

Protean
Instrument
Corporation

MPC-1000

Revision 1.2

Contents

| | |
|---|----|
| About This Manual..... | 8 |
| Installation Overview..... | 9 |
| MPC 1000 Contents..... | 9 |
| Preliminary Preparations..... | 9 |
| Visual Inspection..... | 9 |
| Preliminary Procedures..... | 10 |
| Connect the Counting Gas..... | 11 |
| Printer Testing..... | 12 |
| Manually Count a Test Source..... | 15 |
| Print and Save Factory Plateau..... | 17 |
| Setting the Calendar/ Clock..... | 18 |
| Installations Without Attached Printer..... | 18 |
| Read the Manual..... | 18 |
| MPC 1000 Overview..... | 19 |
| Menu Driven Operation..... | 19 |
| Pass Code Protection..... | 19 |
| Count Function..... | 19 |
| Calibration Function..... | 19 |
| Control Charts..... | 19 |
| Program Function..... | 20 |
| Counting Parameters..... | 20 |
| Background Parameters..... | 20 |
| Efficiency Parameters..... | 20 |
| Battery Backup..... | 20 |
| Printer..... | 21 |
| Computer Connectivity..... | 21 |
| International Power Entry..... | 21 |
| Limited Warranty..... | 21 |
| Sample Loading..... | 22 |

| | |
|--------------------------------------|----|
| Gas Flow Control & Gas-Pro..... | 23 |
| The MPC 1000 Console | 23 |
| The Rear Panel | 23 |
| Getting Started..... | 24 |
| Count a Sample | 24 |
| Step 1 Define..... | 24 |
| Define Counting Routines | 25 |
| Routine Definition Page 1 | 26 |
| Routine Definition Page 2 | 27 |
| Routine Definition Page 3 | 27 |
| Routine Definition Page 6 | 28 |
| Step 2 Calibrate..... | 29 |
| Step 3 Count..... | 31 |
| Review | 33 |
| Setup Menu..... | 34 |
| Screen Utilities | 34 |
| Calibrating the Touch Screen | 34 |
| Backlight Brightness..... | 35 |
| Beep Volume | 35 |
| Program Menu | 36 |
| Import Settings..... | 36 |
| Instrument Parameters..... | 37 |
| Printer | 38 |
| Gas Flow Option..... | 39 |
| Set Calendar/Clock..... | 40 |
| Setup Pass Codes | 41 |
| Set Instrument ID | 42 |
| Define Counting Routines | 42 |
| Count Routine Definition Page 1..... | 43 |
| Naming the Count Routine | 43 |

Preset Time 43

Minimum Count Time 44

Repeats 44

Preset Counts 44

Specifying the Counting Mode..... 45

 Alpha Only 45

 Alpha and Beta 45

Results Storage..... 45

Save Results 45

1 Page per Sample..... 45

Automatic Print 46

Completing Count Routine Definition Page 1 46

Count Routine Definition Page 2..... 47

Count Routine Definition Page 3..... 52

Count Routine Definition Page 4..... 53

Count Routine Definition Page 5..... 54

Count Routine Definition Page 6..... 55

Calibration Menu 57

 Plateau Determination..... 58

 Acquiring a Plateau 59

 Viewing a Plateau..... 60

 Manual Background/Efficiency Entry..... 61

 Radon Efficiency Factors 63

 Import Control Chart Limits 64

 Print All Calibration Info..... 64

Control Charts 65

 Acquiring Control Checks 66

Data Menu 68

 View Count Routine Data..... 69

 Routine Data View 70

Display Option..... 71

Full Record View 71

Page Selection..... 72

Delete Count Routine Data 73

View Control Check Data 74

Background Control Chart..... 74

Alpha Control Chart 76

Beta Control Chart 78

Export Data 80

Diagnostics Menu..... 82

 Trending 83

 Acquiring Trending Data 85

 Printing Trending Data 87

 Manual Count 88

 The Data Display 89

 Printer Test..... 90

Guarding Against Obsolescence 91

Plateau Data CSV File Format 92

Alpha Control Chart Checks Data CSV File Format 93

Beta Control Chart Checks Data CSV File Format 94

Background Control Chart Checks Data CSV File Format..... 95

Sample Data CSV File Format..... 96

Trend Data CSV File Format 97

Radon Subtraction 100

 Determination of Radon Efficiency Factors 101

 Routine Counting with Radon Subtraction 101

External Control 102

Service Guide Introduction 103

 The Power Supply Subsystem 103

 The Linear Electronics Subsystem..... 103

| | |
|---|-----|
| Gas Flow Subsystem..... | 104 |
| Gas Tank Precautions..... | 104 |
| The CPU Subsystem | 105 |
| General Instructions..... | 105 |
| Cover Removal | 106 |
| Cover Installation | 106 |
| Removing the Sample Detector | 106 |
| Installing the Sample Detector..... | 107 |
| Power Entry..... | 107 |
| Line Voltage Selection..... | 107 |
| Checking the Low Voltage Power Supply (LVPS)..... | 108 |
| Removing Low Voltage Power Supply | 108 |
| Installing Low Voltage Power Supply | 108 |
| Operating Environment | 109 |
| General Electrical Failures..... | 109 |
| Blows Main Fuses..... | 109 |
| Failure to Initialize on Power-up..... | 110 |
| Intermittent Lockup | 110 |
| APA-10-D and HV-20-D Status Indicators | 111 |
| Beta Background is High? | 111 |
| Sample Counts are zero? | 111 |
| Performance Changes – Background..... | 111 |
| Gas Quality | 111 |
| Contamination | 112 |
| Electronic Noise | 112 |
| Performance Changes – Efficiency..... | 112 |
| Geometry | 112 |
| Gas Quality..... | 112 |
| Plateau Settings | 113 |
| Recommended Supplies for Cleaning Procedures..... | 114 |

Detector Maintenance – Windowed Configuration 115

Replacing the Anode Assembly (P/N 120-0006) 115

Detector Maintenance – Windowless Configuration 116

Detector Contamination 116

Cleaning the Anode..... 116

Cleaning the Detector Body 117

Replacing the Detector Seal Gasket..... 117

Variable Definitions and Equations..... 118

Concepts of Alpha / Beta Counting..... 123

 The Alpha / Beta Counter 123

 Gas Filled Proportional Detectors 123

 Count Time Requirements 124

 Low Background Material Selection 124

 Background Stability 124

 Absolute Counting Efficiency 125

 Intrinsic Detector Efficiency..... 125

 Counting Geometry and Efficiency 125

 Sample Self-Absorption and Counting Efficiency..... 126

 Calibrated Conversion Factors 127

 The Control Chart..... 127

MPC 1000 OPTIONS 128

MPC 1000 SPARES & ACCESSORIES..... 128

LIMITED WARRANTY 129

About This Manual

This manual provides the information to install, operate, and service the MPC 1000 Alpha/Beta Counting instrument. Also included is a brief introduction to fundamental concepts of alpha/beta counting and instrument architecture. The MPC 1000 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 MPC 1000 quickly and easily.

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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 MPC 1000 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.

MPC 1000 Contents

- **Instruction Manual and Companion Software**
- **Power Cord**
- **Sample Carriers and Control Plates**
- **Sample Carrier Inserts (Planchet Holders)**

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. Allow about six inches in the rear of the instrument for access for peripheral cables.

Visual Inspection

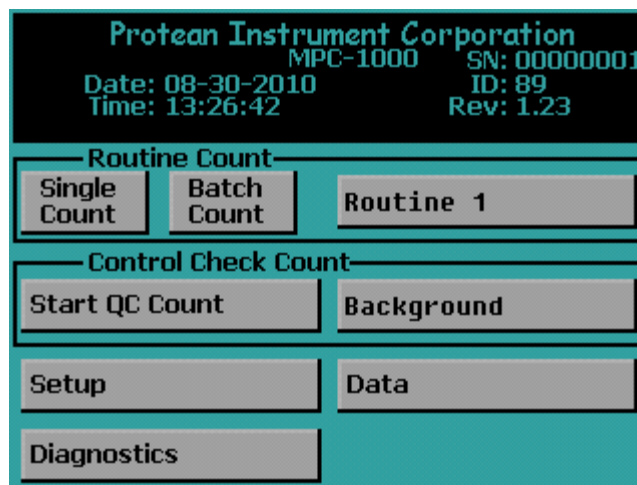
Visually inspect the instrument for any obvious damage. If everything looks in order proceed with the following tests. The procedures that follow are not intended to cover detailed calibration and counting operations. The intention is to verify everything is operable before starting the detailed setup and calibration procedures.

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.

Preliminary Procedures

- Attach the power cord to the IEC power entry module on the bottom 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.



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 MPC-1000 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.
- Connect the gas supply to the MPC-1000 using the rear panel connection.

WARNING

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

Printer Testing

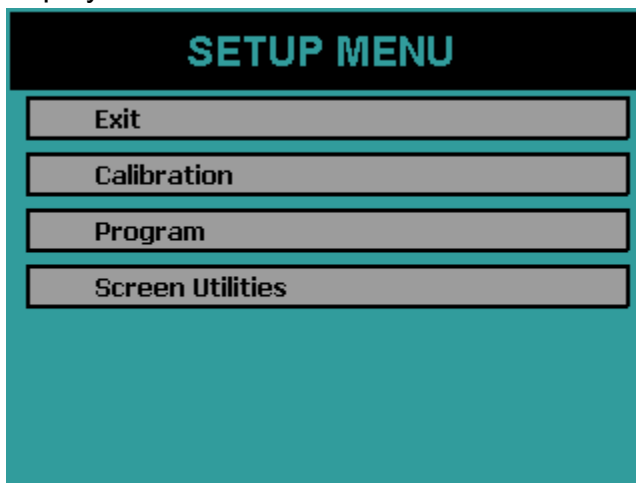
The MPC 1000 prints alphanumeric and graphic information. Graphic commands are kept to a minimum for compatibility purposes. The graphic control commands are compatible with printers that support 9P ESC/P or PCL5 printer command language. We do not maintain detailed instructions for all printer models and brands.

The printer connection is a standard USB interface.

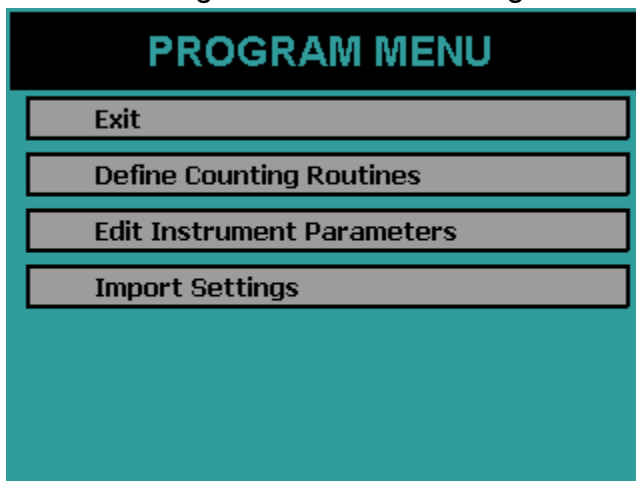
- Connect the printer USB cable to the back of the MPC 1000 USB port.
- Select the correct print driver.

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

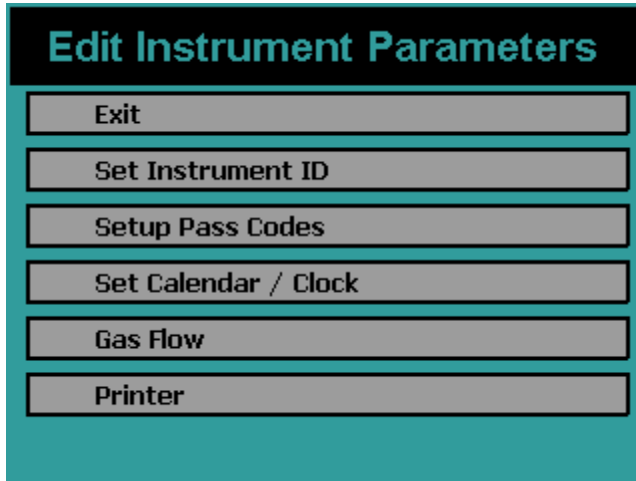
- Press the *Setup* button on the Top Menu screen. The Setup Menu will be displayed as seen below.



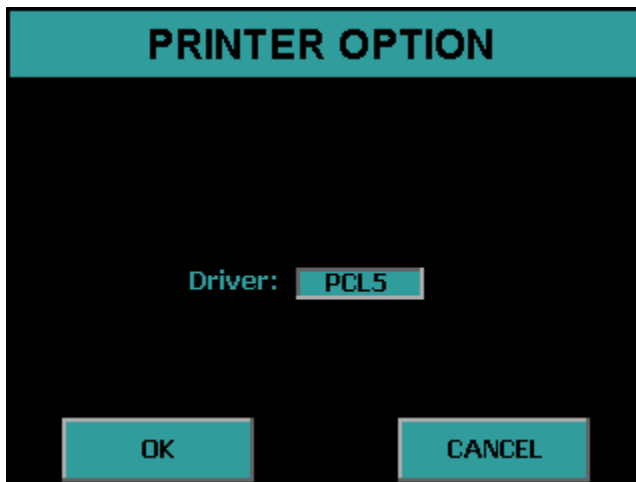
- Press the *Program* button. The Program Menu will be displayed as seen below.



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

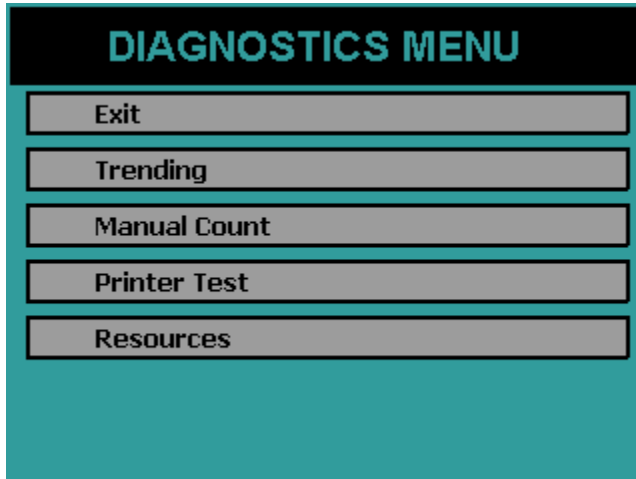


- Press the *Printer* button to display the Printer Option Menu below.



