, and None.
- Format:** A dropdown menu currently set to "Normal".
- Navigation:** Three buttons at the bottom: "PREV", "NEXT", and "DONE".

**Input Units**

Select the units for the volume of your sample or area or select *None* if you do not have an input.

**Report Units**

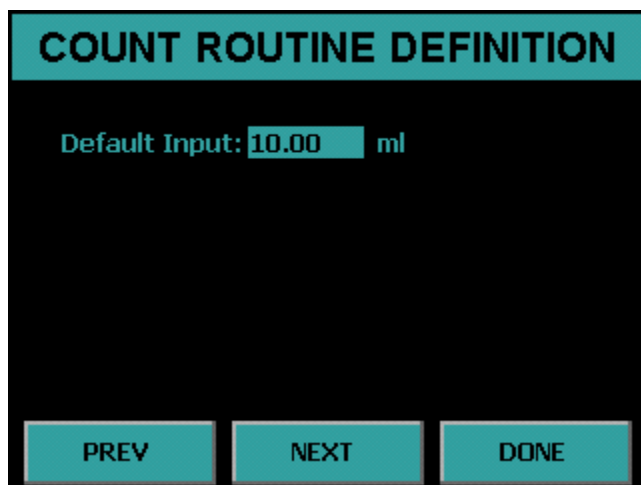
Select the units for which you want to display the Activity.

**Format**

Toggle the button from *Normal* to *Scientific* Notation for the Activity Format.

**Count Routine Definition Page 4**

This page is not displayed if you have input units of None. This page allows for the setting of a default input.



**Default Input**

This field is the default input volume or area depending on the input units from the previous page. This is useful if you are not using batches and your input volume or area is the same for each sample. Therefore, the user will not have to type in the input for each count. If the user is using batches and a input in the batch file is 0 then this Default Input is used.

Count Routine Definition Page 5

This page will appear only for the following report Models:

- Standard Report (High Alpha-Only Recount)
- Flag Concentration
- Flag Concentration (High Alpha-Only Recount)
- Flag Concentration (Radon Subtraction)

This page allows for the ability to set action limits for the alpha only recount and flag concentration reports.

Action Limits	
Alpha dpm/ft3	Beta dpm/ft3
Level 1: 0.000E+00	0.000E+00
Level 2: 0.000E+00	0.000E+00
Level 3: 0.000E+00	0.000E+00
Level 4: 0.000E+00	0.000E+00

PREV      NEXT      DONE

**Action Limits**

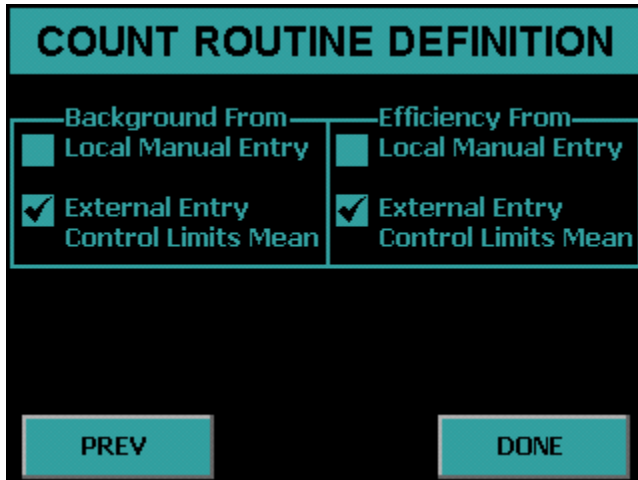
In environments where many samples are counted within a single shift, it may not be possible to closely examine the analysis results for every single sample. The WPC-1050 can provide a warning on the printed report for samples with excessively high activities. The alpha action levels may also be used to automatically mark samples for recounting.

The WPC-1050 provides separate limits for the alpha and beta channels while in the “Alpha and Beta” counting mode. If the counting mode is “Alpha Only” only the alpha action limits are used and the beta action limits are ignored. The action limits are entered in scientific notation.



Count Routine Definition Page 6

Count Routine Definition page 6 provides the ability to set the source for the background and efficiency values.



**Background From**

There are two choices to choose from, Local Manual Entry and External Entry.

**Local Manual Entry** – As its name implies, manual entry relies upon the calibration technician to determine and enter the background values. These values may be obtained through the use of the WPC-1050’s Trending function, or by counting a background reference sample.

**External Entry** – This option is programmed through the USB key. There are three possible options for the selection which are described below.

- **Manual Entry** – Background values are imported from the USB key.
- **Last Control Chart Check** – This method requires that a control chart be in use for tracking backgrounds. The appropriate values are extracted from the last entry in the control chart. Many users believe that this method gives the most accurate picture of the “current” background count rate because it uses the latest available data. However unless the control check is performed for a long period of time (typically 100 minutes or greater), the precision of the background count rate obtained by this method may not be acceptable.

- **Control Limits Mean** – Background values are determined by calculating the mean of all control limit data points. The error in this rate is determined by considering all of the limits data points to be a single acquisition. For example, if the limits data contains forty points at 60 minutes each, the effective count time will be 2400 minutes. This method provides the highest possible precision.

## Efficiency From

There are two choices to choose from, Local Manual Entry and External Entry.

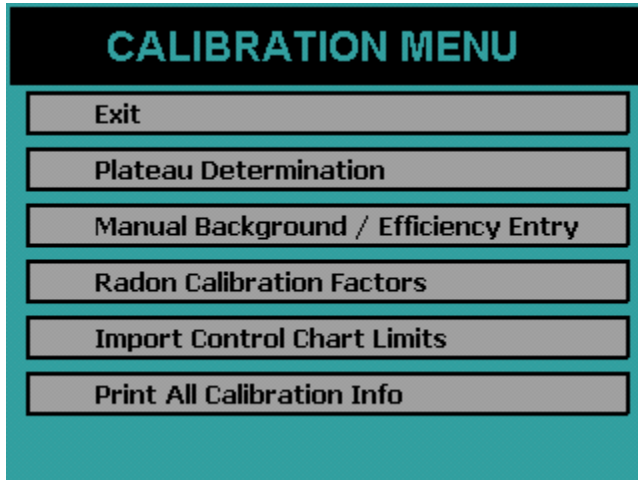
**Local Manual Entry** -- As its name implies, manual entry relies upon the calibration technician to determine and enter the efficiency values.

**External Entry** – This option is programmed through the USB key. There are three possible options for the selection which are described below.

- **Manual Entry** – Efficiency values are imported from the USB key.
- **Last Control Chart Check** – This method requires that control charts for alpha and beta be in use for tracking efficiency. The appropriate values are extracted from the last entry in each control chart. Even though this method is not highly recommended for obtaining background calibrations, it is very useful for obtaining efficiency values. Counting efficiency tends to vary slightly with barometric pressure, temperature, and humidity. This method for obtaining calibration data will provide the most up-to-date efficiency values available.
- **Control Limits Mean**—Efficiency values are determined by calculating the mean of all control limit data points.

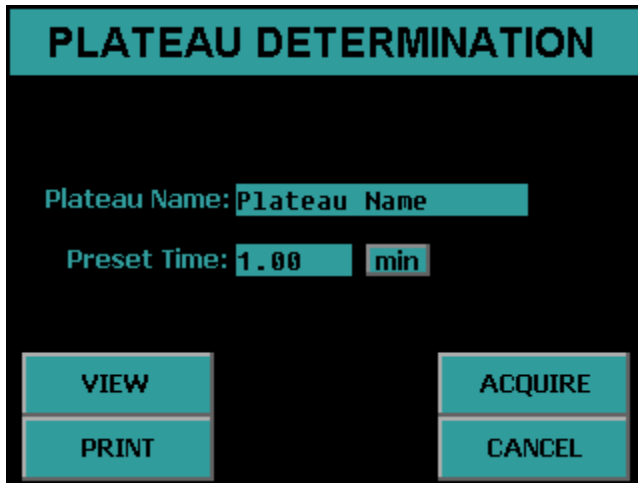
### Calibration Menu

The Calibration Menu is accessed by pressing the *Calibration* button from the Setup Menu. The Calibration Menu is where a plateau can be generated to set operating voltages. Background and efficiency values are entered from the Calibration Menu. Control chart limits are set from this menu as well.



### Plateau Determination

The Plateau Determination screen is accessed from the Calibration Menu. This screen allows the user to acquire, view, and print the plateau.



**Plateau Name** – This field allows the user to provide a name for the acquired plateau.

**Preset Time** – This field allows the amount of time for each acquisition to be specified.

**VIEW** – This button allows the current plateau to be examined on the display. The counting operating bias are also set from the plateau view.

**PRINT** – This button prints the current plateau.

**ACQUIRE** – This button causes a plateau to be generated using the current plateau parameters.

**CANCEL** – This button exits the Plateau Determination screen and goes back to the Calibration Menu.

**Acquiring a Plateau**

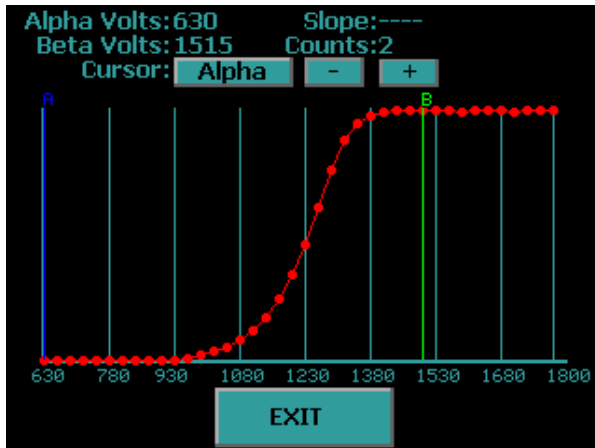
The plateau is acquired by specifying a Plateau Name and Preset Time. Once the desired sample is loaded, the *ACQUIRE* button is used to start the plateau data collection.

The Plateau Acquisition screen is shown below. The first column shows the gross and guard counts. The second column shows the gross and guard cpm. The elapsed and remaining times are updated as well as the current operating voltage. A progress bar is provided to display the status of the current step. The current step number and remaining step total are displayed below the status bar. Pressing *EXIT* before the acquisition is complete aborts the plateau acquisition.



### Viewing a Plateau

Pressing *VIEW* on the Plateau Determination screen displays the screen below.



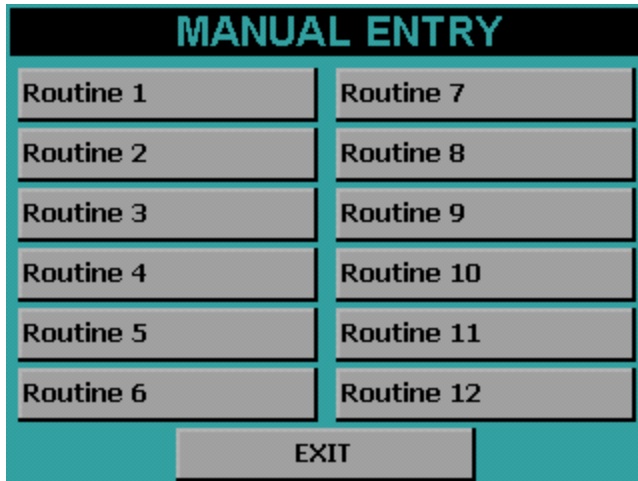
The WPC-1050 will automatically generate a plateau curve. Two cursors are displayed. The blue cursor is the alpha-only operating bias. The green cursor is the alpha and beta operating bias. The % slope per 100 volts is displayed for the active cursor. Note the first two points and last two points for the slope are not displayed because the slope is calculated using a five point smoothing technique for accurate slope determination. Two points before and two points after the cursor position are used in the slope calculation. To toggle the active cursor press the button beside “Cursor.” The + and – buttons allow fine cursor control. Pressing the vertical blue bars causes the cursor to snap to that line. The slope and counts are displayed for the current cursor position. The current alpha-only operating bias is displayed beside “Alpha Volts” and the alpha and beta operating bias is displayed beside “Beta Volts.”

To select the alpha-only voltage, toggle the cursor to Alpha and then move the cursor to the voltage the user wishes to set the alpha-only bias setting. It is recommended to set the alpha-only bias to 705. To set the alpha and beta operating point, toggle the cursor to Beta and then observe the slope. Protean Instrument Corporation recommends that the first point below 5% slope be used for the alpha and beta operating voltage. Pressing the *EXIT* button saves the operating bias settings and returns to the Plateau Determination screen.

When using the plateau function it is critically important to use a point source. Using a distributed source will cause a degraded plateau curve to be generated, leading to a bias set point that is far from optimum. Protean Instrument Corporation encourages users to become familiar with ANSI Standard 42.25-1997 “Calibration and Usage of Alpha/Beta Proportional Counters.”

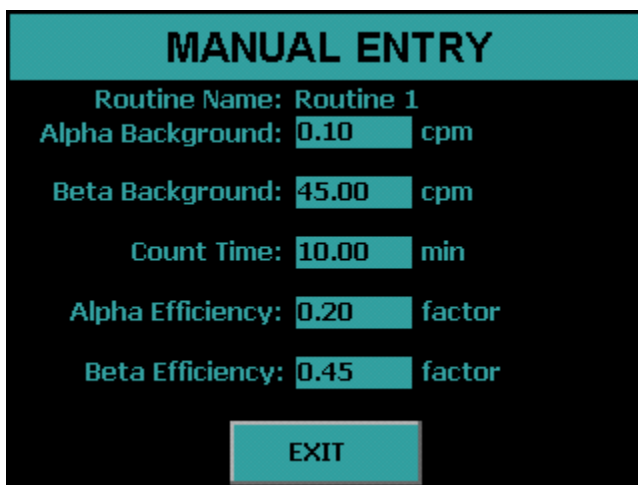
**Manual Background/Efficiency Entry**

Pressing the *Manual Background/Efficiency Entry* button from the Calibration Menu displays the following screen.

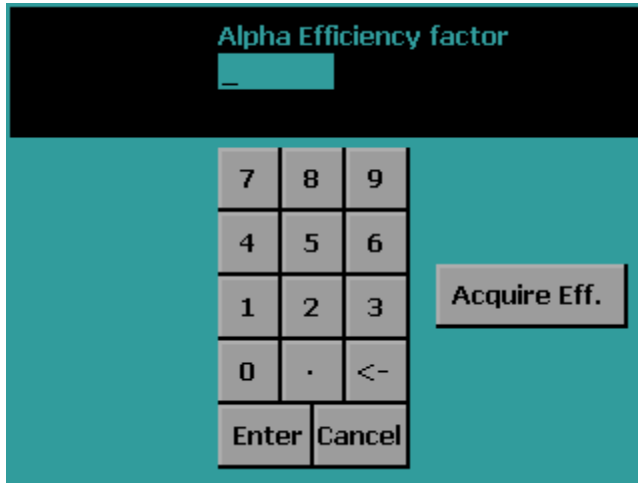


Press the button corresponding to the routine that you wish to add background and efficiency values. Note that efficiency values are entered as factors and not as percentages. Press *EXIT* to return to the Calibration Menu.