- 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

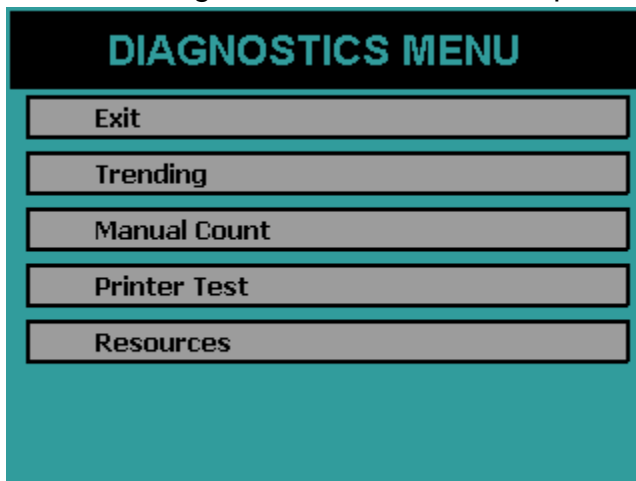
The following items are needed for this test:

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

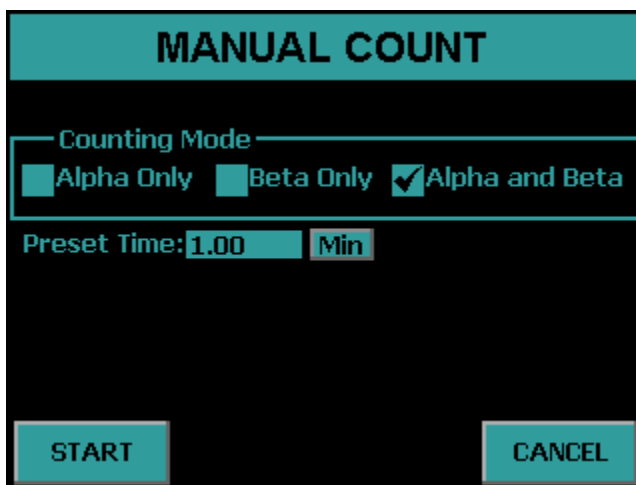
Use a planchet and carrier insert that holds the source as close to the top surface of the carrier as possible.

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

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

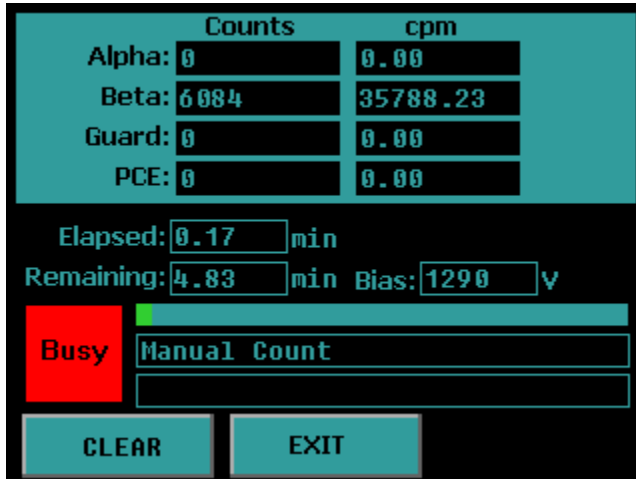


- Press the *Manual Count* Button. Refer to the Diagnostics section of this manual for a detailed account of the Manual Count routine.



- Select *Alpha and Beta* counting mode and Preset Time of 1 min.

- Press *START* 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: 0.10 cpm
Beta: 52 cpm

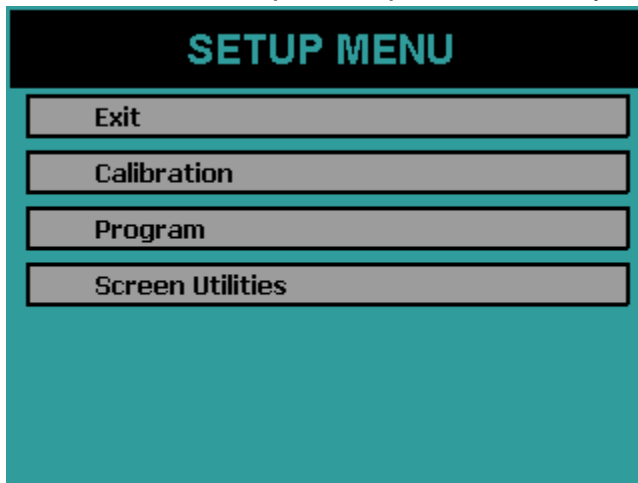
It is normal for these counts to increase 25%-30% at elevations above 5000ft.

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

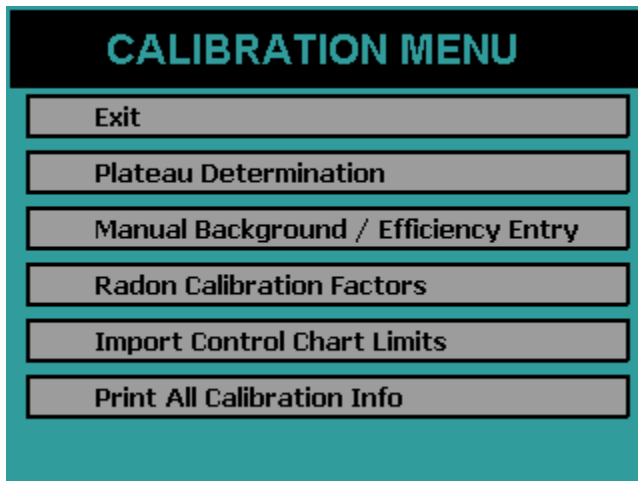
Print and Save Factory Plateau

A detector plateau curve is generated on each MPC 1000 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 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.

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.

Installations Without Attached Printer

If the MPC 1000 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.

Read the Manual

The installation of the MPC 1000 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.

MPC 1000 Overview

The MPC 1000 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 MPC 1000 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 MPC 1000:

- 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 Count* or *Batch Count* button from the Top Menu.

Calibration Function

Calibration of the MPC 1000 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 MPC 1000 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 MPC 1000 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 MPC 1000 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 MPC 1000 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 MPC 1000 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 MPC 1000 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

The sample arm has a lever and rotate mechanism which locks positively in the fully closed position. To open rotate the handle counter clockwise lower the arm and then move to the position shown below.



Open Position

To close move the lever to the position shown in the picture and the rotate the handle clockwise to raise the arm.



Closed Position

Samples are loaded by placing them (in a planchet) into a carrier. 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.

Gas Flow Control & Gas-Pro

Gas flow in the MPC 1000 is factory set at the proper flow levels. The MPC 1000 uses two flow rates, low for rest mode, and high for counting mode. The MPC 1000 also contains a gas flow sensor. A counting sequence will be inhibited if the flow rate changes from the preset rate. Common reasons for a flow rate change are an empty gas tank, a pinched gas line on either the input or output side, a leaking detector window, or a window that is completely ruptured. Any of these conditions will cause the gas flow proportional system to count inaccurately. The Gas-Pro system in the MPC 1000 is designed to halt counting until the fault is corrected.

The MPC 1000 Console

The MPC 1000 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, and two RS-485 connectors.

A quick disconnect gas coupler is located on the rear panel. Pressing the metal tab downwards will release the gas line from the instrument.

Two identical RJ-45 jacks are located at the top right of the rear panel. These connectors are used when connecting to a single PC.

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

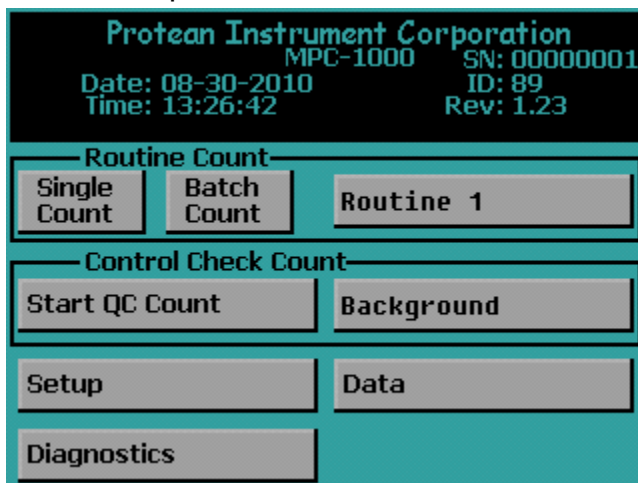
To count a sample three steps must be taken:

1. Define
2. Calibrate
3. Count

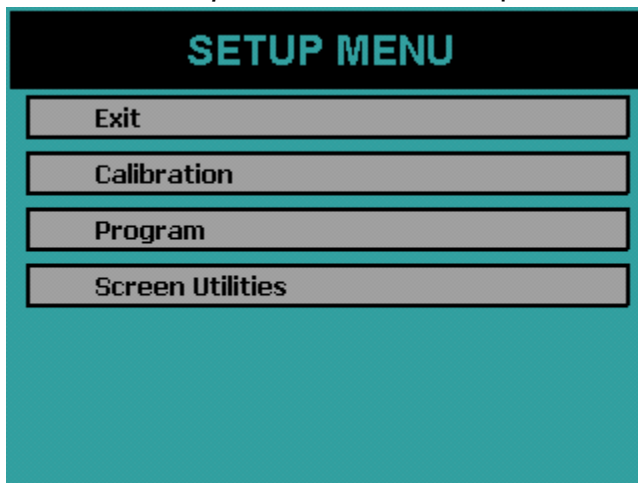
Normally the counting routines are defined and calibrated as part of installation of the system, and when new counting routines are required. On a daily basis only Step 3 the count function is used to count a calibration check source or to count a sample.

Step 1 Define

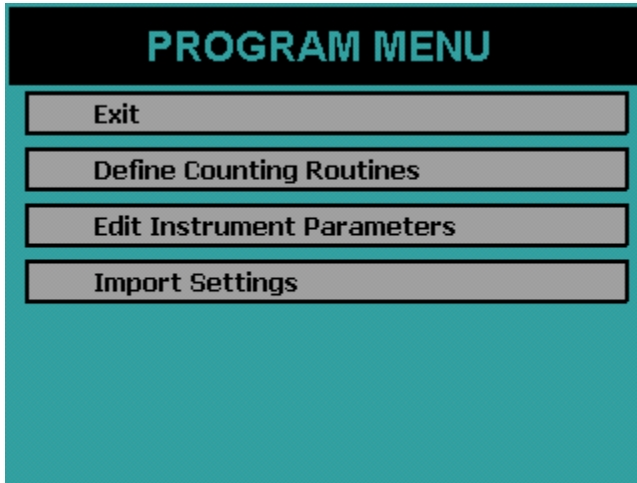
The first step is to define a count routine.



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

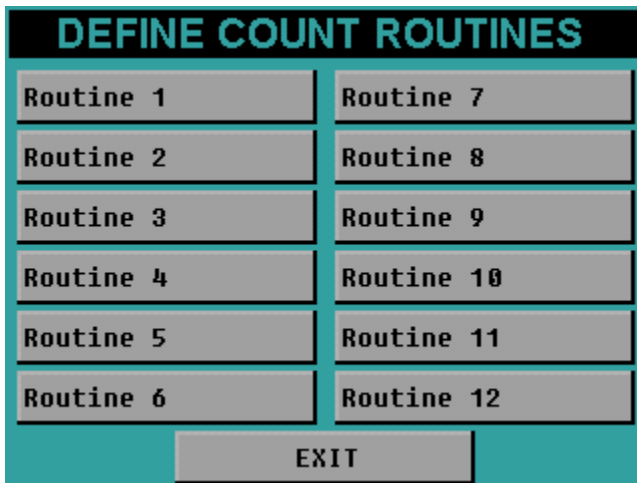


Press the *Program* button from the Setup Menu.



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 Save Results: Yes |
| 1 Page Per Sample: | No Automatic Print: No |
| NEXT DONE | |

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

Save Results: Yes

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 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: **Normal**

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 4 and five are skipped.

Routine Definition Page 6

| COUNT ROUTINE DEFINITION | |
|---|---|
| Background From | Efficiency From |
| <input type="checkbox"/> Local Manual Entry | <input type="checkbox"/> Local Manual Entry |
| <input checked="" type="checkbox"/> External Entry Control Limits Mean | <input checked="" type="checkbox"/> External Entry Control Limits Mean |
| PREV | DONE |

Set the following parameters:

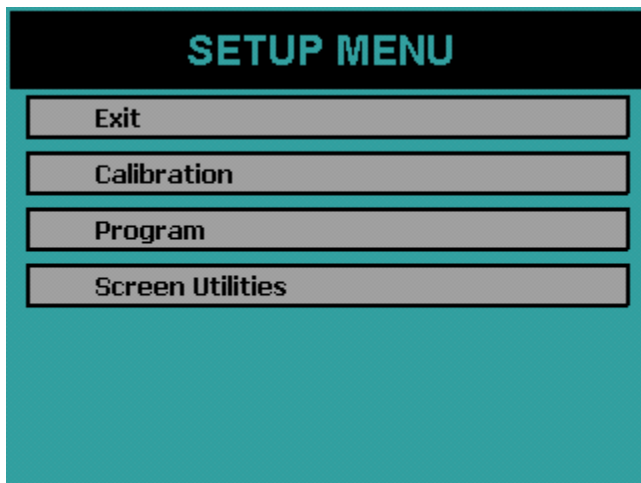
Background From: Local Manual Entry

Efficiency From: Local Manual Entry

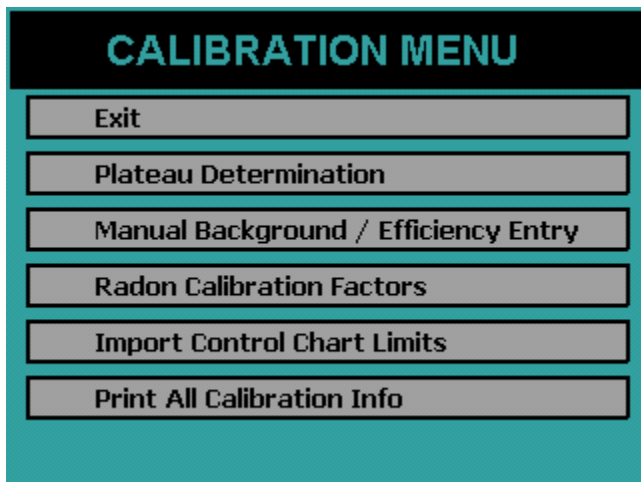
Press the *DONE* button to complete the routine definition.
Step 1 Define is now complete

Step 2 Calibrate

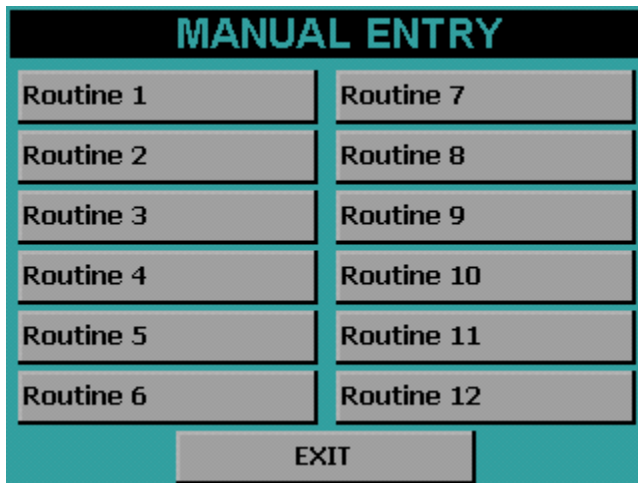
Now press *EXIT* until the Setup Menu is displayed.