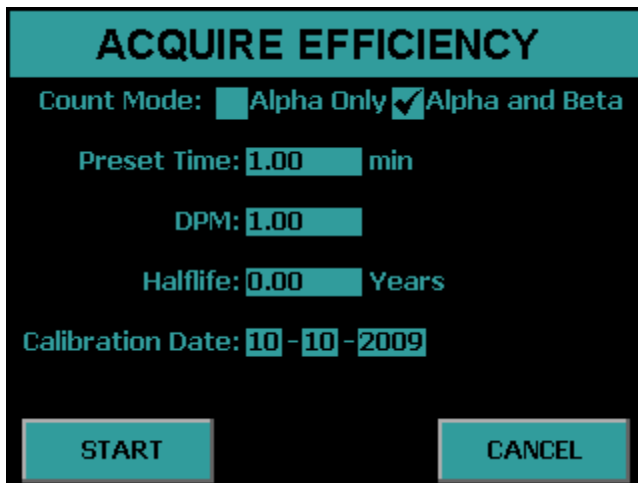
Pressing a routine button displays the following screen.



Pressing the Alpha Efficiency field or Beta Efficiency field displays the following screen. From this screen the user can either enter the efficiency factor and press the *Enter* button or acquire the efficiency by pressing the *Acquire Eff.* button.



Pressing the *Acquire Eff.* button displays the following screen.



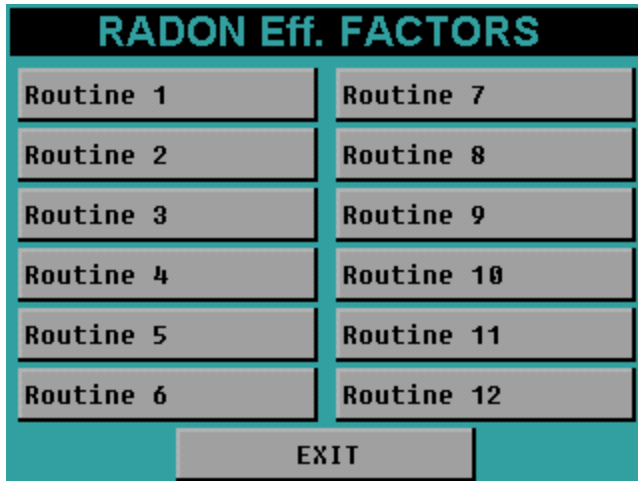
Select the Count Mode, Preset Time, Source DPM, Halflife, and Calibration Date of the source. Insert the source and press the *START* button to acquire the efficiency. Once the count finishes press the *Exit* button and the efficiency factor that was acquired will now be entered.

Press *EXIT* to save the changes and return to the routine selection screen.

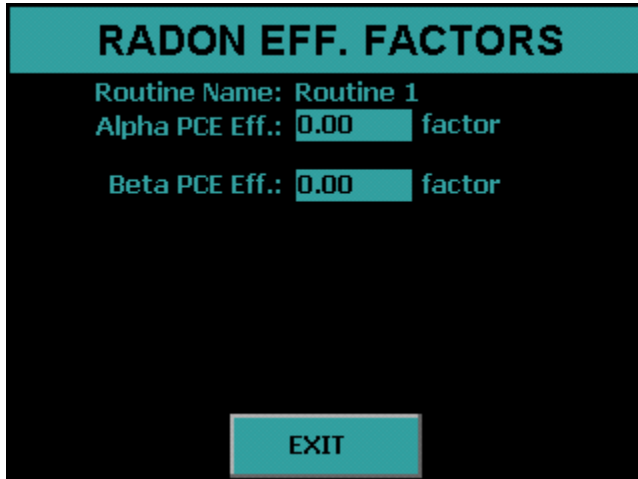


**Radon Efficiency Factors**

Pressing the *Radon Calibration Factors* button from the Calibration Menu displays the following screen.



Press the button corresponding to the routine you wish to edit radon factor values. Press *EXIT* to return to the Calibration Menu.



Press *EXIT* to return to the routine selection screen.

**Import Control Chart Limits**

Pressing the *Import Control Chart Limits* button from the Calibration Menu displays the following screen.



Insert a USB flash drive into the front USB port and then press the *IMPORT* button. The control chart limits which are set on the USB flash drive from the companion software will be imported. The imported limits can be viewed from the Data Menu.

Note only the limits for the control chart are set with the Import Control Chart Limits function. The user must use the *Import Settings* under the Program Menu if the user wishes to change control chart settings other than the limits.

Press the *EXIT* button to return to the Calibration Menu.

**Print All Calibration Info**

Pressing the *Print All Calibration Info* button prints the current plateau and calibration information for each routine.

## Control Charts

Three control charts can be used with the WPC-1050, one chart for tracking alpha and beta background and two charts for tracking alpha and beta efficiency. The specifics of the control chart are defined in the companion software. Control chart limits are established through the companion software and are sent to the USB flash drive. Control chart limits are then imported through the calibration function. Finally, control checks are performed by loading the check source and starting the count from the Top Menu.

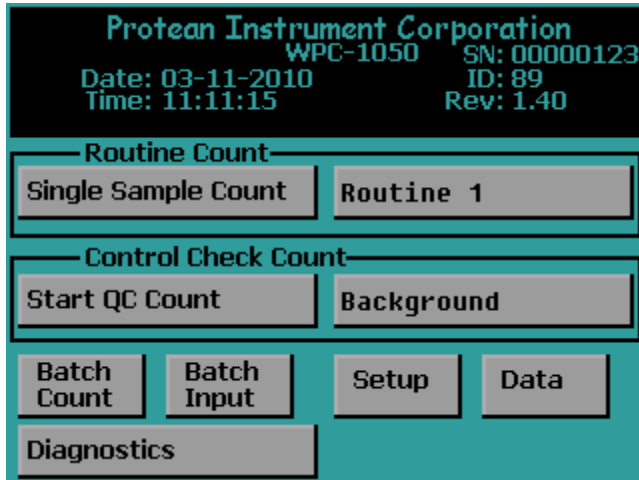
The implementation of a control chart requires that limits be established before routine checks are made. The control limits are established by randomly counting the appropriate standard over a period of several days using the control check acquisition routine. The WPC-1050 stores a maximum of forty check measurements for each control chart. It is recommended that no fewer than ten limit points be acquired before beginning routine control checks. If more than forty check points are acquired, the oldest point is discarded to make room for the next point. Once at least ten checks are acquired then the limits may be sent to the companion software by going to the DATA MENU and then selecting *Export Data*. Select *QC Checks* and press *EXPORT*.

The checks data is now on the USB flash drive ready to upload to the companion software to establish the Control Chart Limits. The companion software then sends Control Limits back to the USB flash drive. The next step is to import the limits that are on the USB flash drive using the Calibration function.

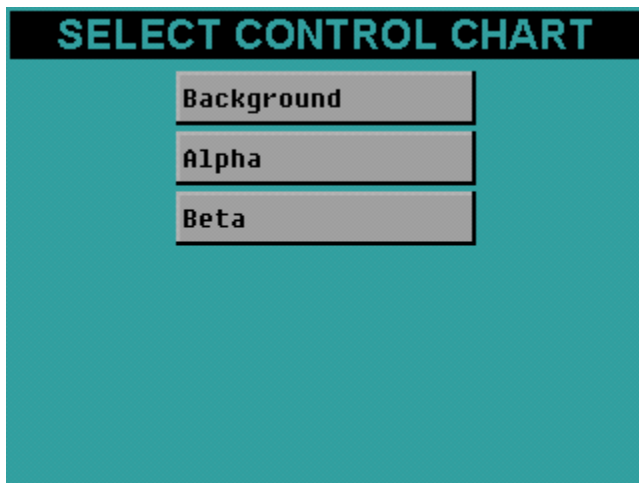
The mean and associated standard deviations established by the control chart limits now become the bench mark by which future performance (the control checks) are judged. The control checks will be plotted on the same scale as the limits data. The two sigma lines around the mean will be considered warning levels. The three sigma lines will be considered control limits. If the instrument is performing in a stable manner, the control checks should follow a statistically predictable distribution about the control limits mean.

It should not be expected that the instrument will continue counting forever in a perfectly stable and predictable manner. Aging of detectors and electronics contribute to performance changes. Control charts should be reestablished at least on an annual basis. Any time components such as detectors or electronics are replaced, adjusted or serviced, the control charts should be reinitialized.

Manually Acquiring Control Checks

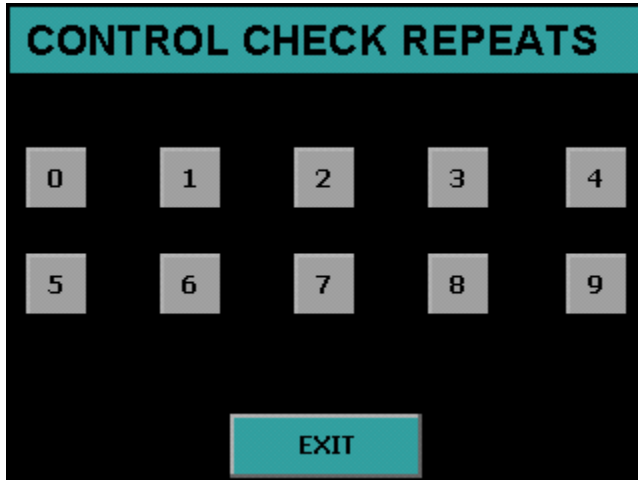


From the Top Menu press the button beside Start QC Count to select the control chart. The screen below will be displayed.



Select the control chart to count by pressing the appropriate button. The control chart that was selected will now appear on the Top Menu.

Press the *Start QC Count* button from the Top Menu and the following screen will appear.

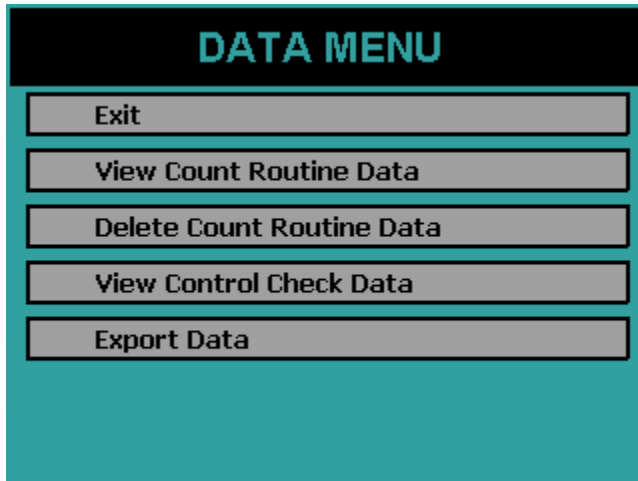


Press the appropriate button for the number of repeats. Pressing the button *0* only one control check count will be performed. Pressing the button *1* two control check counts will be performed. Pressing *EXIT* returns to the Top Menu.

**Acquiring Control Checks**

The control checks may also be acquired using the automatic sample changer. Place the appropriate QC plate on the sample changer and press the Batch Count button from the Top Menu to acquire the control checks. The sample carrier labeled QC 1 selects the background control chart routine. The sample carrier labeled QC 2 selects the alpha control chart routine. The sample carrier labeled QC 3 selects the beta control chart routine.

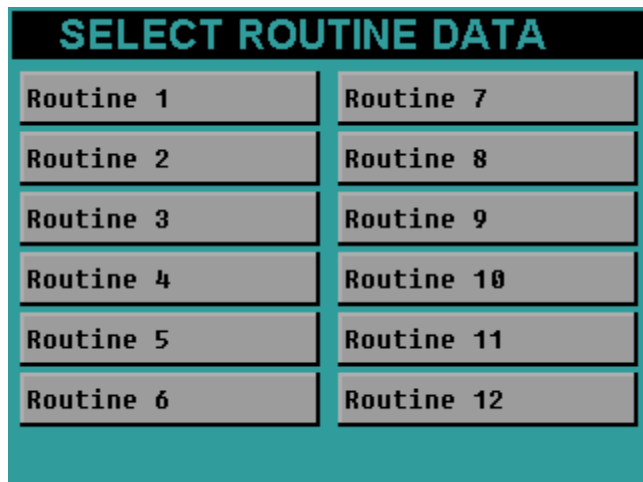
## Data Menu



The Data Menu provides a means of examining, editing, printing and exporting data collected. This data is divided into two main categories, count routine data and control check data. Control check points that were acquired in error may also be deleted using the Data Menu.

**View Count Routine Data**

Pressing the *View Count Routine Data* button from the Data Menu displays the following screen. The data is organized under each count routine. For instance pressing Routine 1 displays all of the data that was acquired using count routine 1.



The screenshot shows a screen titled "SELECT ROUTINE DATA" with a grid of 12 buttons arranged in two columns and six rows. The buttons are labeled "Routine 1" through "Routine 12".

SELECT ROUTINE DATA	
Routine 1	Routine 7
Routine 2	Routine 8
Routine 3	Routine 9
Routine 4	Routine 10
Routine 5	Routine 11
Routine 6	Routine 12

Routine Data View

After selecting a count routine the following screen is displayed.

S#	$\alpha$ cpm	$\beta$ cpm	$\alpha$ dpm/ml	$\beta$ dpm/ml
1	3.00	36629.00	11.60	81396.78
2	0.00	36989.00	-0.40	82196.78

The Routine Name is displayed at the top. The + and – buttons are used to select records. A record can also be selected by simply touching it. The currently selected record is highlighted in white.

The *PREV* and *NEXT* buttons move to the previous and next page of data.

The display option buttons at the top of the four columns can be pressed to change the information displayed in that column. See the Display Option section below for further explanation.

When the *Select* button is pressed the current highlighted record is displayed in a full record view. See the Full Record View section below for further explanation.

The *PAGE* button goes to the PAGE SELECTION screen. See the Page Selection section below for further explanation.



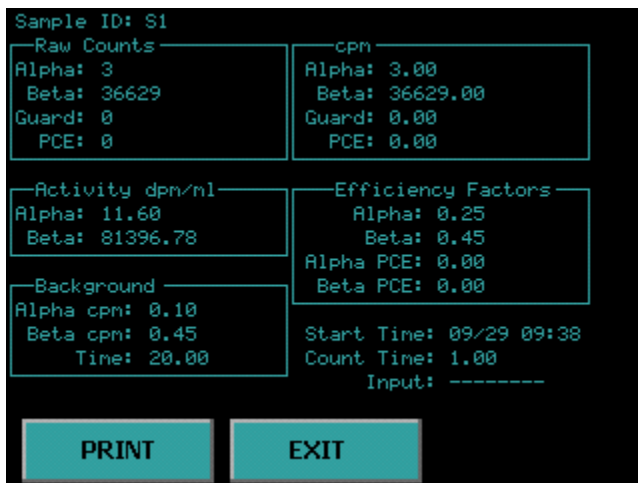
Display Option

The following screen is displayed when pressing one of the four display option buttons on the routine data view screen. Press one of the buttons and the column on the routine data view is updated to reflect the new heading.



Full Record View

The following screen is displayed when pressing the *Select* button on the Routine Data View screen. Pressing the *PRINT* button prints the displayed record on a single page.