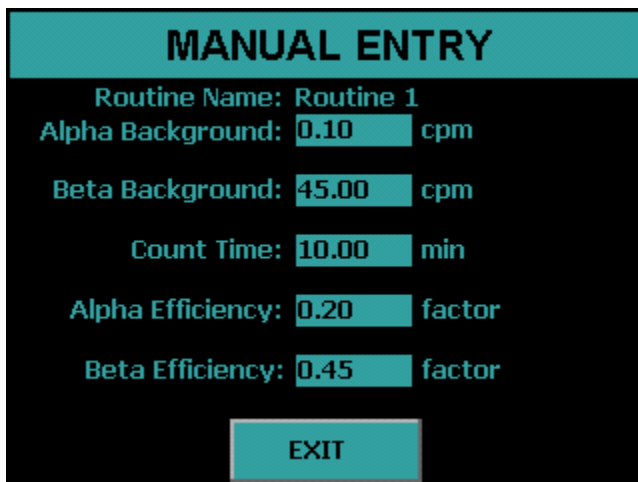
Press the *Calibration* button on the Setup Menu.



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



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



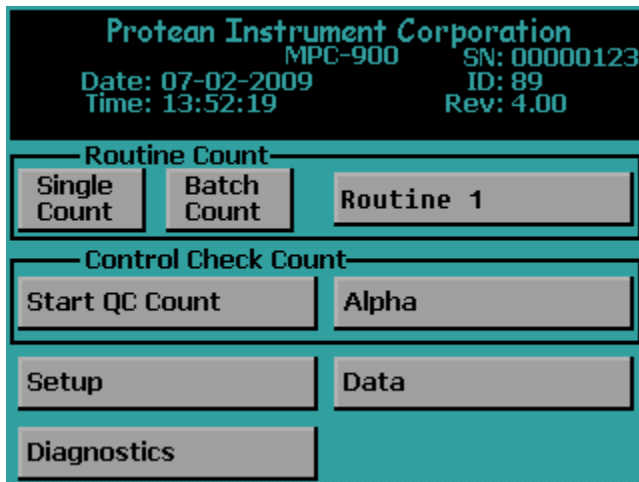
Enter the following calibration factors:

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

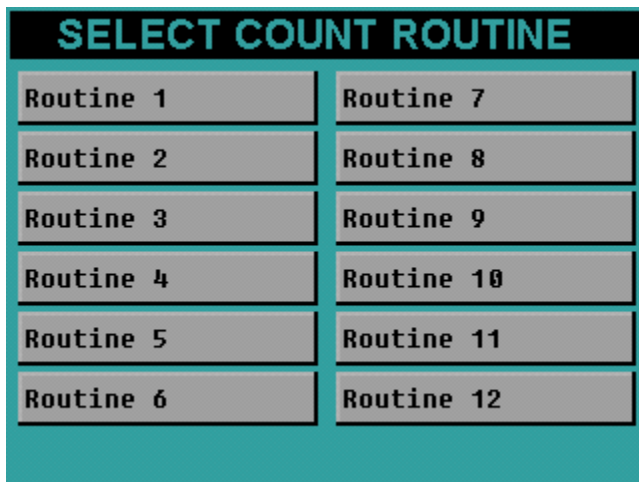
Now press the *EXIT* button.
 Step 2 Calibration is now complete.

Step 3 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.



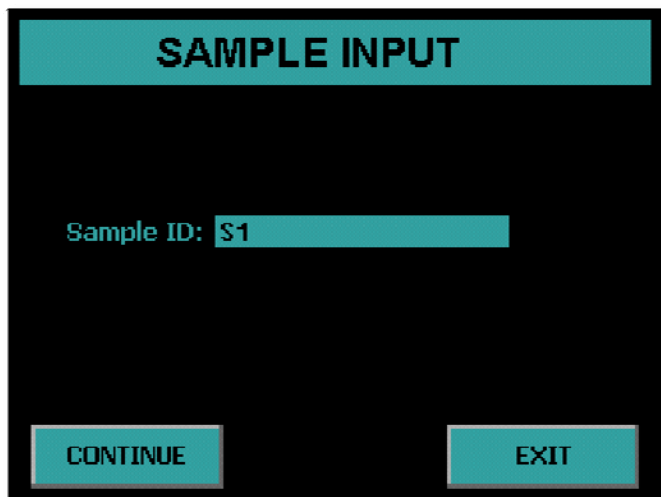
On the Top Menu confirm Routine 1 is selected and displayed. If Routine 1 is not selected then press the button to the right of the *Batch Count* button to display the Select Count Routine menu.



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 Count* on from the Top Menu.

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 begin a sample count. 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.



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.

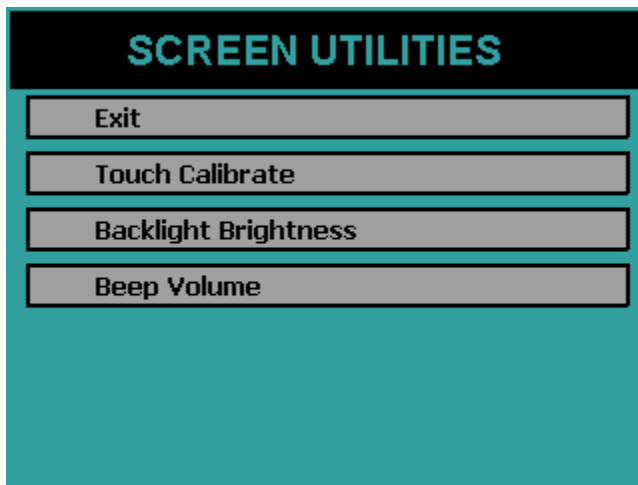
The next section covers all of the menus and a detailed discussion of all of the options that are available to the user.

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.

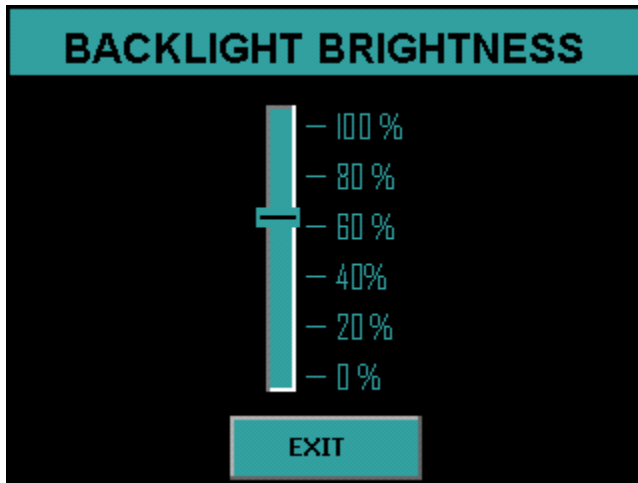


Calibrating the Touch Screen

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

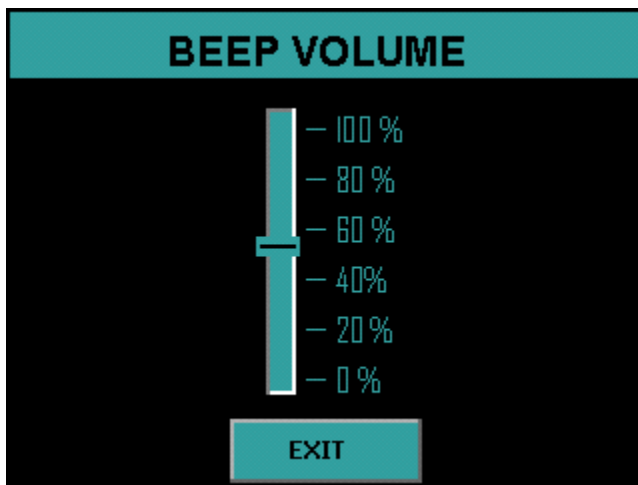
Depending on the lighting of the room you may want to change the brightness of the display. To activate the Backlight Brightness Menu, press the Backlight Brightness button on the Screen Utilities Menu.



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

Beep Volume

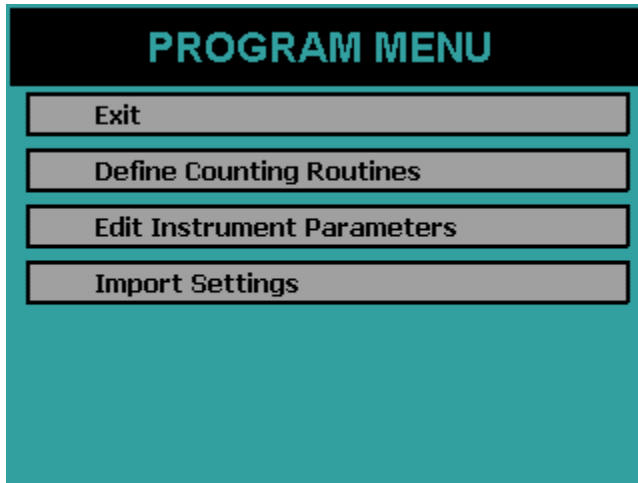
The sound volume of the system can be adjusted through the Beep Volume menu. To activate the Beep Volume menu press the *Beep Volume* button on the Screen Utilities menu.



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

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 MPC-900 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.

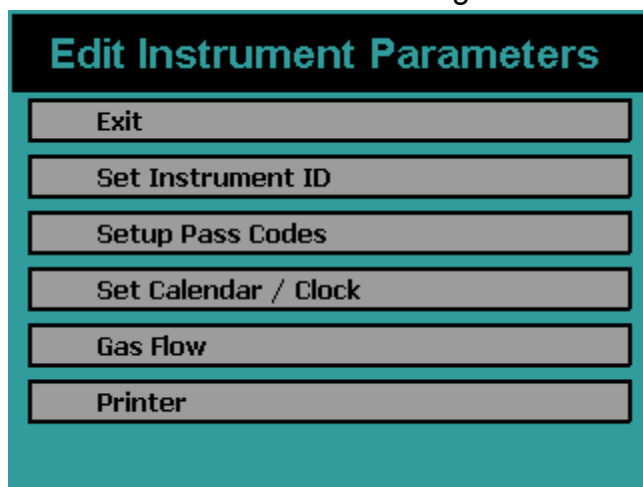


The next screen will display Finished to indicate that the settings have been imported successfully.



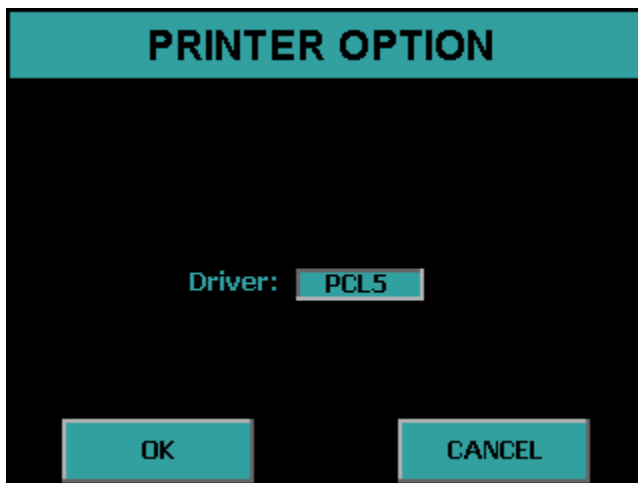
Instrument Parameters

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



Printer

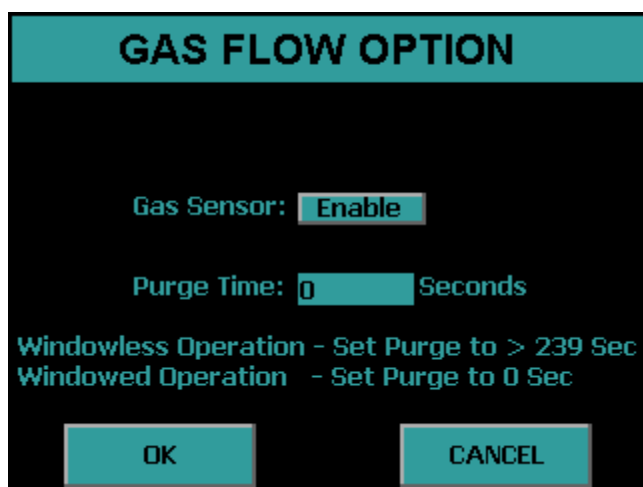
Activate the Printer Option Menu by pressing the *Printer* button. Press the button to select the printer driver. PCL5 is the driver for a printer with PCL5 command support. 9P ESC/P is the driver for a printer with 9P ESC/P command support. Press *OK* to save the setting.



Gas Flow Option

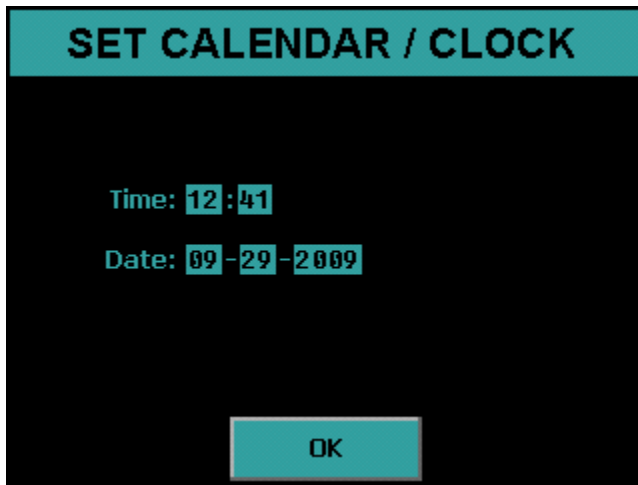
The Gas Flow option allows for enabling and disabling of the gas flow sensor. The gas flow sensor is connected to the gas outlet of the sample detector. Sensing gas flow at this point insures integrity of the gas flow system. The option to disable the sensor is for the unlikely event that the sensor needs repair or replacement. To accomplish this press the *Enable* button to display *Disable*. To enable the sensor press the *Disable* button to display *Enable*.

A purge time is also set on the page. The purge time is the amount of time after the gas sensor senses good gas flow to wait before counting begins. The purge time should be used when operating with a windowless detector otherwise set the purge time to 0 Seconds.



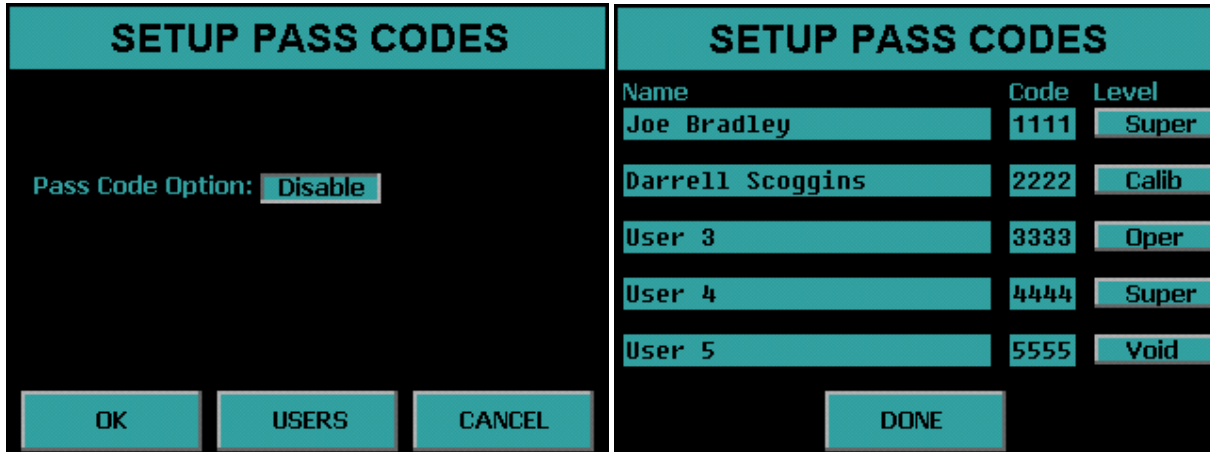
Set Calendar/Clock

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.



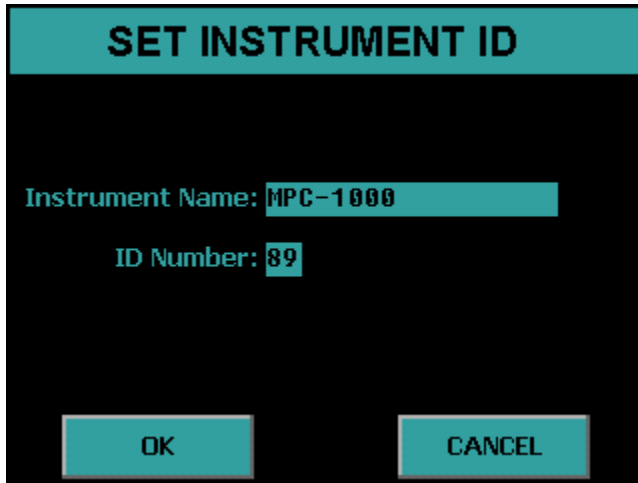
Press the *Name* field to change the user name. Press the *Code* field to change the pass code. Press the *Level* button to select the permission levels.

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.

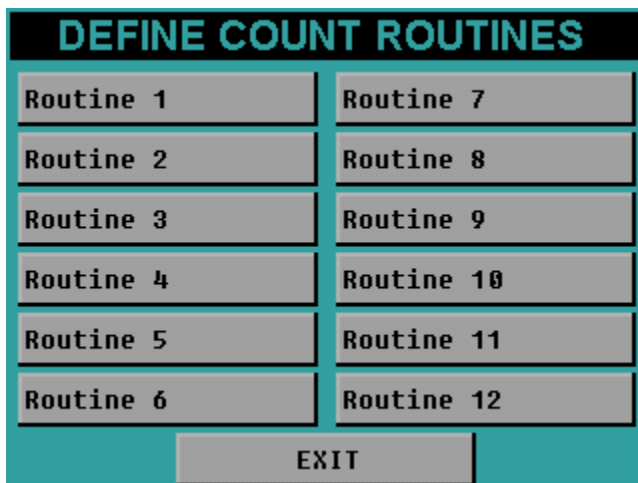
Set Instrument ID

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

COUNT ROUTINE DEFINITION

Routine Name: Routine 1

Preset Time: 1.00 min Repeats: 0

Min Count Time: 0.00 min

Counting Mode: Alpha Only Alpha and Beta

Preset Counts: Alpha: 0 Beta: 0

Results Storage: Internal Save Results: Yes

1 Page Per Sample: No Automatic Print: No

NEXT DONE

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 MPC 1000 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 MPC 1000 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. 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 directly to the USB flash drive. The only limit to the number of records that can be stored is the size of the USB flash drive being used. However, only the last record counted can be viewed from the instrument. To select Internal or External storage toggle the *Internal/External* button.

Save Results

This field allows the count routine to specify whether or not analysis results are saved. If results are not saved then the only record of the count is from the print out if automatic print is selected or by viewing the screen when the count has completed. The only advantage of not saving results is that it is not necessary to perform maintenance operations on the saved count routine data. When you choose to save results then you are able to view previous count records or re-print a previously saved record. To enable or disable Save Results toggle the *Yes/No* button.

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

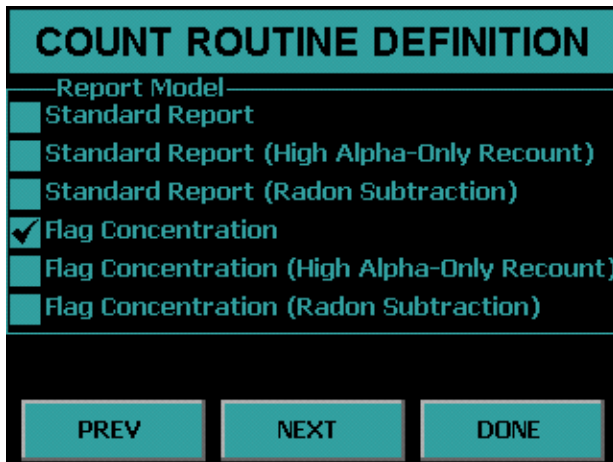
This field controls whether or not data is automatically printed after each acquisition. To enable or disable the automatic printing toggle the *Yes/No* button.

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 screen titled "COUNT ROUTINE DEFINITION". It is divided into two main sections: "Input Units" and "Report Units".

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" and "per".

- Activity:** pCi, uCi, Bq, dpm (checked).
- per:** ml, l, m3, ft3 (checked), cm2, 100cm2, Sample, None.

Below the "Report Units" section is a "Format:" label with a dropdown menu currently set to "Normal".

At the bottom of the screen are three buttons: "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

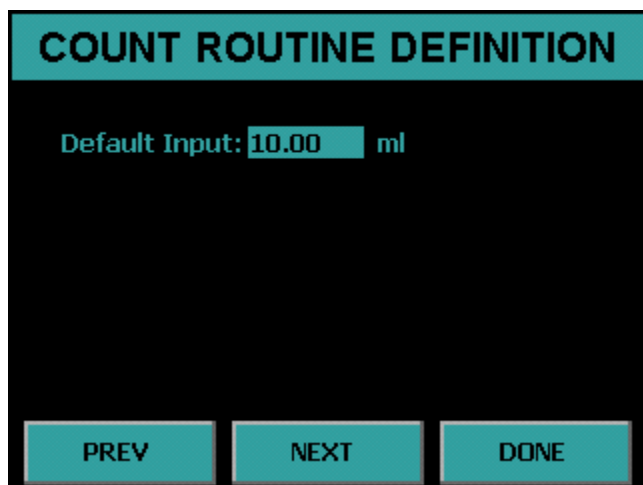
Select the units for which you want to display the Activity.

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, you will not have to type in the input for each count.

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.

| COUNT ROUTINE DEFINITION | | |
|--------------------------|---------------|--------------|
| 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

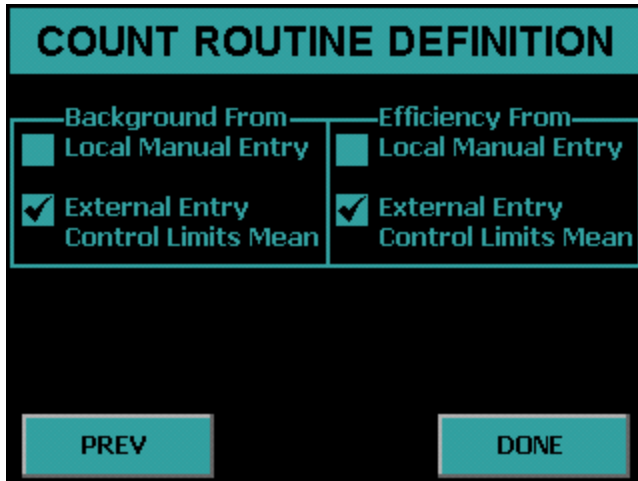
Action Limits

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 MPC 1000 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 MPC 1000 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 MPC 1000’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.

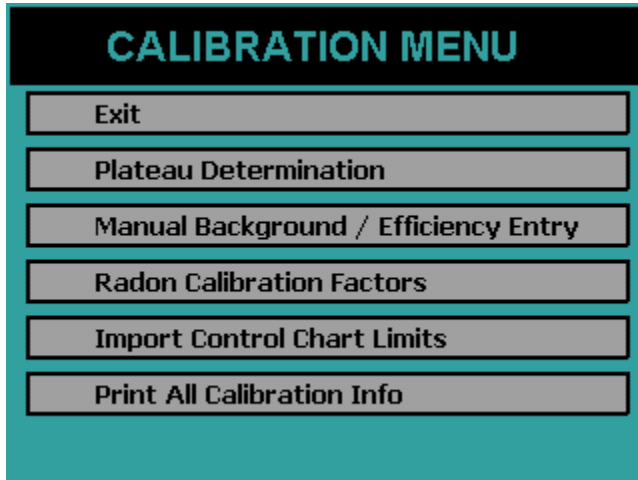
Local Manual Entry -- As its name implies, manual entry relies upon the calibration technician to determine and enter the efficiency values.

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.

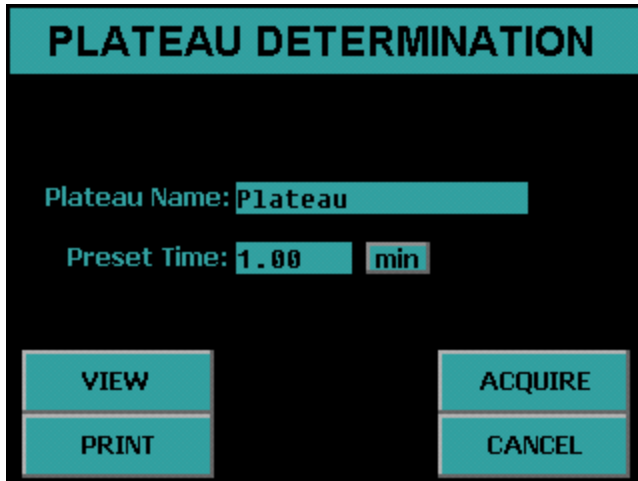
Calibration Menu

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

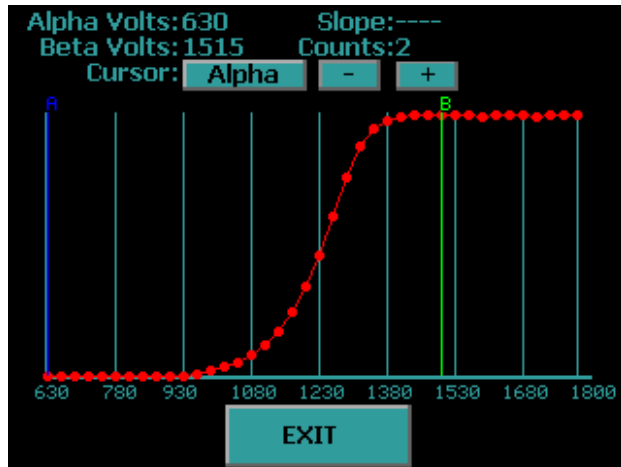
The plateau is acquired by specifying a Plateau Name and Preset Time. Once the desired sample is loaded, the *ACQUIRE* button is used to start the plateau data collection.

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.