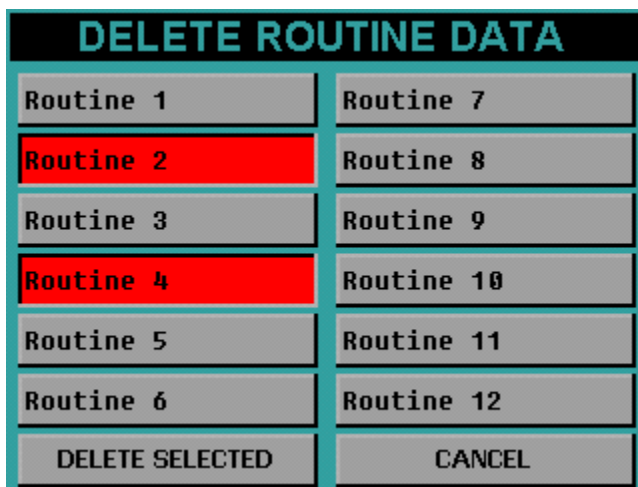
Page Selection

The following screen is displayed when pressing the *PAGE* button on the routine data view screen. Pressing the *PRINT* button prints all data records for this routine. Twenty page buttons each with the record range for that page on the button. Simply press the button corresponding to the record range desired. This feature prevents multiple presses of the *PREV* and *NEXT* buttons to go from the beginning to the end of the record set.



Delete Count Routine Data

The following screen appears if you press *Delete Count Routine Data* on the Data Menu screen. To delete the routine data press the routine buttons to select the desired count routines. The buttons will turn red. To unselect, press the button again and the button will turn back to grey. Once you have selected which routine data to delete, press the *DELETE SELECTED* button and all of the count routine data for the selected routines will be removed. The screen below shows Routine 2 and Routine 4 data ready to be deleted.

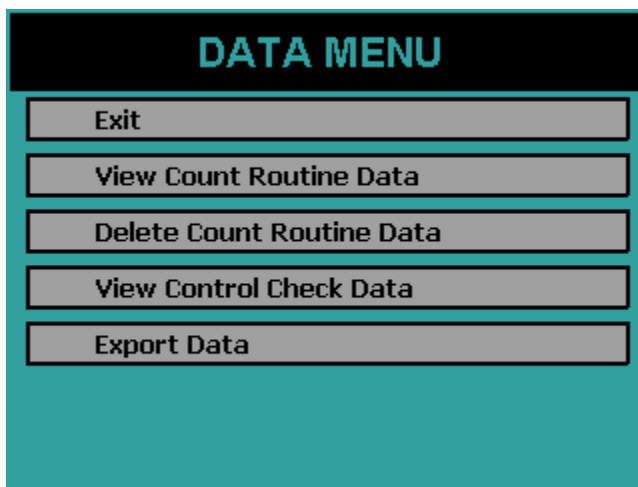


**View Control Check Data**

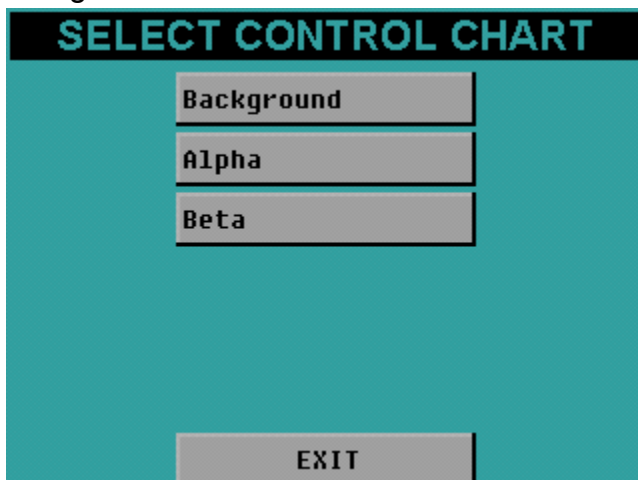
**Background Control Chart**

The background control chart settings are defined using the companion software. However once you have imported the settings through the Program function then the current settings can be viewed.

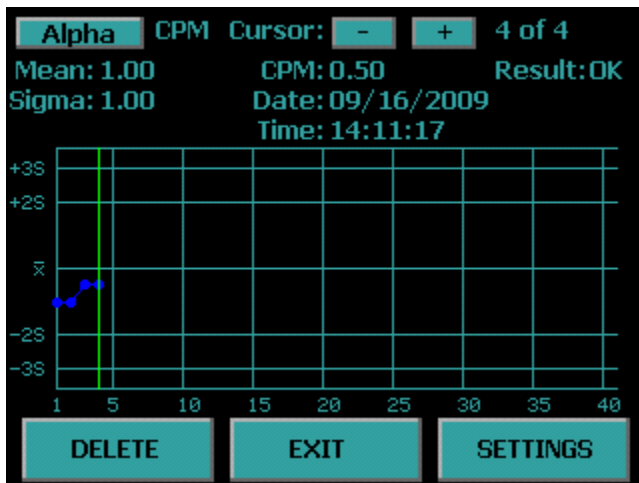
To view the background control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



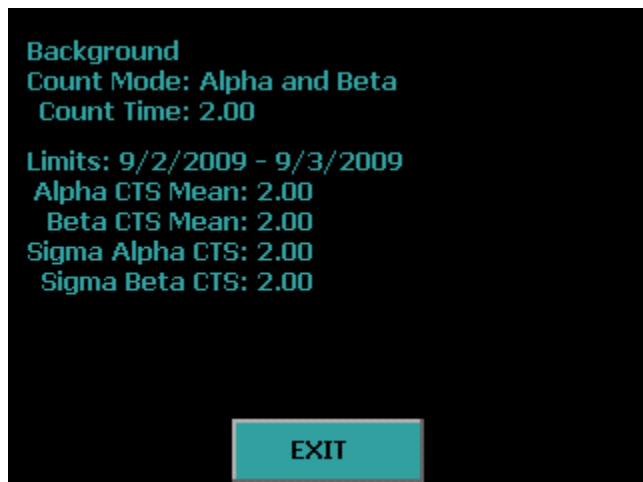
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will always be the beta control chart. Now press the top button (*Background*) to view the background control chart.



The top left button allows you to toggle between viewing the alpha and beta background. The + and – buttons allow fine control of the cursor to look at various points. The vertical green bar is your cursor. Pressing the vertical blue bars causes the cursor to snap to that line if there are points at that location otherwise the button presses are ignored. This feature eliminates the need for multiple + and – button presses to get to the beginning or end of the data set. Below the + and – buttons are data for the current cursor position. Pressing the *DELETE* button deletes the point at the cursor location.



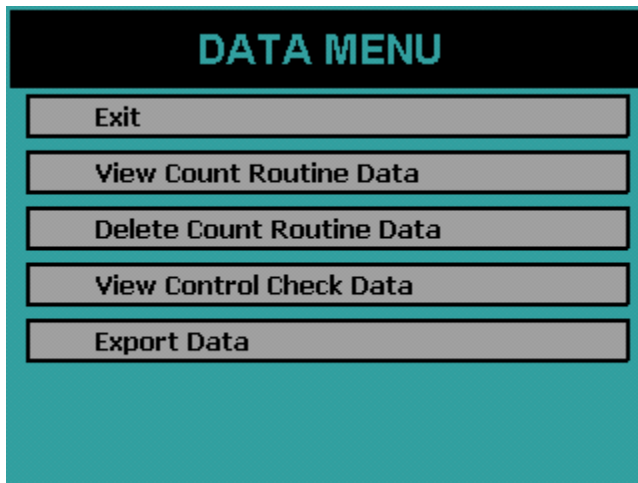
Pressing the *SETTINGS* button allows viewing of the control chart settings.



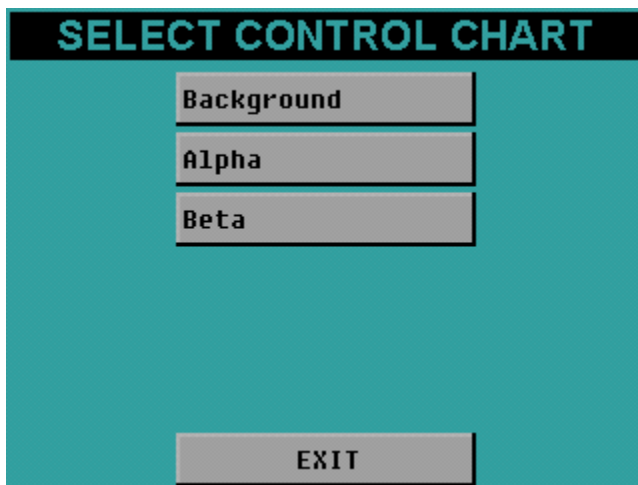
The first line is the control chart name. The second line is the counting mode used during acquisition. The third line is the amount of time for each acquisition. The date range is the date of the first limit point to the date of the last limit point that is used in the Alpha and Beta Mean and Standard Deviation values which are shown on the last four lines.

### Alpha Control Chart

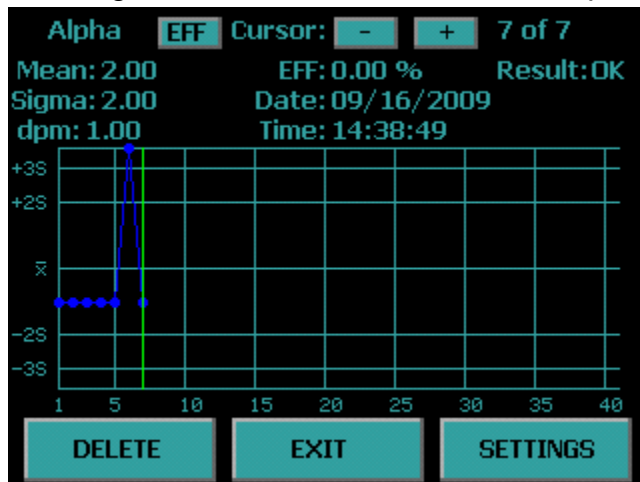
To view the alpha control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



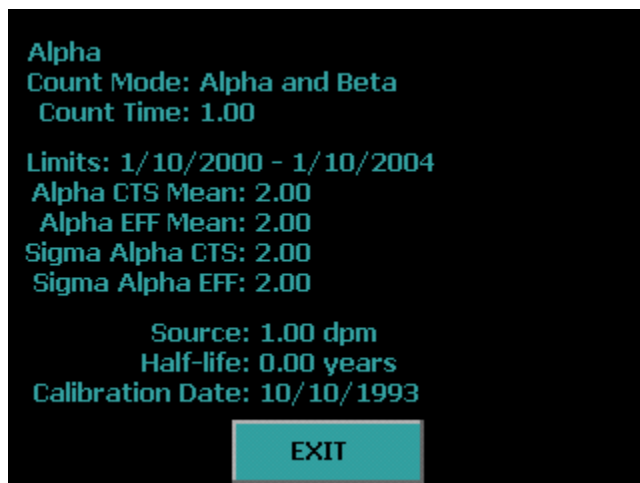
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will always be the beta control chart. Now press the middle button (Alpha) to view the alpha control chart.



The top left button allows you to toggle between viewing the alpha cpm and efficiency. The + and – buttons allow fine control of the cursor (the vertical green bar) to look at various points. Pressing the vertical blue bars causes the cursor to snap to that line if there are points at that location, otherwise the button presses are ignored. This feature eliminates the need for multiple + and – button presses to get to the beginning or end of the data set. Below the + and – buttons are data for the current cursor position. Pressing the *DELETE* button deletes the point at the cursor location.



Pressing the *SETTINGS* button allows viewing of the control chart settings.

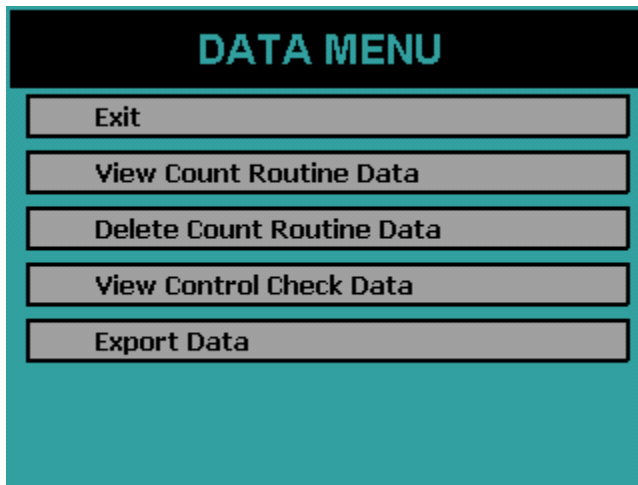


The first line is the control chart name. The second line is the counting mode used during acquisition. The third line is the amount of time for each acquisition. The date range is the date of the first limit point to the date of the last limit point that is used in the Alpha Mean and Standard Deviation values which are shown on the next four lines. The last three lines show the check source information.



**Beta Control Chart**

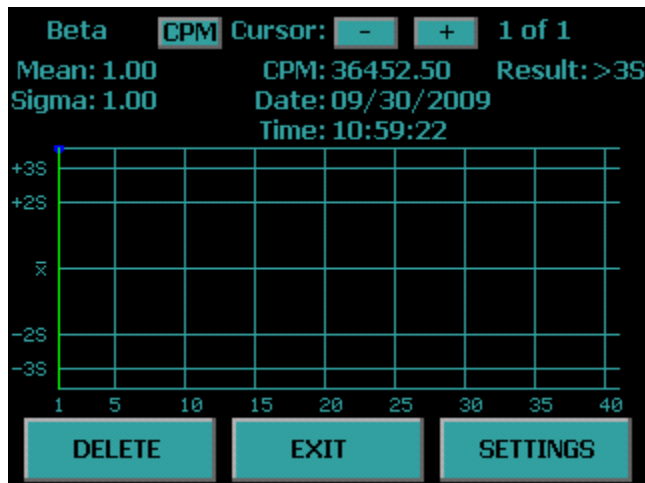
To view the beta control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



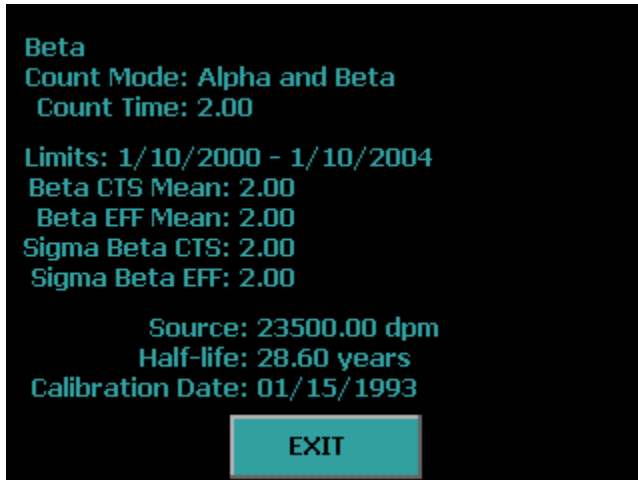
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will be the beta control chart. Now press the bottom button (Beta) to view the beta control chart.



The top left button allows you to toggle between viewing the beta cpm and efficiency. The + and – buttons allow fine control of the cursor (vertical green bar) to look at various points. Pressing the vertical blue bars causes the cursor to snap to that line if there are points at that location, otherwise the button presses are ignored. This feature eliminates the need for multiple + and – button presses to get to the beginning or end of the data set. Below the + and – buttons are data for the current cursor position. Pressing the *DELETE* button deletes the point at the cursor location.



Pressing the *SETTINGS* button allows viewing of the control chart settings.



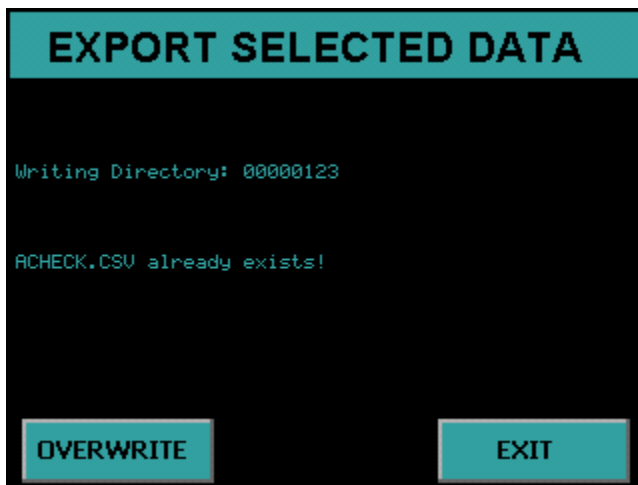
The first line is the control chart name. The second line is the counting mode used during acquisition. The third line is the amount of time for each acquisition. The date range is the date of the first limit point to the date of the last limit point that is used in the Beta Mean and Standard Deviation values which are shown on the next four lines. The last three lines show the check source information.

**Export Data**

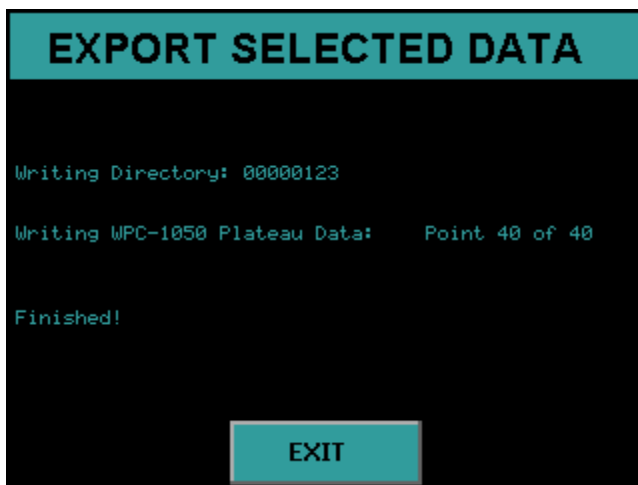
The following screen appears if you press *Export Data* from the Data Menu. To export data to the USB flash drive insert a USB flash drive into the front USB port and press the blue box beside the data you wish to export. Selected data will have a check in the box. To deselect press the box again and the check will be removed. Press the *EXPORT* button to begin the export of the selected data.



Once data export begins the serial number directory is checked to verify that the selected data for export does not overwrite previous data. As displayed on the screen below, a warning message showing the Alpha Control Check data already exists on the USB flash drive. If you wish to overwrite the data press *OVERWRITE* and the Alpha Control Check data that was on the USB flash drive is overwritten. If you wish to keep the Alpha Control Check data press *EXIT*, and remove the USB flash drive and copy the data to another source or insert a new USB flash drive. It is recommended to delete any previous exported data under the serial number directory on the USB flash drive before exporting new data so that you avoid the data overwrite warning.

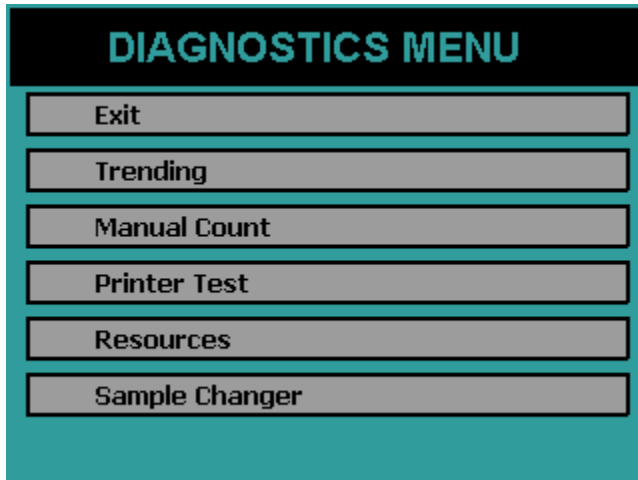


When the data export is successfully completed, "Finished! " will be displayed, as seen on the screen below.



## Diagnostics Menu

The Diagnostics Menu is reached by pressing Diagnostics from the Top Menu. The Diagnostics Menu provides access to a group of diagnostic routines for basic data collection and peripheral testing.



**Trending** – allows sequential counting of a sample or standard to verify proper performance of the electronics and/or detector. A graphical presentation of the sequentially collected data plotted about the mean permits short term trends to be conveniently identified.

**Manual Count** – provides a no frills accumulation routine useful for adjustment of amplifier gains and discriminator levels.

**Printer Test** – used to verify compatibility of printers with the graphics commands utilized when printing.

**Resources** – displays the available count record storage for each routine.

**Sample Changer** – Used to adjust the alignment of the barcode reader, clearing a sample carrier jam, and verifying the operation of the sample changer and associated sensors.

**Trending**

There are occasions when it is desirable to collect a series of counts on a standard or background blank. If erratic counting is suspected, or some short term drifting trend needs checking, the Trending routine provides a convenient multiple count testing format.

Trending provides the collection of data, calculation of mean and standard deviation, calculation of chi-squared values, and generation of reports in graphic and text formats.

### The Trending Screen

The Data Trending routine is accessed from the Diagnostics Menu. This routine displays the screen below which allows the user to acquire, view, and print the trending data.

**DATA TRENDING**

Counting Mode

Alpha Only  Beta Only  Alpha and Beta

Preset Time: 20.00 min

Repeats: 51

VIEW PRINT ACQUIRE CANCEL

**Counting Mode** – Select between “Alpha Only”, “Beta Only”, and “Alpha and Beta” by pressing the blue box to select which counting mode new trending data may be acquired.

**Preset Time** – This field allows the amount of time for each acquisition to be specified for new trending data.

**Repeats** – This field specifies the number of times to analyze a sample when new trending data is acquired.

**VIEW** – This button allows current trending data to be examined on the display.

**PRINT** – This button prints current trending data.

**ACQUIRE** – This button causes the sample to be analyzed using the current trending parameters.

**CANCEL** – This button exits the trending routine and goes back to the Diagnostic Menu.



**Acquiring Trending Data**

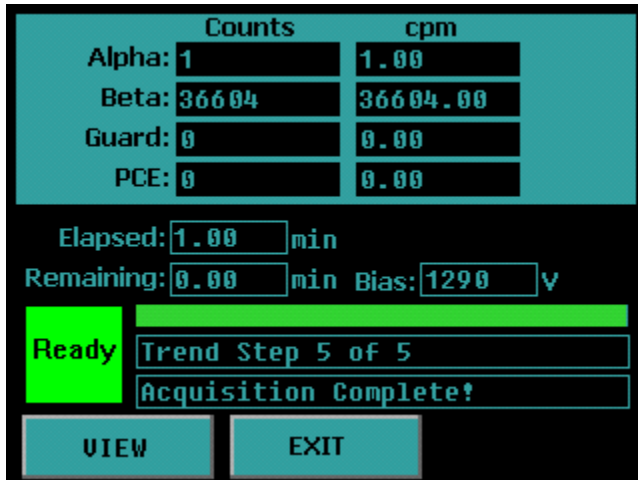
Trending data is acquired by using the Counting Mode, Preset Time , and Repeats fields to specify how the new trending data is to be acquired. Once the desired sample is loaded, the *ACQUIRE* button is used to start the trending data collection.

The detector bias will be applied and a short delay will occur while the bias voltage stabilizes. Finally, the analysis will commence and the display described below will be shown.

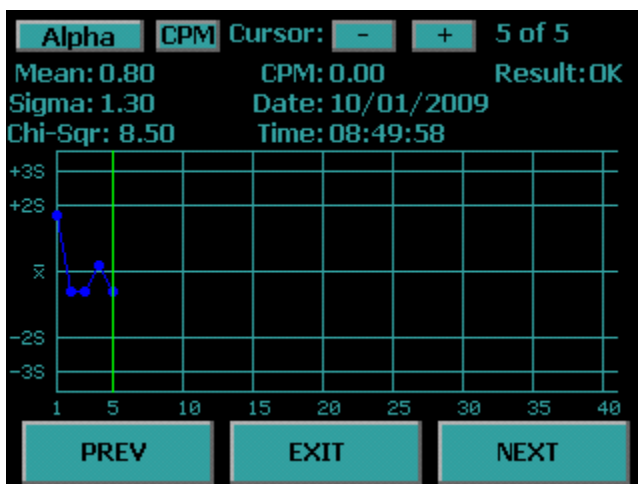
The trending acquisition screen is shown below. The first column shows the raw counts for Alpha, Beta, Guard, and Pseudo-Coincidence. The second column shows the raw cpm for Alpha, Beta, Guard and Pseudo-Coincidence. The elapsed and remaining times are updated as well as the current operating voltage. A progress bar is provided so that a quick glance of the screen is all that is required to view the progress of the current step. Below the progress bar, the current step and remaining number of steps are displayed. A *VIEW* button is provided to view the trend graph during the acquisition, however at least one point must have been acquired before viewing the graph. Otherwise the button press is ignored. The trend graph is not updated during an acquisition so the user must press *EXIT* while on the trend graph screen to view the current count progress. Pressing *EXIT* on the trending acquisition screen before the acquisition is complete aborts the trend acquisition.



The screen below indicates that all five trend steps have been completed and that the acquisition is complete. It is now safe to press *EXIT* without aborting the trend acquisition.



Pressing *VIEW* will display the trending graph screen seen below. The top left button allows the user to toggle between Alpha, Beta, Guard, and PCE data. The button that is adjacent to the top left button allows the user to view the data in units of counts or CPM. The – and + buttons allows fine cursor (vertical green bar) control. Pressing the vertical blue bars causes the cursor to snap to that line. The mean, standard deviation and Chi-Square values are calculated and displayed. The counts, CPM, Date, Time and whether the point is within two and three standard deviations are indicated at the cursor location. Forty points are displayed on each screen. Use the *PREV* and *NEXT* buttons to go to the previous forty points or next forty points.



**Printing Trending Data**

Pressing *PRINT* on the Data Trending screen displays the print selection screen below. Select between CPM or Counts and select the desired data by pressing the blue boxes. Press the box again to deselect data to print. Selected data has a check beside it. The number of pages that will be printed with the current selection is also indicated. Press the *PRINT* button to print the previously collected trend data.

The screenshot shows a 'PRINT SELECTION' dialog box with a black background and white text. At the top, 'Print Units: CPM' is displayed. Below that, 'Print Selection' is followed by four checked items: 'Alpha Trend', 'Beta Trend', 'Guard Trend', and 'PCE Trend'. Underneath, it says 'Pages to Print: 4'. At the bottom, there are two buttons: 'PRINT' on the left and 'CANCEL' on the right.

## Manual Count

**MANUAL COUNT**

Counting Mode

Alpha Only  Beta Only  Alpha and Beta

Preset Time: 1.00 Min

START CANCEL

A no frills count routine is provided for quick checks. This routine is useful if adjustments are necessary for discriminators. There is no report generated from the Manual Count routine other than the data displayed on the screen.

### The Manual Count Screen

This routine displays a screen which allows the user to set count parameters. Selections are made by pressing the blue boxes. The screen contains the following controls:

**Counting Mode** – Select the counting mode which new data may be acquired by pressing the blue box beside the desired mode.

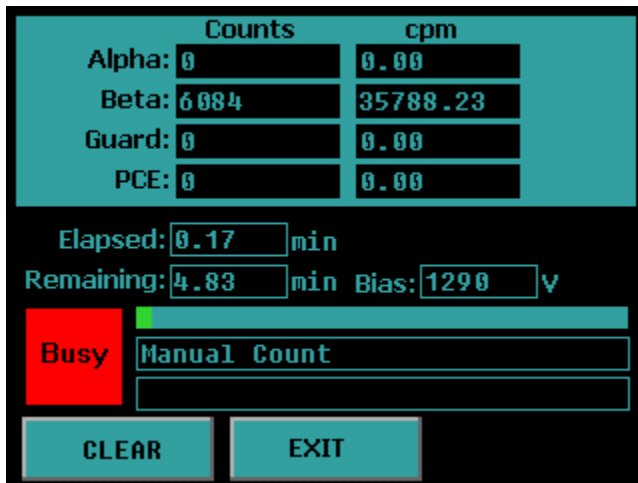
**Preset Time** – This field allows the amount of time for each acquisition to be specified for new data.

**START** – This button causes the sample to be analyzed using the specified counting parameters.

**CANCEL** – This button exits the Manual Count routine and goes back to the Diagnostics Menu.

The Data Display

Once the *Start* button is selected the detector bias voltage is then applied. A short delay will occur in waiting for the bias to stabilize. Once the bias supply is stable, counting will commence. Count data is displayed during and after data acquisition on a screen similar to the one shown below.



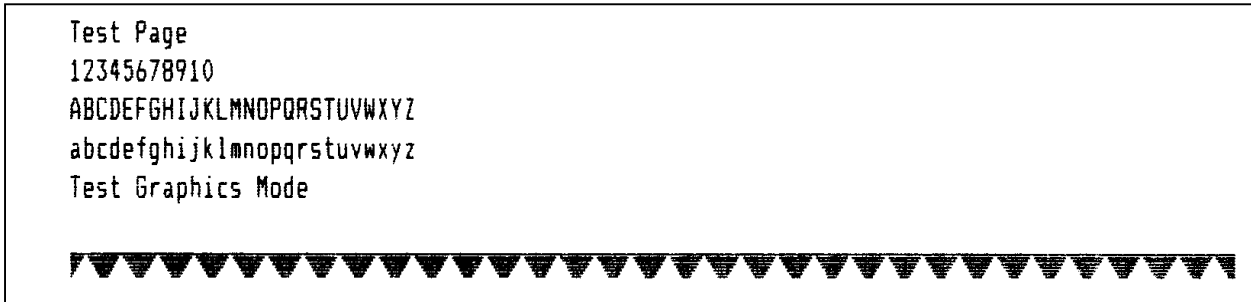
When making certain hardware adjustments, it is desirable to see the results of these adjustments immediately. This feedback enables “tweaking” the adjustment until the desired results are obtained. This requires clearing the display so that the adjustment effects can be viewed. Pressing the *CLEAR* button will clear the counters and reset the elapsed clock

Pressing *EXIT* during the acquisition will abort the count.