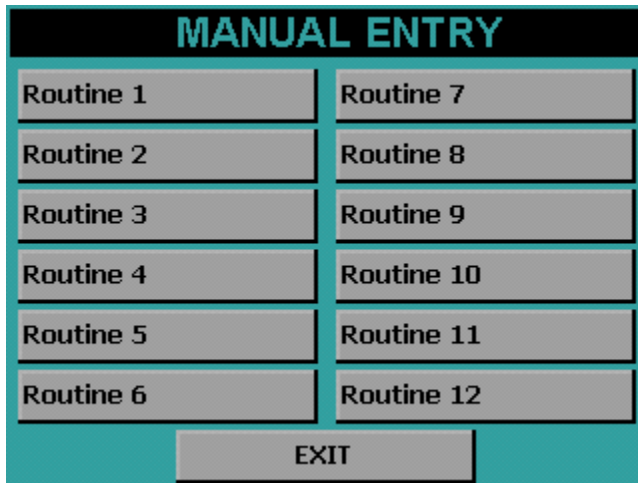
The MPC-1000 will automatically generate a plateau curve. Two cursors are displayed. The blue cursor is the alpha-only operating bias. The green cursor is the alpha and beta operating bias. The % slope per 100 volts is displayed for the active cursor. Note the first two points and last two points for 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 630. 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.

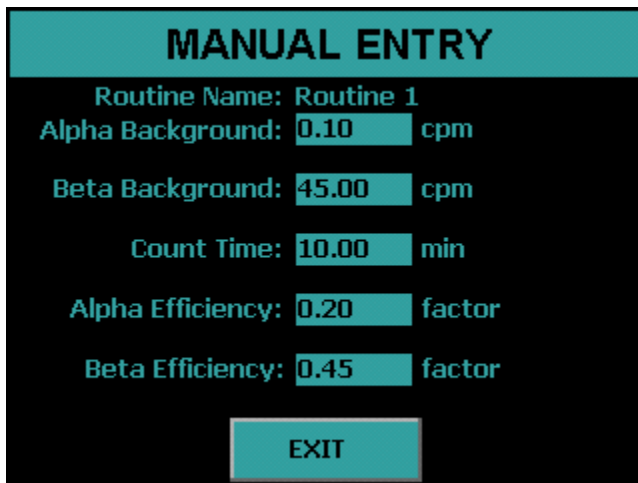
When using the plateau function it is critically important to use a point source. Using a distributed source will cause a degraded plateau curve to be generated, leading to a bias set point that is far from optimum. Protean Instrument Corporation encourages users to become familiar with ANSI Standard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

Manual Background/Efficiency Entry

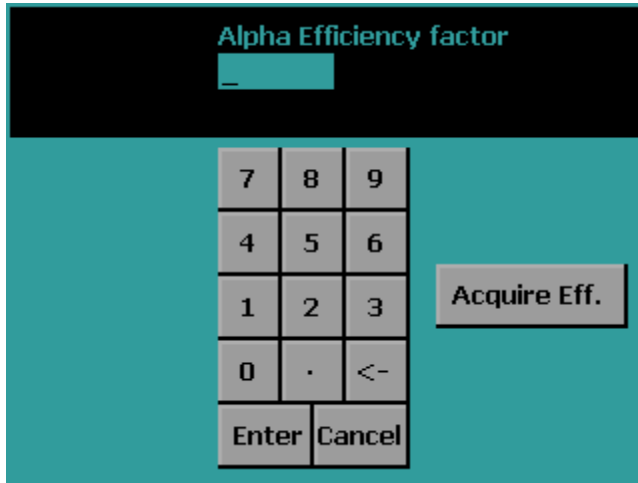
Pressing the *Manual Background/Efficiency Entry* button from the Calibration Menu displays the following screen.



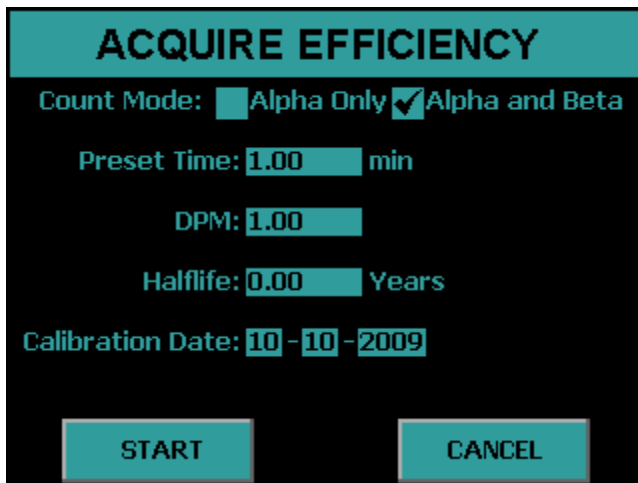
Press the button corresponding to the routine that you wish to add background and efficiency values. Note that efficiency values are entered as factors and not as percentages. Press *EXIT* to return to the Calibration Menu.



Pressing 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.

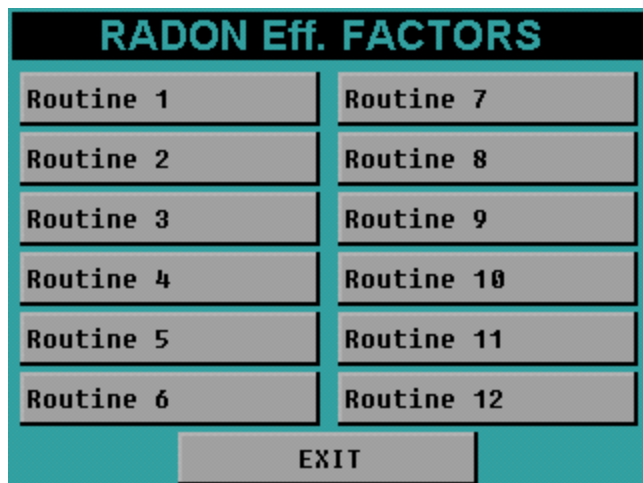


Select the Count Mode, Preset Time, Source DPM, Half-life, and Calibration Date of the source. Press the *START* button to acquire the efficiency. Once the count finishes press the *Exit* button and the efficiency factor that was acquired will now be entered.

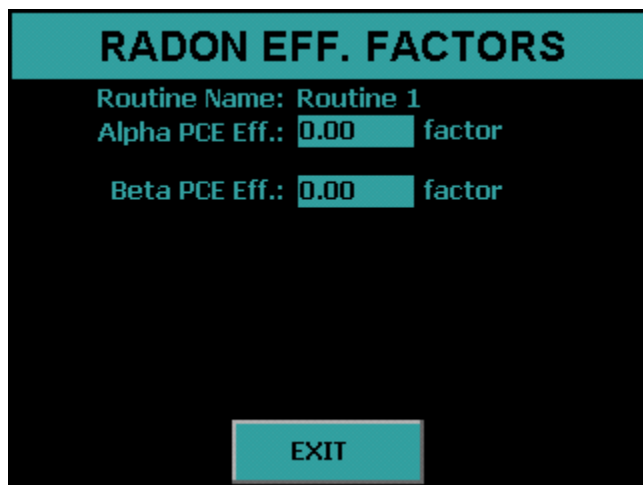
Press *EXIT* to save the changes and return to the routine selection screen.

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 MPC 1000, 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.

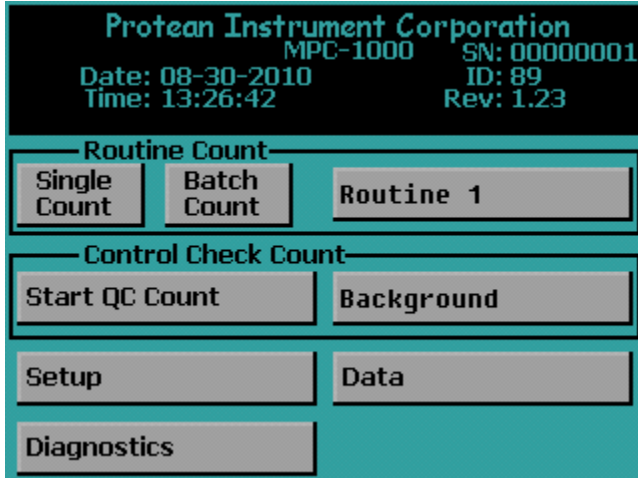
The implementation of a control chart requires that limits be established before routine checks are made. The control limits are established by randomly counting the appropriate standard over a period of several days using the control check acquisition routine. The MPC 1000 stores a maximum of forty 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.

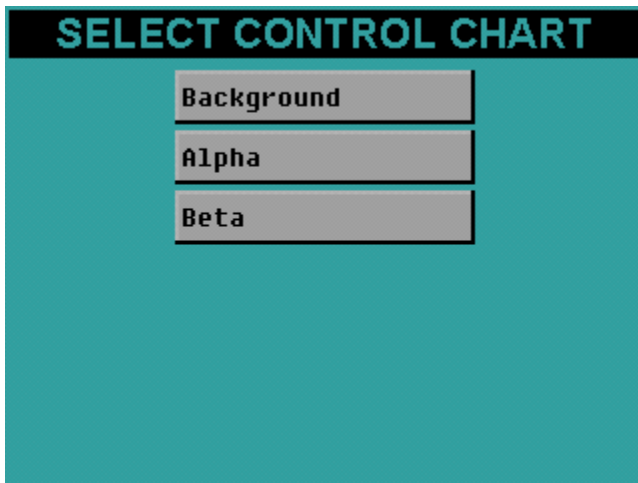
The mean and associated standard deviations established by the control chart limits now become the bench mark by which future performance (the control checks) are judged. The control checks will be plotted on the same scale as the limits data. The two sigma lines around the mean will be considered warning 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.

Acquiring Control Checks

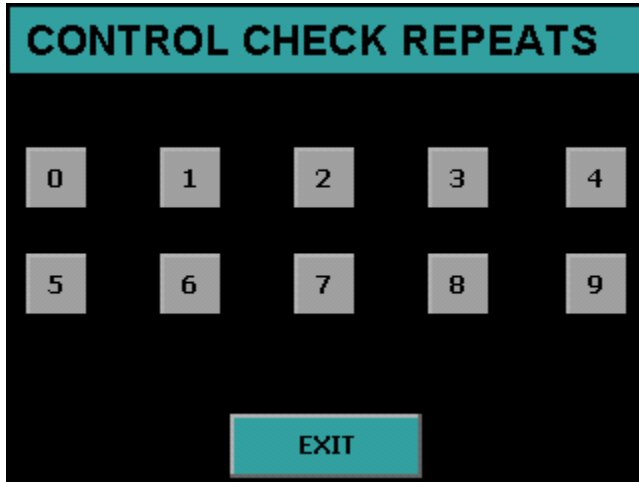


From the Top Menu press the button beside Start QC Count to select the control chart. The screen below will be displayed.



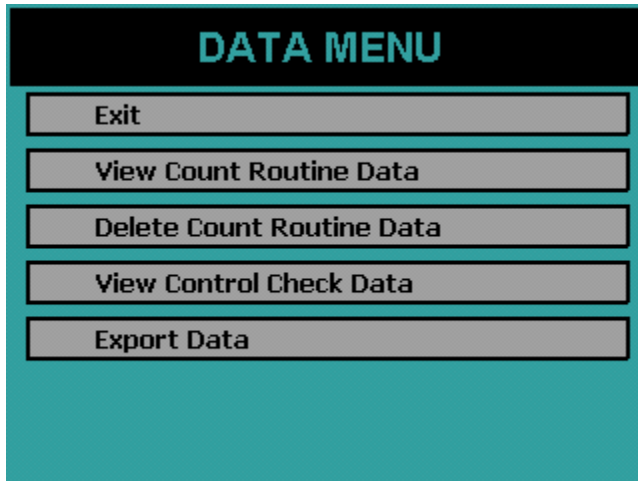
Select the control chart to count by pressing the appropriate button. The control chart that was selected will now appear on the Top Menu.

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.

Data Menu



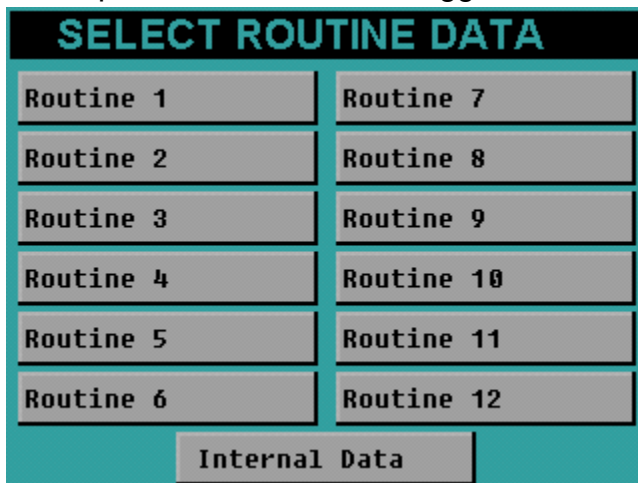
The Data Menu provides a means of examining, editing, printing and exporting data collected. This data is divided into two main categories, count routine data and control check data. Control check points that were acquired in error may also be deleted using the Data Menu.

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.

Pressing the bottom button toggles between *Internal Data* and *External Data*. Internal Data is routine data that is stored locally and external data is routine data that is stored directly on the USB flash drive. Only the last count for each routine can be viewed when viewing external data.

For example to view data counted with Routine 1 that was stored on the USB flash drive, press *Internal Data* to toggle it to *External Data* and then press *Routine 1*.



Routine Data View

After selecting a count routine the following screen is displayed.

| S# | α cpm | β cpm | α dpm/ml | β dpm/ml |
|----|--------------|-------------|-----------------|----------------|
| 1 | 3.00 | 36629.00 | 11.60 | 81396.78 |
| 2 | 0.00 | 36989.00 | -0.40 | 82196.78 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

PREV EXIT PAGE NEXT

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.

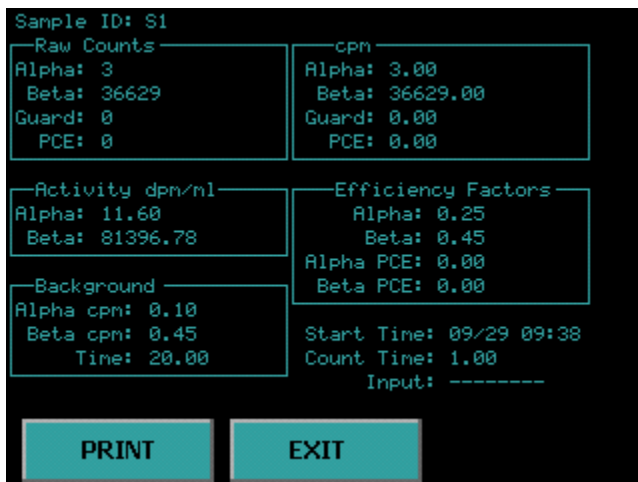
Display Option

The following screen is displayed when pressing one of the four display option button 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.