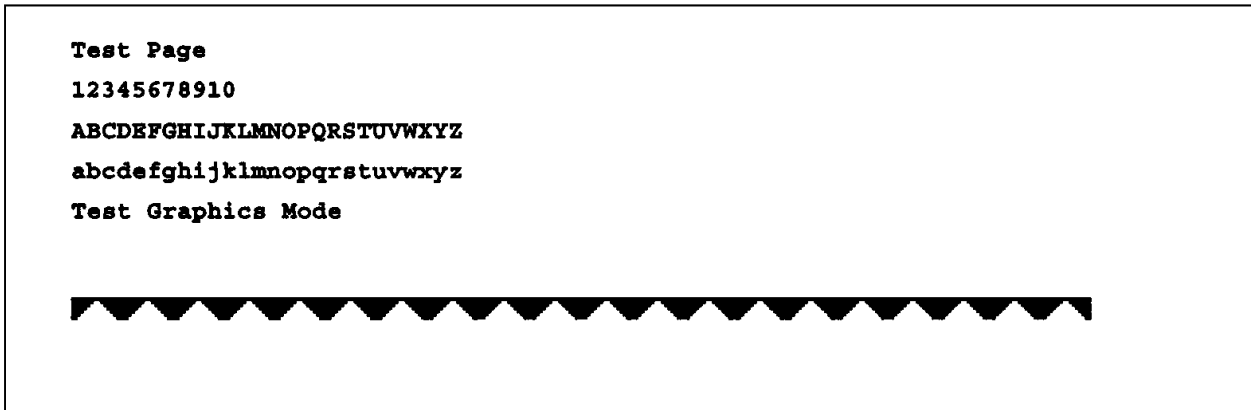
**Printer Test**

The Printer Test routine sends out five lines of alphanumeric data and one line of graphics to insure compatibility between the instrument and the printer. This is also helpful when setting up printers which have their own configuration switches. The test page will appear slightly different depending if it was printed with a line printer or laser printer. Below are examples of what the test page should look like for each printer type.

Epson 9P/ESC P



HP PCL5



## **Guarding Against Obsolescence**

Computer technology and software is probably the most rapidly changing industry on the planet. Whatever you are using today will be obsolete in a few months. Our task is to integrate an instrument designed to last a decade into an environment which changes daily and guard against obsolescence. There are few lasting standards to aid in this quest, especially in software.

If you wonder why we have invested so much effort in the stand-alone features of the WPC-1050, this should be a clue. The methods and procedures built into the WPC-1050 are not likely to change during its useful life. In five years, however, you will probably be on your third or fourth computer and several generations of software upgrades. While you struggle through the new spread sheet help files to learn new syntax, macro languages, etc.; you have the comfort of knowing that you will not have to spend weeks rewriting operating procedures for your old alpha/beta counter. You also have the comfort of knowing that once you master your new tools, you can use them to create spectacular reports from the same old data imported from the same old alpha/beta counter.

We rely on three elements to provide this guard against obsolescence. The first is our commitment to keep the structure of the WPC-1050 data records upwards compatible. The second is a reliance on the computer industry to include a USB port on all new computers. The third element expects that every new spread sheet package, data base manager, etc., will be able to read and parse comma separated field text record structure. These are very safe bets and the foundation for our computer connectivity philosophy.

In the following pages we will describe the details of the data saved on the USB flash drive.

**Plateau Data CSV File Format**

**PLATEAU.CSV                      Record 1    Header 1**

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER
4	OPERATOR
5	PLATEAU_TITLE
6	PLATEAU_DATE
7	COUNT_TIME
8	COUNT_TIME_UNITS

**PLATEAU.CSV                      Record 2    Data Values**

Field	Field Value	Description
1	WPC-1050 Detector Plateau Data	Fixed Test
2	Instrument ID Name	QET 18 Characters
3	Instrument ID Number	Integer Value
4	Operator Name	QET 18 Characters
6	Plateau Generation Date	(mm/dd/yyyy)
7	Count Time	Non-integer
8	Count Time Units	min/sec

**PLATEAU.CSV                      Record 3    Header 2**

Field	Name	Description
1	VOLTS	Detector Voltage integer value
2	COUNTS	Integer Value
3	SLOPE	Non-integer

**PLATEAU.CSV                      Record 4 – 43    Data Values**



**Alpha Control Chart Checks Data CSV File Format**

**ACHECK.CSV                      Record 1    Header 1**

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER
4	CHART_TITLE

**ACHECK.CSV                      Record 2    Data Values**

Field	Field Value	Description
1	WPC-1050 Alpha Control	Fixed Test
2	Instrument ID Name	QET 18 Characters Max
3	Instrument ID Number	Integer Value
4	Chart Title	QET 18 Characters Max

**ACHECK.CSV                      Record 3    Header 2**

Field	Name	Description
1	POINT	Sequence Number (1 – 40) Integer
2	ALPHA_COUNTS	Integer Value
3	BETA_COUNTS	Non-integer
4	DATE	Date (mm/dd/yyyy)
5	TIME	Time (hh:mm:ss) 24 Hour Time Format

**ACHECK.CSV                      Record 3 + n    Data Values**

**Beta Control Chart Checks Data CSV File Format**

**BCHECK.CSV                      Record 1    Header 1**

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER
4	CHART_TITLE

**BCHECK.CSV                      Record 2    Data Values**

Field	Field Value	Description
1	WPC-1050 Beta Control Checks	Fixed Test
2	Instrument ID Name	QET 18 Characters
3	Instrument ID Number	Integer Value
4	Chart Title	QET 18 Characters

**BCHECK.CSV                      Record 3    Header 2**

Field	Name	Description
1	POINT	Sequence Number (1 – 40) Integer
2	ALPHA_COUNTS	Integer value
3	BETA_COUNTS	Non-integer
4	DATE	Date (mm/dd/yyyy)
5	TIME	Time (hh:mm:ss) 24 Hour Time Format

**BCHECK.CSV                      Record 3 + n    Data Values**

**Background Control Chart Checks Data CSV File Format**

**BKGCHECK.CSV                      Record 1    Header 1**

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER
4	CHART_TITLE

**BKGCHECK.CSV                      Record 2    Data Values**

Field	Field Value	Description
1	WPC-1050 Background Control Checks	Fixed Test
2	Instrument ID Name	QET 18 Characters
3	Instrument ID Number	Integer Value
4	Chart Title	QET 18 Characters

**BKGCHECK.CSV                      Record 3    Header 2**

Field	Name	Description
1	POINT	Sequence Number (1 – 40) Integer
2	ALPHA_COUN	Integer value
3	BETA_COUNT	Non-integer
4	DATE	Date (mm/dd/yyyy)
5	TIME	Time (hh:mm:ss) 24 Hour Time Format

**BKGCHECK.CSV                      Record 3 + n    Data Values**

**Sample Data CSV File Format**

RXDATA.CSV                      Record 1    Header 1

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER

RXDATA.CSV                      Record 2    Data Values

Field	Field Value	Description
1	WPC-1050 RXDATA	Fixed Test
2	Instrument ID Name	QET 18 Characters
3	Instrument ID Number	QET 18 Characters

RXDATA.CSV                      Record 3    Header 2

Field	Name	Description
1	SEQUENCE_NUMBER	Sequence Number Integer
2	ROUTINE_NAME	QET 18 characters
3	SAMPLEID	QET 18 characters
4	START_TIME	mm/dd/yyyy hh:mm
5	COUNT_TIME	Non-integer
6	ALPHA_CPM	Non-integer
7	BETA_CPM	Non-integer
8	GUARD_CPM	Non-integer
9	PCE_CPM	Non-integer
10	ALPHA_BKG_CPM	Non-integer
11	BETA_BKG_CPM	Non-integer
12	ALPHA_EFF	Non-integer
13	BETA_EFF	Non-integer
14	BKG_TIME	Non-integer
15	INPUT	Non-integer
16	INPUT_UNITS	Text
17	ALPHA_RECOUNT	Integer

RXDATA.CSV                      Record 3 + n    Data Values

**Trend Data CSV File Format**

TREND.CSV                      Record 1    Header

Field	Name
1	DESCRIPTOR
2	ID_NAME
3	ID_NUMBER
4	COUNT_MODE
5	COUNT_VOLTAGE
6	COUNT_TIME
7	COUNT_TIME_UNITS
8	REPEATS
9	MEAN_CTS_ALPHA
10	MEAN_CPM_ALPHA
11	SIGMA_CTS_ALPHA
12	SIGMA_CPM_ALPHA
13	CHI-SQUARED_ALPHA
14	MEAN_CTS_BETA
15	MEAN_CPM_BETA
16	SIGMA_CTS_BETA
17	SIGMA_CPM_BETA
18	CHI_SQUARED_BETA
19	MEAN_CTS_GUARD
20	MEAN_CPM_GUARD
21	SIGMA_CTS_GUARD
22	SIGMA_CPM_GUARD
23	CHI_SQUARED_GUARD
24	MEAN_CTS_PCE
25	MEAN_CPM_PCE
26	SIGMA_CTS_PCE
27	SIGMA_CPM_PCE
28	CHI_SQUARED_PCE

TREND.CSV

Record 2 Data Values

Field	Field Value	Description
1	WPC-1050 Trend Data	Fixed Text
2	ID Name	QET 18 Characters Max
3	ID Number	Integer
4	Count Mode	Text
5	Count Voltage	Integer
6	Count Time	Non-integer
7	Count Time Units	Text
8	Repeats	Integer
9	Mean Alpha Counts	Non-integer
10	Mean Alpha CPM	Non-integer
11	Sigma Alpha Counts	Non-integer
12	Sigma Alpha CPM	Non-integer
13	Chi-Square Alpha	Non-integer
14	Mean Beta Counts	Non-integer
15	Mean Beta CPM	Non-integer
16	Sigma Beta Counts	Non-integer
17	Sigma Beta CPM	Non-integer
18	Chi-Square Beta	Non-integer
19	Mean Guard Counts	Non-integer
20	Mean Guard CPM	Non-integer
21	Sigma Guard Counts	Non-integer
22	Sigma Guard CPM	Non-integer
23	Chi-Square Guard	Non-integer
24	Mean PCE Counts	Non-integer
25	Mean PCE CPM	Non-integer
26	Sigma PCE Counts	Non-integer
27	Sigma PCE CPM	Non-integer
28	Chi-Square PCE	Non-integer

TREND.CSV

Record 3 Header

Field	Name	Description
1	POINT	Sequence Number Integer
2	ALPHA_COUNTS	Integer
3	ALPHA_CPM	Non-integer
4	BETA_COUNTS	Integer
5	BETA_CPM	Non-integer
6	GUARD_COUNTS	Integer
7	GUARD_CPM	Non-integer
8	PCE_COUNTS	Integer
9	PCE_CPM	Non-integer
10	TREND_DATE	mm/dd/yyyy
11	TREND_TIME	hh:mm:ss 24 Hour Format
12	ALPHA_RESULT	Text (OK, >2S, >3S)
13	BETA_RESULT	Text (OK, >2S, >3S)
14	GUARD_RESULT	Text(OK, >2S, >3S)
15	PCE_RESULT	Text (OK, >2S, >3S)

TREND.CSV

Record 3 + n

Data Values

## Radon Subtraction

The WPC-1050 utilizes a Pseudo-Coincidence method to compensate for Radon progeny interference when the report model (Standard Report (Radon Subtraction) or Flag Concentration (Radon Subtraction)) are selected in the count routine definition.

This method is based upon a unique feature of the radon and thoron decay schemes. The probability is >99% that a <sup>214</sup>Po atom created from the beta decay of a <sup>214</sup>Bi atom will decay by emitting an alpha particle within 7 half-lives.

Protean’s implementation attempts to optimize the time window in which 95% of the emissions occur. This helps to maximize coincidence detection efficiency yet create a minimum number of chance or random coincident events ( $R_{CC}$ ) as predicted by the following equation.

$$R_{CC} = \frac{R_{\alpha}R_{\beta}T_{\mu s}}{6 \times 10^7}$$

$R_{\alpha}$  = Alpha cpm

$R_{\beta}$  = Beta cpm

$T_{\mu s}$  = pseudo-coincidence time window in  $\mu s$

To summarize, the pseudo-coincidence method uses the beta detector to open a time gate within which any detected alpha event is surmised to have originated from radon. With a proper calibration of alphas and betas per pseudo-coincidence events (PCE), the gross alpha counts and gross beta counts may be corrected to compensate for the elevating effects of the radon interference.

The alpha and beta radon contribution is the rate determined from the number of pseudo-coincidence events (PCE) as shown in the following equations.

$$R\alpha_{Radon} = \frac{(PCE - R_{CC}t)\alpha \epsilon_{PCE}}{t} \qquad R\beta_{Radon} = \frac{(PCE - R_{CC}t)\beta \epsilon_{PCE}}{t}$$

The  $\alpha\epsilon_{PCE}$  and  $\beta\epsilon_{PCE}$  radon efficiency factors convert the number of coincidence events into the equivalent number of counts. The determination of these factors is described below.



**Determination of Radon Efficiency Factors**

The user should use the provided radon source to prepare a radon standard. Without delay insert the prepared source and use the diagnostic trending routine to count the source in Alpha and Beta counting mode with a Preset Time of 1 min and repeats of 120. Export the trend data to a spread sheet and graph Net Alpha per PCE as well as Net Beta per PCE omitting the first 30 data points

$$Net\ Alpha\ per\ PCE = \frac{R_{\alpha}}{PCE - \frac{R_{\alpha}R_{\beta}}{8.01 \times 10^4}} \qquad Net\ Beta\ per\ PCE = \frac{R_{\beta}}{PCE - \frac{R_{\alpha}R_{\beta}}{8.01 \times 10^4}}$$

R<sub>α</sub> = Alpha cpm

R<sub>β</sub> = Beta cpm

PCE = PCE cpm

The two resulting graphs should be almost linear. Now average the 90 Net Alpha per PCE and Net Beta per PCE points to use as the alpha radon efficiency factor ( α ∈<sub>PCE</sub> ) and beta radon efficiency factor ( β ∈<sub>PCE</sub> ) respectively.

For more information on this technique see Application Note – AN0409-1.

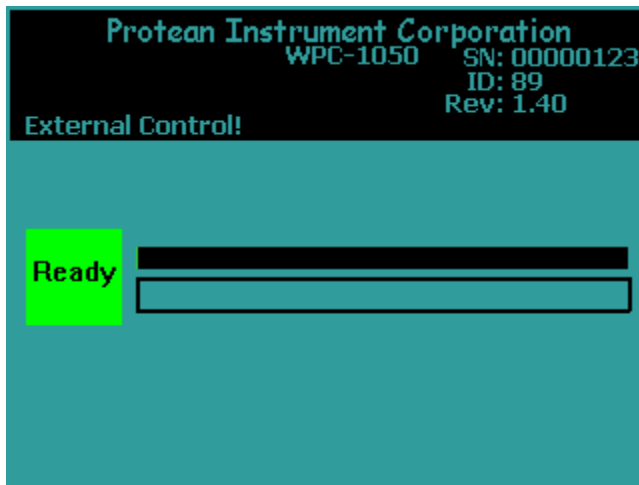
**Routine Counting with Radon Subtraction**

When performing a routine count utilizing one of the radon subtraction report models then it is necessary to wait at least 30 minutes before counting so that the influence of <sup>218</sup>Po and its 3 minute half-life does not interfere with the pseudo-coincidence method for radon subtraction.

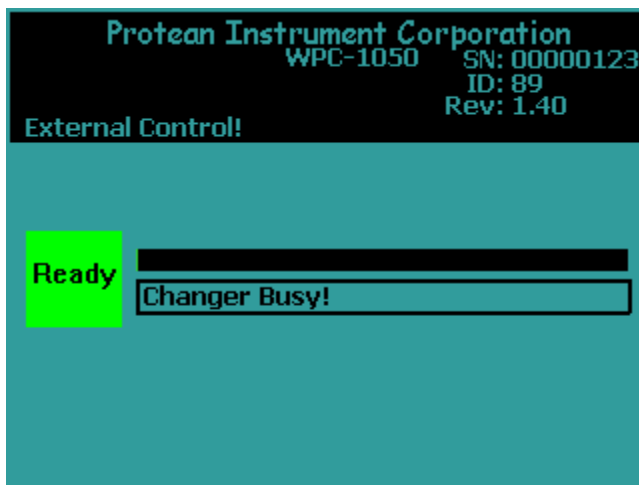
### External Control

In order for the instrument to connect to a Protean Instrument Corporation application for external control the display should be on the Top Menu. External control is disabled when not on the Top Menu so that any active routine counting cannot be interrupted by an outside application.

When the instrument is controlled with a Protean Instrument Corporation application the following screen is displayed.



If the count is halted for any reason such as voltage bias stabilization or the sample changer is busy this information is displayed in the box below the progress bar as in the screen below.



## **Service Guide Introduction**

The WPC-1050 is designed to be serviced by modular replacement. Isolating faults to a specific module requires a basic understanding of the functions of each module or assembly inside the instrument.

The instrument subsystems fall into one of six categories. These are the power supply, the detector subsystem, the gas flow subsystem, the sample changer, the linear electronics, and the CPU or central processing unit.

### **CAUTION**

*Do not attempt any detector maintenance without first disconnecting the sample detector coax cable from the sample amplifier (APA-10) PREAMP IN connector. This removes DANGEROUS HIGH VOLTAGE from the detector.*

### **The Power Supply Subsystem**

The power circuitry consists of a power entry module, a low voltage power supply (LVPS), and a power distribution circuit board. The power entry module contains the line fuses, selects the main AC voltage requirements, and transient suppressor (filter network). The LVPS provides  $\pm 12\text{VDC}$  and  $+5\text{VDC}$  for the instrument.

DC power is routed from the LVPS to the power distribution board. Since the presence of proper power is fundamental in all electrical and electronic trouble shooting, test points are provided. Keyed connectors simplify the removal and replacement of the LVPS should it become necessary.

The power distribution board further routes the dc voltages to the various linear electronics modules and the sample changer's motor driver board.

### **The Detector Subsystem**

The instrument contains two detectors which are both gas flow proportional detectors. The cosmic guard detector is a 7.5" diameter pancake style detector located in the bottom hemisphere of the lead shield. This detector is not serviceable in the field and defective units must be replaced or returned to the factory for repair.

The sample detector is a low profile detector with an ultra thin replacement window. The windows are field replaceable. Procedures are covered later in this section.

**The Gas Flow Subsystem**

The detectors must be supplied with a continuous flow of P-10 nuclear counting gas. The gas flow subsystem provides a regulated flow of gas. A sensor detects breaches in this flow.

**The Sample Changer Subsystem**

The sample changer transports the samples between the removable stacks and the shield containing the detectors. The sample changer contains two motors and a number of position sensors. A motor driver board mounted in front of the sample changer powers the motors under directions from the CPU. Signals from the sample changer's position sensors are also routed back to the CPU through this board.

**The Linear Electronics Subsystem**

The detectors must have counting gas and high voltage in order to detect radiation. The source of the high voltage is the HV-20-D module. Radiation passing through the detectors produces a small electrical charge. This charge is converted to a voltage pulse and is amplified and filtered (shaped) by one of the two APA-10-D Preamp/Amplifiers. Although the two APA-10-D amplifiers can be temporarily interchanged for trouble shooting purposes, they are factory calibrated to match the specific type of detector (sample or guard) prior to shipment. If replacements are ordered, the respective detector type should be identified.

The bipolar shaped pulses from the APA-10-D sample channel can be categorized as either alpha or beta radiation due to the distribution of the pulse heights unique to both types. Sample detector events coincident with cosmic guard events are rejected since their origin is other than the sample under test. The discriminators necessary to categorize the radiation connect to the cpu board through a ribbon cable that attaches to the small board (170-0027) inside the APA-10-D amplifier. The alpha/beta discriminator is fixed at 7.0 volts. The CPU board includes an 8 bit register that connects via a ribbon cable to the HV-20-D High Voltage module. It contains a digital to analog converter which controls the voltage output. The HV-20-D also includes a discriminator used to monitor the level of gas flow from the flow sensor and passes this information to the CPU through the HV-20-D control cable.

## The CPU Subsystem

All functions of the WPC-1050 are controlled by a central processing unit (CPU). The CPU is a single board computer with an extensive program retained in read only memory. Transient data is collected in static random access memory backed by a lithium battery. Sample data, calibration data and setup information are stored in unique file structures and are continually checked for integrity. A RS-232-C/RS-485 port for external computer communications is included as well as a bar code reader interface.

The CPU card interfaces to the linear electronics through the APA-10-D-DP. Three other interfaces are provided on the CPU. These are the USB interface, touch screen interface and sample changer interface. A ribbon cable connects to a printed circuit board (170-0015) containing drivers for the two sample changer motors.

## General Instructions

Familiarize yourself with the following general instructions. These instructions pertain to routine operations such as cover and detector removal, and recommended maintenance supplies. Subsequent maintenance instructions assume familiarity with these general instructions.

### **CAUTION**

*Do Not attempt any detector maintenance without first disconnecting the sample changer detector coax cable from the sample amplifier (APA-10) PREAMP IN connector. This removes **DANGEROUS HIGH VOLTAGE** from the detector.*

## Removing the Cover

There are two parts to the instrument cover – front and rear. Always remove the front cover first. Next remove the stacks by first removing the retaining pins and then pulling the stack straight up. The rear cover can only be removed after the front cover and stacks have been removed. The rear cover is then lifted from the base. There are no screws attaching either cover.

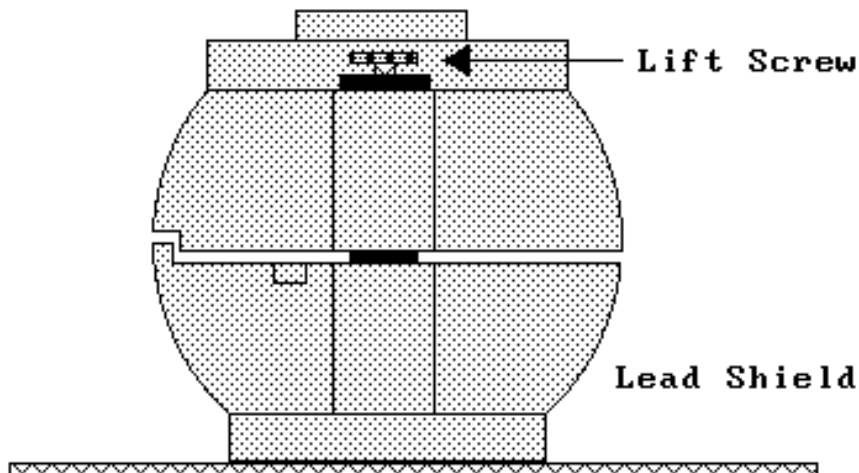
### Opening and Closing the Shield

The hinged shield allows easy access to both the sample and cosmic guard detectors. The shield consists of an upper and lower hemisphere.

#### **CAUTION**

*The lead is very soft and easily damaged. Open and close the shield carefully and avoid contact with the sample changer and electronics support mechanics.*

To open the shield, first insure that the carrier slide is withdrawn. You can accomplish this by using the "Sample Changer Diagnostics" function. Turn the shield lifting screw 5-6 turns clockwise to separate the two shield hemispheres. Rotate the top hemisphere clockwise until it overhangs the left side of the instrument.



WPC-1050 Lead Shield

To close the shield, rotate the top hemisphere until it is directly above the lower hemisphere and is in contact with the stop. If the upper hemisphere is elevated such that it swings past this stop, rotate it clockwise slightly in front of the lower hemisphere, turn the lifting screw counter clockwise one or two turns to lower the top hemisphere and try again. With the upper hemisphere resting against the stop, turn the lifting screw counterclockwise until the upper hemisphere is completely resting on the lower hemisphere. The shield is self-centering if this procedure is followed.

**Removing the Sample Detector**

The sample detector is mounted in the upper portion of the lead shield. Hold the edges of the detector to prevent it from falling as the mounting screws are removed. The ultra thin window and anode wire inside the cavity is very fragile. Do not touch either. Remove the 4 mounting ring screws and slowly lower the detector. Disconnect the cable. The gas lines are press fitted to the barbed connectors. The two connections are interchangeable. Remove the gas lines by pulling straight away from the connector and remove the detector.

**Installing the Sample Detector**

Inspect the detector mounting recess inside the shield and note the orientation of the gas port reliefs. Connect the gas inlet and outlet lines by pressing them onto the barbed fittings. Connect the coax cable. Pull the gas lines tight to prevent them from being crimped during installation. Align the gas port and cable connection with the recesses in the shield and raise the detector into position. Install the four mounting ring screws.

**Warning**

*The inserts in the lead shield are easily stripped. Do Not Over Tighten.*

Reconnect the coax cable to the appropriate Amplifier (APA-10) PREAMP IN.

**Power Entry**

The WPC-1050 is equipped with a power entry module located on the rear of the instrument. This module includes an on/off switch (1-ON; 0-OFF), line filter network and fuse cartridge. The fuse cartridge is removable for fuse replacement and line voltage selection. To remove, detach the line cord, place a small flat blade screwdriver in the slot on top of the cartridge, and slide the cartridge forward by turning the screwdriver.

**Fuse Rating**

The fuse cartridge's insertion orientation selects Input Line Voltage (nominal 120VAC or 230VAC). Fuse size are ratings are:

120VAC      3.0A 250V 3AG

230VAC      1.5A 250V 3AG

**Line Voltage Selection**

To select the line voltage, insert the cartridge so that the printed white arrow below the appropriate line voltage selection is pointing down and towards the black arrow in the lower right hand corner of the module housing. Replace the IEC line cord as required.



**Checking the Low Voltage Power Supply (LVPS)**

The Low Voltage Power Supply or LVPS provides +12VDC, -12VDC, and +5VDC for the instrument’s subassemblies. The LVPS is modular and can be replaced if necessary. It includes test points which can be used to check for proper voltages.

**LVPS Voltage Check**

To access the LVPS, first remove the front instrument cover. The LVPS is mounted behind the operator’s console. The test points are labeled and color coded. Use a Digital Volt Meter (DVM) or VOLT-OHM meter (VOM) to check voltage levels as necessary. If an oscilloscope is available, also check the LVPS test points for proper AC filtering.

<b>DC Volts</b>	<b>Test Point Color</b>	<b>Voltage Limits</b>
<b>+12</b>	<b>RED</b>	<b>± 0.1</b>
<b>-12</b>	<b>BLACK</b>	<b>± 0.1</b>
<b>+5</b>	<b>GREEN</b>	<b>5.0 to 5.2</b>
<b>Ground</b>	<b>WHITE</b>	<b>N/A</b>

**LVPS Replacement**

Procedures to replacement the LVPS if required.

**Removal:**

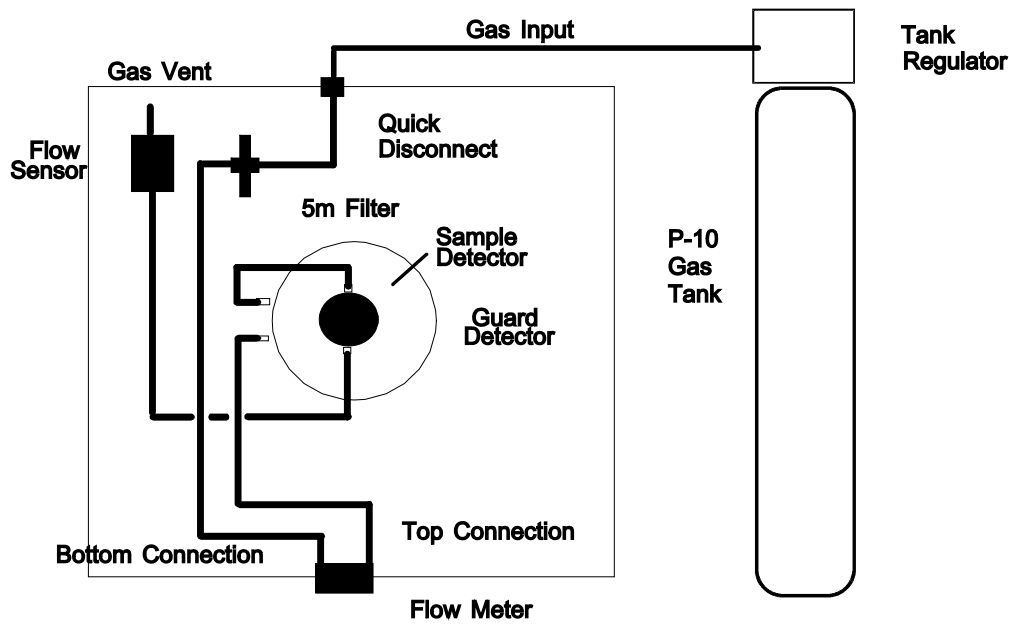
- **Disconnect the line cord from the instrument.**
- Disconnect the 3 keyed connectors.
- Remove the 4 mounting screws on the bottom of the LVPS.
- Lift the LVPS from the instrument.

**Installation:**

- Align the LVPS with the mounting holes.
- Install the 4 mounting screws.
- Connect all keyed connectors.
- Connect the line cord and check voltage levels

### Service Guide for Gas Flow Subsystem

The plumbing and components of the instrument's gas flow system is illustrated in the following diagram.



Gas Flow Diagram

The recommended counting gas is P-10 nuclear counting gas (90% Argon, 10% Methane). Standard tank sizes are 300 ft<sup>3</sup> (Size T) and 220 ft<sup>3</sup> (Size K 220). The secondary regulator pressure should be adjusted for 10 PSI. The flow rate adjusted through the flow meter is 60cc/min.

### CAUTION

*Abrupt increases in the flow rate can stretch or rupture the window. Do Not Operate Above 150 cc/min!*

Notice the flow meter is located between the gas source and the detectors. The flow rate indicates the gas supplied to the detectors, not their output flow rate. The flow sensor located in the detector vent line monitors the output flow rate and provides assurance of adequate gas integrity.

The first steps in trouble shooting the gas system are to verify that you have the recommended tank pressure, no pinched supply gas lines, and a secure connection to the instrument. If a "Waiting For Gas Flow" message is displayed despite an indication of the recommended flow rate, more investigation is necessary.

## Low Gas

Open the lead shield. Inspect the sample detector window for damage. If replacement is required, refer to detector maintenance.

## The Gas Filter

The 5µm particle filter is installed between the quick disconnect and the flow meter. It will trap particles passing through the gas lines. The greatest likelihood for this to occur is during tank installations and replacements. It is doubtful whether the filter will ever require replacement, however, it can be bypassed for trouble shooting and replaced if necessary.

## Gas Tank Precautions

Be aware of SAFETY procedures in handling Gas Cylinders and Tank Regulators. Refer to the regulator manufacturer's instructions and safety guidelines provided with the regulator. Gas cylinders should be kept secured with wall, bench, or stationary cylinder holders.