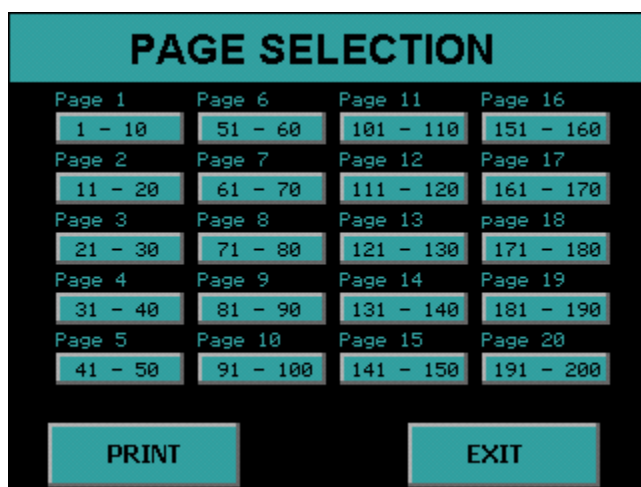
Full Record View

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



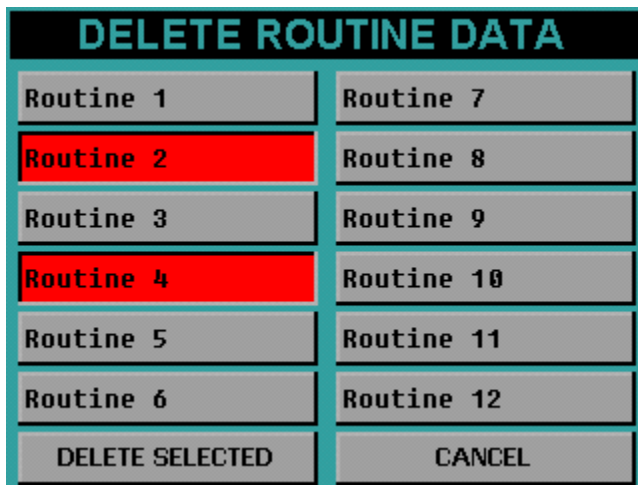
Page Selection

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.

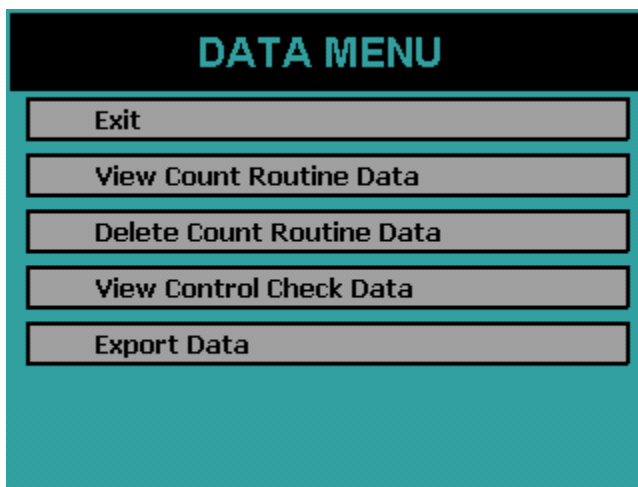


View Control Check Data

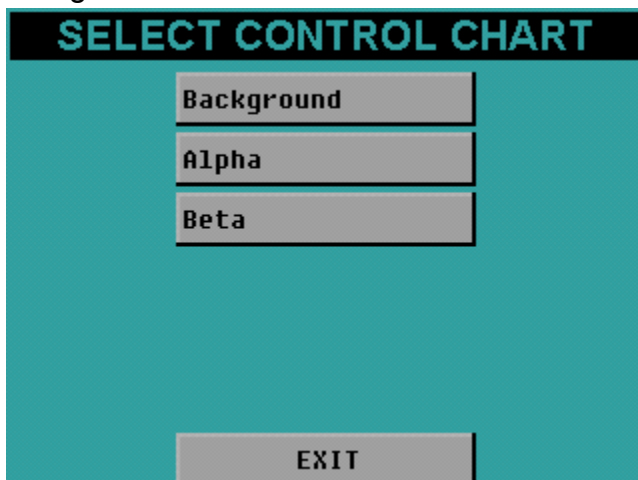
Background Control Chart

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.

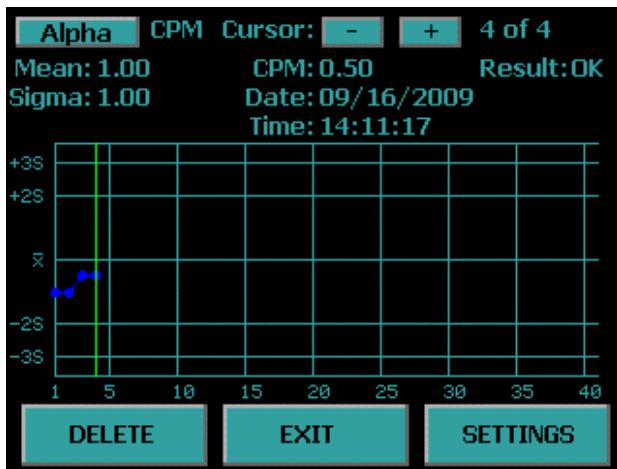
To view the background control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



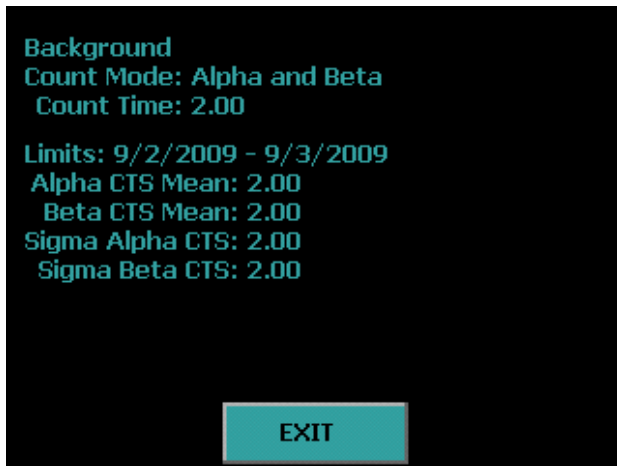
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will always be the beta control chart. Now press the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



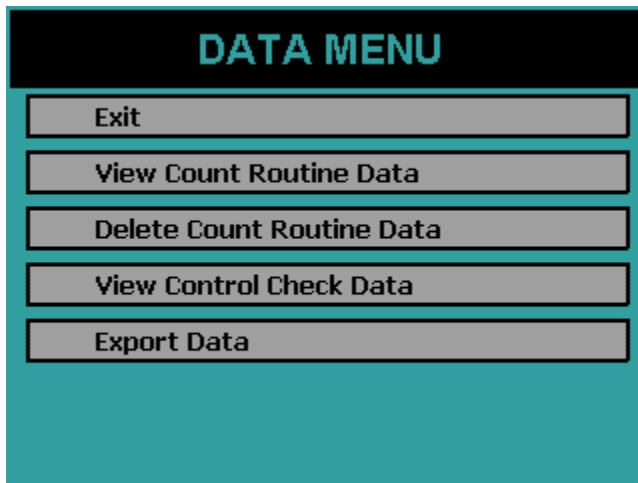
Pressing the *SETTINGS* button allows viewing of the control chart settings.



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

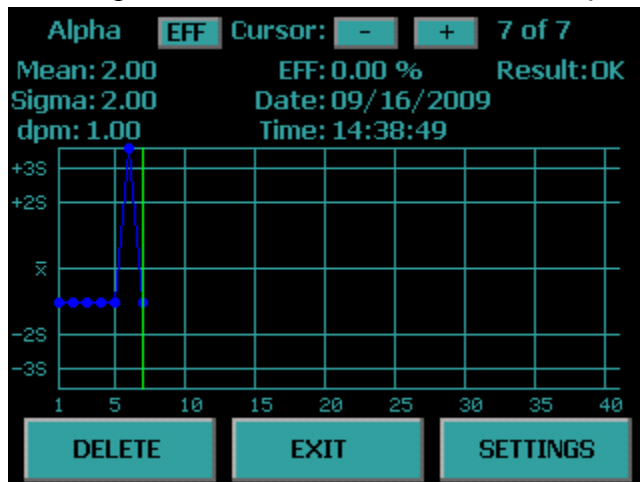
To view the alpha control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



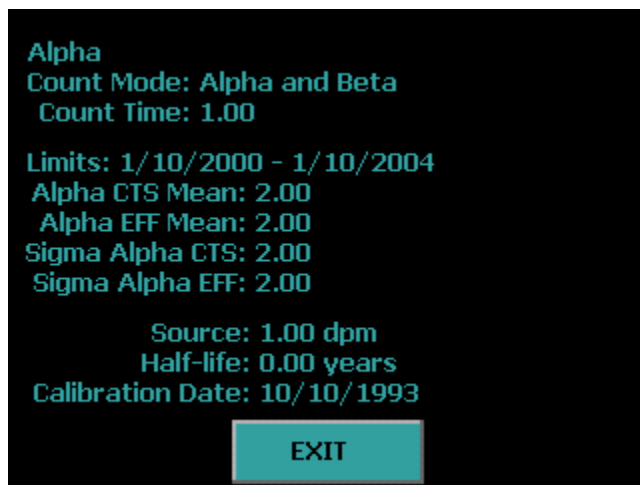
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will always be the beta control chart. Now press the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



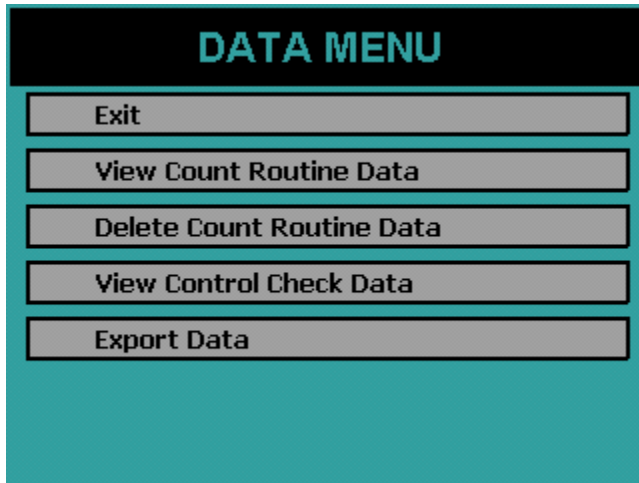
Pressing the *SETTINGS* button allows viewing of the control chart settings.



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

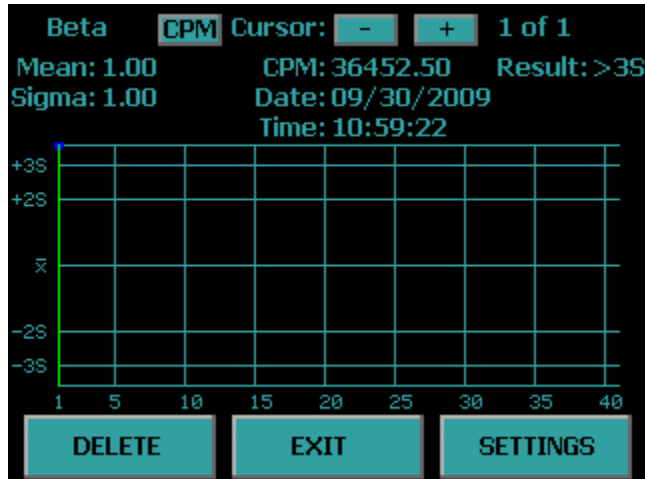
To view the beta control chart settings from the Top Menu press *Data*. The next screen will be the Data Menu. Press *View Control Check Data*.



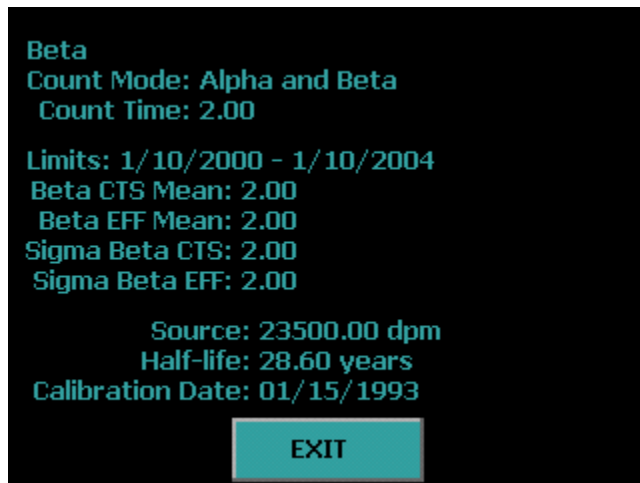
Now select a control chart to view. The names of the control charts are defined by the companion software. However the top button will always be the background control chart. The middle button will always be the alpha control chart. The bottom button will be the beta control chart. Now press the bottom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



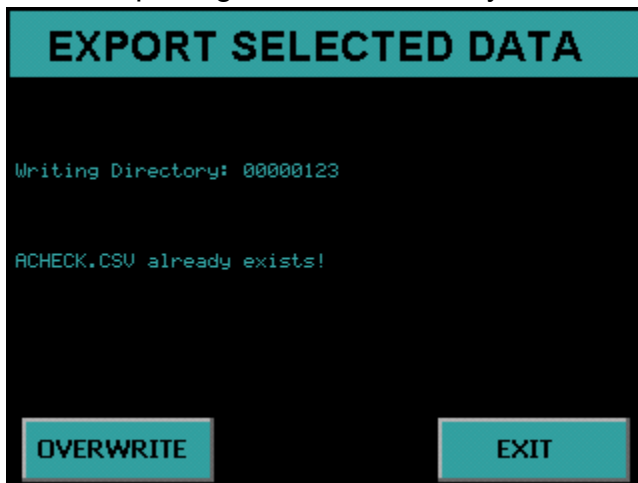
The first line is the control chart name. The second line is the counting mode used during acquisition. The third line is the amount of time for each acquisition. The date range is the date of the first limit point to the date of the last limit point that is used in the Beta Mean and Standard Deviation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

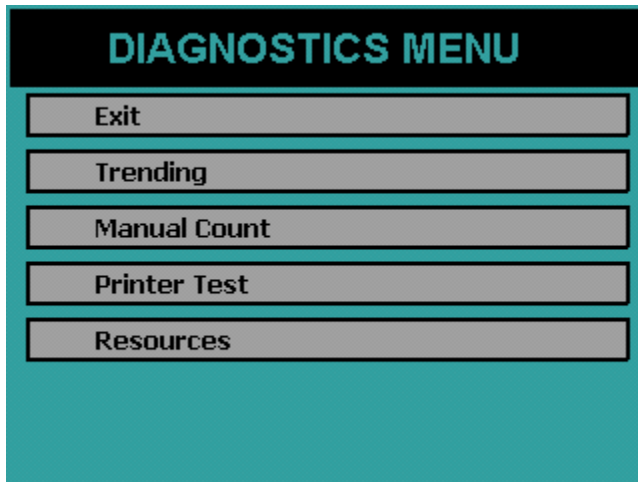


When the data export is successfully completed, "Finished! " will be displayed, as seen on the screen below.



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.

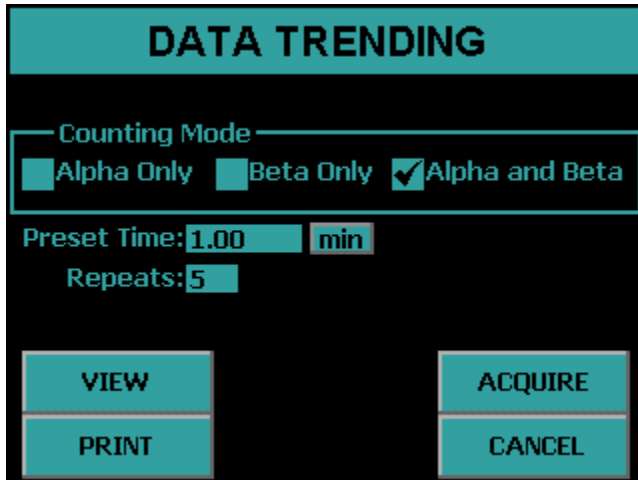
Trending

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.



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

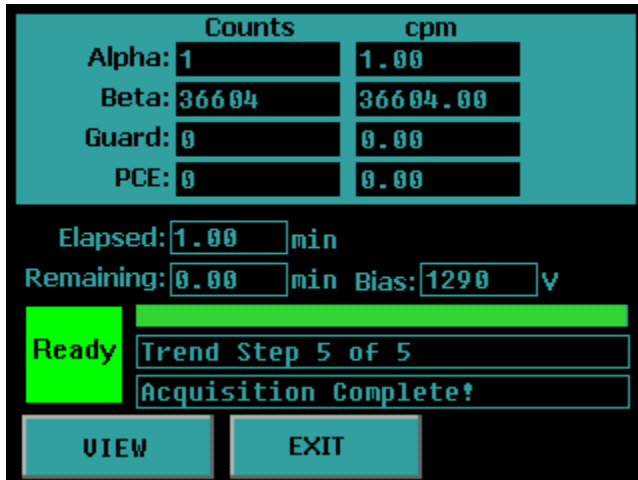
Trending data is acquired by using the Counting Mode, Preset Time , and Repeats fields to specify how the new trending data is to be acquired. Once the desired sample is loaded, the *ACQUIRE* button is used to start the trending data collection.

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.

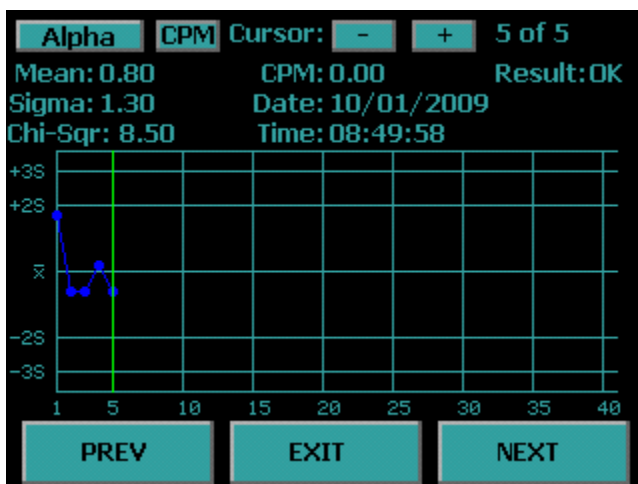
The trending acquisition screen is shown below. The first column shows the raw counts for Alpha, Beta, Guard, and Pseudo-Coincidence. The second column shows the raw cpm for Alpha, Beta, Guard and Pseudo-Coincidence. The elapsed and remaining times are updated as well as the current operating voltage. 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'. At the bottom of the dialog, it says 'Pages to Print: 4'. Two buttons, 'PRINT' and 'CANCEL', are located at the very bottom.

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.

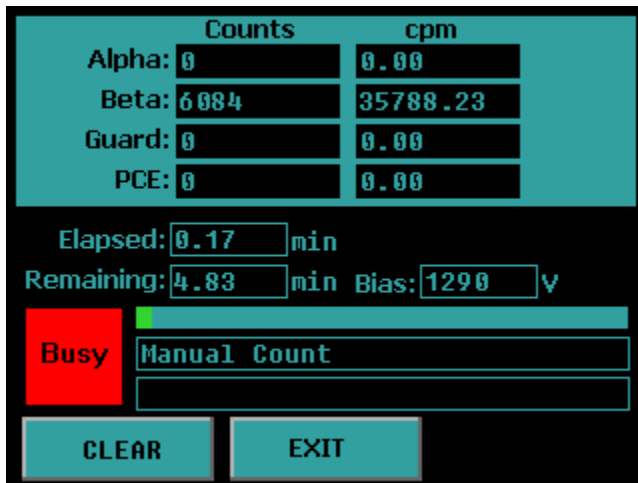
Preset Time – This field allows the amount of time for each acquisition to be specified for new data.

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.



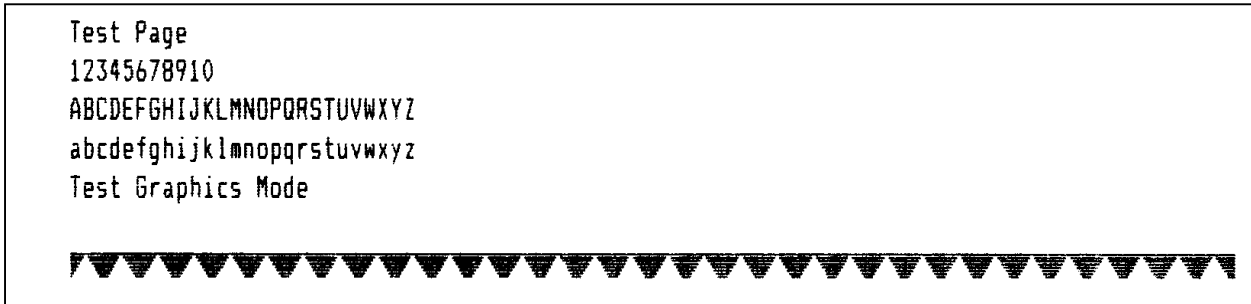
When making certain hardware adjustments, it is desirable to see the results of these adjustments immediately. This feedback enables “tweaking” the adjustment until the desired results are obtained. This requires clearing the display so that the adjustment effects can be viewed. Pressing the *CLEAR*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

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

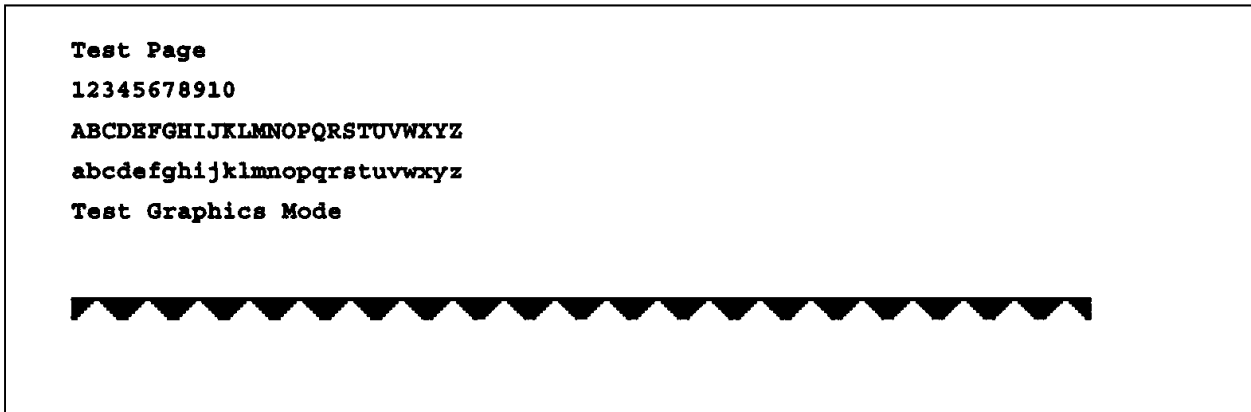
Printer Test

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 MPC 1000, this should be a clue. The methods and procedures built into the MPC 1000 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 MPC 1000 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 | MPC-1000 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 | MPC-1000 Alpha Control Checks | 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 | MPC-1000 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 | MPC-1000 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 | MPC-1000 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 | MPC-1000 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 |

Protean Instrument Corporation

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 MPC 1000 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 ²¹⁴Po atom created from the beta decay of a ²¹⁴Bi 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_{α} = Alpha cpm

R_{β} = Beta cpm

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

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

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

R_α = Alpha cpm

R_β = 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 ($\alpha \in_{PCE}$) and beta radon efficiency factor ($\beta \in_{PCE}$) respectively.

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

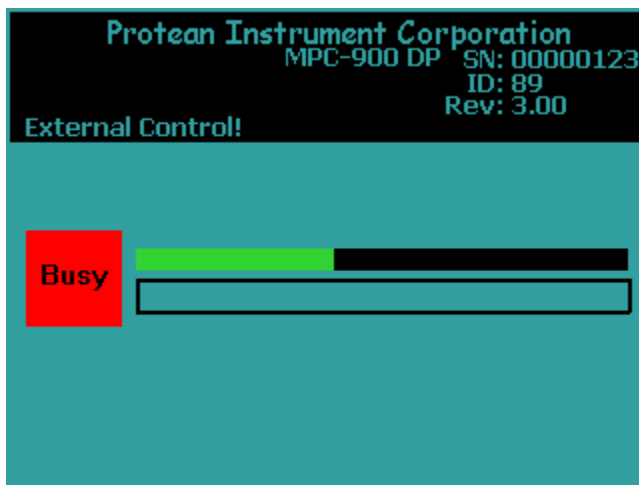
Routine Counting with Radon Subtraction

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 ²¹⁸Po and its 3 minute half-life does not interfere with the pseudo-coincidence method for radon subtraction.

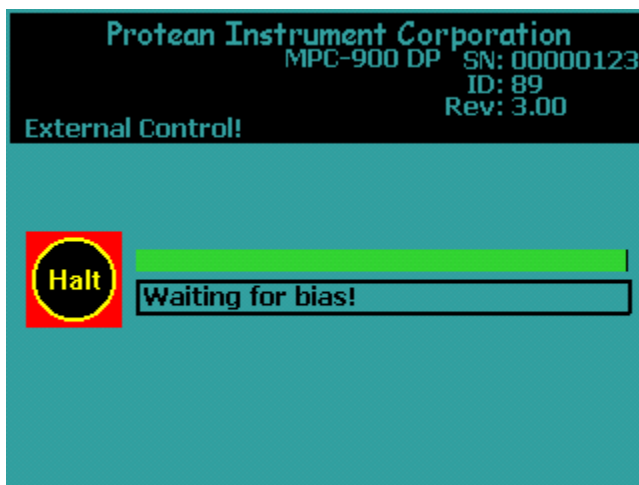
External Control

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 door is open this information is displayed in the box below the progress bar as in the screen below.



Service Guide Introduction

The MPC 1000 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 four categories. These are the power supply, the detector subsystem, the gas flow subsystem, the linear electronics, and the CPU or central processing unit.

The Power Supply Subsystem

The power circuitry consists of power entry module and a low voltage power supply (LVPS). The power entry module contains the line fuses, selects the main AC voltage requirements, and a transient suppressor. The LVPS provides +-12VDC and +5VDC for the instrument.

DC power is routed from the LVPS to the CPU card. 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.

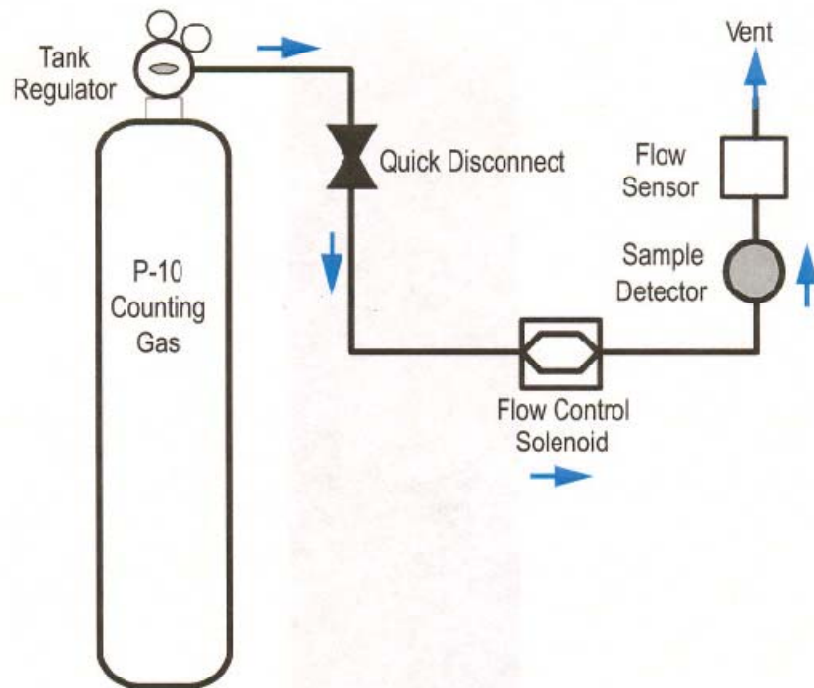
The Linear Electronics Subsystem

The detector must have high voltage in order to detect radiation. The source of the high voltage is the HV-20-D module. Radiation passing through the detector ultimately produces a small electrical charge. This charge is converted to a voltage pulse and is amplified and filtered (shaped) by the APA-10-D-DP Preamp/Amplifiers.

The bipolar shaped pulses from the APA-10-D-DP sample channel can be categorized as either alpha or beta radiation due to the pulse height. The HV-20-D provides an interface to the CPU for which the HV-20-D voltage output is controlled.

Gas Flow Subsystem

The recommended counting gas is P-10 nuclear counting gas (90% Argon, 10% Methane). Standard tank sizes are 300ft³ (Size T) and 220 ft³ (Size K 220). The secondary regulator pressure should be adjusted for 10 PSI. The flow rate is factory set at the correct flow rate of 60/150 cc/min. 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 gas lines, and a secure connection to the instrument. If a “Waiting For Flow” message is displayed despite an indication of the recommended flow rate, more investigation is necessary.

Gas Tank Precautions

Be cognizant 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.

The CPU Subsystem

All functions of the MPC 1000 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.

The CPU card interfaces to the linear electronics through the APA-10-D-DP. Two other interfaces are provided on the CPU. These are the USB interface and touch screen interface.

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.

Cover Removal

Gently pull the cover up and off of the chassis.

Cover Installation

To replace the cover, slide the cover over the chassis.

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.

Removing the Sample Detector

The sample detector is mounted to a flange supported by three posts. To service the detector, remove the three screws securing the flange to the posts. Remove the detector and flange as a unit. The gas lines are press fitted to the barbed connectors. Mark the gas lines for identification prior to removal. The vertical fitting (Gas Inlet) originates at the flow meter. The line connected to the 45° fitting (Gas Outlet) originates at the flow sensor. It is particularly important that these lines are correctly connected in the windowless configuration. Remove the gas lines by pulling straight away from the connector and remove the detector.

Installing the Sample Detector

Reverse the removal directions to install the detector. The flange is a tightly machined fit. This insures reproducible counting geometry. The flange should be aligned perfectly horizontal as it is lowered onto the posts. Reconnect the coax cable to the Amplifier (APA-10) PREAMP IN.

Power Entry

The MPC 1000 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) and a 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.

The system is factory set to either ~120 VAC or ~ 240 VAC operation. The fuse cartridge's insertion orientation selects Input Line Voltage of 120 VAC or 240 VAC. Fuse size ratings are:

120 VAC 3.0 A 250V 3AG

230 VAC 1.5 A 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 towards the black arrow in the lower right hand corner of the module housing

Checking the Low Voltage Power Supply (LVPS)

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

To access the LVPS, first remove the front instrument cover. 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 any excessive ripple.

| DC Volts | Test Point Color | Voltage Limit |
|----------|------------------|---------------|
| + 12V | RED | ± 0.1 |
| -12 | BLACK | ±0.1 |
| +5 | GREEN | 5.0 to 5.2 |
| GROUND | WHITE | N/A |

Removing Low Voltage Power Supply

- Disconnect the line cord from the instrument.
- Disconnect the two keyed connectors from the power supply.
- Remove the two mounting screws.
- Lift the LVPS from the instrument.

Installing Low Voltage Power Supply

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

Operating Environment

The MPC 1000 is operable within 10-40 degrees C, and 20-90% humidity (non-condensing). The MPC 900 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 MPC 1000 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.

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

HV-20-D Sensor Green LED indicates adequate gas flow through the sample detector.

APA-10-D LLD/ULD Sensor Bi-color LED flashes green when an event 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 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 or a bad APA-10-D-DP module.

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 environmental sources. An abrupt change can also be a sign of contamination, electronic failures, or a light leak 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.

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 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.

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.

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 705 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 requires cleaning or replacing. When operated in the windowless configuration, the anode acts like an electrostatic air cleaner attracting airborne particles and dust. 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. Keep the detector covered with a blank sample when not in use.

Recommended Supplies for Cleaning Procedures

Dry Gas Source – Certain procedures call for the use of a gas source as a drying agent. The recommended gas for this purpose is dry nitrogen. Do not use compressed air unless it is free of moisture and is generated by an oil-less compressor. In the absence of another suitable gas, you may use the P-10 gas supply. Disconnect the P-10 gas line from the rear of the instrument. Pull the supply line loose from the quick-disconnect fitting. This provides a supply of dry gas at 10 PSI, the regulator may be adjusted for a higher pressure if necessary. **Warning- Reset the regulator pressure to 10 PSI before reconnecting the gas line to the instrument.**

Small camel hair brush – select a quality brush that will not lose its bristles.

Methanol – Electronic grade.

Wisk – This brand name liquid detergent has been used successfully without increasing background counts.

Detector Maintenance – Windowed Configuration

The entrance 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).

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. This requires for two of the mounting ring holes to be in line with the detector gas fittings.

Replacing the Anode Assembly (P/N 120-0006)

Remove the detector. Remove the three screws securing the anode and gently pull the anode straight out. (Notice: the assembly has an O-ring which creates resistance to this procedure). Inspect the top gasket and replace if damaged. A spare gasket with the instrument in the Gasket Set (P/N 120-0007).

Remove the replacement anode assembly from the plastic shipping container. Be careful not to bend the loop. The shipping container should keep the assembly clean as packaged at the factory. Inspect the anode assembly for dust and lint on the loop or MHV high voltage connector. If necessary, blow off the particles with dry gas. Install the anode assembly.

Whenever the anode is replaced, the instrument must be recalibrated. A plateau curve must be generated to determine proper high voltage operating points.

Detector Maintenance – Windowless Configuration

Detector Contamination

In the windowless configuration, the anode(loop) and detector body are subjected to contamination by dust and lint particles. These particles may originate from the sample or the room environment. The purpose of the purge cycle is two fold. The first is to purge the airborne contaminants from the detector volume. The second is to establish adequate gas integrity prior to the counting cycle. Particles which attach themselves to the loop or detector body tend to cause an erratic increase in background counts. Another indication of accumulated contaminants on the loop is a gradual shifting upwards of a plateau knee.

Instruments configured for windowless operation should be operated in relatively clean environments and when not in use, an empty sample carrier should be parked underneath the detector.

Cleaning the Anode

To clean the anode or detector, remove the detector and anode assembly. Flood the loop and brush with methanol. Carefully brush the loop on both sides in a direction from the insulator towards the end of the loop. The insulator may also be cleaned with the brush and methanol. Blow the assembly dry with a source of dry gas. Further drying should be accomplished by placing the anode under and incandescent desk lamp for a couple of hours.

Cleaning the Detector Body

Remove the anode assembly, mounting rings and seal gaskets. Wash the detector and rings with a mild solution of the recommended detergent. Rinse thoroughly and dry as described in the anode cleaning instructions.

Assemble the body and rings with a new seal gasket. Refer to the illustration of the windowless detector assembly for proper orientation of the gasket. Pay particular attention to the orientation of the relief cut on the gasket. Inspect the loop and detector body for any dust or lint that may have attached itself during the drying phase. If necessary, blow these particles away with a source of dry gas. Install the anode assembly. Install the detector assembly.

Replacing the Detector Seal Gasket

The seal gasket can be replaced by removing the 8 screws that secure the gasket support ring to the detector. Pay particular attention to the orientation of the relief cut on the gasket. Install a new seal gasket, the gasket support ring and screws.

Variable Definitions and Equations

| Variable | Definition |
|-----------------|---|
| 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 |
| 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.

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

$$R_{A_RADON} = \frac{(PCE - RCC(CNT_TIME))A_{PCE_EFF}}{CNT_TIME}$$

$$A_{NET_CPM} = A_{CPM} - A_{BG_CPM} - R_{A_RADON}$$

$$A_{LLD_DPM} = \frac{\left(\frac{2.71}{CNT_TIME}\right) + 3.29 \sqrt{\frac{A_{BG_CPM}}{CNT_TIME} \left[1 + \frac{CNT_TIME}{BG_TIME}\right]}}{A_{EFF}/100}$$

$$A_{DPM} = \frac{A_{NET_CPM} \times 100}{A_{EFF}}$$

$$A_DPM_SD = A_DPM \sqrt{\left[\frac{A_NET_CPM_SD}{A_NET_CPM}\right]^2 + \left[\frac{A_EFF_SD}{A_EFF}\right]^2}$$

$$A_NET_CPM_SD = \sqrt{A_CPM_SD^2 + A_BG_CPM_SD^2}$$

$$A_CTS_SD = \sqrt{A_CTS}$$

$$B_CTS = \text{Data Buffer}$$

$$B_CTS_SD = \sqrt{B_CTS}$$

$$B_NET_CPM_SD = \sqrt{B_CPM_SD^2 + B_BG_CPM_SD^2}$$

$$B_BG_CPM_SD = \text{Calibration File}$$

$$B_NET_CPM = B_CPM - B_BG_CPM$$

Radon compensated in bold.

$$\mathbf{R_B_RADON} = \frac{(\mathbf{PCE} - \mathbf{RCC}(\mathbf{CNT_TIME}))\mathbf{B_PCE_EFF}}{\mathbf{CNT_TIME}}$$

$$\mathbf{B_NET_CPM} = \mathbf{B_CPM} - \mathbf{B_BG_CPM} - \mathbf{R_B_RADON}$$

$$B_CPM = \frac{B_CTS}{CNT_TIME}$$

$$B_CPM_SD = \frac{B_CTS_SD}{CNT_TIME}$$

$$B_BG_CPM = \frac{B_BG}{BG_TIME}$$

$$B_EFF = \text{Calibration File}$$

$$B_EFF_SD = \text{Calibration File}$$

$$B_DPM = \frac{B_NET_CPM \times 100}{B_EFF}$$

$$B_LLD_DPM = \frac{\left(\frac{2.71}{CNT_TIME}\right) + 3.29 \sqrt{\frac{B_BG_CPM}{CNT_TIME} \left[1 + \frac{CNT_TIME}{BG_TIME}\right]}}{B_EFF/100}$$

Activity Reports

The MPC 900 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 ² |
| μCi | ml | 100 cm ² |
| Bq | m ³ | |
| DPM | ft ³ | |

| 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 x 10 ⁻³ |
| ml | m ³ | 1.00 x 10 ⁶ |
| ml | ft ³ | 2.83 x 10 ⁴ |
| l | ml | 1.00 x 10 ⁻³ |
| l | l | 1.00 |
| l | m ³ | 1.00 x 10 ³ |
| l | ft ³ | 2.83 x 10 ¹ |
| m ³ | ml | 1.00 x 10 ⁻⁶ |
| m ³ | l | 1.00 x 10 ⁻³ |
| m ³ | m ³ | 1.00 |
| m ³ | ft ³ | 2.83 x 10 ⁻² |
| ft ³ | ml | 3.53 x 10 ⁻⁵ |
| ft ³ | l | 3.53 x 10 ⁻² |
| ft ³ | m ³ | 3.53 x 10 ¹ |
| ft ³ | ft ³ | 1.00 |

Activity Conversion Factors

| Activity Units | ACF DPM per units |
|----------------|------------------------|
| pCi | 2.22 |
| µCi | 2.22 x 10 ⁶ |
| Bq | 6.00 x 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 sufficiency 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 MPC-1000 may be configured with both detectors.

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 Material Selection

Construction material used in the MPC-1000 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

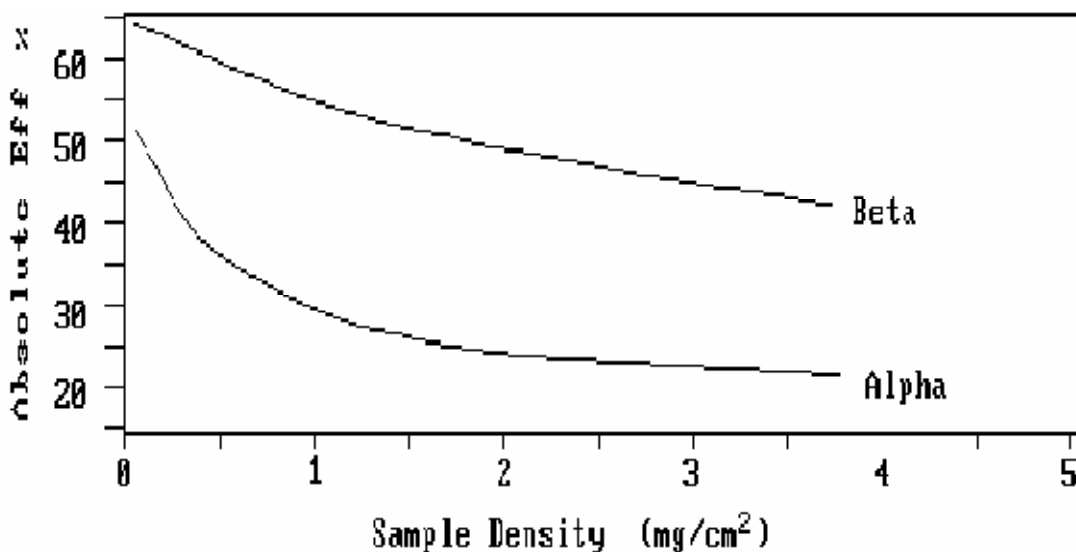
Since geometry places such a vital role in counting efficiency, it is important to match the geometries of the calibration source to that of the unknown samples. One aspect of the counting geometry is the distance between the sample and the active volume of the detector.

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).

MPC 1000 OPTIONS

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

MPC 1000 SPARES & ACCESSORIES

| | |
|---------------|---|
| APA-10 | Amplifier / Preamplifier |
| HV-20 | High Voltage Power Supply, 2kV |
| 110-0013 | Power Supply, +5V, ±12V |
| 120-0008 | 80µg/cm ² 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 |

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