## Operating Environment

The WPC-1050 is operable within 10-40 degrees C, and 20-90% humidity (non-condensing). The WPC-1050 is classed as: Over-Voltage Category II, and Pollution Category II.

## General Electrical Failures

Certain circumstances may result in a totally nonfunctional instrument. We will refer to these types of faults as general failures. The following cases describe preliminary checks which should be performed.

## Blows Main Fuses

The presence of at least partial power inside the instrument is indicated if the backlight on the display is illuminated. If not, switch the power off and check the line fuses and main voltage selection. If the fuses are blown, insure that the fuse ratings correctly match the power entry voltage selection. Next check your power receptacle for correct wiring and grounding. Replace the fuses and once again apply power. If the instrument blows the replacement fuses and all else is correct, contact the factory for assistance.

**Failure to Initialize on Power-up**

If the sign-on screen does not appear or if it does appear but the clock does not update, a more permanent problem is indicated. You should first check the levels of the Low Voltage Power Supply as described earlier.

A component failure in any one of the linear electronic modules can trigger an overload protection circuit in the LVPS. This results in a low voltage condition. With the instrument turned off, remove the keyed power connectors from the APA-10 and HV-20 modules. Apply power to the instrument. If the boot-up sequence is normal, try to isolate the faulty module. To do this, turn off the instrument and reconnect the module power connectors one-at-a-time, reapply power and observe for normal boot-up sequence. If there is a permanent component failure, the user should isolate the faulty module in this manner.

If the +5VDC test point indicates low voltage and the previous procedure fails to isolate the problem, the failure may be either the LVPS or the CPU. Disconnect the CPU power connector and observe the +5VDC test point as you cycle power. The instrument will not boot-up however you may identify the overload this way.

Once the user has performed the preceding trouble shooting tasks, consult the factory for replacement modules as required or for additional assistance.

**Intermittent Lockup**

The WPC-1050 contains an embedded controller (the CPU). Static potentials, line voltage variations, faulty line power grounding, or noise from inductive loads on the power distribution network may cause infrequent Lockup conditions. The intermittent nature of these faults is usually difficult or impossible to totally eliminate. The usual indication of such a condition is a lack of response from the touch screen. To recover control, turn off the power for approximately 15-30 seconds. This delay allows the internal dc power supply to completely discharge. Restart the unit by turning on the power. The instrument will go through the normal initialization routine (boot-up). Observe that the main clock indicates correct time and is updating.

**Trouble Shooting the Linear Channels**

The indicators on the front panel of the APA-10-D can aid in the trouble shooting of the linear channels. Even if a count cycle is not in progress, you can tell at a glance if the linear electronics is processing data. You can also tell if adequate gas is flowing through the detectors from the indicator on the HV-20-D. If the guard and sample channels are processing pulses, the respective LEDs will flash with each event. The following is a description of these indicators and a few tips on using them.

**APA-10-D and HV-20-D Status Indicators**

The discriminator board in the APA-10-D bridges the linear subsystem to the digital subsystem. Detector signals are processed by one of the two APA-10-D amplifiers and routed to the CPU board. The output of the APA-10-D connected to the cosmic guard detector is also routed to CPU board. Both of these amplifiers have a front panel signal indicator. The HV-20-D includes a rear panel connector for the gas sensor, a front panel sensor indicator, and a ribbon control cable that attaches to the CPU board.

The functions of the LED indicators on the front panel of the modules are defined below.

HV-20-D SENSOR Green LED indicates adequate gas flow through the sample and guard detectors.

APA-10-D LLD/ULD SENSOR Bi-color LED flashes green when the respective channel processes an event that exceeds the Lower Level Discriminator (LLD) and red when the Upper Level Discriminator is exceeded. When the instrument is properly calibrated, a red flash on the sample channel indicates the detection of an alpha event on the beta plateau voltage. A green flash indicates the detection of a beta event.

**Beta Background is High?**

If the beta background increases by a few cpm, the problem is probably due to some type of contamination. If it increases to 20-30 cpm, there is a possibility that the guard channel is not functioning. A simple way to check the linear portion of the guard channel is to view the LED indicator on the associated APA-10-D. When the instrument is operating at the beta plateau voltage, the guard channel typically processes about 200 cpm. The LED indicator should flash 2 to 4 times per second. A quick way to verify if the amplifier is at least partially functioning is to thump the coaxial cable between the detector and the PREAMP-IN. Microphonics will produce a burst of pulses which should trigger the LED indicator.

**Sample Counts are zero?**

A quick way to verify the sample channel is to place a source underneath the detector and observe the LED on the APA-10-D-DP module. If it is not flashing then this indicates a non functioning APA-10-D-DP module. To eliminate the possibility of the source of the problem as the detector, thump the coaxial cable between the detector and the PREAMP-IN. Microphonics will produce a burst of pulses which should trigger the LED on the APA-10-D-DP.

**Performance Changes – Background**

Increases in background can occur gradually due to exposure from contaminated samples or a result of poor gas, electronic failures or a piece of lint in the detector.

**Gas Quality**

It is not uncommon to experience an abrupt change or erratic background counts after a change of gas cylinders. This could be a bad tank of gas, which is not completely uncommon. Moisture or other contaminants in the gas may cause high voltage corona discharges in the detectors. These problems are difficult to pinpoint unless a backup supply of qualified gas is available. The only remedy is to change the gas and purge the instrument for several hours. Many laboratories keep a qualified tank of gas on hand as a backup for these type of problems. A qualified tank is one that has been used on a instrument for several days to establish its integrity.

Any changes in background may be monitored using the “Trending” routine. A good test is to monitor the backgrounds for 1000 minutes by using 100 checks at 10 minutes each.

**Contamination**

Background counts may increase abruptly or gradually over a long term due to contamination. In either case, it will be necessary to decontaminate the instrument. The following items may be source and should be cleaned:

- Sample Carriers – Use the recommended liquid detergent and dry thoroughly.
- Sample Drawer – Clean with methanol.
- Detector – Replace the window If contamination has entered the detector, it must be replaced.

**Electronic Noise**

An increase in background counts can be caused by a noisy high voltage supply, preamplifier, main amplifier, or cables. As a simple test check these components, Disconnect the sample detector from the sample amplifier by removing the coax cable from the PREAMP-IN connector of the APA-10-D-DP. Run a trending background check. The counts due to electronic noise are typically less than 0.1 cpm.

**Performance Changes – Efficiency**

Changes in efficiency may be caused by an inadvertent change in counting geometry, poor gas integrity and/or quality, or detector changes. A continually increasing or decreasing trend in a beta control chart requires investigation.

**Geometry**

For alpha and low energy beta radiation the efficiency may decrease by 10% to 15% using 5/16 planchet as compared to a 1/8” planchet. Verify the calibration sources are counted geometrically the same as the reference used to establish the instrument efficiency.

If there has been reason to open the lead shield, verify it is positioned and seated properly in the closed position. Note that there is a raised portion on the bottom section at the rear of the shield. The top section has been machined to mate with this protrusion and eliminate a line-of-sight opening when the shield is properly seated. Should the top be resting on the raised part, it will change the detector to sample spacing approximately ¼ inch and be the cause for lower efficiency.

**Gas Quality**

Insure that the efficiency change is not associated with a recent gas cylinder change or changes in the gas supply system.

Verify proper flow rate. Nominal flow is 60 cc/min. If a greater flow rate is required to sense “Good Flow” you may have a tear or pin hole in the window and it should be replaced.

**Sample Changer**

To test the mechanical functions of the sample changer use the “Diagnostics” menu and select “Sample Changer”. Refer to the Sample Changer Diagnostics for a detailed description.

The sample changer requires no preventive maintenance or adjustments. Should sensor assemblies or motors require replacement, detailed instructions will be provided. Do not attempt to service the assemblies in the field as this will devalue the exchange value.

**Plateau Settings**

Insure that the proper sample detector voltage is selected for both “Alpha Only” and “Alpha and Beta” counting modes. The “Alpha and Beta” operating point is typically set 30 volts above the knee of the beta plateau curve. The knee is defined as the point at which the slope first drops to 5% per 100 volts. The “Alpha Only” operating point is set well below the foot of the beta curve. The foot is defined as the point at which beta counts are first detected. The recommended “Alpha Only” voltage is 630 volts.

Verification of the detector plateau curve may be necessary to identify any performance changes due to electronic drift or detector degradation.

A continual shift in the plateau curve may be an indication that the detector anode is becoming contaminated with gas by-products. Over a period of time these may build up on the anode wire. The result is a decrease in the internal field strength causing a shift downward in efficiency and a shift upwards in the beta plateau knee. Should this happen, the detector must be replaced.



**Replacing the Entrance Window**

The window can be replaced without removing the detector from the shield if you are careful not to move the detector once the screws have been removed. Remove the 8 screws that secure the window ring to the detector and remove the damaged window. DO NOT REMOVE the 4 outer screws on the mounting ring. Reverse the procedure to attach a new window (P/N 120-0008).

**CAUTION**

*Never touch the anode wire. The anode wire is very fragile and easy to break. Detectors with broken anode wires must be returned for factory repair.*

It may be safer to remove the detector for window replacement. If the mounting ring is removed from the detector in the process of changing a window, it is essential that it is replaced in the correct orientation. The detector will not fit into the shield unless these holes are correctly aligned. Take care not to pinch the gas lines when the detector is installed back in the shield.

**Detector Contamination**

Even with the gas filter, the anode and detector body can become contaminated with dust and lint particles. This usually occurs after a window has been ruptured. Particles which attach themselves to the anode or detector body tend to cause an erratic increase in background counts. Another indication of accumulated contaminants on the anode is a gradual shifting upwards of a plateau knee. This is also observed as a declining trend in a control chart tracking beta counts.

If the detector cavity has been exposed to the atmosphere due to a major tear in the window, inspect the anode and detector body for any dust or lint that may have become attached. If necessary, blow these particles away with a source of dry gas like the P-10 gas supply. Install the window and remount the detector assembly in the shield.

**Variable Definitions and Equations**

<b>Variable</b>	<b>Definition</b>
A_CTS	Gross Alpha Counts
A_CTS_SD	Gross Alpha Counts Standard Deviation
A_CPM	Gross Alpha Counts per Minute
A_CPM_SD	Gross Alpha Counts per Minute Standard Deviation
A_BG	Alpha Background Counts
A_BG_CPM	Alpha Background Counts per Minute
A_BG_CPM_SD	Alpha Background Counts per Minute Standard Deviation
A_NET_CPM	Net Alpha Counts per Minute
A_NET_CPM_SD	Net Alpha Counts per Minute Standard Deviation
A_EFF	Alpha Efficiency Percent
A_EFF_SD	Alpha Efficiency Percent Standard Deviation
A_DPM	Net Alpha Disintegrations per Minute
A_DPM_SD	Alpha Disintegrations per Minute Standard Deviation
A_LLD_DPM	Alpha Lower Limits of Detection in DPM
BG_TIME	Background Counting Time Minutes
CNT_TIME	Sample Counting Time Minutes
B_CTS	Gross Beta Counts
B_CTS_SD	Gross Beta Counts Standard Deviation
B_CPM	Gross Beta Counts per Minute
B_CPM_SD	Gross Beta Counts per Minute Standard Deviation
B_BG	Beta Background Counts
B_BG_CPM	Beta Background Counts per Minute
B_BG_CPM_SD	Beta Background Counts per Minute Standard Deviation
B_NET_CPM	Net Beta Counts per Minute
B_NET_CPM_SD	Net Beta Counts per Minute Standard Deviation

Variable	Definition
B_EFF_SD	Beta Efficiency Percent Standard Deviation
B_EFF	Beta Efficiency Percent
B_DPM	Net Beta Disintegrations per Minute
B_DPM_SD	Beta Disintegrations per Minute Standard Deviation
B_LLD_DPM	Beta Lower Limits of Detection in DPM
A_PCE_EFF	Alpha PCE Efficiency Factor
B_PCE_EFF	Beta PCE Efficiency Factor
RCC	Chance Coincident Events
R_A_RADON	Total Alpha Radon Contribution
R_B_RADON	Total Beta Radon Contribution
PCE	Pseudo-coincidence Events

$A_{BG\_CPM\_SD} = \text{Calibration File}$

$A_{NET\_CPM} = A_{CPM} - A_{BG\_CPM}$

**Radon compensated in bold.**

$$RCC = \frac{A_{CPM} \times B_{CPM} \times 709}{6 \times 10^7}$$

$$R_{A\_RADON} = \frac{(PCE - RCC(CNT\_TIME))A_{PCE\_EFF}}{CNT\_TIME}$$

$$A_{NET\_CPM} = A_{CPM} - A_{BG\_CPM} - R_{A\_RADON}$$

$$A_{LLD\_DPM} = \frac{\left(\frac{2.71}{CNT\_TIME}\right) + 3.29 \sqrt{\frac{A_{BG\_CPM}}{CNT\_TIME} \left[1 + \frac{CNT\_TIME}{BG\_TIME}\right]}}{A_{EFF}/100}$$

$$A_{DPM} = \frac{A_{NET\_CPM} \times 100}{A_{EFF}}$$

$$A\_DPM\_SD = A\_DPM \sqrt{\left[\frac{A\_NET\_CPM\_SD}{A\_NET\_CPM}\right]^2 + \left[\frac{A\_EFF\_SD}{A\_EFF}\right]^2}$$

$$A\_NET\_CPM\_SD = \sqrt{A\_CPM\_SD^2 + A\_BG\_CPM\_SD^2}$$

$$A\_CTS\_SD = \sqrt{A\_CTS}$$

*B\_CTS = Data Buffer*

$$B\_CTS\_SD = \sqrt{B\_CTS}$$

$$B\_NET\_CPM\_SD = \sqrt{B\_CPM\_SD^2 + B\_BG\_CPM\_SD^2}$$

*B\_BG\_CPM\_SD = Calibration File*

$$B\_NET\_CPM = B\_CPM - B\_BG\_CPM$$

**Radon compensated in bold.**

$$R\_B\_RADON = \frac{(PCE - RCC(CNT\_TIME))B\_PCE\_EFF}{CNT\_TIME}$$

$$B\_NET\_CPM = B\_CPM - B\_BG\_CPM - R\_B\_RADON$$

$$B\_CPM = \frac{B\_CTS}{CNT\_TIME}$$

$$B\_CPM\_SD = \frac{B\_CTS\_SD}{CNT\_TIME}$$

$$B\_BG\_CPM = \frac{B\_BG}{BG\_TIME}$$

*B\_EFF = Calibration File*

*B\_EFF\_SD = Calibration File*

$$B\_DPM = \frac{B\_NET\_CPM \times 100}{B\_EFF}$$

$$B\_LLD\_DPM = \frac{\left(\frac{2.71}{CNT\_TIME}\right) + 3.29 \sqrt{\frac{B\_BG\_CPM}{CNT\_TIME} \left[1 + \frac{CNT\_TIME}{BG\_TIME}\right]}}{B\_EFF/100}$$

Activity Reports

The ASC-950 provides an extensive selection of report units from which to select. Selections are made using the Define Counting Routines under the Program Menu.

Activity	Volume	Area
pCi	l	cm <sup>2</sup>
μCi	ml	100 cm <sup>2</sup>
Bq	m <sup>3</sup>	
DPM	ft <sup>3</sup>	

Variable	Definition
A_ACT	Alpha Activity expressed in units of activity per volume or area.
B_ACT	Beta Activity expressed in units of activity per volume or area.
DF	Decay Factor calculated using the half-life for the specific routine. The decay factor is calculated from the midpoint of the count time to the date and time of the sample collection.
VOL	Sample Volume expressed in defined output units.
VOL_IN	Input Sample Volume as entered by the operator
CF	Input Volume Conversion Factor. The value depends on the input units and the output units selected.
ACF	DPM to activity units conversion factor. Value depends on the units specified in the Define Counting Routine.

$$DF = 2^{-\left(\frac{t}{T^{1/2}}\right)}$$

$$T^{1/2} = HALF\_LIFE$$

$$t = Decay\ Time$$

Note: Decay time is calculated in seconds from the entered collection date/time to the midpoint of the count. Half-life is from the count routine definition.

$$VOL = VOL\_IN \times CF$$

**Input Volume Conversion Factors**

Output Vol Units	Input Vol Units	CF
ml	ml	1.00
ml	l	$1.00 \times 10^{-3}$
ml	m <sup>3</sup>	$1.00 \times 10^6$
ml	ft <sup>3</sup>	$2.83 \times 10^4$
l	ml	$1.00 \times 10^{-3}$
l	l	1.00
l	m <sup>3</sup>	$1.00 \times 10^{-3}$
l	ft <sup>3</sup>	$2.83 \times 10^1$
m <sup>3</sup>	ml	$1.00 \times 10^{-6}$
m <sup>3</sup>	l	$1.00 \times 10^{-3}$
m <sup>3</sup>	m <sup>3</sup>	1.00
m <sup>3</sup>	ft <sup>3</sup>	$2.83 \times 10^{-2}$
ft <sup>3</sup>	ml	$3.53 \times 10^{-5}$
ft <sup>3</sup>	l	$3.53 \times 10^{-2}$
ft <sup>3</sup>	m <sup>3</sup>	$3.53 \times 10^1$
ft <sup>3</sup>	ft <sup>3</sup>	1.00

**Activity Conversion Factors**

Activity Units	ACF DPM per units
pCi	2.22
µCi	$2.22 \times 10^6$
Bq	$6.00 \times 10^1$

$$A\_ACT = \frac{A\_DPM}{(VOL)(DF)(ACF)}$$

$$A\_MDA = \frac{A\_LLD\_DPM}{(VOL)(DF)(ACF)}$$

$$B\_ACT = \frac{B\_DPM}{(VOL)(DF)(ACF)}$$

$$B\_MDA = \frac{B\_LLD\_DPM}{(VOL)(DF)(ACF)}$$

## **Concepts of Alpha / Beta Counting**

### **The Alpha / Beta Counter**

The evolution of alpha/beta counting instruments has been driven by application requirements and advances in computer technology. The first counters (often referred to as scalers) were simple to use and simple in scope. In fact, referring to them as counters is a clue as to how little was expected of them. The operator inserted a sample underneath a detector, started a timer, and recorded the accumulated counts at the termination of the preset period. Reporting a result in counts per minute, however, is of little benefit. Calculations must be performed on the raw data in order to produce a meaningful report. These calculations convert the raw counts from counts per minute (CPM) into disintegration's per minute (dpm) and finally into units of activity per sample such as pCi/l. As is the practice in all analytical measurements, propagated uncertainties should also be calculated and reported.

### **Gas Filled Proportional Detectors**

The gas filled radiation detector is a conductive cavity (cathode) filled with an ionizable counting gas. A small diameter wire (anode) is positioned in the center of the gas volume and a high positive potential is applied. Radiation entering the volume ionizes the gas creating a cloud of electrons and positively charged atoms are attracted to the cathode. As the electrons accelerate towards the anode under the influence of the electric field, further ionization takes place resulting in a multiplication effect. After external electronic amplification, this results in a pulse which is of sufficient amplitude to be detected and counted.

Some detectors are permanently sealed. This requires a relatively thick entrance window through which the incident radiation must penetrate. So thick, in fact, that much is absorbed before detection. A thin window may be used to minimize this loss, however, it then becomes necessary to constantly replenish the counting gas. Still greater counting efficiency can be realized by totally eliminating the entrance window and inserting the sample directly in the detector volume.

Protean Instrument offers instruments with windowless detectors and ultra thin windowed detectors. The WPC-1050 uses the detector with an ultra thin entrance window. The ultra thin entrance window reduces the risk of contamination and eliminates the need to purge the detector prior to each counting sequence while providing optimum counting efficiency.

**Count Time Requirements**

The counting time required to meet specific measurement sensitivity is dependent upon the absolute counting efficiency, the inherent background of the instrument, and the representative volume or mass of the sample. Measurement sensitivities are often referred to as Lower Limits of Detection (LLD) or Minimum Detectable Activity (MDA) and their respective equations were developed using statistical decision theory techniques.

**Low Background Concepts**

Any detectable radiation not originating from the sample under test is considered background and is an interference. This background must be characterized and subtracted from the gross sample counts. Obviously it is desirable to reduce the backgrounds to as low a level as possible without adversely affecting the other performance factors of the instrument.

**Shielding and Background**

Environmental gamma radiation is most effectively reduced by lead shielding. This source of radiation arises principally from naturally radioactive elements present in all soil, rocks and construction materials. Any amount of lead is effective in reducing this radiation but the practical and economical limitation is about 4 inches. Increasing the shielding from 2 to 4 inches achieves about a factor of two reduction in environmental gammas while increasing from 4 to 6 inches only provides about a 10% further reduction. Beyond 6 inches, the internal contaminants of the lead shield become dominant and no additional benefits are realized. Not all lead is of the quality suitable for a low background shield. Selected low background virgin lead must be used in the fabrication of these shields.

The interactions of external gammas with the walls of the shield can produce characteristic lead x-rays. These x-rays can be blocked from the sample detectors sensitive volume by lining the internal cavity of the shield with copper. The WPC-1050 utilizes the detector body, which is solid copper, for this purpose.

A historical drawback to the use of lead shielding is its weight and the inconvenience it poses when accessing the detectors. The WPC-1050 addresses these problems with a custom designed shield with hinged separation. This shield provides 4 inches of lead around the detector while reducing the weight by about 70% as compared to other comparable instruments. Hinged access eliminates the need to lift or disassemble heavy components during servicing.



**The Cosmic Guard and Background**

The earth is constantly being bombarded by showers of cosmic radiation. The energy spectrum of these primary and secondary radiation showers extends beyond  $10^{19}$  ev. While lead shielding effectively removes the low energy components of these showers, there is an element made up mostly of mu mesons which will penetrate the lead shield and be detected with relatively high efficiency. This type of radiation accounts for approximately 35% of the background in a conventional counting system.

Cosmic background counts are eliminated using electronic rejection in conjunction with a cosmic (guard) detector. The guard detector is of similar construction as the primary sample detector and is mounted such that it will intercept any cosmic radiation seen by the sample detector. Any event detected in the sample detector which is coincident with an event detected in the guard detector is rejected.

**Low Background Material Selection**

Construction material used in the WPC-1050 is carefully selected for low inherent activity. The sample media used should also be selected carefully, if the lowest background performance is desired. Stainless steel planchets are preferable to aluminum for this reason.

**Background Stability**

Now that most of the sources and remedies for background have been discussed, it is appropriate to mention a few pitfalls. Backgrounds are due to random decay and therefore are subject to statistical fluctuations. Backgrounds are due to random decay and therefore are subject to statistical fluctuations. When background values are determined, they are mean values gathered from several tests. The lower the background becomes, the more difficult (time consuming) it is to determine the true mean of the background value. Often the background fluctuations due to random decay is confused as instrument instability.

A source of background instability is often attributed to the environment of the counting room. A measurable amount of background can originate with radioactivity carried by the ambient air in the counting room. This appears in the form of trace amounts of radioactive gases or dust particles which settle on samples or the counting instrument. Radon (Rn-222 and Rn-220) are short-lived radioactive gases which originate as daughter products in the decay chains of the uranium and thorium present in soil and laboratory construction materials. Their concentration in the atmosphere can vary significantly depending on the time of day and meteorological conditions. Radioactive dust can be largely eliminated through effective filtration (activated charcoal) of the air supply to the counting room.

**Absolute Counting Efficiency**

The absolute counting efficiency, usually expressed as a percentage, represents the ratio of the measured count rate and the actual count rate (total disintegrations per minute) emitted by the sample. The absolute counting efficiency is influenced by the intrinsic detector efficiency, counting geometry effects, and sample self absorption. Absolute counting efficiency is very much energy dependent. This dependence is due primarily to the absorption characteristics of the radiation and the design of the detector.

**Intrinsic Detector Efficiency**

The intrinsic efficiency of a detector is the probability that any ionizing radiation which enters the sensitive volume will result in a count.

**Counting Geometry and Efficiency**

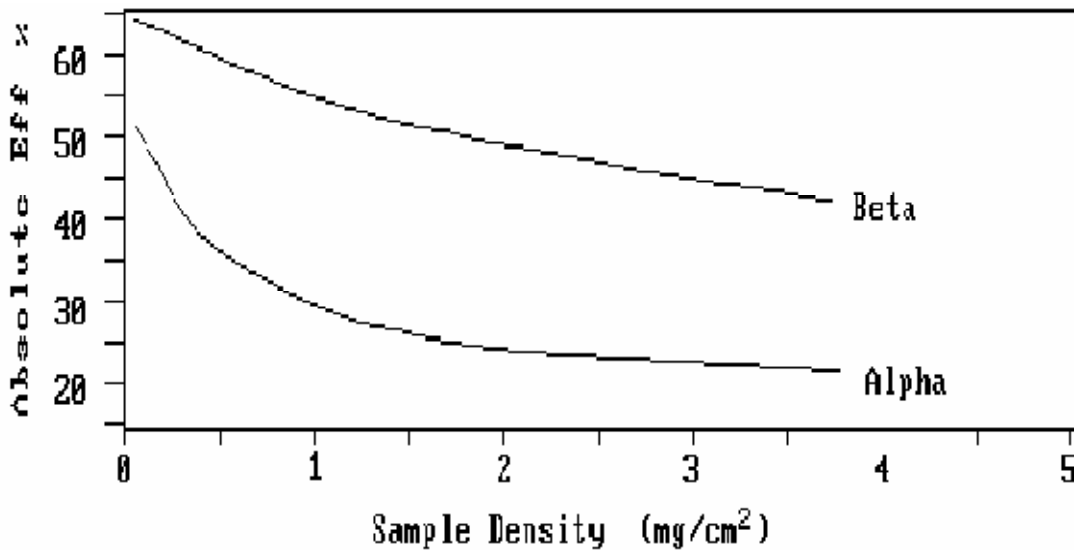
Since geometry places such a vital role in counting efficiency, it is important to match the geometries of the calibration source to that of the unknown samples. One aspect of the counting geometry is the distance between the sample and the active volume of the detector.

Alpha and beta particles emitted at small angles from thin samples placed in deep planchets will lose energy in interaction with the planchet walls. This loss of energy decreases the likelihood of detection since the lower ionization trail produced can recombine before multiplication occurs.

Energy absorption will occur in the air molecules between the sample and the window. It is best to position the sample as close as practical to the top of the sample carrier. This is especially important if alphas and low energy betas ( $<0.3$  MeV) are to be counted efficiently. Air absorption will reduce the relative efficiency of C-14 by about 22% with a 4 mm spacing. The choice of planchet depth is often influenced by the practicalities of sample preparation. Once a depth is selected, do not change unless you intend to recalibrate against the new geometry.

**Sample Self-Absorption and Counting Efficiency**

The effect energy absorption has on counting efficiency is apparent from the discussion on counting geometry. Absorption also occurs within the sample itself. An alpha particle ejected by a decaying nuclide surrounded by a mass of inert molecules will not escape the mass without losing some energy through collisions. The greater the mass, the higher the probability of energy loss.



*Counting Efficiency Reduction due to Sample Density*

In most (if not all) applications the sample weight cannot be closely controlled. For this reason, a table of absolute counting efficiency values versus sample density is often determined using appropriately prepared standards.

**Calibrated Conversion Factors**

In order to report accumulated counts in terms of activity, several conversion factors must be determined and applied. Determination of these conversion factors constitutes the instrument calibration.

Once determined, conversion factors must be revalidated on a routine basis to insure instrument stability. This is accomplished (usually daily) by collecting counts from a standard and comparing the results to those obtained during the calibration. If these results repeat within statistical expectations, the instrument is stable and the calibration conversion factors are valid.

**The Control Chart**

Revalidation procedures are called control checks. Control checks are usually plotted on a chart representing a control mean and the standard deviations of the control mean. This chart is referred to as a control chart. Several control charts are usually maintained (e.g., one for an alpha standard, one for a beta standard, and one for background).

**WPC-1050 OPTIONS**

	Line Printer 9P ESC/P with USB Port Interface
	Laser Printer HP PCL5 with USB Port Interface

**WPC-1050 SPARES & ACCESSORIES**

APA-10	Amplifier / Preamplifier
HV-20	High Voltage Power Supply, 2kV
110-0013	Power Supply, +5V, ±12V
120-0008	80µg/cm <sup>2</sup> Window
140-0278-1/4	Sample Holder ¼" Depth Stainless Steel
140-0278-1/8	Sample Holder 1/8" Depth Stainless Steel
140-0278-5/16	Sample Holder 5/16" Depth Stainless Steel
700-0007	Planchet 2"x1/8" Stainless Steel Flat
700-0008	Planchet 2"x1/4" Stainless Steel Flat
700-0009	Planchet 2"x5/16" Stainless Steel Flat

**Protean Instrument Corporation  
231 Sam Rayburn Parkway  
Lenoir City, TN 37771**

**Phone/ Fax: (865)717-3456**

**LIMITED WARRANTY**

*Protean Instrument* warrants that the products or components manufactured by it shall be free from defects in material or workmanship for a period of one year from the date of delivery to purchaser. If such product or component is determined to be defective by *Protean Instrument*, its sole warranty obligation shall be limited to either replacing or repairing such defective product or component or allowing credit therefore, at *Protean Instrument's* option. Such warranty is further conditioned upon the purchaser's giving prompt notice of any such defect and satisfactory proof thereof to *Protean Instrument's* customer service manager. Thereafter upon *Protean Instrument's* approval, the purchaser shall return such defective product or component to *Protean Instrument's* factory at Lenoir City, Tennessee, all transportation charges prepaid. *Protean Instrument* shall be responsible only for transportation charges incurred in returning such product or component to purchaser. All customs, brokerage and duty charges shall be at the expense of the purchaser. Damage in transit due to inadequate packaging will be repaired at purchaser's expense. Any repairs or replacements by the purchaser without *Protean Instrument's* approval, any willful abuse or any evidence that the product or component was not properly used and maintained, would automatically void this warranty.

*Protean Instrument* makes no warranty whatsoever in respect to products or components not manufactured by it but instead the applicable warranties, if any, of the respective manufacturers thereof shall apply. Likewise fuses, batteries and other consumable items are specifically excluded from this warranty.

THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS.