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LS 6000™ Series

Scintillation System

User's Guide

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Table of Contents

Section 1 Introduction

Section 2 Getting Started

Table of Contents

Table of Contents

Section 3 Counting Samples

Section 4 Setting Up User Programs

Table of Contents

Section 5 Data Calculation

Table of Contents

Section 6 Isotope/DPM Libraries

Section 7 How Sample Preparation Affects Results

Table of Contents

Table of Contents

Introduction

1.1 Intended Use

The Beckman LS 6720/6730/6750 Scintillation System is designed to provide highly accurate, automated counting of the level of radioactivity in radioactively-tagged samples. The instrument can perform several types of calculations on the data obtained from counting, as selected by the user.

1.2 General Description

Description of the Instrument

The Beckman LS 6720/6730/6750 Scintillatin System is a state-of-the-art bench top liquid scintillatin counter, featuring a Motorola 68000 Series microprocessor, a Digital Signal Processor and a 32,768 channel Multichannel Analyzer.

The instrument is available with either a monochrome or a color monitor; Hot Graph is included with the color monitor system. The monitor displays an extensive user-interface system that includes Help screens and instructions. The robust rack sample changer will accommodate either 336 standard vials or 648 miniature vials (depending upon the version.)

Basic System

The system calculates counts per minute (cpm). The standard quench monitor is the IC#. Data can be normalized and blanks and/or backgrounds can be subtracted. Percent of reference can be calculated. Other standard features include a high count rate terminator that automatically rejects samples with too much activity, an electrostatic controller to reduce the interference of static electricity, and an 80-column printer for output of data. Twenty different User Programs, which are the instructions for processing either a single sample or a batch of samples, can be stored. Different racks of samples can be counted under different User Programs without user intervention. An Isotope Library stores the window settings for access by any User Program. Automatic operation can be interrupted to allow processing of priority samples or to edit a User Program.

Value System

The Value System includes all the features of the Basic System, plus Versa-Rack™ and H#. Versa-Rack allows you to count standard vials, miniature vials or Bio-Vials™ on the same system. H# uses an external quench monitor (^{137}Cs) for Automatic Quench Compensation (AQC).

Enhancement Packs

Productivity Pack

This is an option for the Value System and includes Xtalscint® CPM/DPM, single- and dual-label DPM and an RS-232 interface.

Confidence Pack

The requires the Productivity Pack and includes color detection and correction, Lum-Ex™ for luminescence correction and two-phase monitor.

Data Management Pack

This includes the Data Buffer and Transfer System and the Radioactive Waste Manager.

Environmental Pack

This includes low level count mode and Alpha/Beta Discrimination.

Many of these options can also be purchased separately and many require additional options to operate. For detailed information on options, contact your local Beckman Coulter Sales Office.

This User's Guide includes instructions for the Basic System, Value System, Productivity Pack, and many of the options. A few of the options have their own instructions, which are designed to be added at the back of this User's Guide.

Principles of Operation

Liquid scintillation involves the detection and counting of radioactive decay. The radioactive sample is combined with a liquid scintillation cocktail or solid scintillator. Decay of a radionuclide produces an ionizing particle. Part of the kinetic energy of this ionizing particle is transferred to the "scintillator" which converts the energy of the particle emitted during the radioactive decay process into light which is detected by the LS system. The number of photons produced from one ionizing particle is proportional to its kinetic energy. All photons produced by one ionizing particle are emitted isotropically over a nanosecond time scale.

The collecting optics of the LS system direct the photons emitted to either of two photomultiplier tubes (PMT's). If both PMT's are activated by one photon burst, then one nuclear decay event is registered and converted into a measurable electrical pulse. The voltage pulse produced by the PMT's is proportional to the number of photons. Therefore, the pulse height at the output of the tubes is proportional to the energy of the particle.

The pulses from the PMT's are analyzed, converted to digital form, and stored in the appropriate channel of a multichannel analyzer, corresponding to the particle energy. The data accumulated in the multichannel analyzer over the counting time of the sample is used to determine the energy of the particles in the sample and the rate (counts per minute, or cpm) of radio-active decay in the sample. The cpm is the total number of pulses in the channels of the multichannel analyzer divided by the total time in minutes for obtaining the counts.

Operating the Instrument

To use the liquid scintillation instrument, the samples are placed in vials together with a scintillation cocktail or a solid scintillator. The vials are placed in the racks provided, and the racks are placed into the sample changer of the instrument.

During operation, the racks are moved in a counter-clockwise direction in the sample changer. When a rack reaches the right rear most position, each vial within the rack is

stepped into position for processing. In turn, each vial is raised by the elevator into position within the counting chamber and counted.

Instructions for processing samples, as well as other operating and system commands, are entered using the keyboard on the front of the instrument. A series of menus is displayed on the monitor to guide you through the process of setting up the programs used by the system. During processing, the display screen shows details on the progress of the count. Results of the sample processing are printed out on the printer and/or sent to the RS232 port.

Operating Modes

The instrument has the following operating modes:

Automatic Count

This mode is ordinarily used for counting **a** batch of samples unattended. Any one of the 20-50 stored User Programs can be selected for conducting the count. Refer to Section 3.2 for more information.

Multi-Task

Operation during an Automatic Count can be interrupted to count up to one rack of priority samples, to edit a User Program, or to manually set up a new isotope or new quench curve (if dpm is installed). Refer to Section 3.5 for more information.

Count Single Rack

This mode allows you to count a few samples (up to one rack) quickly using a default program or a previously stored User Program. Refer to for more information.

Auto DPM

This mode allows you to obtain dpm results for single label, alpha- or beta-emitting samples, without using quench curves. Refer to Section 3.4 for more information.

Edit User Program

This mode allows you to edit any of the 20-50 User Programs to set up the instrument for counting liquid scintillators or Xtalscint and to set up the desired Data Calculation Program. Refer to Section 4 and Section 5 for more information.

Set Up New Isotope

This mode allows you to add a new isotope to the Isotope Library. The Isotope Library contains the window settings and half-life for the isotopes called up by the User Program for both liquid and Xtalscint scintillators. Five factory installed isotopes are permanently stored in the Isotope Library. Refer to Section 6.1 for more information.

Set Up Quench Curve

When dpm is installed, another operating mode is used to set up and store a dpm quench curve into the DPM Library. Each isotope must have a stored quench curve to calculate dpm, unless using Auto DPM or Xtal DPM. Refer to Section 6.2 for more information.

System Setup

System Setup allows you to set system parameters tailored to your laboratory requirements and to set up count parameters and calibration information for Auto DPM. Refer to Section 2.6 for more information.

System Test

System Test provides a number of routines to verily performance of the mechanics, electronics and memory of the instrument and to test the printer. This mode is used by your Authorized Beckman Service Representative for servicing the instrument.

Pre-Installation, Installation and Moving

Prior to installation of the instrument or when you want to move the instrument, ensure that the space and power requirements can be met. Refer to Appendix b for these requirements.

The instrument must be installed, set up, and initially adjusted by your Authorized Beckman Service Representative.

CAUTION Operation of the instrument before it has been installed and adjusted by your Authorized Beckman Service Representative may void the warranty.

If it becomes necessary to move the instrument, be careful to avoid any mechanical shock. For transporting the instrument to another location, contact your Authorized Beckman Service Representative.

1.3 Specifications

Specifications for the instrument are provided in Appendix a.

1.4 Precautions and Limitations

The following points are important for accurate and trouble-free operation:

1. The symbol A appears on the instrument. Read this user's guide thoroughly before operating the instrument. The user's guide contains important information about the safe and proper use of your system.
2. Leave the power on at all times once the instrument is installed. Initial warm-up and stabilizing time varies from one instrument to another. Leaving the power on ensures you will not take critical measurements while the instrument is still stabilizing after powering up.
3. Perform a background count and efficiency check periodically to detect possible radioactive contamination of the detector system and to check overall performance. Refer to Section 7.5 for information on performing these checks.
4. There is a limit to the amount of cpm the LS counter can process. If a sample is rejected because it exceeds this limit, it can be counted by diluting it.
5. Sample vials of the wrong size or shape, or standard vials with overhanging caps, may jam the internal mechanism. Figure 1.1 provides specifications for vial size and configuration.
6. Even though the instrument is equipped with a static eliminator, static charges can build up on vials and cause errors in counting. In particular, handling plastic vials with latex

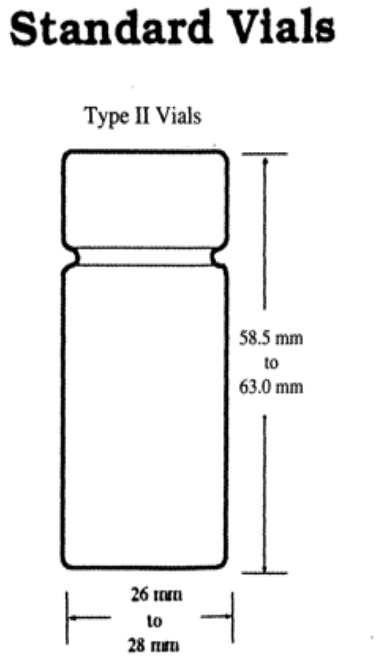
gloves can cause severe static problems which may produce highly erroneous and misleading results. Refer to Section 7.2 for more information on static problems.

7. If the instrument is used in a manner other than as described, the safety and performance of the instrument can be impared.

Standard Vials

The dimensions given on the left reflect the International Standard for IS vials. Standard Vials within these dimensions are compatible with the Beckman Standard Rack. The cap must not overlap the vial body.

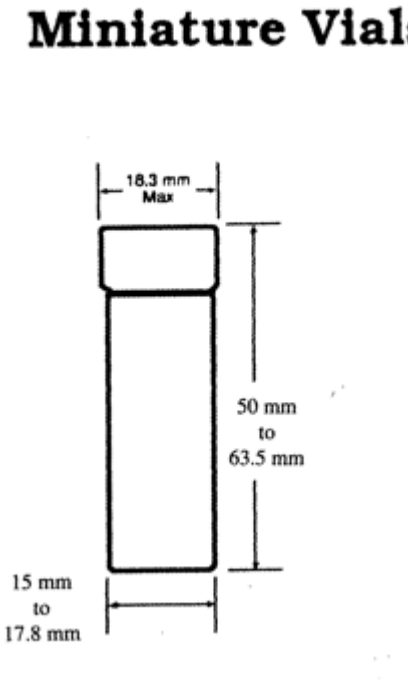
Figure 1.1 Standard Vial



Miniature Vials

Miniature Vials within the dimensions given on the left are counted regardless of cap configuration or cap color. The dimensions are compatible with the Beckman Miniature Rack.

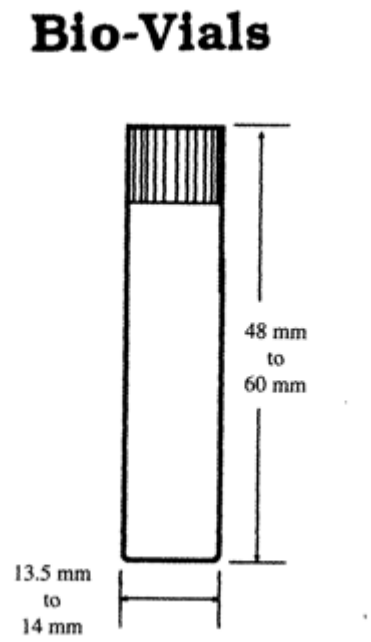
Figure 1.2 Miniature Vials



Bio-Vials

Bio-Vials within the dimensions given on the left are compatible with the Beckman Coulter Bio-Vial Rack.

Figure 1.3 Bio-Vials



1.5 Hazards

Electrical

This instrument should be operated from a supply source which incorporates a third wire protective grounding conductor which conforms to local codes. Three to two wire isolation adapters must not be used.

A shock hazard exists inside this instrument. This instrument is not designed nor intended to be serviced by the user. Do not remove any panels. Refer problems to an Authorized Beckman Service Representative.

Radiation

NOTE LS 6720/6730/6750 Scintillation Systems are manufactured under California Radioactive Materials License No. 0441-30, and distributed under California Radioactive Materials License No. 1313-3OGL

1. The instrument contains a 30 microcurie (1.11 MBq) ^{137}Cs source enclosed in a lead container. Gamma ray emission at any exterior panel is less than 0.5 rem per year.

2. Contact your Radiation Health and Safety Officer for assistance. Further information may be found on the labeling on the back of the instrument and in Appendix e of this user's guide.
3. If the instrument becomes contaminated with radioactive material, immediately contact your Radiation Health and Safety Officer and an Authorized Beckman Service Representative.

Maintenance

All radioactive-related cleaning and preventative maintenance must be performed by an Authorized Beckman Service Representative.

Getting Started

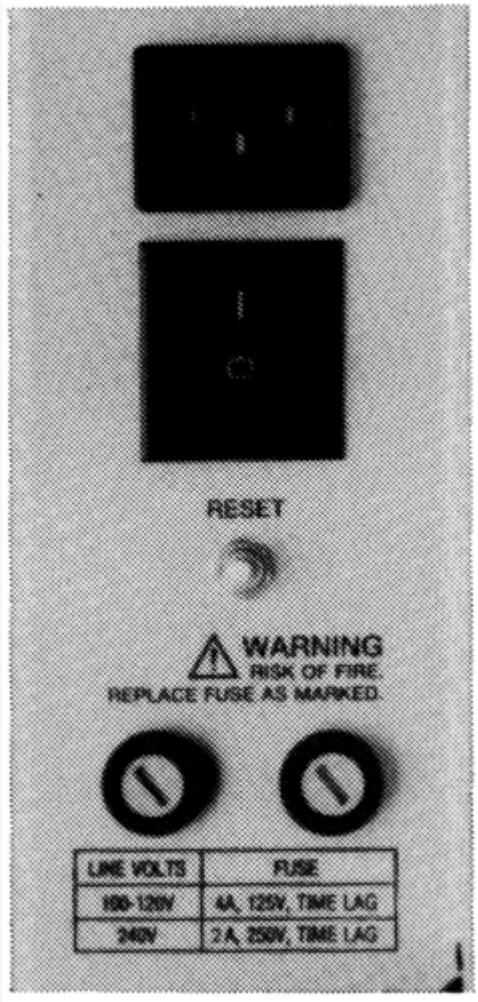
2.1 Powering Up

The power switch for the LS is in a recessed well on the left side of the instrument (Figure 2.1). It is recommended that the main power be left on at all times.

To start the instrument when powered down, simply throw the power switch to On (the "1" position).

A reset switch is located close to the main power switch (Figure 2.1). This switch is used when the keyboard does not respond to inputs.

Figure 2.1 Instrument Power Switch



NOTE Refer to the SAFETY NOTICE before following a procedure in this section. Refer all servicing for procedures not contained in this section to qualified Service personnel.

The only user accessible fuses are the power fuses, located next to the receptacle where the power cord is plugged into the instrument. The instrument has two fuses.

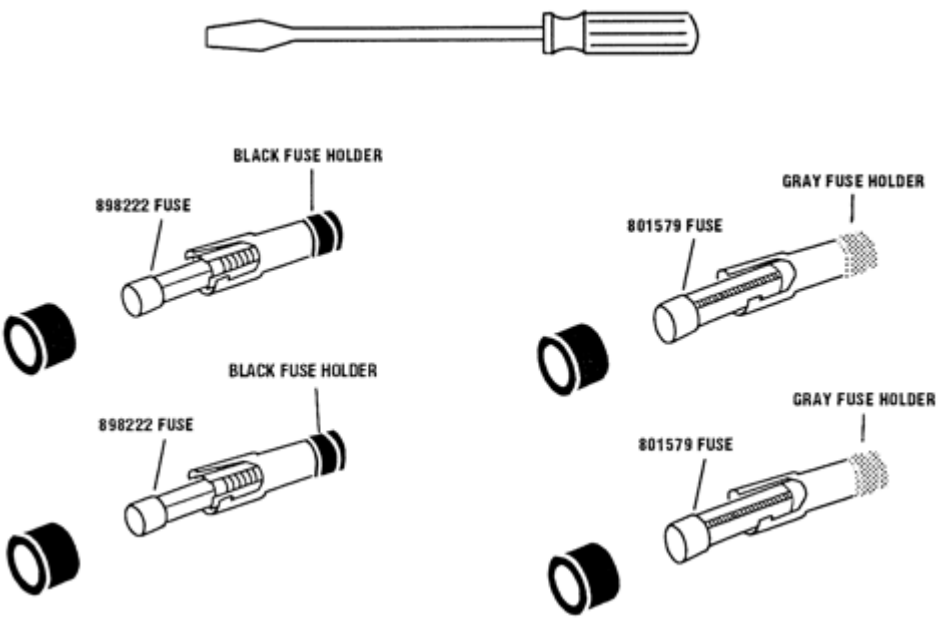
Parts required:

100/ 120V instrument—4A time lag fuse (UL/CSA),P/N *801579*

220/240V instrument—2A time tag fuse (lEO), P/N 898227

Tools required: Small flatblade screwdriver.

Figure 2.2 Tools Required



110/120 v INST	220/240 V INST
Two 801579	Two 898222
4 A Time Lag Fuses	2 A Time Lag Fuses
0.25” X 1.25”	(5 mm X 20 mm)

1. Locate the power cord receptacle, located on the left-hand side of the instrument, in the lower rear corner. Try not to move the instrument. If it is necessary to move the instrument, move it carefully, so that the lead blocks do not harm the photomul-tiplier tubes.
2. Unplug the power cord from the instrument.
3. Use the screwdriver to remove fuses from the fuse holder.

WARNING For continued protection against risk of fire, re-place the fuse(s) only with the type and current rating specified above.

WARNING Afin d'assurer une protection permanente contre les risques d'incendie, remplacer uniquement par un fusible de même type et valeur.

4. Replace the fuse.
5. Plug the power cord back into the instrument.
6. Reposition the instrument, if neccessary.

2.2 Power Failure

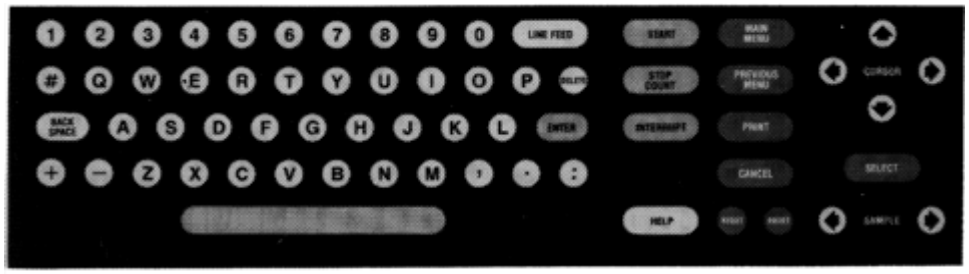
If a power failure occurs during an Automatic Count, the processing of the samples is interrupted. An internal battery provides back-up of the system memory. When power is restored, operation is automatically resumed. A message "POWERFAIL RECOVERY" and the date and time are printed to indicate the occurrence of a powerfail.

2.3 Operating Controls

On the front of the instrument are two groupings of controls:

the alpha-numeric keyboard for making letter and number entries; and the operator control keypad for controlling the instrument and for program editing. See Figure 2.3.

Figure 2.3 Keyboard and Operator Controls



Alpha-numeric Keyboard

The keyboard is used for entering information when setting up a user program, a new isotope, or a dpm quench curve (if dpm is installed). The basic design is similar to the computer terminal keyboard. All entries are made in upper case (capital letters). The numeral keys are used for numbers only. There are separate keys for these symbols: # + - , . :.

The remaining keys on the keyboard are as follows:

ENTER	Used following entries to indicate to the system that the information entered is complete. Can be used interchangeably with the SELECT key on the Operator Control keypad.
DELETE	Used to correct an error in making an entry. Pressing DELETE clears the entry and moves the cursor to the beginning of the field, ready for you to re-enter the information correctly.
BACK SPACE	Moves the cursor to the left, deleting one character at a time.
LINE FEED	Advances the paper in the printer, one line at a time. Resets printer when paper out message is displayed.

Operator Control Key pad

In addition to the keyboard, the user is provided a group of keys to direct the functions of the instrument and to display menus for editing user programs, setting up new isotopes and setting up dpm quench curves (if dpm is installed).

The specific keys on the Operator Control Keypad are as follows:

START	Starts the count of the vials loaded in the sample changer, provided all necessary setup steps have been accomplished.
STOP COUNT	Terminates the current sample count and prints the results of the count up to termination; the next sample is advanced and counting continues.
INTERRUPT	Stops the counting in progress to allow counting a single rack of priority samples.
HELP	Presents a display of useful information. Pressing Help during editing displays in-formation regarding a specific prompt. This key is a toggle switch; pressing it again (or any key except RESET) clears the Help window from the display.
MAIN MENU	Calls up a display of the Main Menu.
PREVIOUS MENU	Returns to a display of the previous menu (i.e., the menu displayed before the cur-rent one).
PRINT	Causes the printer to produce a hard copy of the information currently displayed on the screen. This key is not active when the system is counting.
CANCEL	Terminates any editing function without storing the changes and returns you to the Main Menu. If Cancel is pressed during Multi-Task, you are returned to the Multi-Task Menu. Counting is not affected.
RESET (Two Identical Keys)	Terminates action in progress, returning the system to Standby Status. The keys must be pressed simultaneously

START	Starts the count of the vials loaded in the sample changer, provided all necessary setup steps have been accomplished.
CURSOR ARROW KEYS	There are four cursor keys: Up, Down, Left, and Right. Prompts on the menus are selected (highlighted) using the Up/Down Cursor Arrow keys. When the first prompt is highlighted, pressing the Up Cursor Arrow key presents the previous menu. When the last prompt is highlighted, pressing the Down Cursor Arrow key presents the next menu. The Left/Right Cursor Arrow keys are used to make choices from a list of selections displayed in the Data Entry Window for the selected prompt.
SELECT	Used following entries to indicate to the system that the information entered is complete. Can be used interchangeably with the ENTER key. Generally, this key is used when using the keypad and EN-TER is used when using the alphanumeric keyboard.
SAMPLE ARROW KEYS	The Forward (left-arrow) key advances the rack currently in the counting position by one vial for counting the next sample. If the rack is finished, or if no rack is in the counting position, all racks are moved forward, advancing them until the next rack is in position for counting. The Backward (right-arrow) key moves the rack currently in the counting position one vial to the right, putting the previous vial into position for counting. If a rack is not in the counting position, all racks are moved until the next rack is in position for counting. Holding a Sample Arrow Key gives continuous motion of the racks in the indicated direction.

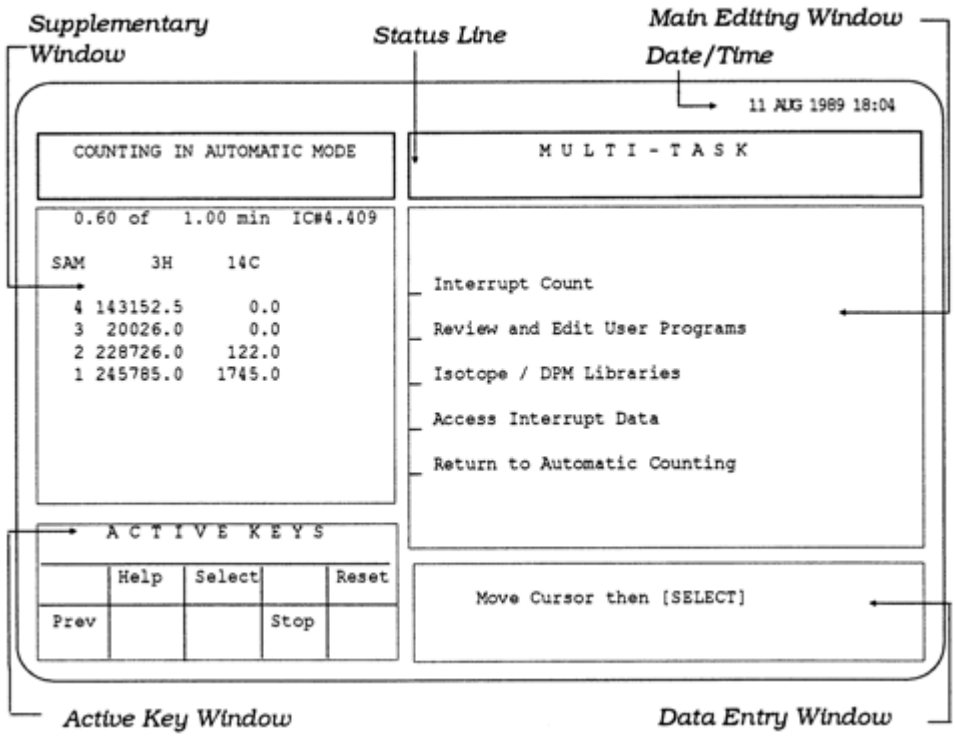
Display

A monitor is used to display the menus and instructions for specifying operations, editing a User Program, and setting up new isotopes and quench curves. The screen is divided into areas to display the information. Refer to Figure 2.4.

The first line on the screen displays the Date/Time. Next, a status line showing the operating mode and/or the name of the menu is presented. The Main Editing Window displays the

menus. Below the Main Editing Window is the Data Entry Window. This area is used to display instructions for the prompt selected on the menu.

Figure 2.4 Typical Screen



The Supplementary Window on the left is used to display a summary of the User Program during editing, to display the count data during Multi-Task, or to display additional comments. Below this area, the Active Key Window displays the names of the keys active in the current operating mode. Pop up windows are used to display Help screens, error messages and warnings. The display may be printed (except during Automatic Count) by pressing the **PRINT** key.

Figure 2.4 shows a typical editing screen during Multi-Task. A highlighted box marks the selected prompt in the Main Editing Window. The Data Entry Window shows instructions for the selected prompt. The Supplementary Window displays the counting data and the Active Key Window shows the keys that can be used during Multi-Task.

During a counting mode, the Supplementary Window covers the top half of the screen and displays the count data. The Data Entry Window displays the prompt to initiate Multi-Task. The Active Key Window displays the active keys. A typical screen displayed during Automatic Count is shown in Figure 3.2.

Using the Operating Controls

The alphanumeric keyboard and the operator control keypad are used to operate the instrument. The keys that can be used during the current operating mode are shown in the

Active Key Window. The monitor displays the count data and the menus and instructions for using the instrument. If you are not familiar with these operating controls or the display, refer to Operating Controls Section 2.

The Main Menu, shown in Figure 2.7, is used to access the various operating modes of the system. An operating mode is selected using the Up/Down Cursor Arrow keys to highlight the desired choice. Pressing **SELECT** displays the menu or further instructions for that selection. Except for Automatic Count, a series of menus is presented when an operating mode is selected. Prompts on these menus are also selected using the Up/Down Cursor Arrow keys. When the last prompt is high-lighted, pressing the Down Cursor Arrow key displays the next menu. When the first prompt on the menu is highlighted, pressing the Up Cursor Arrow key displays the previous menu.

In this User's Guide, "select" means highlight the operating mode or prompt and press **SELECT**. "Highlight" means use the Up/Down Cursor Arrow keys to move the highlighted bar designating the active prompt.

Whenever a prompt is highlighted, the Data Entry Window provides instructions for completing the selection. A list of choices may be presented. The active choice is displayed using inverse video. The present selection is given next to the prompt in the Main Editing Window. To change the parameter, use the Right/Left Cursor Arrow keys to highlight the desired choice. Press **SELECT**. The prompt in the Main Editing Window displays the new choice.

In this User's Guide, "choose" means highlight the desired selection from the list of choices presented and press **SELECT**.

Another way instructions are given, is to display a message with a highlighted box, indicating that new information can be typed in. Pressing **HELP** will display information regarding the selected prompt, acceptable values and the format to use to enter the information. Use the alphanumeric keyboard to type in the information. If you make an error in typing an entry, use the **BACKSPACE** key to delete the unwanted characters, or the **DELETE** key to delete everything. When the entry is correct press **ENTER**. This new information is shown next to the prompt in the Main Editing Window. The prompt is not changed until you press **ENTER**.

In this User's Guide, "enter" means type in the requested information and press **ENTER**.

The instructions given in the Data Entry Window may also be informational. Press **SELECT**. Either a new menu is displayed, or more prompts are displayed in the Main Editing Window. Further instructions are given in the Data Entry Window.

NOTE In this User's Guide, **SELECT** is given when using the operator control keypad. **ENTER** is given to complete an entry when typing in a response using the alpha-numeric key-board. Both **SELECT** and **ENTER** perform the same function and may be used interchangeably.

2.4 Using the Racks

Description of the Racks

Racks for holding the sample vials during counting are sup-plied. These racks may be either standard racks or miniature racks depending on the version of your instrument. Both types of

racks are supplied if Versa-Rack is installed. Bio-Vial racks are purchased separately and are used in place of the miniature vial racks.

Each rack has vial position numbers in raised numerals along the bottom edge of one side. The other side of the rack has two slots, one to hold a Command Card and one to hold a Rack Number Card. If a Rack Number Card is installed, the Rack Number and position number are printed next to the Sample Number. Refer to the printouts in Section 5 for an example. The types of racks and cards are described below.

Standard Racks (White)

These racks hold 12 standard-size vials per rack. A maximum of 28 racks may be loaded at a time.

Miniature Racks (Blue)

These racks hold 18 miniature vials per rack. A maximum of 36 racks may be loaded at a time.

Bio-Vial *Racks* (Green)

These racks hold 18 Bio-Vials. A maximum of 36 racks may be loaded at one time. These racks can only be used on a system which uses miniature racks.

Color-Coded Racks

A red rack and yellow rack are supplied for use as a HSalt Rack and Interrupt Rack, respectively. These racks are color coded for easy recognition only; they are identical to the other standard or miniature racks supplied. If Versa-Rack is installed on your system, the type of color coded racks matches the size of your unquenched standards. Refer to Section 2 Setting Up the Racks below for information on setting up these racks.

Command Cards

Command Cards have a recognition code (white areas against a black background) which is "read" by photo sensors. Command *Cards* are used to instruct the instrument on the operation to perform; Calibrate, Automatic Count Using A Specific User Number, Auto DPM, or Halt. Each time a rack bearing one of these cards moves into counting position, the instrument recognizes the card and takes the appropriate action. The Command Cards can be stored in a slide out drawer located under the center-front of the instrument. Refer to Section 2 Setting Up the Racks for installing the Command Cards onto the appropriate racks.

Rack Number Cards

Rack Number Cards also have a recognition code (white areas against a black background) which is "read" by the photo sensors prior to counting samples in the rack during Automatic Counting. Rack Number Cards are used to indicate the number of the rack providing positive sample identification. When Rack Number Cards are installed on the sample racks, the printout shows both rack number and position number within the rack, so a sample can be located specifically within a batch of samples. Refer to Section 2 Setting Up the Racks for installing the Rack Number Cards onto the Sample Racks.

Setting Up the Racks

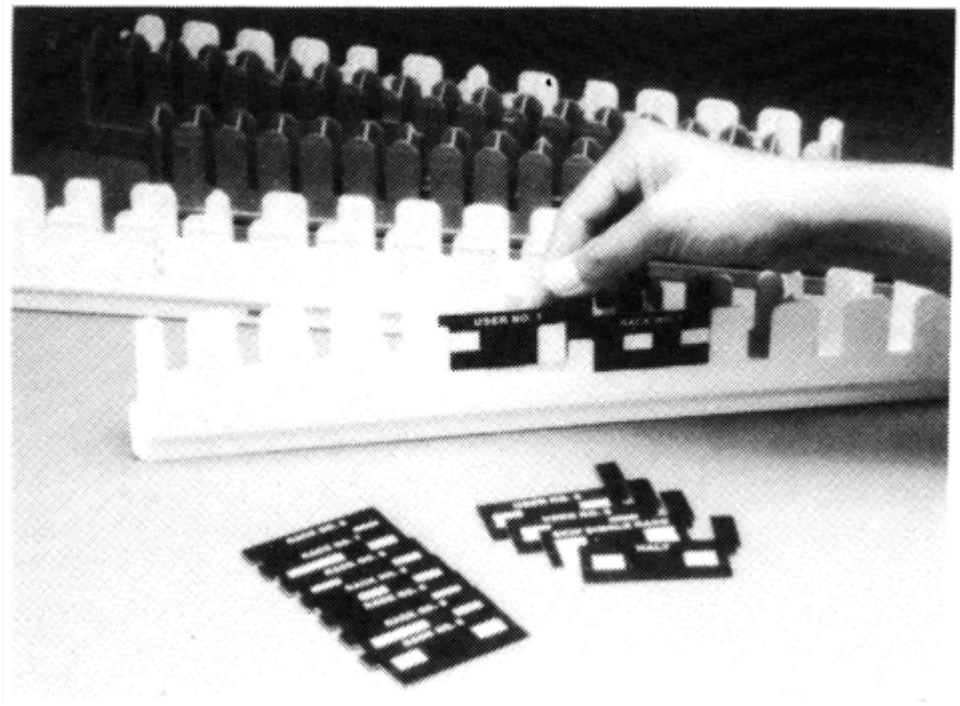
It is recommended that the Command Cards and Rack Number Cards be installed onto the racks and left on them. The following racks are suggested for set up: Calibrate Rack; Halt Rack; Interrupt Rack; Auto DPM Rack and Sample Racks. Installing the cards and each kind of rack is described below.

Installing Cards

To install the cards onto the racks:

1. Select the appropriate rack and card(s) as described in each section below.
2. With the side of the rack with the slots on it facing you, install the Command Card onto the rack by sliding it between the edge-guides of the left-hand slot. See Figure 2.5.

Figure 2.5 Installing a Command Card/User Number Card



3. Install a Rack Number Card onto the rack by sliding it between the edge-guides of the right-hand slot. See Figure 2.5.
4. Store the racks in a convenient location.

Calibrate Rack

The Calibrate Rack is **a** rack bearing the Auto Calibrate Card and has the unquenched ^{14}C standard in position **#1.** For more information on calibration, refer to Section 2.7. This same rack is used for Auto DPM Calibration. Refer to Section 2 Setting Up the Racks for more information on Auto DPM Calibration.

To set up the Calibrate Rack, select one of the standard or miniature racks, depending on the size of your unquenched standards. If the instrument is ordered as a Miniature Rack System, the unquenched calibration standards supplied with the instrument are miniature vials. If the instrument is ordered as a Standard Rack System, the unquenched calibration standards supplied with the instrument are standard vials. The size of the colored racks matches the size of the calibration standards.

Install the Auto Calibrate Card as a Command Card. Refer to Installing Cards Section 2 above. Turn the rack around, and place the sealed, unquenched ~ standard in the #1 position of the rack. Only the first sample in the rack is counted during calibration, except when calibrating for Auto DPM. Place the other two sealed standards in the same rack. Although not used for calibration, these samples are required for other procedures and this is a useful place to store them.

NOTE The 3H standard is used for calibrating the system for Auto DPM. Refer to Section 2 Auto DPM for more information on Auto DPM.

Halt Rack

The Halt Rack is a rack bearing the Halt Card. The Halt Rack is placed after the last rack of samples. It does not contain any samples. The instrument recognizes the Halt Rack and stops counting. Refer to Section 2.4 for information on using the Halt Rack.

To set up the Halt Rack, select the red rack provided and insert the Halt Card as a Command Card onto the rack as described above.

Interrupt Rack

The Interrupt Rack is the rack bearing the Interrupt Card. The Interrupt Rack with the Interrupt Card installed on it will not be counted during Automatic Count when it is left in the instrument, unless Interrupt Count is initiated from Multi-Task. Refer to Section 2 Setting Up the Racks for information on using the Interrupt Rack.

To set up the Interrupt Rack, select the yellow rack and insert the Interrupt Card as a Rack Number Card onto the rack as described above.

NOTE The Interrupt Rack does not have a Command Card in-stalled. The Interrupt Card is a Rack Number Card.

Auto DPM Rack

The Auto DPM Rack is a rack bearing the Auto DPM Card. The Auto DPM Rack is used to initiate the Auto DPM Program. Refer to Section 2 Setting Up the Racks for information on using the Auto DPM Rack. To *set* up the Auto DPM Rack, select a miniature or standard vial rack and insert the Auto DPM Card as a Command Card onto the rack as described above. Place a Rack Number Card on the rack as described above, if desired.

Sample Racks

Up to *50* different User Programs can be stored in the instrument and called up during Automatic Count using the User Number Cards 1 –*50*. The first rack of each batch of samples has the appropriate User Number Card installed on it. The first rack and the remaining Sample Racks can have a Rack Number Card installed on them to provide positive sample identification. It is convenient to install the User Number Cards and the Rack Number Cards you anticipate using onto the racks and leaving them there.

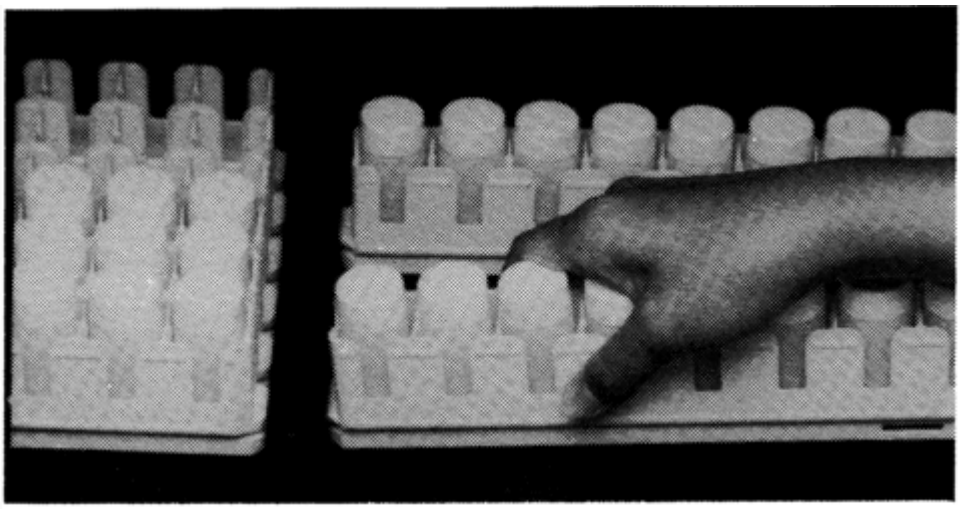
To set up the Sample Rack(s), select any of the supplied racks other than the color-coded racks. Insert the desired User Number Card as a Command Card onto the rack as described above. Continue to make other Sample Racks by placing a User Number Card in the slot. Place a Rack Number Card on the racks with User Number Cards and any other racks you will use for counting samples. Refer to Section 3.2 for more information on using the Sample Racks.

Installing the Racks

For counting, the racks are placed in the sample changer (the bed of the instrument which transports the samples). The racks are moved in a counter-clockwise motion. The vials are counted when the rack has reached the right rear position where the elevator that moves the vial into the counting chamber is located.

To install a rack, hold it so that the molded position numbers are toward you, and the cards (if any) face away from you. Place the rack on the right side of the sample changer, inserting it at an angle so that the lip on the left end slides under the groove along the middle of the sample changer. See *Figure 2.6*. After installing the rack, push it away from you, toward the back of the sample changer where the elevator is located.

Figure 2.6 PLacing the Rack In The Sample Changer



Since the racks are moved in a counter-clockwise direction, the second and successive racks are installed progressively toward the front of the instrument. When the right-hand side of the sample changer is filled, load additional racks on the left-hand side, front to rear. The racks on the left side are also loaded with the molded numbers toward you, cards (If any) away from you. Slide the lip on the left end of the rack under the groove along the left side of the sample changer.

2.5 Preparing the Printer

The printer is set up at the time of installation by your Beckman Service Representative. Details of the printer operation are provided in the printer manual that was delivered with your instrument.

Loading the Paper

Refer to the User's Manual provided with the printer for instructions on loading the paper. When the paper runs out while an instrument procedure is in progress, the instrument stops and displays an error message. To clear the error message, load more paper and press the **LINE FEED** key on the instrument keyboard. Counting resumes.

2.6 System Setup

About the System Parameters

System Parameters are incorporated into the LS to configure the instrument to your laboratory requirements and preferences. When your instrument is installed or your laboratory requirements change, these system parameters can be changed.

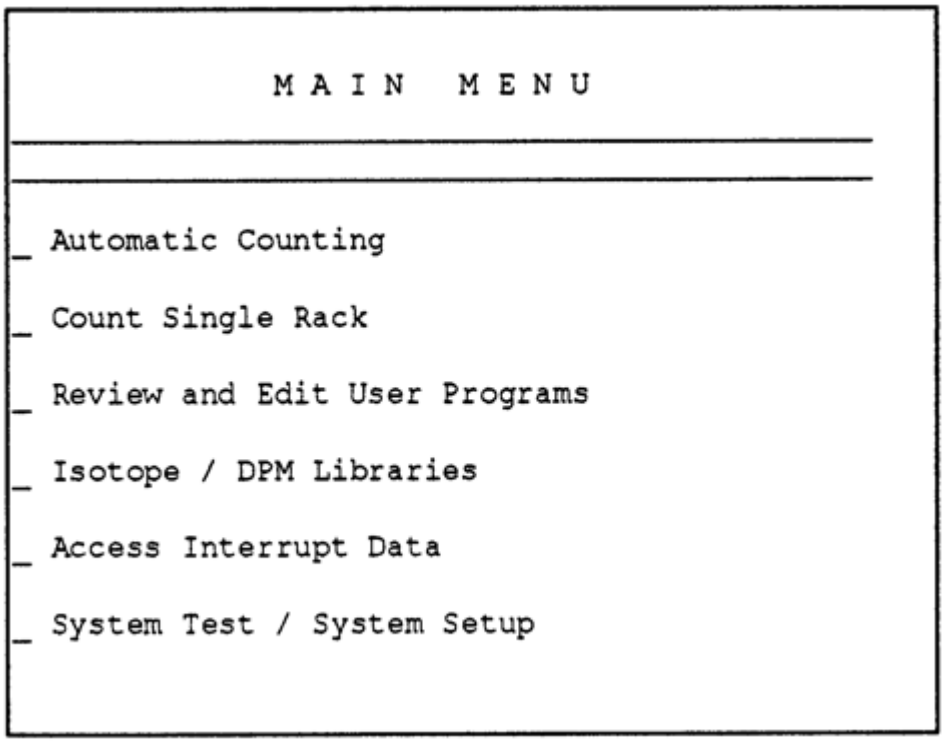
Changing the System Parameters

NOTE This section assumes you are familiar with the Operating Controls of the LS. If you are not familiar with these controls, refer to Section 2.3.

To change the system parameters:

1. Press **MAIN MENU** if the Main Menu shown in Figure 2.7 is not displayed in the Main Editing Window.
2. Highlight "System Test/System Setup" and press **SELECT**. The Main Editing Window displays two choices: System Tests or System Setup.

Figure 2.7 The Main Menu



NOTE System Test is designed for use by a Beckman Coulter Authorized Service Representative. It is not discussed in this User's Guide. For more information on System Test, contact your local Beckman Coulter Authorized Service Representative.

3. Highlight "System Setup" and press **SELECT**. The System Setup Menu shown in Figure 2.8 is displayed.
4. Highlight the prompt you wish to change. The Data Entry Window provides information for entering your changes. Default values and allowable responses are given in Figure 2.4. Refer to Section 2 Energy Scale - Section 2 Color Selection - Monitor for more information on each prompt.
5. Highlight and change any other desired prompts. When all changes are made, press **MAIN MENU**.

Energy Scale

The energy scale for entry and printout of window settings may be set in channels (0—1000) based on lnE, where E is energy, or KeV (0—2000). The selection is based on your preference.

To change the settings, highlight "Energy Scale" and choose the desired setting.

Figure 2.8 System Setup Menu

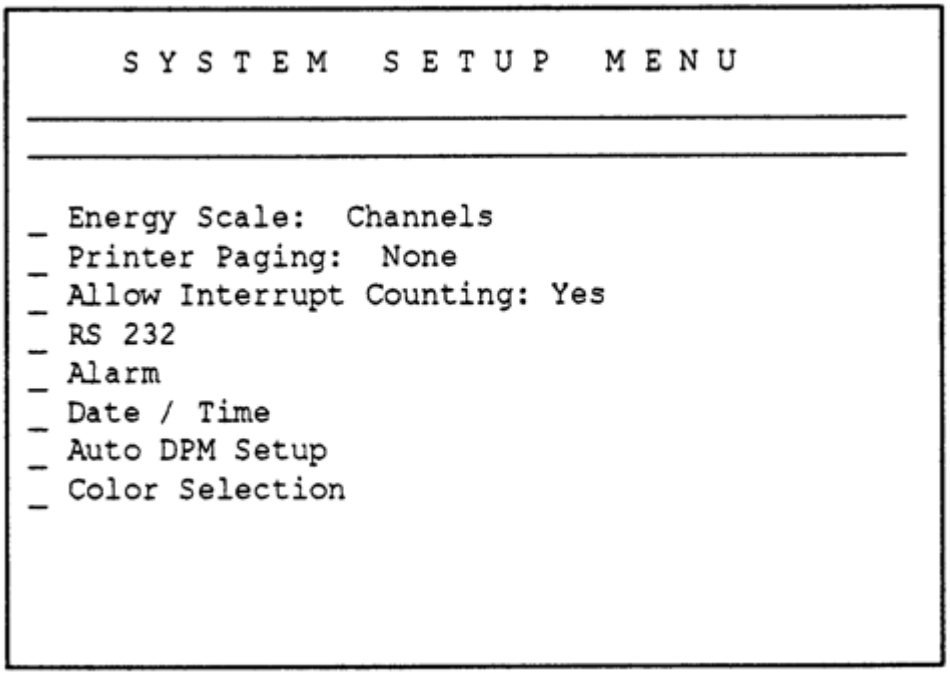


Table 2.1 System Setup Parameters

Item	Default	Allowable Responses
Energy Scale	Channels	Channels: KeV
Printing Paging	11 in.	11 in.; 12 in.; None

Table 2.1 System Setup Parameters

Item	Default	Allowable Responses
Allow Interrupt Count	Yes	Yes; No
RS232		
Baud Rate	1200	110; 300; 600; 1200; 2400; 4800; 9600; 19200
Parity	None	None; Odd; Even
Stop Bits	1	1; 2
XON/XOFF	Yes	Yes; No
DTR	No	Yes; No
CTS	No	Yes; No
Alarm		
Audible Alarm	Yes	Yes; No
Full Alarm Repeats	Yes	Yes; No
Date and Time	None	Time: Hours, 00-24; Minutes, 00-59; Date: Days, 01-31; Month, 3 letter code; Year, 0000-9999
Auto DPM - Setup		
Counting Time	1.00	0.01 - 999.99
Counting Precision	2.00%	0.00 - 00.99%
Standard DPM	None	0 - 9999999
Standard DAte	None	Date: Days, 01 - 31; Month, 3 letter code; Year, 0000 - 9999
Color Selection - Monitor		
Normal color palette	Vibrant	Vibrante; Classic; Earth Tones
Graphics Color		
Selection	Inv. Classic	Vibrant; Classic; Earth Tones; Inv. Vibant; Inv. Classic; Inv. Earth Tones

Printer Paging

The printer sets the top of page based on paper size. If the printer paper is perforated every 11 inch, set this to 11 inch. If the printer paper is perforated every 12 inch, set this to 12 inch. If the printer paper is not perforated and br paging is not desired, set this to None.

To change the settings, highlight ‘Printer Paging” and choose the desired setting.

Allow Interrupt Count

During Automatic Counting, the system is designed to allow temporary interruption of the counting mode to count up to a single rack of samples. If you want to allow Interrupt Count, choose Yes. If you do not want interruption during Automatic Counting, choose No.

To change the settings, highlight “Allow Interrupt Count” and choose the desired setting.

RS232

The parameters for the RS232 port are selectable based on the external device connected to the port. To set up the RS232 parameters, highlight RS232 and press **SELECT**. The RS232 Setup Menu shown in Figure 2.9 is displayed. Each of the displayed prompts is described below. Allowable responses are given in Table 2.1.

Baud Rate

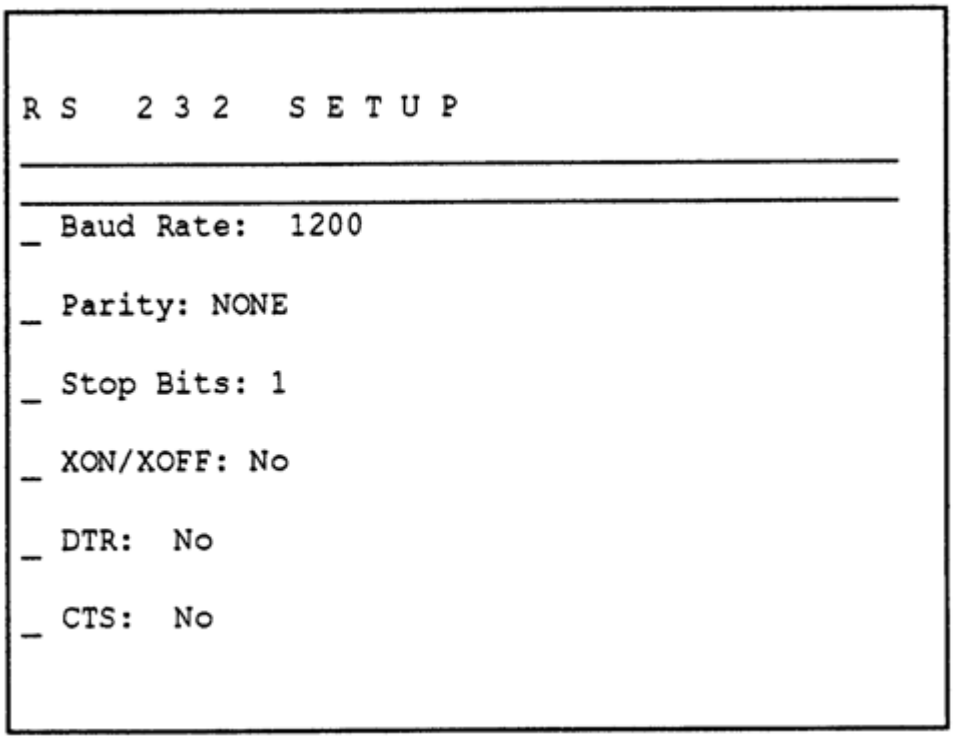
The baud rate of the RS232 port must match the baud rate of the external device for transmission to occur.

To change the settings, highlight "Baud Rate" and choose the appropriate setting from the list of choices presented.

Parity

The parity of the R5232 port must match the parity of the external device for transmission to occur.

Figure 2.9 RS232 Setup Menu



To change the settings, highlight "Parity" and choose the appropriate parity from the list of choices presented.

Stop Bits

The number of stop bits of the RS232 port must match the number of stop bits of the external device for transmission to occur.

To change the settings, highlight “Stop Bits” and choose the appropriate number from the choices presented.

XON/XOFF

If the external device connected to the R5232 port uses software handshaking (XOn/XOff), then choose Yes. If software hand-shaking Is not desired, choose No.

To change the settings, highlight “XON/XOFF” and choose the desired setting.

DTR

If the external device connected to the RS232 port uses hard-ware handshaking on the DTR line (Pin 20 on the standard 25-pin connector), then choose Yes for DTR. If the device uses hardware handshaking on some other R5232 pin, a special cable is required. If hardware handshaking is not used, choose No.

To change the settings, highlight “DTR” and choose the desired setting.

CTS

If the external device connected to the RS232 port operates with the CTS line high (Pin 5 on the standard 25-pin connector), then choose Yes for CTS. If the device cannot operate with the CTS line high, choose No. This is very infrequent and found only in devices which do not use standard RS232 pin definitions.

To change the settings, highlight “CTS” and choose the desired setting.

Alarm

Built-in error messages are displayed and/or printed whenever there is an inconsistency in editing User Programs, setting up special programs, or for system software or hardware failures. In addition, an audible beep may be turned on whenever an error message Is displayed.To set the Alarm, highlight “Alarm” and press **SELECT**. The Main Editing Window displays two items: Audible Alarms and Full Alarm Repeats. Each prompt is described below.

Audible Alarms

Whenever appropriate, error messages are always displayed. An audible alarm can be sounded when errors occur in editing or operation. If you want an audible alarm, choose Yes. If you do not want an audible alarm sounded, choose No.

To change the settings, highlight “Audible Alarms” and choose the desired setting.

Full Alarm Repeats

The instrument can generate an audible alarm whenever a fatal error, such as a printer failure, occurs while counting samples. This alarm continues until the error is corrected or 60 minutes have elapsed. If you want to hear an audible alarm for fatal error during counting, choose Yes. Choose No to disable this feature.

To change the settings, highlight “Full Alarm Repeats” and choose the desired setting.

Date/Time

The current date and time is set at time *of* installation. To change either the date or the time, highlight "Date/Time" and press **SELECT**. The Main Editing Window displays two items: Time and Date.

Time

The time is set on a 24 hour clock and entered as hour and minutes, or hour, minutes, and seconds. To change the settings, highlight 'Time" and enter the new time. The clock is updated when **MAIN MENU** or **PREVIOUS MENU** is pressed.

Date

The date is set in this format: DD MMM YYYY (2 digits for the day, a 3 letter code for month, and 4 digits for the year). To change the settings, highlight "Date" and enter the new date.

Auto DPM

Auto DPM is an operating mode that is accessed with the Command Card, AUTO DPM, or as a Data Calculation program in a User Program. When a Command Card is used to access this counting mode, the system parameters are fixed except for count time and counting precision. These parameters are stored as System Parameters. For more information on Auto DPM, refer to Section 3.4 and Section 5.4.

Auto DPM Calibration is performed at the factory. The ^{14}C and ^{3}H unquenched standards are used for Auto DPM Calibration and the standard dpm and standardization date for both isotopes are stored in Auto DPM. Check these parameters at the time of installation to make sure the stored dpm and standardization date agree with those printed on the label of the standards supplied with the instrument. For more information on Auto DPM Calibration, refer to Section 3 Auto DPM Calibration.

To change the Auto DPM parameters, highlight "Auto DPM" and press **SELECT**. The Main Editing Window displays two prompts: AUTO DPM Rack Setup and AUTO DPM Calibration Setup. Each prompt is described below.

Auto DPM Rack Setup

This prompt is used to change the count time and counting precision for Auto DPM initiated from the Command Card. Whichever condition is satisfied first, terminates the count.

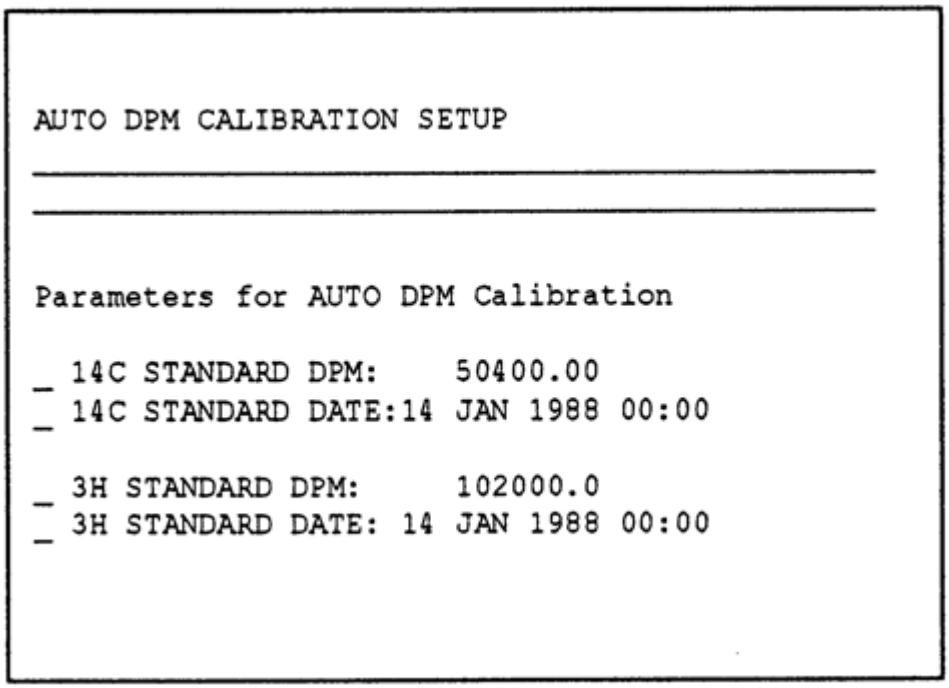
To change these parameters, highlight "AUTO DPM Rack Setup" and press **SELECT**. The Main Editing Window displays two prompts: Count Time and Counting Precision. Highlight each prompt and enter the desired values. Press **PREVIOUS MENU** to change Auto DPM Calibration.

Auto DPM Calibration Setup

This prompt is used to change the standard dpm and standardization date for both ^{3}H and ^{14}C unquenched standards. This information is printed by the manufacturer on the label of the standards.

To change these parameters, highlight "AUTO DPM Calibration Setup" and press **SELECT**. The menu shown in Figure 2.10 is displayed. Highlight each prompt and enter the values for the appropriate isotope.

Figure 2.10 Auto DPM Calibration Setup Menu



Color Selection - Monitor

If a color monitor is installed, this parameter is used to select the colors displayed on the monitor and the colors displayed on the graphics window. To change the settings, highlight "Color Selection" and choose the desired color for both the normal display and the graphic display.

2.7 Calibration

Calibrating is done to ensure that when an isotope is chosen, the window setting covers the energy spectrum for the isotope.

Calibrating the Instrument

Calibration is performed using the Calibrate Rack set up as described in Section 2 Setting Up the Racks. Calibration can be performed before beginning an Automatic Count or whenever desired. Refer to Section 2 When Calibration Should Be Done for recommendations.

To calibrate:

1. Place the Calibrate Rack on the right-hand side of the sample changer, in the rear, so it Is the first rack counted.

NOTE The unquenched ^{14}C standard must be the first sample in the Calibrate Rack. If a vial is detected in position #2 of the Calibrate Rack, Auto DPM Calibration is also per-formed. Refer to Section 3 Auto DPM Calibration for information on Auto DPM Calibration. Other vials in this rack are not counted. If calibrating before an Automatic Count, samples for counting must be loaded in the Sample Racks following the Calibrate Rack, not in the Calibrate Rack.

2. Immediately following the Calibrate Rack, place the Halt Rack (described in Section 2 Setting Up the Racks). If calibrating before Automatic Count, place the sample racks to count immediately after the Calibrate Rack, followed by the Halt Rack.
3. Press **START**. The instrument counts the standard and makes the appropriate internal corrections. A message is printed stating whether calibration was successful or not. If calibration was unsuccessful, the instrument retains the last calibration.

When Calibration Should Be Done

The instrument should be calibrated daily for the first week or two after installation, until the phototubes settle in.

After this initial warm-up period, calibration can be performed as follows:

- Once a month.
- Prior to initiating dpm programs (recommended).
- When setting up a new isotope automatically using the New Isotope Setup program (required).
- Prior to setting up quench curves (required).
- Prior to initiating an Auto DPM program. Refer to Section 3 Auto DPM Calibration for information on Auto DPM Calibration (recommended).

2.8 Temperature Control Accessory

Temperature Control Accessory, if installed, maintains the sample changer at a constant temperature. Always operate your LS System with the changer base cover closed when the Temperature Control Accessory is being used. For most efficient performance, limit the frequency of opening the changer base cover. If additional samples are being placed on the changer base, allow sufficient time for the new samples to cool down before counting these samples.

Under high humidity, some condensation will occur on the changer base, the air vents, the changer base cover, etc. This is normal. To minimize condensation, ensure that the cooling unit and the IS unit are positioned as close together as possible and their air vents are correctly aligned. Operating the Temperature Control Accessory beyond the operating specifications will cause excessive condensation.

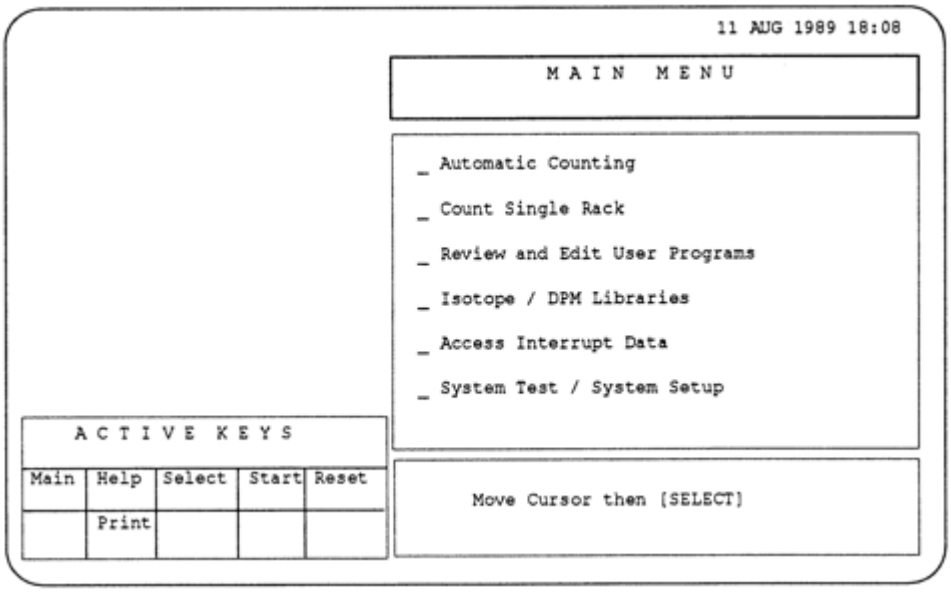
Counting Samples

3.1 Preparations for Use

Provided the power has been left on, as recommended, the instrument is ready for use any time. When the instrument is powered up and in a standby status, the screen shown in Figure 3.1 is displayed. The Main Menu is displayed in the Main Editing Window. Press **MAIN MENU** if the Main Menu is not displayed in the Main Editing Window.

NOTE This section assumes you are familiar with the Operating Controls of the LS. If you are not familiar with the Operating Controls, refer to Section 2.3.

Figure 3.1 Display During Standby Status.



3.2 Conducting An Automatic Count

Automatic Count permits a large number of samples to be counted without monitoring or intervention by the operator. A User Program is used to specify the counting parameters during Automatic Count. Refer to Section 4 for information on the User Programs and how to edit them. Different racks of samples can be counted under different User Programs.

Automatic Count continues until a stop command is given manually by pressing the two RESET keys simultaneously or automatically by using a Halt Rack. Automatic Count can be temporarily interrupted using Multi-Task. Refer to Section 3.5 for more information on Multi-Task.

Loading the Racks for Automatic Counting

If you are not familiar with the racks and how to place them in the LS instrument, refer to Section 2.4.

You can load up to 28 standard vial racks or 36 miniature racks or Bio-Vial racks. With Versa-Rack installed, standard, miniature and Bio-Vial racks may be intermixed within the same run. Care must be taken not to place more racks in the sample changer than it is capable of using. An error message is displayed *if* the sample changer is overloaded.

If you want to calibrate the instrument before counting your samples, first place the Calibrate Rack into the sample changer. Be sure this rack has the Auto Calibrate Card installed and the ^{14}C unquenched standard is in position #1. Refer to Section 2.7 for more information on calibration.

NOTE Programs using blanks, replicates, % of Reference, or Xtal DPM require specific sample loading sequences within the racks. Refer to the appropriate sections in Section 5 for more information on the required loading sequences of the samples within the racks.

Load your samples that have been placed in the appropriate Sample Racks. The first Sample Rack must be the rack with the User Number Card installed that corresponds to the User Program you wish to use. During Automatic Count, only the first rack of samples requires a User Number Card. All following racks are counted under the same program, until a new User Number Card or Halt Card is encountered.

Sample Racks may be loaded even if they are less than full. The instrument skips past the empty positions and proceeds to the next rack. Rack Number Cards are not required on the racks. If they are installed, however, Sample Racks can be used in any rack number order. The system reads and prints the number from the card before processing the rack.

Place all the racks together that are to be counted under the same User Program. If one or more additional sample sets are to be counted under different User Numbers during the same Automatic Count, make certain that the first rack in each set bears the correct User Number Card. When a Sample Rack with a User Number Card reaches the position for processing, the instrument “reads” the new user number and changes the processing parameters to those specified in that User Program.

When all the Sample Racks to be counted are loaded, place the red Halt Rack behind the last rack of samples to terminate Automatic Count.

NOTE Samples placed in the Halt Rack are not counted. Do not place samples to be counted in the Halt Rack.

Additional sample sets may be loaded after Automatic Count has been initiated. Load the new sample sets in front of the Halt Rack, being careful that the new sample sets are not loaded in the middle of a set of samples waiting to be counted.

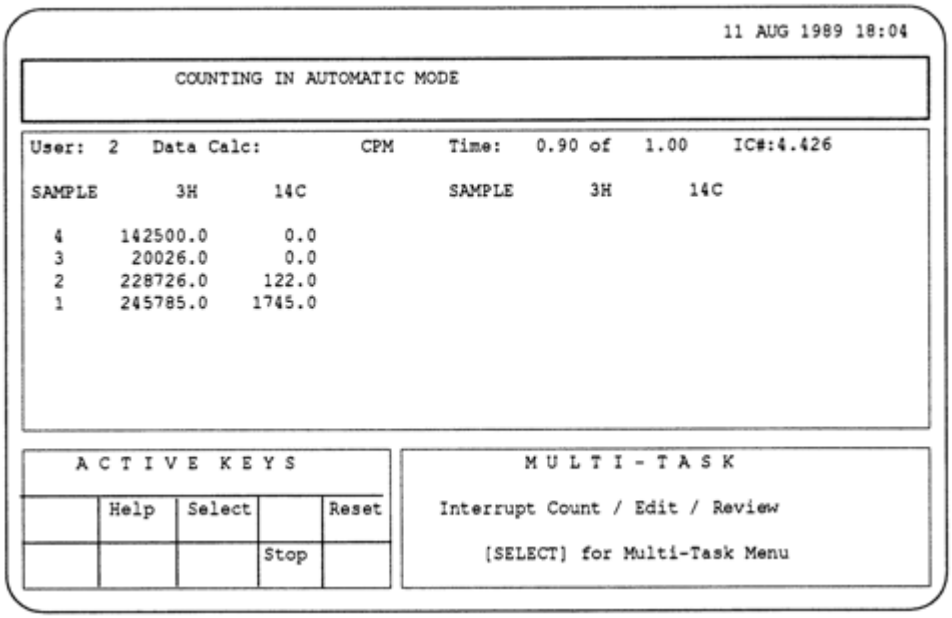
Starting the Automatic Count

NOTE Check that the printer is ON (it should be left on). Also check that the ON LINE light is lit, and that paper is loaded and is at the top of the form. Refer to Section 2.5 for more information on setting up the printer.

Automatic Count is initiated from the Main Menu. Highlight Automatic Counting and press **SELECT** to begin the counting process. The Main Editing Window displays instructions to load your samples. Load the samples as described in Section and press **START**. The racks are advanced to the rear of the instrument and counting commences. A typical screen displayed during Automatic Count is shown in Figure 3.2.

NOTE If your samples have already been placed in the sample changer, you may simply press **START** after selecting Automatic Counting on the Main Menu.

Figure 3.2 Screen Displayed During Automatic Count



During Automatic Count, pressing the two **RESET** keys simultaneously terminates the counting process and returns the LS to Standby. The **STOP COUNT** key is used to terminate the counting of the current sample. The system prints the data accumulated up to the time of termination and advances to the next sample. Counting continues. The Halt Rack automatically terminates counting after all the samples are counted.

Data is printed and/or transmitted to the RS232 port depending on the User Program setup for Output Formats. Typical print-outs for each data calculation program are shown in Section 5. For more information on the printout parameters, refer to Output Formats Section 4.

To temporarily use the instrument during Automatic Count, press **SELECT**. The system is in the Multi-Task mode. You may count a small batch of samples, edit or review a User Program, or manually set up a new isotope or quench curve. Refer to Section 3.5 for more information on Multi-Task. You may also count samples during Automatic Counting using the **INTERRUPT** key. Pressing the **INTERRUPT** key presents the Count Single Rack Menu shown in Figure 3.9. Refer to the instructions in Interrupt Count in Multi-Task Section 3 for conducting an Interrupt Count.

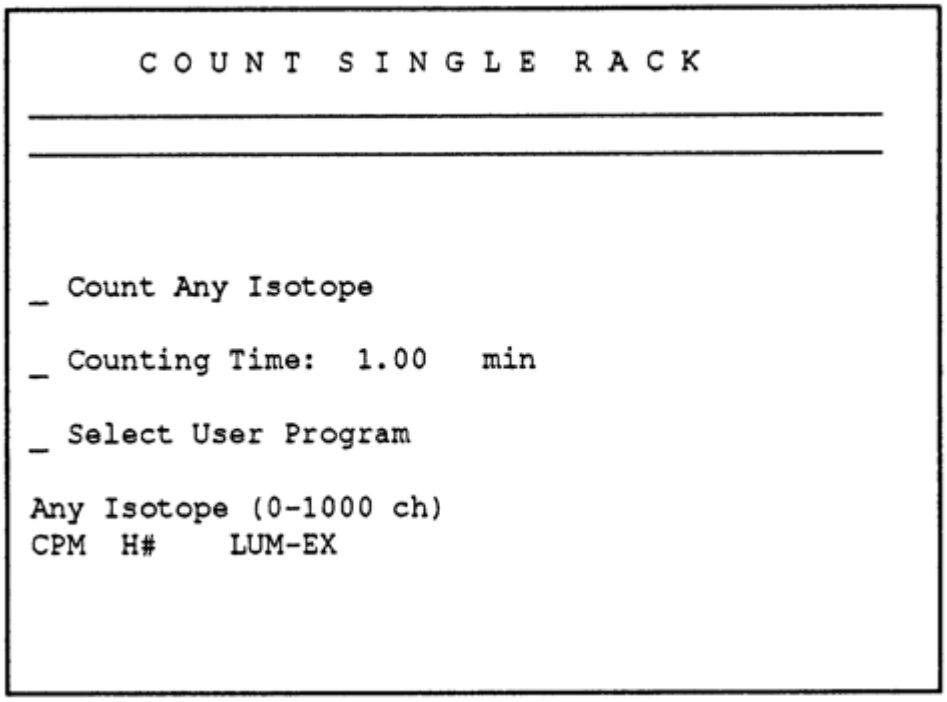
3.3 Conducting Count Single Rack

Count Single Rack is especially useful for counting a single sample such as a blank standard or a reference standard, or a few experimental samples (up to one rack). A count of the sample can be obtained using a default program or a User Program.

Counting a Single Rack with the Default Parameters

A permanent set of default parameters can be used to obtain a quick count of samples under Count Single Rack. The default parameters, shown in Figure 3.3, provide a window of 0 to 1000, the entire 2000 KeV energy range of the instrument and a counting time of 1.00 minute. The results are presented as cpm.

Figure 3.3 Count Single Rack Menu



IC# (or H# Plus, If Installed) and Lum-Ex (If Installed) are turned on. Only the counting time may be changed.

To perform Count Single Rack:

1. With the Main Menu displayed, highlight "Count Single Rack" and press **SELECT**. The Count Single Rack Menu shown in Figure 3.3 is displayed.
2. To count without any changes in the program setup, press **SELECT**.

To change the counting time, highlight "Counting Time". Enter the desired counting time (0.01 to 999.99 mlns.). Highlight "Count Any Isotope", and press **SELECT**.

NOTE The counting time is not permanently stored; following the count of the one rack, the counting time is reset to 1.00 minute.

3. The Main Editing Window prompts you to load your Sample Rack containing the vials you wish to count. Load the rack into the right side of the sample changer so it is the first rack counted, and press **START**.

Figure 3.4 Typical Printout from Count Single Rack.

PAGE: 1

SAM NO	POS	TIME MIN	H#	WIDE CPM	WIDE %ERROR	LUMEX %	ELAPSED TIME
1	**-1	0.10	11.3	249330.0	1.27	0.00	0.55
2	**-2	0.10	40.8	230260.0	1.32	0.00	1.12
3	**-3	0.10	333.4	20420.00	4.43	0.02	1.78
4	**-4	0.10	123.0	142670.0	1.67	0.00	2.47

4. The sample(s) are counted and the results printed. A typical printout is shown in Figure 3.4. The Main Menu is displayed.

Counting a Single Rack with a User Program

A single rack of samples may be counted with any **one of the** User Programs. You may not edit the program in the Count Single Rack mode, except for counting time. Refer to Section 4 for editing a User Program prior to using this operating mode.

To perform Count Single Rack using a User Program:

Figure 3.5 User Program Selection Menu

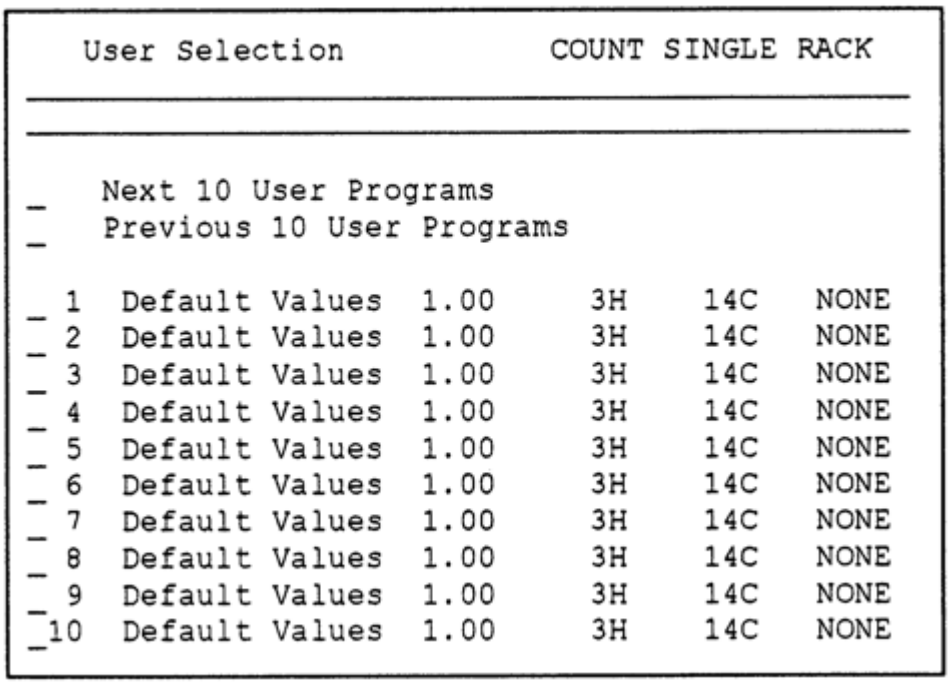
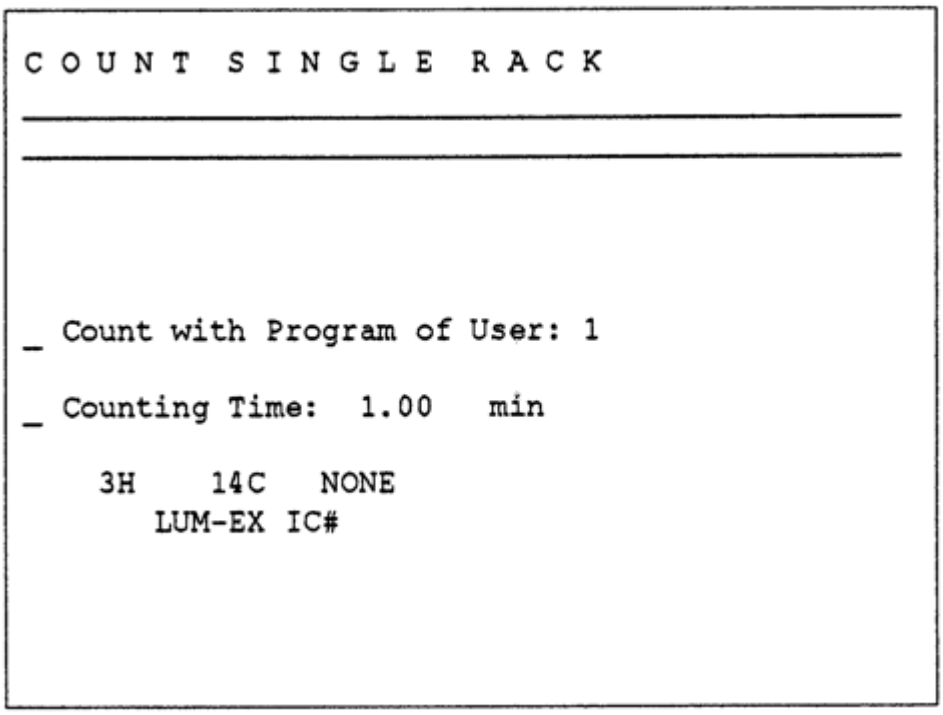


Figure 3.6 Summary Of User Program in Count Single Rack



1. With the Main Menu displayed, highlight "Count Single Rack" and press **SELECT**. The Count Single Rack Menu shown in Figure 3.3 is displayed.
2. Highlight "Select User Program" and press **SELECT**. The User Program Selection Menu shown in Figure 3.5 is displayed.
3. Select the desired User Program. A summary of the counting time and isotope settings is displayed. A typical example is illustrated in Figure 3.6.

To change the counting time, highlight "Counting Time", and enter the desired counting time (0.01 to 999.99 minutes).

NOTE The counting time is not permanently stored; following the count of the one rack, the counting time is reset to the previously stored value.

4. Highlight "Count With Program of User", and press **SELECT**. The Main Editing Window prompts you to load your Sample Rack containing the vials you wish to count. Load the rack into the right side of the sample changer so it is the first rack counted, and press **START**.

If the User Program selected is setup for single photon monitoring, the Main Editing Window displays instructions to start elapsed time before starting the sample count. Press **START** when you initiate the sample reaction to obtain elapsed time from the start of the reaction.

The Main Editing Window then prompts you to load your samples and initiate counting by pressing **START** again. Refer to Section 5.9 for more information on Single Photon Monitor.

Figure 3.7 Typical Printout from Count Single Rack

PAGE: 1

SAM NO	POS	TIME MIN	H#	3 H CPM	3 H %ERROR	1 4 C CPM	1 4 C %ERROR	W I D E CPM	W I D E %ERROR	ILMEX %	ELAPSED 2P TIME
1	**-1	0.50	13.7	242875.4	0.57	2982.65	5.18	245876.1	0.57	0.02	1.23
2	**-2	0.50	43.1	222580.8	0.60	2549.12	5.60	225136.0	0.60	0.02	5.11
3	**-3	0.50	336.0	12947.66	2.48	5708.81	3.74	18660.54	2.07	0.19	8.73
4	**-4	0.50	126.8	134470.2	0.77	2284.05	5.92	136757.5	0.76	0.03	12.14

5. The sample(s) are counted and the results printed. Figure 3.7 shows an example of a resulting printout from Count Single Rack using a User Program. The Main Menu is displayed.

3.4 Auto DPM

Auto DPM allows you to obtain dpm values for singe label 14 samples labeled with a pure beta-emitting Isotope (I.e. ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, or ^{86}Rb) without running quench curves.

Auto DPM can be initiated from a Command Card. This program uses default parameters set by the instrument. The count time and counting precision may be set under System Parameters. Refer to Color Selection - Monitor Section 2 for more information on setting these parameters.

Auto DPM may also be selected as a Data Calculation Program and initiated with a User Number Card. The parameters set in the User Program are used to count the samples. Refer to *Section 5.4* for more information on using Auto DPM as a Data Calculation Program.

NOTE Auto DPM is designed for use with liquid scintillators only. Using this operating mode for counting samples on Xtalscint products may give erroneous results.

Auto DPM Calibration

Auto DPM Calibration is performed at the factory and the calibration stored. The calibration data is stored under System Setup. Verify that the calibration data stored in System Setup agrees with the unquenched ^{3}H and ^{14}C standards of your instrument. Refer to Color Selection - Monitor Section 2 for verifying the data under System Setup.

It is recommended that you perform Auto DPM Calibration only when you receive the instrument and do not change it. The Calibrate Rack is used to perform Auto DPM Calibration. Place the unquenched ^{14}C standard in position #1 and the un-quenched ~ standard in position #2. The instrument first performs calibration and then when a second vial is detected in position #2, the system backs up to the ~ standard and performs Auto DPM Calibration.

NOTE The Calibrate Rack must contain the unquenched I4~ standard in position #1 and the unquenched ~ standard in position #2. Standard DPM and the date of standardization of the unquenched standard used for Auto DPM Calibration must be stored under System Setup.

Counting With Auto DPM

Counting in Auto DPM is similar to Automatic Count. Refer to Section 3.2 if you are not familiar with counting in the automatic mode. Place your samples to count in the Auto DPM Rack. Refer to Setting Up the Racks Section 2 for information on setting up the Auto DPM Rack. Place remaining samples in Sample Racks that do not have a User Number Card installed on them.

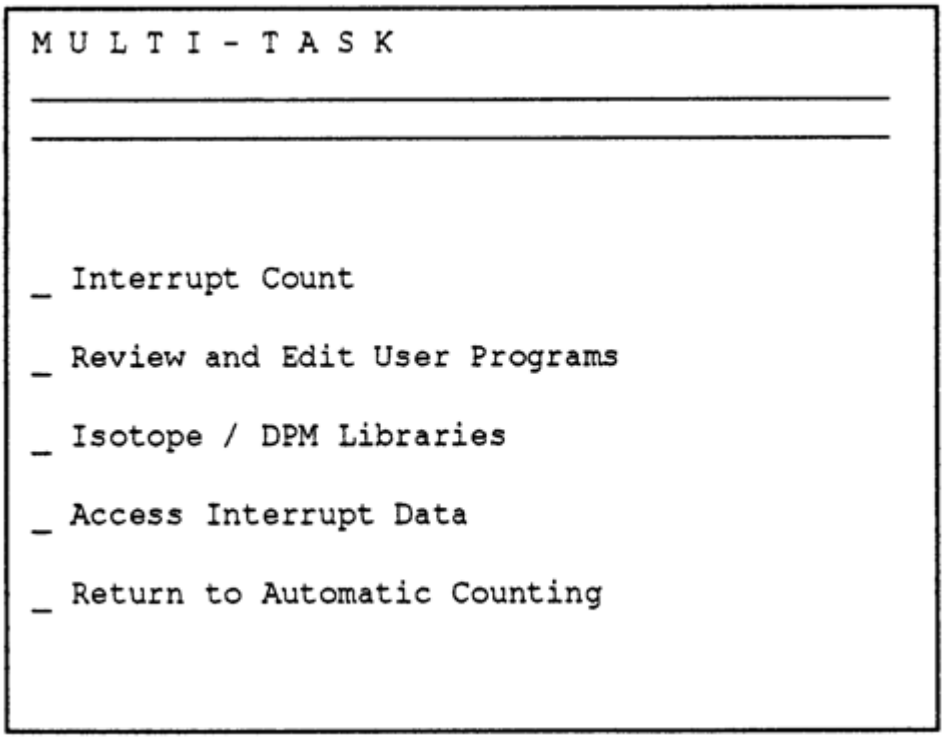
For Auto DPM Calibration, place the Calibrate Rack set up as described in Auto DPM Calibration Section 3 in the instrument so it is the first rack to be counted. Place the Auto DPM Rack after the Calibrate Rack. Place the remaining Sample Racks into the instrument. Place a Halt Rack after the last sample and initiate Automatic Count. A typical printout of the results is shown in Figure 5.6.

3.5 Multi-Task

Multi-Task allows you to obtain an immediate count of a small number of samples (a maximum of one full rack) using Count Single Rack mode, to edit a User Program, or to manually set up a new isotope or quench curve (if DPM is installed). The counting process is terminated only when you initiate counting samples in Interrupt Count.

NOTE Multi-Task is automatically terminated if no user action (either editing or counting) takes place within a 10 minute period while in Multi-Task.

Figure 3.8 The Multi-Task Menu



Interrupt Count in Multi-Task

A single sample or up to one rack of samples may be counted in this mode during Multi-Task. Load the priority samples to count into the Interrupt Rack. Refer toSetting Up the Racks Section 2 if you are not familiar with the Interrupt Rack. The rack must have the Interrupt Card installed. It will not be counted again if left in the sample changer with the Sample Racks during Automatic Count. The samples may be counted using the default parameters for Count Single Rack or a User Program.

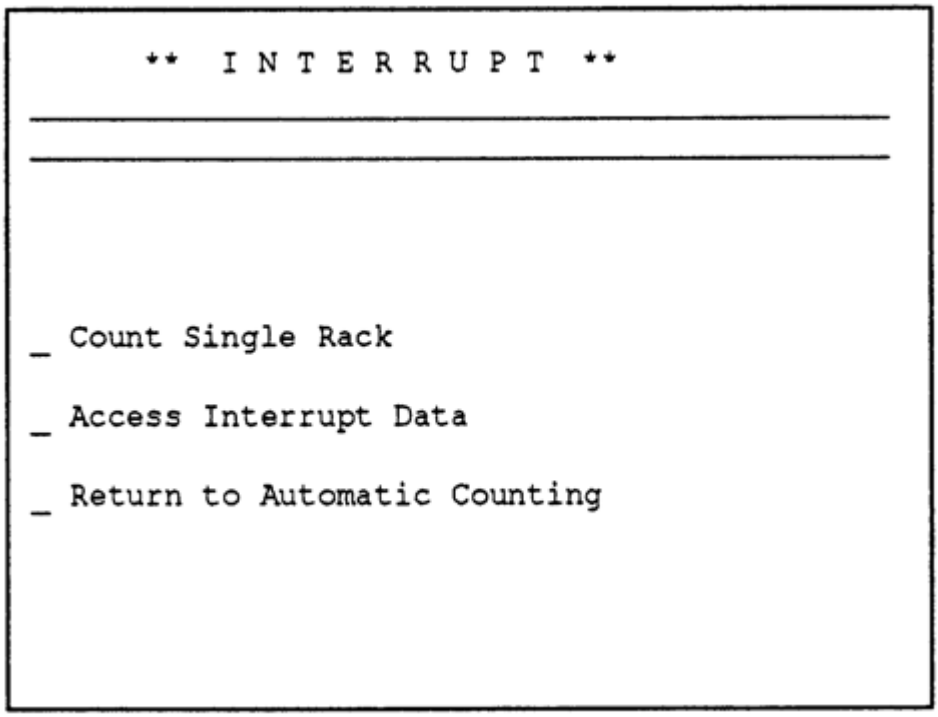
NOTE Interrupt Count may also be initiated by pressing **INTERRUPT** during Automatic Counting. The menu shown inFigure 3.9 is displayed.

To count a few samples during Automatic Counting:

1. During Automatic Count, press **SELECT** to display the Multi-Task Menu shown in Figure 3.8.

2. From the Multi-Task Menu, highlight “Interrupt Count” and press **SELECT**. The menu shown in Figure 3.9 is displayed.

Figure 3.9 The Interrupt Menu



3. Highlight “Count Single Rack” and press **SELECT**. The Count Single Rack Menu (Figure 3.3) is displayed.

NOTE If Interrupt Data is stored, this data must be reviewed, printed or deleted before another Interrupt Count can be performed. Refer to Interrupt Data Section 3 for information on Interrupt Data. Press [PREVIOUS MENU] to return to the Count Single Rack Menu when you are finished in Interrupt Count.

4. To count using the default parameters without any changes, press **SELECT**.

   To change the counting time, highlight “Counting Time”, and enter the desired counting time (0.01 to 999.99 minutes). Highlight “Count Any Isotope”, and press **SELECT**.

   To count with a User Program, refer to Counting with a User Program at the end of this section.

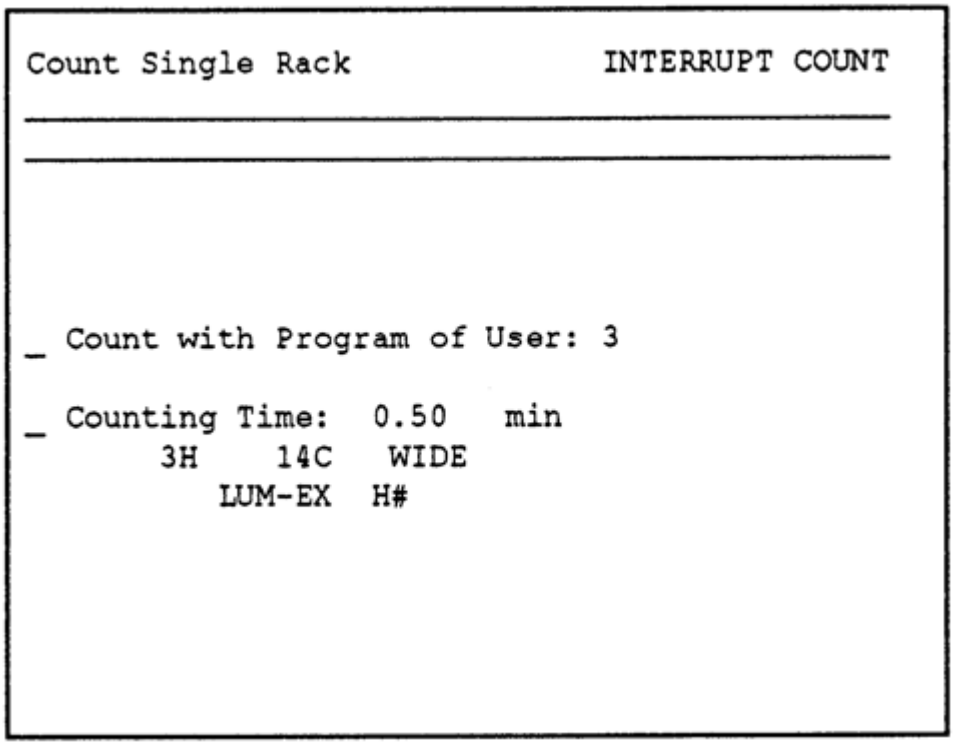
5. The Main Editing Window displays instructions to load the samples. Load the Interrupt Rack with the samples you wish to count as described on the screen.

NOTE The Interrupt Rack with the Interrupt Card installed must be used to count samples during Multi-Task. Once the samples are counted, the rack is skipped when Auto Count is resumed.

6. Press **START** to begin Interrupt Count. The screen displays a message “Suspending Auto Count” and the sample being counted is terminated. The Sample Rack in position is moved out of the count position and the instrument searches for the Interrupt Rack. The screen displays “Searching for Interrupt Rack”.

NOTE You may abort the Interrupt Count and resume Automatic Count by pressing [SELECT] at any time after this point.

Figure 3.10 Summary of User Program in Interrupt Count



7. When the samples in the Interrupt Rack have been counted, the instrument resumes the previous Automatic Count where it was interrupted.

Results of Interrupt Count are displayed and stored. They are not printed out. Refer to Interrupt Data Section 3 for information on accessing Interrupt Data.

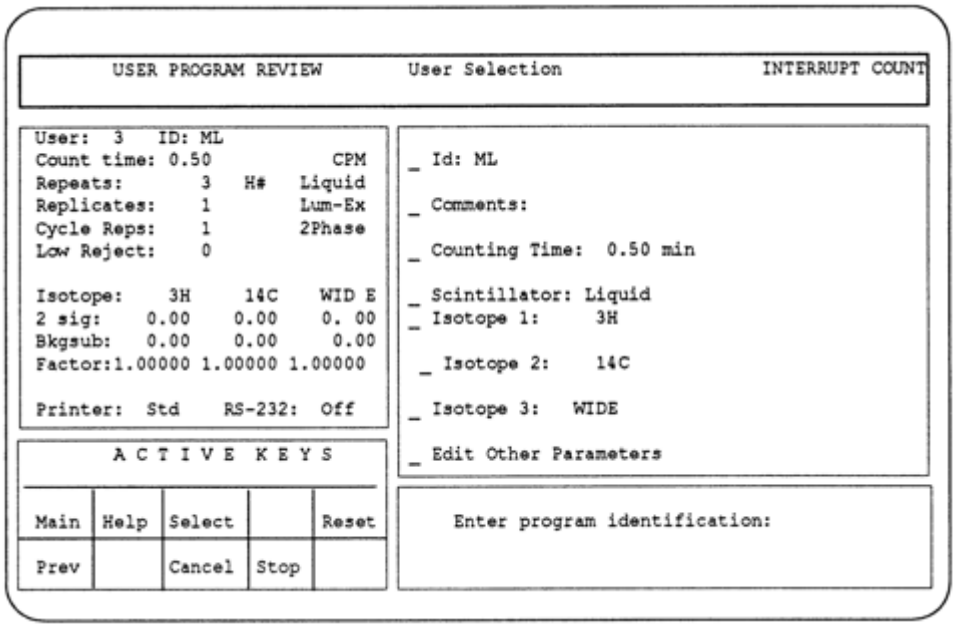
Interrupt Count Using a User Program During Multi-Task

To count with a User Program:

1. Highlight “Select User Program” from the Count Single Rack Menu (Figure 3.3) and press **SELECT**. The User Program Selection Menu (Figure 3.5) is displayed.
2. 2. Select the desired User Program. The Main Editing Window displays a summary of the program. A typical summary is shown in Figure 3.10.
3. To change only the counting time, highlight “Counting Time” and enter the desired count time. Highlight “Count With Pro-gram of User:” and press **SELECT**. Refer back to step 5 above to continue Interrupt Count.
4. To change other counting parameters, highlight “Change Counting Parameters” and press **SELECT**. The Main Editing Window displays the parameters of the User Program.

The User Program Review is displayed in the Supplementary Window to the left. See Figure 3.11.

Figure 3.11 Summary User Program in Interrupt.



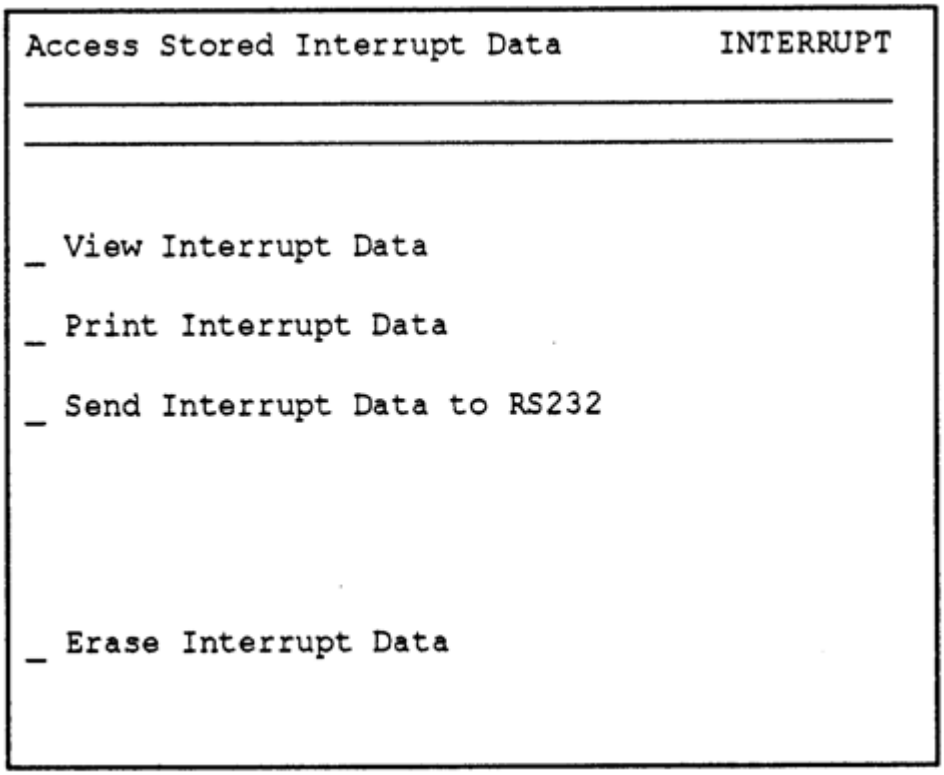
5. Make the desired changes in the User Program. Refer to Section 4 for more information on editing. Any changes to the User Program are not permanently stored. They are used to count the samples during Interrupt Count only.
6. When editing is complete, press **PREVIOUS MENU**. The menu shown in Figure 3.10 is displayed. Highlight "Count with Program of User:" and press **SELECT**. Refer back to step *5* above to continue Interrupt Count.

Interrupt Data

The results of an Interrupt Count during Multi-Task are not printed out at the time of the count to avoid interference with the printout of the results for the Automatic Count. The

results of the Interrupt Count are displayed and stored. Once stored, Interrupt Data can be viewed on the display, printed, sent to the RS232 port, and/or deleted.

Figure 3.12 Access Stored Interrupt Data Menu.



To access Interrupt Data:

1. From either the Main Menu (Figure 3.1) or the Multi-Task Menu (Figure 3.8), highlight 'Access Interrupt Data", and press **SELECT**. The Access Stored Interrupt Data Menu shown in Figure 3.12 is displayed.

Figure 3.13 Data Displayed During View Interrupt Data.

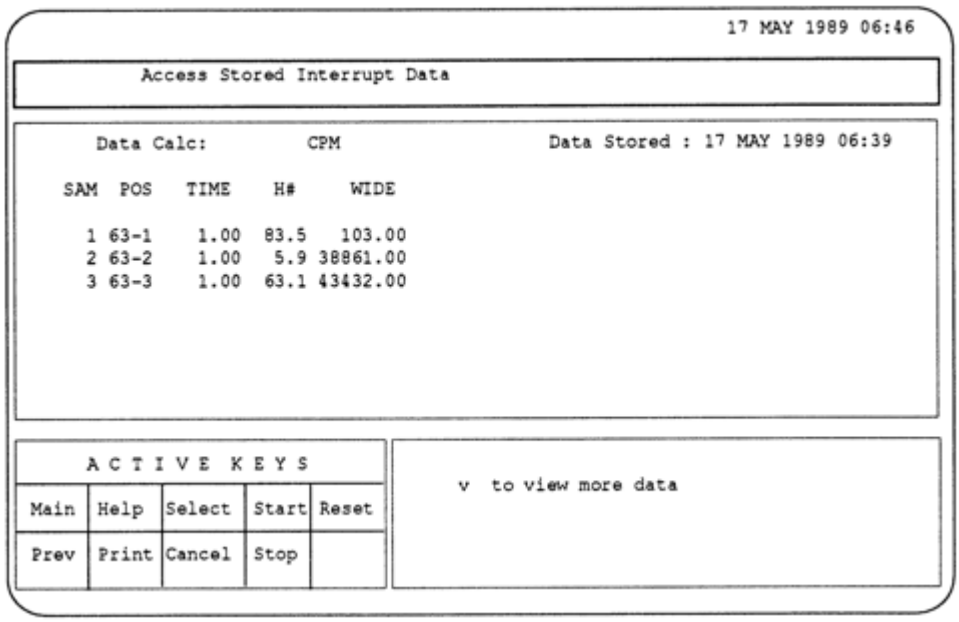


Figure 3.14 Typical Printout of Interrupt Results

PAGE: 1

Printout of Stored Interrupt Count Data 17 MAY 1989 06:30

USER: 0 DATA CALC : CPM
Data Stored : 17 MAY 1989 06:23

SAM NO	POS	TIME MIN	H#	WIDE CPM	WIDE %ERROR	LUMEX %	ELAPSED TIME
1	63-1	1.00	83.2	115.00	18.65	8.08	1.38
2	63-2	1.00	4.2	39259.00	1.01	0.00	2.90
3	63-3	1.00	65.5	38768.00	1.11	0.00	4.31

2. To view the data, highlight "View Interrupt Data" and press **SELECT**. The data is presented on the screen as shown in Figure 3.13. If more data is present than displayed on the screen, use the Down Cursor Arrow key to view more data. Press **PREVIOUS MENU** to return to the Access Stored Interrupt Data Menu.

3. To print the data, highlight "Print Interrupt Data" and press **SELECT**. All stored data are printed. Figure 3.14 shows a typical printout. If data is printed during Automatic Count, the printer advances to the top of the next page before it prints the Interrupt Data. When Automatic Count is resumed, the Automatic Count data is put on a new page. The Access Stored Interrupt Data Menu is displayed.
4. To transmit data to the R5232 port, highlight "Send Interrupt Data to RS232" and press **SELECT**. All stored data are transmitted. The Access Stored Interrupt Data Menu is displayed.

NOTE RS232 cannot be used if the current count is generating RS232 output.

5. To erase data, highlight "Erase Interrupt Data" and press **SELECT**. The data is erased and the Multi-Task Menu or Main Menu is displayed.
6. If you initiated Access Interrupt Data from Multi-Task, press **PREVIOUS MENU** to return to the Auto Count display.

Editing A User Program in Multi-Task

While Auto Count is in progress, you may edit any of the User Programs under Multi-Task. Editing is performed as described in Section 4. To avoid confusion in the interpretation of results, the User Program currently in use may only be edited with respect to length of processing time per sample.

To edit a User Program under Multi-Task:

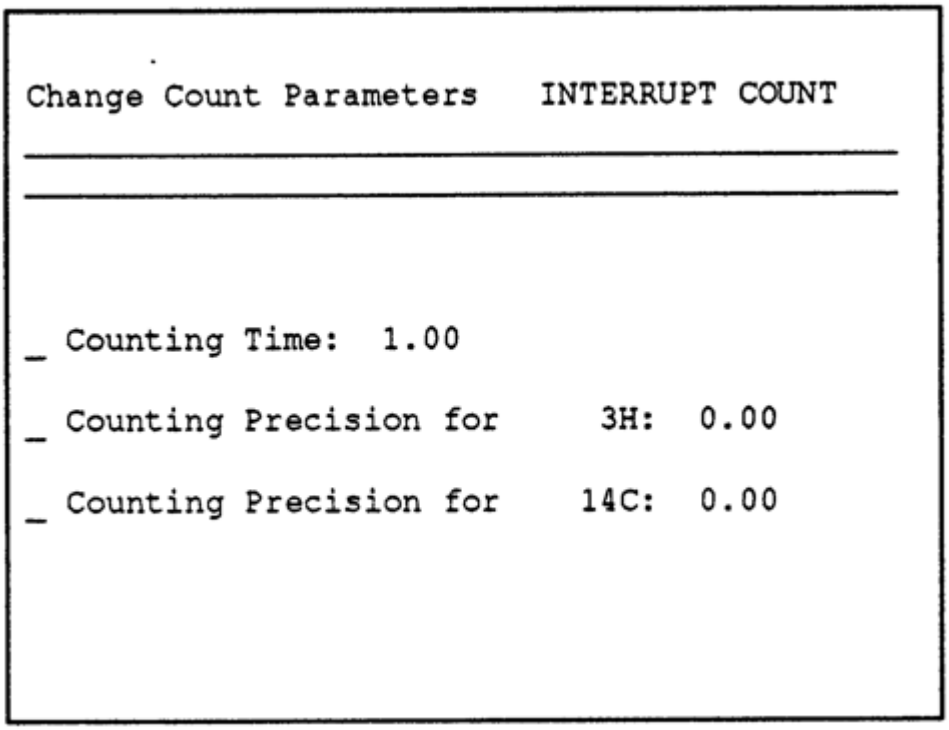
1. During Automatic Count, press **SELECT** to display the Multi-Task Menu shown in Figure 3.8.
2. From the Multi-Task Menu, highlight "Review and Edit User Programs" and press **SELECT**. A menu similar to that shown in *Figure 3.5* is displayed.
3. Select the desired User Number. The screen displayed is similar to the one shown in Figure 3.11.

   If the User Program in use during Automatic Count is selected, refer to the instructions given below, Editing the Current User Program.
4. Edit the program as described in Section 4. When editing is complete, press **MAIN MENU**. These new parameters are stored in the User Program until changed again. The Multi-Task Menu is displayed.
5. Press **PREVIOUS MENU** to return to the Auto Count display.

Editing the Current User Program

Only the counting time or counting precision of the User Program in use during Automatic Count can be edited. A change made to the processing time of the samples applies only to the Interrupt Count. It is not stored as a permanent change to the program.

Figure 3.15 Edit Current User Program During Multi-Task.

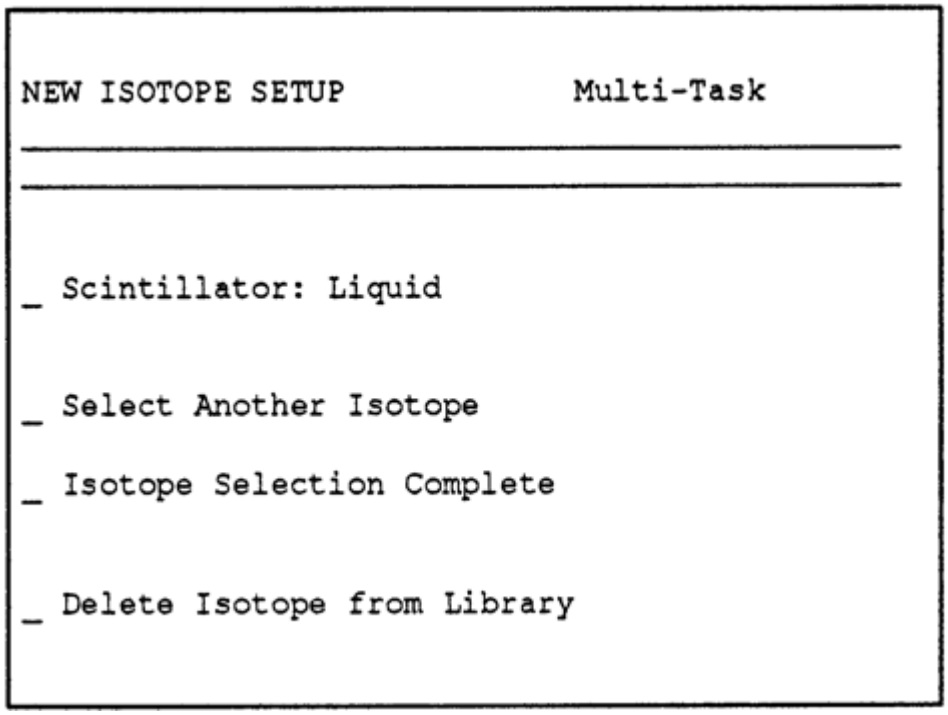


To edit the User Program currently in use during Auto Count:

1. During Automatic Count, press **SELECT** to display the Multi-Task Menu shown in Figure 3.8.
2. From the Multi-Task Menu, highlight "Review and Edit User Programs" and press **SELECT**. A menu similar to that shown in Figure 3.5 is displayed.
3. Select the current User Number. The menu shown in Figure 3.15 is displayed.
4. With "Counting Time" highlighted, enter the desired counting time.
5. Highlight "Counting Precision" and enter the desired precision for each Isotope selected in the User Program.
6. Press **MAIN MENU** to store the values and return to the Multi-Task Menu. The new values are valid only for the current sample set and are not permanent. They take effect on the next sample, not the sample being counted while changes are made.

7. Press **PREVIOUS MENU** to return to the Auto Count display.

Figure 3.16 New Isotope Setup Menu in Multi-Task.



Using New Isotope Setup in Multi-Task

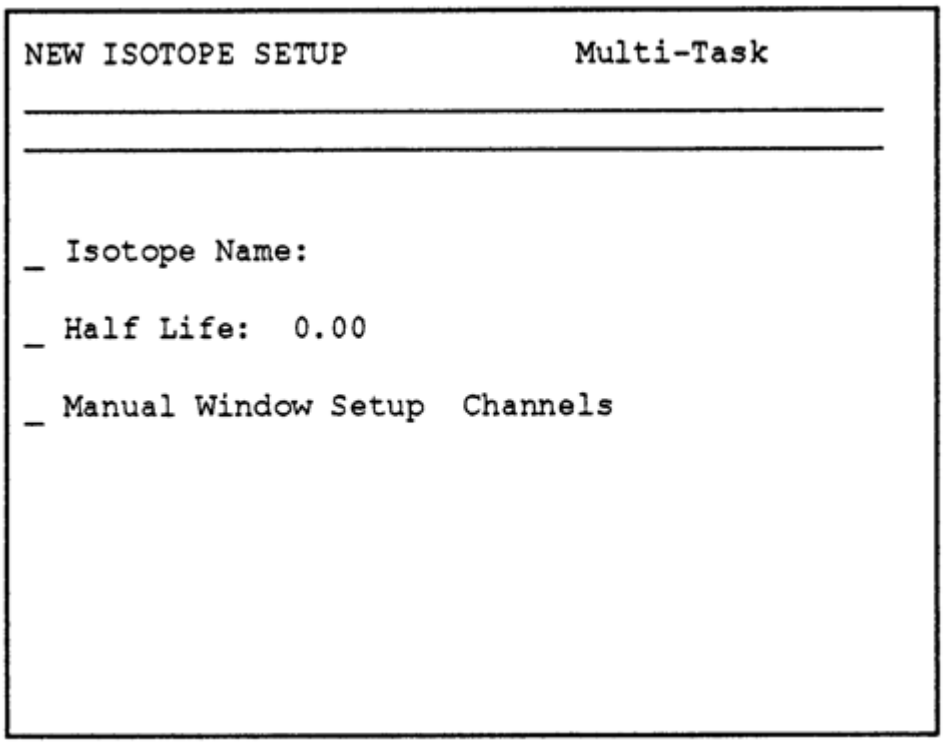
During Automatic Count, New Isotope Setup can be accessed using Multi-Task. An isotope not currently stored in the Isotope Library may be set up manually or an isotope can be deleted. Refer to Section 6.1 for more information on the Isotope Library.

To use New Isotope Setup:

1. During Automatic Count, press **SELECT** to display the Multi-Task Menu shown in Figure 3.8.
2. From the Multi-Task Menu, highlight "Isotope/DPM Libraries" and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.
3. Highlight "Setup and Review Isotopes" and press **SELECT**. The New Isotope Menu for Multi-Task shown in Figure 3.16 is displayed.
4. A new isotope can be manually stored in the library, or a stored isotope may be deleted, just as if you were in New Isotope Setup. When you select "Select Another Isotope", the menu shown in Figure 3.17 is displayed. Enter the appropriate information. Refer to Adding A New Isotope to the Isotope Library Section 6 and Deleting Isotopes from the

Isotope Library Section 6 for adding and deleting isotopes if you are not familiar with these tasks.

Figure 3.17 Select Another Isotope Menu in Multi-Task.



NOTE You may not set up an isotope in Multi-Task using Automatic Setup.

5. When you are finished using New Isotope Setup, highlight "Isotope Selection Complete' and press **SELECT**. The Multi-Task Menu is displayed.
6. Press **PREVIOUS MENU** to return to the Auto Count display.

Using the DPM Library in Multi-Task

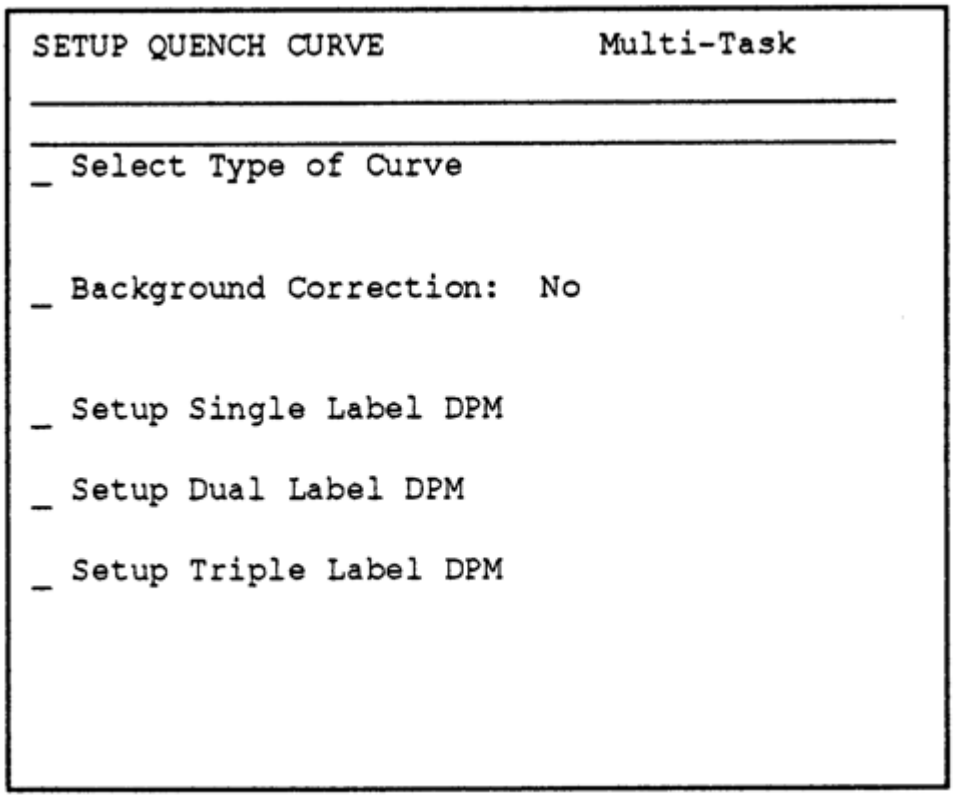
The DPM Library can be accessed during an Automatic Count using Multi-Task. Stored quench curves can be reviewed, edited or deleted. A quench curve not currently stored in the DPM Library may be set up manually.

To set up a new quench curve:

1. During Automatic Count, press **SELECT** to display the Multi-Task Menu shown in Figure 3.8.

2. From the Multi-Task Menu, highlight “Isotope/DPM Libraries” and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.

Figure 3.18 Menu to Edit Quench Curves in Multi-Task.



3. Highlight ‘Setup and Review DPM Quench Curves” and press **SELECT**. The menu shown in Figure 3.18 is displayed.
4. A new quench curve is manually entered just as if you were manually entering it in the DPM Setup. Refer to Manual Entry of Quench Curves Section 6 for more information on entering quench curves manually. You may also edit or delete a stored quench curve. Refer to Editing Quench Curves Section 6 and Deleting A Quench Curve Section 6, respectively, for more information.

NOTE You cannot count standards to set up quench curves or print correlation tables in Multi-Task.

5. When you are finished using the DPM Library, press **PREVIOUS MENU**. The Multi-Task Menu is displayed.
6. Press **PREVIOUS MENU** again to return to the Auto Count display.

Setting Up User Programs

4.1 About the User Programs

Twenty to fifty User Programs are available for editing. When the instrument is first installed, each User Program contains default parameters given in Figure 4.1. An overview of the parameters in the User Program with the default values and allowable responses is given in Figure 4.2. More information on each item is presented in ID Section 4 to Protect User Program Section 4.

Each User Program is identified by a User Number ***1—50***. These numbers correspond to the User Number Cards described in Section 2.4. The User Number Cards are used to call up the User Programs for processing the samples during Automatic Count. This section describes editing the User Programs. Refer to Section 3 for counting samples with the User Programs.

Figure 4.1 Summary of User Program Default Parameters.

```
USER PROGRAM REVIEW

User:  16   ID:  Default Values
Count time: 1.00            CPM
Repeats:      1    H#   Liquid
Replicates:   1
Cycle Reps:   1
Low Reject:   0

Isotope:    3H     14C    NONE
2 sig:    0.00    0.00
Bkgsub:   0.00    0.00
Factor:1.00000 1.00000
Units:    CPM     CPM
Printer:  Std     RS-232:  Off
```

Figure 4.2 Overview of User Program

Item	Default	Allowable Responses
Id	Default Values	Maximum 15 characters.
Comments		Maximum 28 character.
Counting Time	1.00 min.	Liquid; Xtal.
Isotope 1	^{3}H	Isotopes stored in Isotope Library for the selected scintillator; for dual or triple label, the lower-energy isotope; Manual; Wide; SPM.
Isotope 2	^{14}C	Isotopes stored in Isotope Library for the selected scintillator: for dual label, the higher-energy isotope; Manual; Wide.
Isotope 3	None	Isotopes stored in Isotope Library for the selected scintillator; for triple label, the highest-energy label; Manual; Wide.
Data Calculation	CPM	Depends on Scintillator selection and Data Calculation programs installed; see Figure 4.5.
Half-life Correction	0	Date: Days, 01-3 1; Month, 3 letter code; Year, 0000-9999 Time: Hours, 00-24; Minutes, 00-59.
Count Sample	1	1-10.
Replicates	1	1-10.
Count Sample Set	1	1-10.
Factor for Isotope 1	1	0.00000001-99999999.9; exponential, 10 characters (exponent limit = ± 24)
Factor for Isotope 2	1	0.00000001-99999999.9; exponential, 10 characters (exponent limit = ± 24)
Factor for Isotope 3	0	0.00000001-99999999.9; exponential, 10 characters (exponent limit = ± 24)
Counting Precision Isotope 1	0.00%	0.00% - 99.99%
Counting Precision Isotope 2	0.00%	0.00% - 99.99%
Counting Precision Isotope 3	0.00%	0.00% - 99.99%
Blank	No	Yes; No
Background Isotope 1	0	0 - 9999.9
Counting Precision Background, Isotope 1	0	0.00-99.99%
Background Isotope 2	0	0 - 9999.9
Counting Precision Background, Isotope 2	0	0.00-99.99%
Background Isotope 3	0	0 - 9999.9

Figure 4.2 Overview of User Program

Item	Default	Allowable Responses
Counting Precision Background, Isotope 3	0	0.00-99.99%
Quench	IC#	IC#; H#; Off
AQC	No	Yes; No
Lum-Ex Correction	No	Yes; No
2 Phase Monitor	No	Yes; No
Low Level	Off	Off; On
Low Count Reject	0	0 - 9999
Output Formats/Printer	Std	0 - 9999.9
Output Formats/RS232	Off	0 - 9999.9
Output Formats/Disk	Off	0 - 9999.9
Project User Program	No	Yes; No
Copy User Program		1 - 50

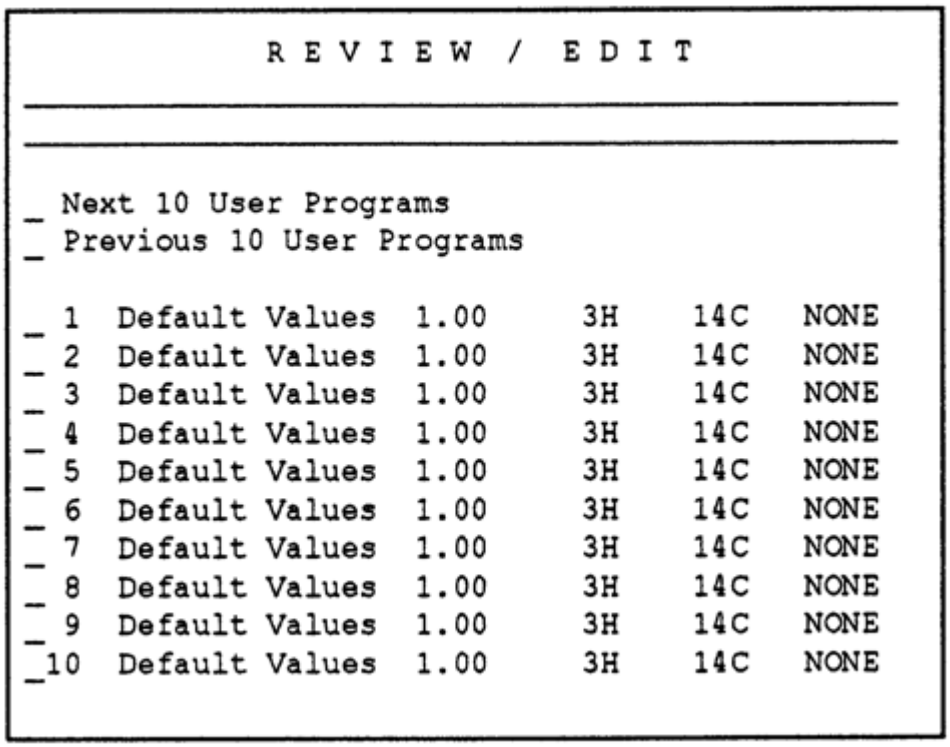
NOTE This section assumes you are familiar with the Operating Controls of the LS. If you are not familiar with these controls, refer to Section 2.3.

4.2 Editing A User Program

A series of menus are used to edit a User Program. Parameters are listed with the default value (a recommended or commonly used value), or if the program has been edited, the previously stored value. Pressing the HELP key at any of the prompts displays a pop up window with an explanation of

that selection, the allowable responses and the format, if information is to be typed in. The default values and allowable responses are also given in Figure 4.2.

Figure 4.3 Summary Screen of User Programs



To edit a User Program:

1. With the Main Menu displayed, highlight “Review and Edit User Program” and press **SELECT**. The menu shown in Figure 4.2 is displayed.

   This summary menu displays the number of the User Program, any identification names assigned to the User Program, the counting time and the isotopes.

2. User Programs 1—10 are presented on the first menu. To access other User Programs, highlight “Next 10 User Programs” or “Previous 10 User Programs” at the top of the menu and press **SELECT**. To edit or review a User Program, highlight the desired User Program, and press **SELECT** or type in the number of the User Program and press [ENTER].

3. Once a User Program is selected, the Review/Edit Menu shown in Figure 4.3 is displayed. The Supplementary Window shows a summary of the User Program (Figure 4.1).

   Editing may be performed in any order. Use the Up/Down Cursor Arrow keys and PREVIOUS MENU key to display the desired menus. If the default or previous entry is

acceptable, use the Down Cursor key to move to the next prompt. If the value is to be changed, follow the instructions in the Data Entry Window.

Figure 4.4 Review/Edit Menu 1

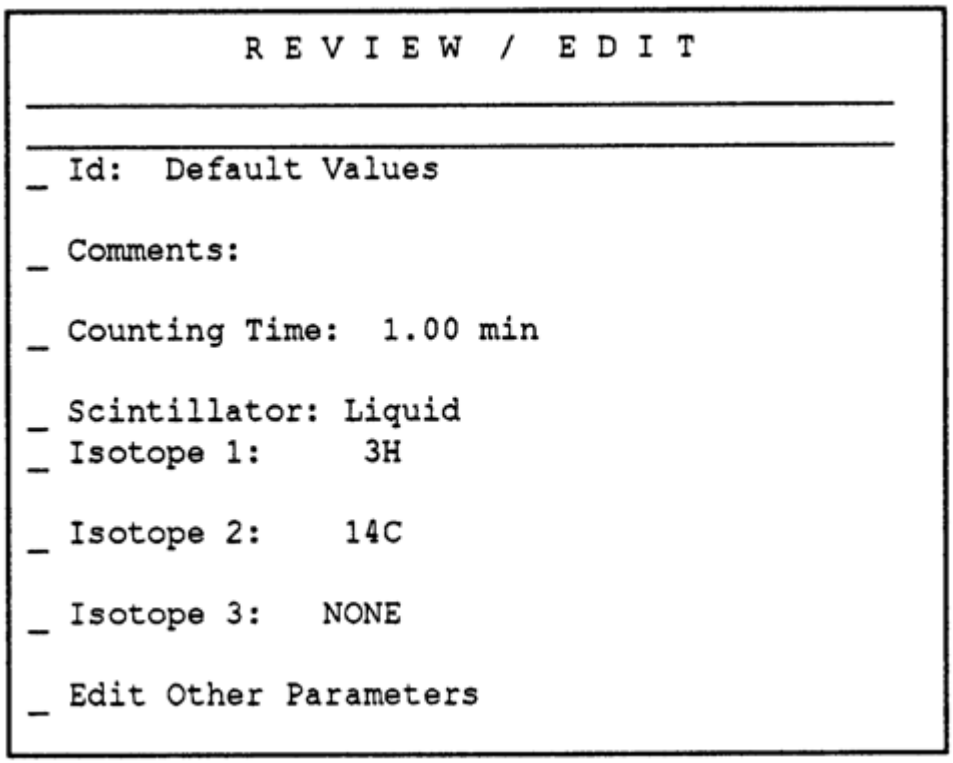
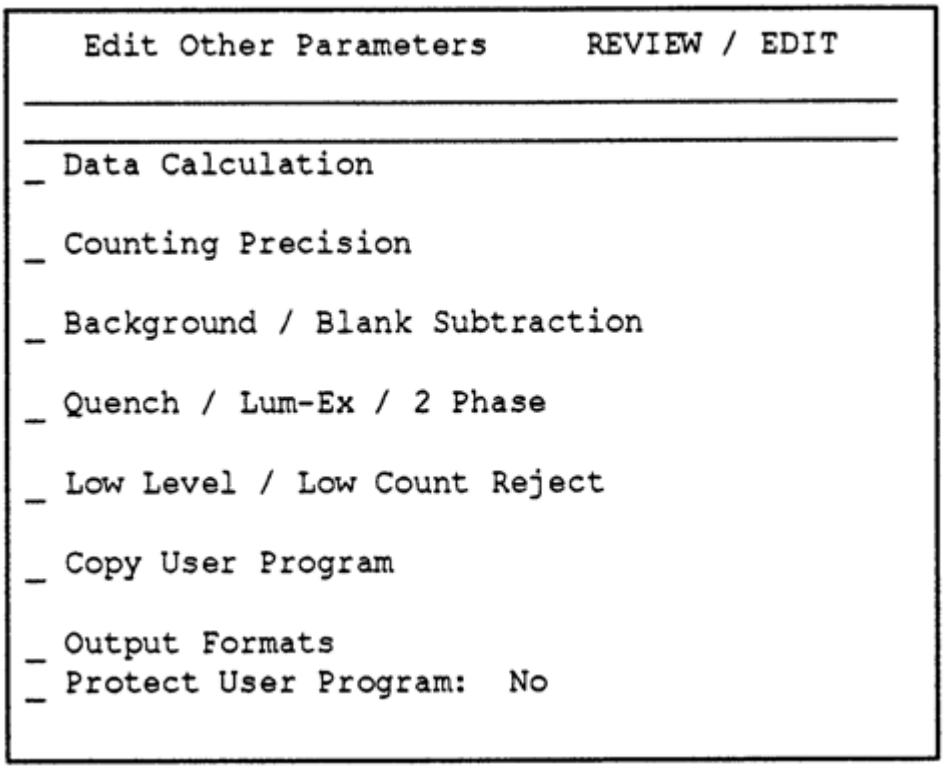


Figure 4.5 Review/Edit Menu 2



Continue onto the second Review/Edit Menu shown in Figure 4.4.Highlight "Edit Other Parameters" and press **SELECT**. Make any other desired changes.

Figure 4.1 gives the default values and allowable responses for the parameters of the User Program. Refer to ID Section 4 - Protect User Program Section 4 for more information on each parameter.

4. Press **CANCEL** if, after editing, you wish to retain the original User Program and return to the Main Menu. The changes are not stored.
5. When editing is complete and you want to store the program, press **MAIN MENU**. If any inconsistencies exist, the system returns to the first Review/Edit Menu (Figure 4.3) and displays an error message defining the problem and suggesting a correction. The inconsistency must be corrected before the User Program can be stored.
6. Make any necessary changes and press **MAIN MENU** again. The User Program is stored and ready for use when the Main Menu is displayed.

ID

ID provides a descriptive name for the User Program. This name is displayed on the summary screen of the User Program and is printed with the Program Summary. An ID is not required.

To change the identification, highlight "ID". Enter in the desired name using up to 15 characters.

Comments

The Comments line provides descriptive data that is printed in the program summary. A comment line is not required.

To enter or revise a comment, highlight "Comments". Enter your comments using up to 28 characters.

Counting Time

The counting time is the length of time each sample is counted. To change counting time, highlight "Counting Time". Enter the desired counting time in minutes.

NOTE Counting a sample may be terminated before reaching this selected counting time if the selected counting precision is achieved earlier. See Counting Precision Section 4 for more information on counting precision.

Liquid or Xtal Scintillator

Beckman instruments has developed Xtalsclnt^{tm} (pronounced crystalsclnt) products (Ready Cap™ and Ready Filter™ for counting samples using solid scintillators. When using a solid scintillator, setting the instrument to Xtal optimizes the counting conditions. The Data Calculation programs are set for use with solid scintillators and the Isotope Library is set to Xtal. When liquid is chosen as the scintillator, the system is optimized for liquid scintillators, and the Data Calculation programs and Isotope Library are set for liquid scintillator counting.

NOTE Xtal is not selected as the scintillator for counting samples on solid supports such as filters, if liquid scintillator cocktail is used to emulsify the sample.

To change the type of scintillator, highlight "Scintillator" and choose the desired value, Liquid or Xtal.

Isotope 1

Isotope 1 sets the counting window for the samples counted based on the settings stored in the Isotope Library for the Isotope selected. The isotopes displayed are either from the Liquid Isotope Library or the Xtal Isotope Library, depending on the choice for scintillator described in Liquid or Xtal Scintillator Section 4. Refer to Section 6.1 for more information on the Isotope Library.

To change the selected Isotope, highlight "Isotope 1". The Isotopes stored in the Isotope Library are displayed in the Data

Entry Window: ^{3}H; ^{125}I; ^{14}C; ^{35}S; ^{32}P; Manual; Wide; and SPM (if installed). Any Isotopes added to the Isotope Library are displayed also. Choose the desired Isotope from the list.

NOTE If the isotope you wish to count is not listed, return to the Main Menu and set up the isotope using New Isotope Setup. Refer to Section for adding an isotope to the library.

Choose Wide when you want to count the entire energy spectrum. Choose Manual to enter in the desired window settings. A prompt appears under Isotope selection when Manual is selected. Highlight the prompt and enter the desired window settings in the format shown: 0— 1000 channels (or 2000 Key). The scale used is determined by the parameter set for Energy Scale in System Setup. Refer to Section for more information on Energy Scale.

Choose SPM (if installed) if you want to do single photon counting. The User Program is modified for single photon counting. These parameters are not available: Quench Monitor; Lum-Ex Correction (if installed); 2 Phase (if installed); and Counting Precision. The Data Calculation program defaults to the Single Photon Program. Refer to Section 5.9 for more information on single photon monitoring.

Isotope 2 and Isotope 3

The procedure for setting up Isotope 2 and Isotope 3 is identical to that of Isotope 1 except the list of choices includes NONE. SPM is not included.

For single label studies, choose NONE for Isotopes 2. The prompt for Isotope 3 is not displayed when Isotope 2 is set to None.

For dual label studies, choose Isotope 1 as the lower energy isotope and Isotope 2 as the higher energy isotope. The lower limit for Isotope 2 is set the same as the upper limit for Isotope 1. Choose Isotope 3 as None.

For triple label studies, set up Isotope 3 as the highest energy isotope. The lower limit for Isotope 3 is set the same as the upper limit for Isotope 2.

Edit Other Parameters

If no further editing is desired, press **MAIN MENU**. If any inconsistencies exist, a pop up window displays the error message defining the problem and suggesting a correction. The error must be corrected before proceeding.

Figure 4.6 Data Calculation Programs/Liquid.

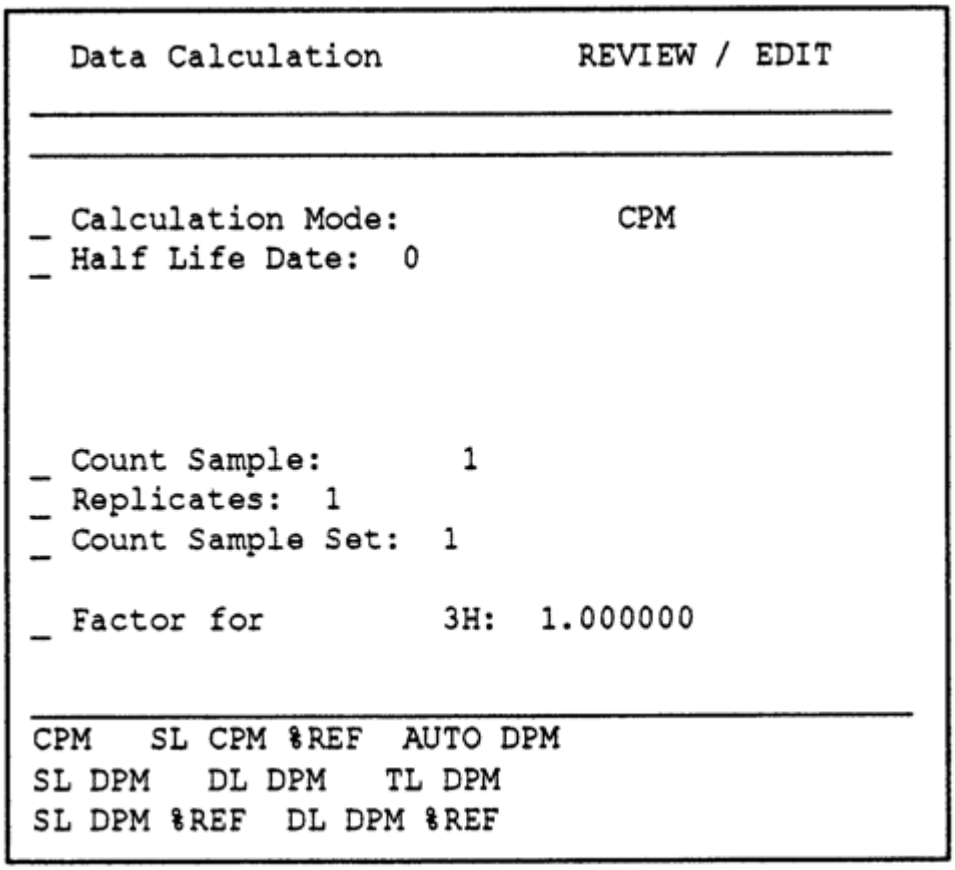
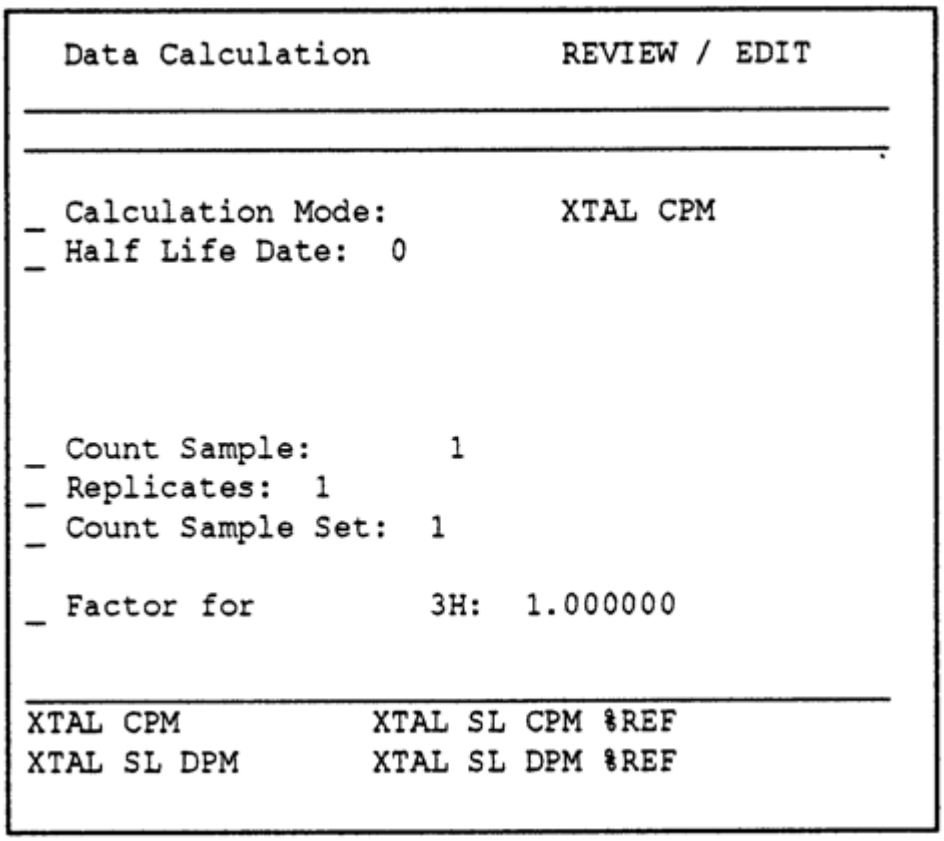


Figure 4.7 Data Calculation Programs /Xtal



To edit the other parameters, highlight "Edit Other Parameters", and press **SELECT**. The menu shown in Figure 4.4 is displayed.

Data Calculation

Data Calculation provides selection of programs for processing the data. Data Calculation is also used to choose the number of times each sample is counted, the number of times the sample set is counted, the number of replicates, and the use of a factor to normalize the data.

To change the Data Calculation program, press **SELECT**. The Review/Edit Menus for Data Calculation programs are shown in Figure 4.5. If Liquid is chosen as the scintillator, the menu in Figure 4.6 is presented. If Xtal is chosen as the scintillator, the menu in Figure 4.7 is presented. Some of the Data Calculation programs shown here may not be installed on your instrument. If they are not displayed, they are not installed.

Refer to Section 5 for information on setting up the Data Calculation Programs. Press **PREVIOUS MENU** to return to the Review/Edit Menu shown in Figure 4.4.

NOTE When Single Photon is chosen as Isotope 1, the default program for Single Photon is displayed. It cannot be changed, except by choosing another isotope.

Counting Precision

Counting to a preset counting precision is used so all results have the same precision, eliminating one source of variation in the experiment. The value entered for counting precision establishes the 95% confidence level for the count (the 2 sigma statistical value). A value of 2.00% indicates that in 95 out of 100 cases, the counts per minute obtained are within 2% of the mean, and in the remaining 5 cases may be outside that 2%. This results from the randomness of the radioactive decay process, and not from any variation within the instrument.

The relationship between counting precision/total counts is:

Counting Precision,%	Total Counts
20	100
15	177
10	400
5	1,600
2	10,000
1	40,000
0.5	160,000
0.2	1,000,000

When sufficient counts have been accumulated to yield the counting precision specified, counting of that sample is terminated even if the specified counting time has not been satisfied. For dual and triple label, the counting precision must be reached for all isotopes selected before the count is terminated. If the counting time is reached before obtaining the specified counting precision, counting is terminated. The printout shows the value of counting precision achieved.

To change the setting, highlight "Counting Precision" and press **SELECT**. The Main Editing Window presents prompts to enter the counting precision for each isotope selected. Enter the desired counting precision for each isotope. A counting precision of "0" results in counting to the count time entered. Press **PREVIOUS MENU** to return to the Review/Edit Menu shown in Figure 4.4.

Background/Blank Subtraction

Two methods are available for subtracting values from the unknown samples being counted; background subtraction or counting blanks. A separate background and/or blank value may be subtracted for each isotope.

A background is a value obtained from a count performed in advance. For correct results, the background must be counted with the same User Program used to count the samples. Since the background is counted separately, it can be counted for a long time to obtain an accurate value. The background cpm and the background counting precision are then entered manually into the User Program. These values are used to accurately correct each sample value, including the blanks, for contributions from background.

Blanks are samples that are counted at the beginning of your unknown samples, and the value of the blanks are subtracted from each of the subsequent samples. Blanks are counted along with the samples, and have the same counting time and counting precision as the samples. The counting precision obtained when the blank is counted is used to correct the precision of the unknown samples.

To change the settings, highlight "Background /Blank Subtraction" and press **SELECT**. The Main Editing Window displays prompts to count the blanks and to enter values for Back-ground. Blanks and/or backgrounds may be used.

To change the setting for blanks, highlight "Count Blanks" and choose Yes or No. To change the background values, highlight the background for each isotope and enter the cpm and counting precision from a previously counted background sample. The counting precision must be entered as a 2 sigma value. Press **PREVIOUS MENU** to return to the Review/Edit Menu shown in Figure 4.4.

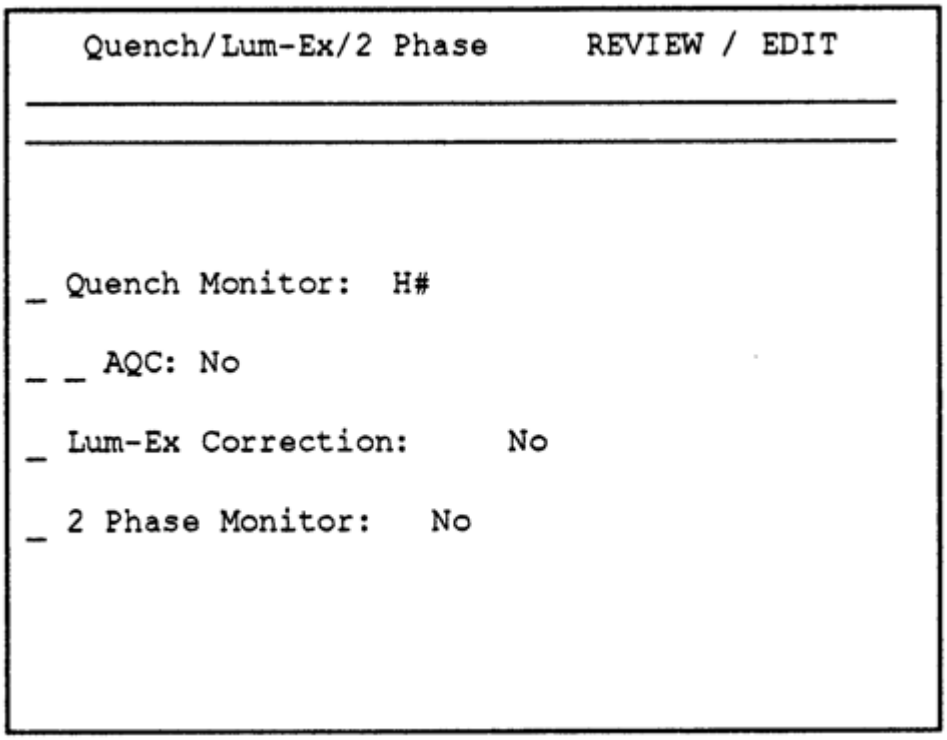
NOTE Blank vial(s), if selected, must be loaded in the first position of the first rack, followed by an empty space. Refer to Section 5 for loading sequences using blanks.

Quench

Quench reduces the light output from the sample and hence affects the accuracy of the cpm. Quench may result from color in the sample or from chemicals that affect energy transfer in the cocktail. The instrument provides a Quench Monitor, which determines the extent of quench in the sample and prints out a number which is proportional to the amount of quench. Two methods of monitoring quench are available; IC# and H# Plus (if installed). When H# Plus is installed, Automatic Quench Compensation (AQC), a method of automatically adjusting the window settings as a function of quench, is available. This adjustment in window settings, based on the value of H#, is performed to keep the spill of the

higher energy isotope into the lower energy isotope window essentially constant. It is selectable.

Figure 4.8 Quench/Lum-Ex/2Phase Selection Menu.



To change the settings, highlight "Quench/Lum-Ex/2Phase" and press **SELECT**. The menu shown in Figure 4.8 is displayed. Choose the desired quench monitor. If H# is chosen, choose AQC On (Yes) or Off (No). If no other changes are desired, press **PREVIOUS MENU** to return to the menu shown in Figure 4.4.

NOTE If a Dual or Triple Label DPM program is selected, the quench monitor is automatically set to H# and AQC is turned on. This cannot be changed. When Xtal is selected as the scintillator, or when Xtal DPM program is selected, H# and AQC are not available.

Lum-Ex Correction

Lum-Ex Correction provides a means of distinguishing between counts of actual radioactive disintegrations within the sample and other light-producing events, such as chemiluminescence. The % of the total count rate that is luminescence is always printed *as* % Lum-Ex on the printout whether it is selected On or Off. When Lum-Ex Correction is selected On, the luminescence counts in the counting window of each isotope are subtracted.

To change the setting, highlight "Quench/Lum-Ex/2Phase" and press **SELECT**. The menu shown in Figure 4.8 is displayed. Highlight "Lum-Ex Correction" (if installed) and choose NO *(Off)* or YES (On). If no other changes are desired, press **PREVIOUS MENU** to display the Review/Edit Menu shown in Figure 4.4.

Phase Monitor

The 2 Phase Monitor detects and flags samples that have separated into two phases. A two phase sample may yield inaccurate counting data. The sample may be thoroughly emulsified when placed in the instrument, and may separate while waiting to be counted. Sometimes the two phases are visually distinct. In other cases the only difference seen is a slight haze. When plastic vials are used, even a distinct separation is not visible. If the sample and LS cocktail separate into two distinct phases, the counting results may be invalid. When 2 Phase is selected On, a warning is printed as 2P on the printout under the column heading 2Phase, if phase separation has occurred. The sample is still counted.

To change the setting, highlight "Quench/Lum-Ex/2Phase" and press **SELECT**. The menu shown in Figure 4.8 is displayed. Highlight "2 Phase Monitor" (if installed) and choose NO (Off) or YES (On). If no other changes are desired, press **PREVIOUS MENU** to display the Review/Edit Menu shown in Figure 4.4.

NOTE H# must be selected when 2 Phase Monitor is On. The minimu.m sample volume is 2.5 mL.

Low Level

Low Level provides a method of reducing the background counts caused by cosmic ray interaction with glass in the counting chamber. Typically, the background of the unquenched back-ground standard supplied with the instrument is reduced *50%* when Low Level is used.

To change the setting, highlight "Low Level/Low Count Reject" and press **SELECT**. The Main Editing Window displays two prompts. Highlight "Low Level Count Option" (if installed) and choose Off or On. Press **PREVIOUS MENU** to display the Review/Edit Menu shown in Figure 4.4.

NOTE Low Level is not available when Xtal is selected as the scintillator, or when Auto DPM Data Calculation program is selected.

Low Count Reject

Low Sample Reject is provided to avoid excessive time counting samples with little or no radioactivity, if these samples are not of interest. When Low Sample Reject is On, the sample is monitored during the first 6 seconds of count time and then monitored every 3 seconds. If the level of radioactivity in the sample is below the value entered for Low Count Reject during any 3 second update, the sample count is terminated, the data printed, and the next sample counted. The sample is rejected only if the cpm value is below the established value for all isotopes selected.

To change the setting, highlight "Low Level/Low Count Reject" and press **SELECT**. The Main Editing Window displays two prompts. Highlight "Low Count Reject Threshold", and enter the cpm of the threshold for low count reject. A zero turns Low Count Reject off. Press **PREVIOUS MENU** to display the Re-view/Edit Menu shown in Figure 4.4.

Output Formats

The Output Format is dependent upon the Data Calculation Program selected. Standard print formats for each of the Data Calculation Programs are given in the respective sections in Section 5. The format of the printout can be customized to your requirements. The Edit Formats are described in this section. If the RS232 port and/or the disk are installed, the output formats for these can also be edited, as described in this section.

To change the settings, highlight "Output Formats" and press **SELECT**. The Main Editing Window displays three prompts:

Printer Format, RS232 Format (optional) and Disk File Format (optional). The formats are identical in setup. Highlight "Printer Format", "RS232 Format" or "Disk File Format" and highlight one of the choices: Standard, Edit or Off. "Off" cannot be selected for all three locations. That is, data must be output to at least one of the three locations.

If data from your instrument is being sent out the R5232 port to a computer or data-logging device or to the data buffer for disk storage, you may prefer that the instrument printer not produce a hard-copy of the results. In this case, choose Printer Format: Off.

To select what appears on the printout, is transmitted out the RS232 port or is stored in the data buffer, choose Edit. A number of menus are presented with choices of items for your selection. The items presented are dependent upon the features installed on your instrument and the Data Calculation Program selected. The menus displayed for a cpm program are shown in Figure 4.9, Figure 4.10 and Figure 4.11. Figure 4.2 shows all the allowable choices. Refer to Collecting Spectral Data below for more information on obtaining spectra under Edit Format.

NOTE Data file storage on a disk is an option. Refer to Section 2 of the Operating Manual for the Data Buffer and Transfer System, Beckman Instructions 015-510642, for specific information about the formats available for disk file storage.

Figure 4.9 Menu 1 for Edit Format: CPM.

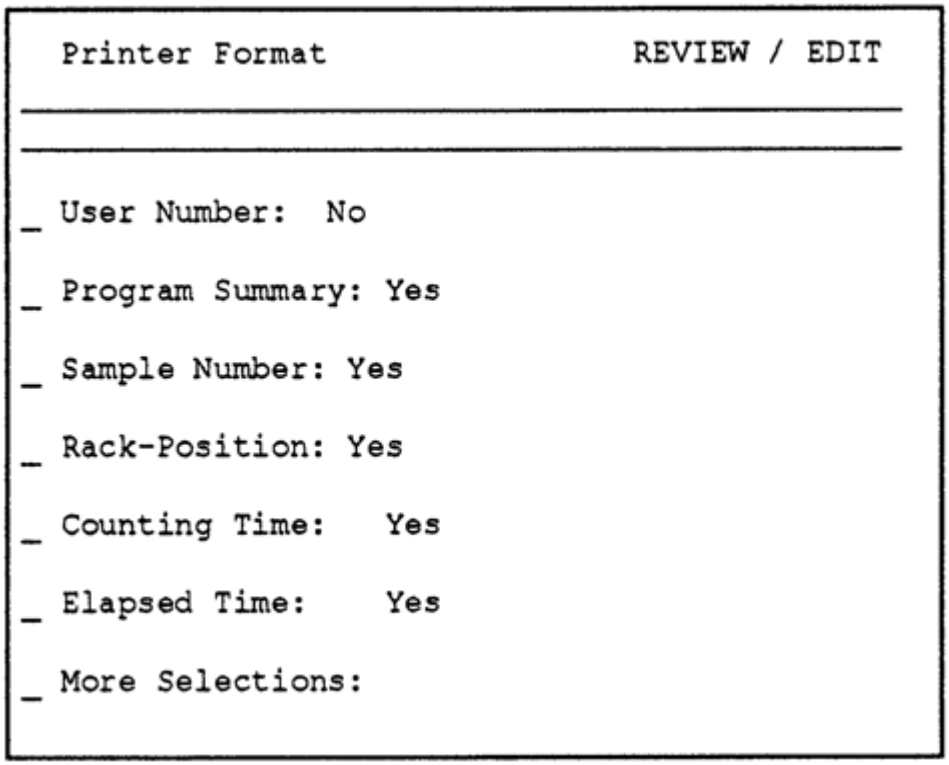


Figure 4.10 Menu 2 for Edit Format: CPM.

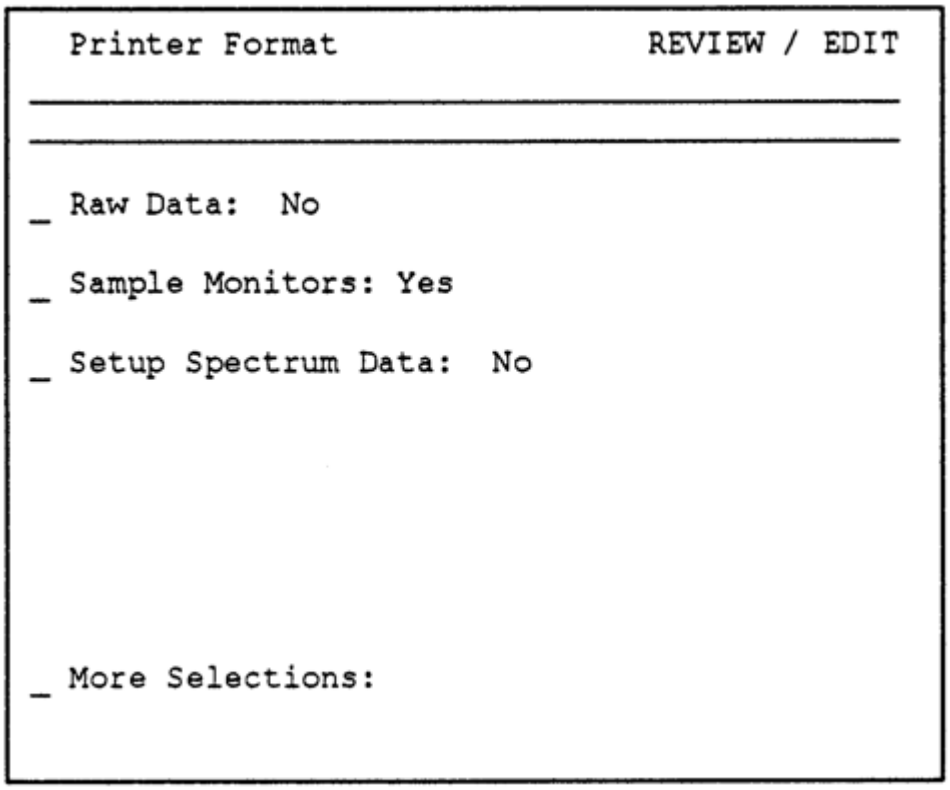


Figure 4.11 Menu 3 for Edit Format: CPM.

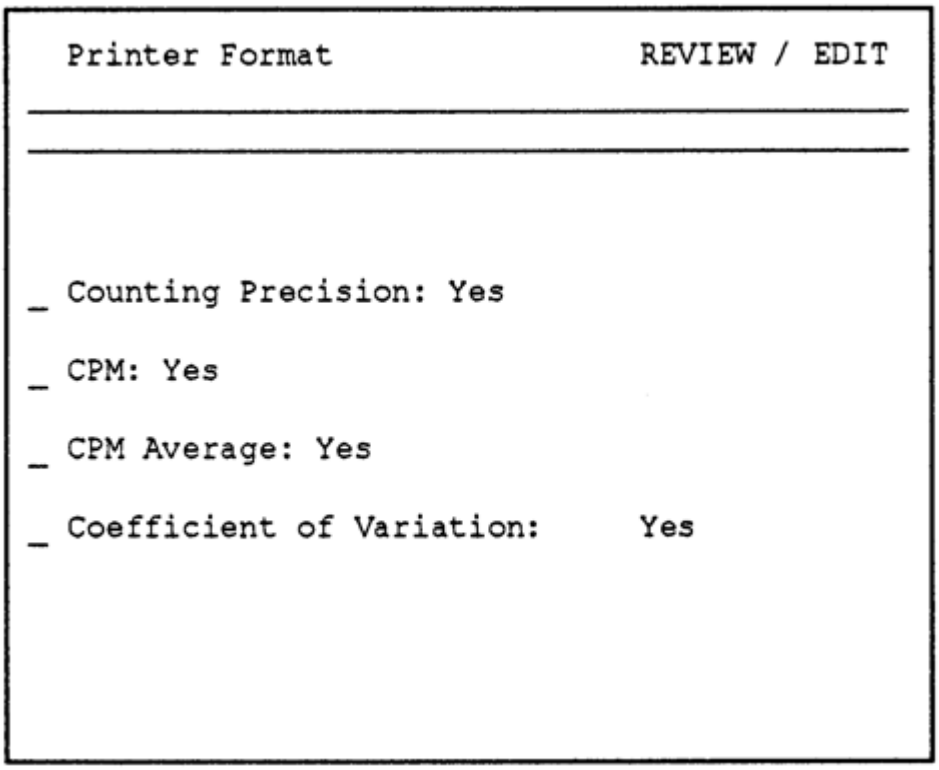


Table 4.1 List of Selectable R5232 Items

List of Selectable Parameters For Edit Format

Record Keeping Parameters	Count Data
User Number	Raw Data
Sample Number	CPM
Rack-Position Number	% Reference
Program Summary	DPM
Elapsed Time	
Sample Monitors	**Sample Processing**
Quench Monitor (H# or IC#)	Sample Repeats
Sample Monitors (Lum-Ex, 2P)	Sample Replicate Factors

Table 4.1 List of Selectable R5232 Items

List of Selectable Parameters For Edit Format

Counting Efficiency	Count Time DPM Ratio
Statistics	**Spectral Data**
Means*	Sample Spectrum Energy Data
Coefficient of Variation*	Compton Spectrum Energy Data
Counting Precision	Sample Spectrum Channel Data
	Compton Spectrum Channel Data

*Means and Coefficients of Variance are computed for sample repeats, replicates, blanks and Reference samples. Those transmitted are determined by the selections in the User Program.

The Program Summary Includes:

Replicates	Printer Format
User Number	Count Precision
Factor	Quench Monitor
Program ID	Count Blank
Data Calculation	Lum-Ex
Count Time	Background Subtract
%REF, DPM	Sample Repeats
2 Phase	Half-life
Cycle Repeats	
RS232	

To select an item to include on the printout, highlight the desired item and choose Yes. The order of the items is predetermined and cannot be changed. All sample data are printed on one line, with print size automatically set to 80, 96 or 132 characters per line, as required. If the characters per line exceeds 132 characters, then one line of data per isotope is printed.

Collecting Spectral Data

Both sample and Compton spectral data may be obtained from the multi-channel analyzer (MCA) either as a routine part of a general counting program or by itself (no other type of data is collected). If spectral data are needed for only part of a particular sample set, then it is convenient to divide the set into two groups: those requiring spectral data and those which do not. Set up two User Programs with identical counting programs. Under one User Program set up Edit Format with Spectral Data. This permits the original sample set to be counted under identical conditions as the set counted to obtain Spectral Data only.

Either Sample or Compton Spectrum, neither spectrum or both spectra may be transmitted. Each spectral type may be transmitted as a function of energy (E), Log E, or both. The data may be printed or sent to the RS232 port.

The number of channels transmitted for a sample spectrum is always equal to the width of the window in the Isotope Library plus 10%. For example, if the window in the Isotope Library covers 300 channels in the multi-channel analyzer, then the number of channels transmitted is 330. If two or more isotopes are counted, then the window of the higher energy isotope controls the number of channels transmitted. The end-point of the Compton Spectrum determines its width for trans-mission. When Wide is selected as the isotope, all channels of data are transmitted.

To select spectral data:

1. Highlight Output Format for Printer or RS232, and choose Edit. The menu shown in Figure 4.9 is displayed. You may choose any other parameters desired. This section describes collecting spectral data only.
2. Press the Down Cursor key until the menu shown in Figure 4.10 is displayed.
3. Highlight "Setup Spectrum Data Output" and press **SELECT**. The screen displays two prompts: Sample Spectrum Data and Compton Spectrum Data.
4. Highlight the desired prompts, choose Linear, Log or Both and press **SELECT**.
5. When editing is complete, press **PREVIOUS MENU** or **MAIN MENU**.

Protect User Program

If you do not want any one to change this program inadvertently, you can protect this User Program. Highlight "Protect User Program" and choose Yes. To unprotect a User Program, permitting changes, choose No.

NOTE A protected User Program can be copied and then changed under the new User Number.

4.3 Copy User Program

You may have previously set up a program and want to create a new program with only minor differences from the original (and still retain the original). You can copy the original program into another User Program and then modify it, without having to enter all the parameters from the beginning.

To copy a program:

1. From the Main Menu, highlight "Edit and Review User Program" and press **SELECT**. The Summary Screen of User Programs (Figure 4.2) is displayed.
2. Select the User Program in which to store the modified program. The Review/Edit Menu shown in Figure 4.3 is displayed.
3. Highlight "Edit Other Parameters" and press **SELECT**. The Review/Edit Menu shown in Figure 4.4 is displayed.
4. Highlight "Copy User Program". Enter the User Program number you wish to copy. That program is copied into the displayed User Program. The Supplementary Window shows the program summary. Edit the program as described in ID Section 4 to Protect User

Program Section 4. The program copied is still stored under its original program number.

Data Calculation

5.1 Introduction

The Data Calculation programs are divided into two groups depending on the type of scintillator selected in the User Pro-gram. When Xtal is selected as the scintillator, Xtal precedes the Data Calculation program. The following Data Calculation programs are provided.

CPM/Xtal CPM

For each sample count, divides total counts by counting time and records the resulting counts per minute

Single Label CPM % of Reference/Xtal SL % of Reference

Divides the result of each sample count by the count obtained from a reference sample, and records the cpm results as well as the percentage of the reference

Single, Dual or Triple Label DPM/Xtal SL DPM

If installed, corrects for counting efficiency to produce results that represent the actual number of disintegrations per minute in the sample

Single or Dual Label DPM % of Reference/Xtal SL DPM % of Reference

If installed, corrects for counting efficiency to produce results that represent the actual number of disintegrations per minute in the sample and records the dpm results as well as the percentage of the reference

Auto DPM

Corrects for counting efficiency to produce results that represent the actual number of disintegrations per minute in single label samples of a pure beta emitting isotope without the need for quench curves

Single Photon Monitor

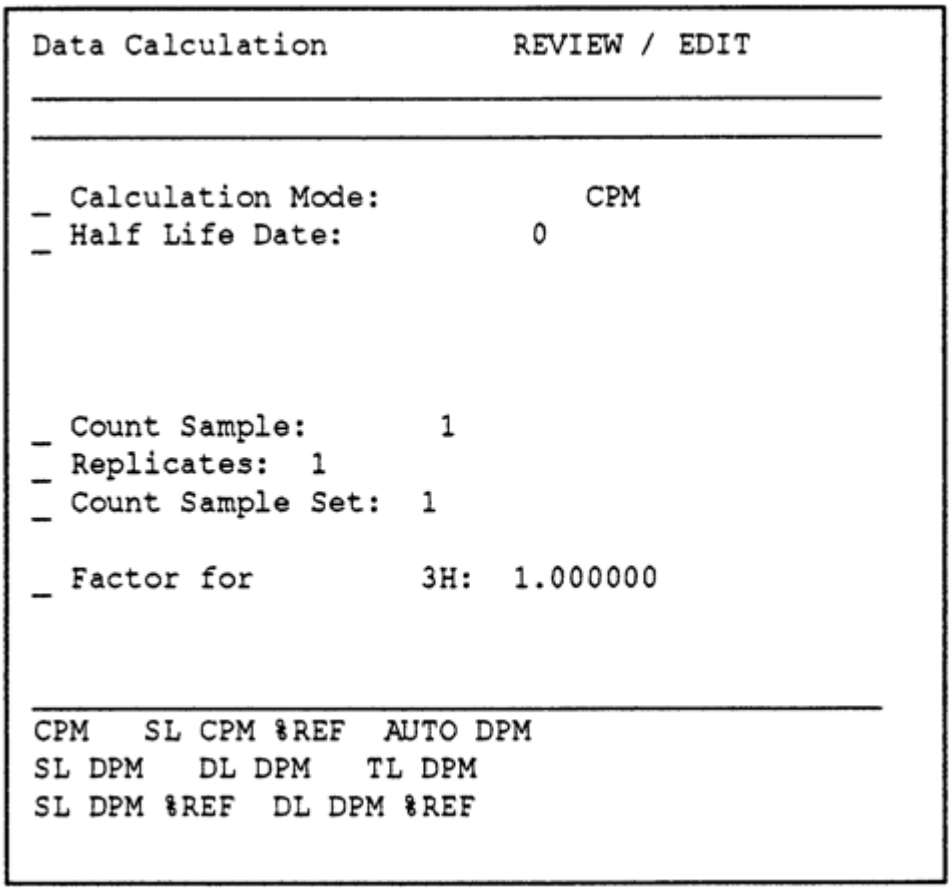
If installed, provides counting of single-photon events, such as occur in chemilumlnescence or bioluminescence studies

In addition to calculation program, Data Calculation provides the following capabilities:

- Half-life correction of the samples to any date
- Repeated counts of each sample to minimize statistical variation
- The use of replicates to minimize experimental variation
- Number of times to count the sample set to minimize statistical variation
- The use of a multiplying factor to normalize results for each Isotope

Procedures for setting up the data calculation programs are presented in this section. Figure 5.1 shows a Data Calculation Menu. Refer to Data Calculation Section 4 for information on calling up the Data Calculation Menu when editing a User Program.

Figure 5.1 The Data Calculation Menu



NOTE This section assumes you are familiar with the operating controls of the LS and you are familiar with editing a User Program if you are not familiar with the operating controls, refer to Section 2.3. For information on editing a User Program, refer to Section 4.

5.2 CPM/Xtal CPM

CPM is the basic calculation mode. On completion of the count, the system divides the total counts by the time, obtaining a value representing the counts per minute. Blanks and back-ground can be subtracted, if selected in the User Program as described in Background/Blank Subtraction Section 4.

Setting Up CPM/Xtal CPM

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose CPM or Xtal CPM. The following parameters are available.

Half-Life Correction

Sample data can be half-life corrected to the standardization date of the isotopes used in the samples. This date is printed by the manufacturer on the label of the isotope container. If a date is not entered (a zero is entered), then half-life correction is calculated from the start of the count cycle. A half-life for the isotope must be stored in Isotope Library to obtain half-life correction. For accurate half-life correction, the real time clock in the instrument must be set to the correct date and time. Refer to Auto DPM Section 2 for setting the clock.

To enter the half-life correction date of an isotope, highlight "Half Life Date" for that isotope and enter the required date in this format: dd mmm yyyy hr:min(2 digits for day, a 3 letter code for month, and 4 digits for the year, 2 digits for the hour and 2 digits for the minutes).

NOTE When a CPM/Xtal CPM or SL CPM % of Reference/Xtal SL CPM % of Reference program is selected, half-life correction is only performed for single label samples. When Wide or Manual is selected as an isotope, half-life correction is not performed on the data from that window.

Count Sample

This feature provides repeated counts of each sample, and is useful to detect static problems, two-phase samples, sample precipitation or any time-dependent sample variations. Refer to Section 7 for more information on how these sample preparation problems affect the results. When a value greater than one is entered, the printout shows the results of each sample count, the average, and the coefficient of variation (CV).

To change the number of times to count the sample, highlight "Count Sample" and enter the desired number of times to count the sample.

Replicates

This feature makes it possible to run experimental samples in replicate to detect experimental variation and to average out pipetting variations. For example, experiments may be set up in duplicate (two samples per data point), triplicate (three samples per data point), etc.

The printout for replicate counts includes individual counts, the average for the vials in each replicate group, and the coefficient of variation (CV). Sample repeats and replicates can be used together.

To change the number of replicates, highlight "Replicates" and enter the number of sample replicates.

Count Sample Set

The entire set of samples can be recounted a number of times. When another User Number Card or Halt Card is detected, the sample changer backs up to the beginning of the sample set and recounts the samples. This is repeated until the entry for Count Sample Set is satisfied.

To change the number of times to count the sample set, highlight "Count Sample Set' and enter the desired number.

Factor

This feature enables you to obtain a printout in which the final results (cpm, dpm, or % of Reference values) have been multi-plied by a constant:

CPM X Factor = Final Answer Printed Out

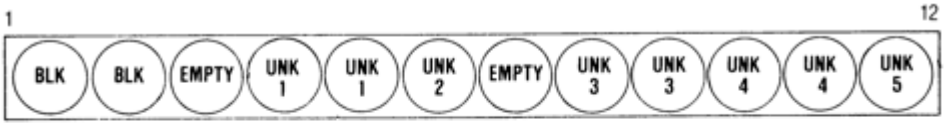
To change the factor for any isotope, highlight “Factor” for that isotope and enter the new factor. The factor may have a maximum of nine digits and decimal point. Values greater than or less than this range may be entered as an exponential using a 10 character field. For example, the number 1.0623 X 10- is entered as 1.0623E 23•

Loading Samples for CPM/Xtal CPM

An example loading sequence for a cpm program using blanks and replicates is shown in Figure 5.2.

When loading samples for cpm, if blanks or replicates are not used, the samples may be loaded in any manner desired. If blanks are specified in the User Program as described in ID Section 4, the blanks must be loaded first. Any number of blanks may be used. After the blanks, an empty space is used, signal-ling the instrument that samples follow. Load the samples after the empty space.

Figure 5.2 Loading Sequence for CPM.



BLK = Blank
UNK = Unknown
EMPTY = No Vial in the Rack Position

Experiment in Duplicate; One UNK 2 Replicate Missing

Figure 5.3 Typical Printout for CPM in Standard Format.

PAGE: 1

I D : C P M 11 AUG 1989 17:59
USER: 2 COMMENT:
PRESET TIME : 1.00
DATA CALC : CPM H# : NO SAMPLE REPEATS: 1 PRINTER :EDIT
COUNT BLANK : NO IC# :YES REPLICATES : 1 RS232 : OFF
TWO PHASE : NO LUMEX: NO CYCLE REPEATS : 1
SCINTILLATOR: LIQUID LOW SAMPLE REJ: 0
LOW LEVEL : 0

ISOTOPE 1: 3H %ERROR: 0.00 FACTOR:1.0000 BKG. SUB: 0

SAM NO	POS	TIME MIN	IC#	3 H CPM	3 H %ERROR	1 4 C CPM	1 4 C %ERROR	LUMEX %	ELAPSED TIME
1	**-1	1.00	8.265	245785.0	0.40	1745.00	4.66	0.00	1.32
2	**-2	1.00	6.815	228726.0	0.42	122.00	13.42	0.00	2.71
3	**-3	1.00	2.277	20026.00	1.41	0.00	63.25	0.02	4.02

If you are using replicates, the replicates must be loaded in adjacent positions. To indicate that one or more replicates are missing from a group, leave only one empty position; the system recognizes the vial following the empty space as being the first replicate of the next set.

NOTE Do not leave an empty space for each missing replicate. One empty space indicates to the system that a new group of replicates follows.

Results for CPM/Xtal CPM

To count the samples, refer to Section 3.2. A typical printout for CPM in standard format is shown in Figure 5.3.

5.3 SL CPM % of Reference/Xtal SL CPM % of Reference

The Single Label CPM % of Reference program is used for any type of single label experiment that requires dividing each of the unknowns by a reference, yielding a percent value. Blanks and backgrounds can be subtracted if selected in the User Program.

$$\% \text{ Ref} = \frac{\text{Sample CPM - Blank CPM x 100 x Factor}}{\text{Reference CPM - Blank CPM}}$$

Setting Up SL CPM % of Reference! Xtal SL CPM % of Reference

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose “SL CPM %REF’ or ‘XTAL SL CPM %REF”. The prompts displayed on the menu when either program is selected are the same as described for the CPM program. Refer to Setting Up

CPM/Xtal CPM Section 5 for information on these prompts. In addition, a prompt to set the units is provided. This prompt is described below.

Units

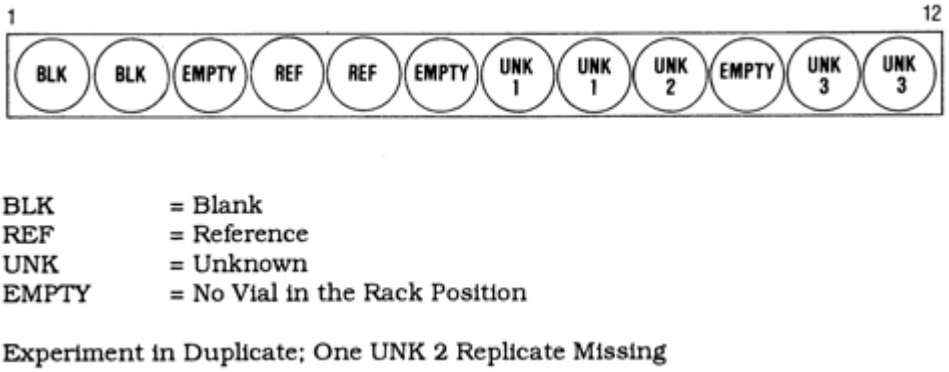
Units allows you to enter units or any name you want printed as the final results. This name is used in place of the %REF heading in the printout.

To change the setting, highlight "Units" and enter the desired name using up to 5 characters.

Loading Samples for SL CPM % of Reference/Xtal SL CPM % of Reference

Since the instrument has no way of distinguishing among blanks, references, and unknowns, a convention has been established for identifying them by the sequence in which they are loaded. An example loading sequence is shown in Figure 5.4.

Figure 5.4 ***Loading Sequence for SL % of Reference.***



If blanks are specified in the User Program as described in Background/Blank Subtraction Section 4, the blanks are loaded first. Blanks are optional. Any number of blanks may be used. The average is printed. Leave an empty space between the last blank and first reference; this indicates to the instrument that the next vial encountered is a reference.

Reference standards follow the blanks. Any number of replicates of the reference standard may be used. If more than one reference is used, the system computes the average. Leave an empty space following the last reference. References must be used.

Unknowns follow the references. If you are using replicates, the replicates must be loaded in adjacent positions. To indicate that one or more of replicates are missing from a group, leave one empty position; the system recognizes the vial following the empty space as being the first replicate of the next set.

NOTE Do not leave an empty space for each missing replicate. One empty space indicates to the system that a new group of replicates follows.

Figure 5.5 Typical Printout for SL CPM % of Reference

```
                                                                        PAGE: 1

I D : S L   P R C T   R E F                              21 AUG 1989 19:02
USER: 9                COMMENT:EXP 1
PRESET TIME :       1.00
DATA CALC   :       %REF  H#   : NO  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :        YES  IC#  :YES  REPLICATES    :   2    RS232        : OFF
TWO PHASE   :         NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:     LIQUID  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :        OFF  HALF LIFE CORRECTION DATE:  21 AUG 1975 12:10

ISOTOPE 1:   14C  %ERROR: 0.00  FACTOR:1.0000  BKG. SUB:      0

SAM  POS   TIME   IC#  _______1 4 C___  %REF   LUMEX  ELAPSED
 NO         MIN            CPM  %ERROR           %      TIME

B1   3-1    1.00 511.9     27.00  38.49          2.20     1.22
B2   3-2    1.00 627.1     34.00  34.30          1.42     2.59
          Blank Average CPM for    14C     30.50  COEF. OF VAR:   16.229

R1   3-4    1.00 47.48  148397.5   0.52          0.00     3.99
R2   3-5    1.00 53.58  149427.5   0.52          0.00     5.34
          Reference Average CPM for    14C   148912.5  COEF. OF VAR:    0.490

  1  3-7    1.00 27.03  143559.5   0.53  96.41   0.00     6.71
  1  3-8    1.00 26.44  142047.5   0.53  95.39   0.00     8.06
          Replicate Average CPM for    14C  142803.5  COEF. OF VAR:    0.749

           Average %REF for    14C   95.90

  2  3-9    1.00 12.51  127383.5   0.56  85.54   0.00     9.64
  2  3-10   1.00 12.01  126123.5   0.56  84.70   0.00    10.97
          Replicate Average CPM for    14C  126753.5  COEF. OF VAR:    0.703

           Average %REF for    14C   85.12
```

Results for SL CPM % of Reference/Xtal SL CPM % of Reference

To count the samples, refer to Section 3.2. A sample printout for % of Reference in Standard Format is shown in Figure 5.5. The calculated result is shown under the % Ref column heading.

5.4 Auto DPM

Single label DPM for pure beta emitting isotopes (i.e. H, C, 32 35 4586 5, Ca or Rb) can be determined without a quench curve using this program. IC# or H# Plus (if installed) can be used. If H# Plus is used, the applicable quench range for tritium is extended. Samples can be chemically quenched and half-life corrections can be made.

NOTE Auto DPM can also be performed using the Command Card, Auto DPM. Refer to Section 3.4 for more information on Auto DPM.

Setting Up Auto DPM

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose "Auto DPM". The prompts displayed for this program are the same as described for CPM. Refer to Setting Up CPM/Xtal CPM Section 5 for information on setting these prompts.

Loading Samples for Auto DPM

The same loading sequence used for CPM is used for DPM. Refer to Loading Samples for CPM/Xtal CPM Section 5.

Figure 5.6 Typical Printout for Auto DPM.

PAGE: 1

```
I D : a u t o   d p m   r a c k                          21 AUG 1989 18:22
USER: 0                  COMMENT:
PRESET TIME :       10.00
DATA CALC   :   AUTO DPM  H#   :YES  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :         NO  IC#  : NO  REPLICATES    :   1    RS232        : OFF
TWO PHASE   :         NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:     LIQUID  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :        OFF

ISOTOPE 1:  WIDE  %ERROR: 0.50  FACTOR:1.0000  BKG. SUB:      0

SAM  POS    TIME    H#      W I D E       WIDE    WIDE  LUMEX  ELAPSED
 NO         MIN              CPM  %ERROR    DPM    EFF-1    %      TIME

  1  3-1   1.57  57.4   107269.7   0.49  186329.2   57.57   0.02     2.48
  2  3-2   1.57  87.8   105036.0   0.49  207008.3   50.74   0.00     5.26
  3  3-3   1.57  50.6   104744.8   0.49  177654.0   58.96   0.02     8.08
  4  3-4   1.57 132.7   105212.7   0.49  266159.1   39.53   0.01    10.93
```

Results for Auto DPM

To count the samples, refer to Section 3.4. It is recommended that Auto Calibration be performed before the samples are counted. A typical printout in standard format for Auto DPM is shown in Figure 5.6.

5.5 DPM

The Counts per Minute (CPM) Program provides a measure of the activity as observed by the instrument. The Disintegrations per Minute (DPM) Program provides a measure of the absolute activity within the sample.

When CPM data is used, It is assumed that the counting efficiency of all samples is the same. In practice, however, counting efficiency is affected by a wide range of factors. Some of these factors are choice of liquid scintillation cocktail; amount of cocktail; type of sample; amount of sample; and size and type of vial. The use of DPM makes the results independent of these factors.

Single, Dual and Triple Label DPM programs are available (if installed) when Liquid is selected as the scintillator. When Xtal is selected as the scintillator, Xtal DPM is available. Refer to Section 5.6 for more information on Xtal DPM.

Single Label DPM uses either IC# or H# Plus (if installed) as the quench monitor. AQC must be off. Color Quench Correction (if installed) automatically corrects for single label, colored samples when H# is selected and one of the five factory stored Isotopes is chosen as Isotope 1. Refer to The DPM Library Section 6 for more information on Color Quench Correction. Dual and Triple Label DPM always uses H# Plus as the quench monitor. AQC is On. Color Quench Correction is not used for Dual or Triple Label DPM.

The DPM Library stores quench curves for the Isotopes used to determine dpm results. A single label ^{3}H quench curve, a single label ^{3}H quench curve, and a dual label $^{3}H/^{14}C$ quench curve are stored in the DPM Library at the factory. Refer to Section 6.2 for more information on the DPM Library and setting up other quench curves.

Once the quench curves are stored in the DPM Library, they are accessed by any User Program and used to calculate the dpm. When selecting a DPM program, a quench curve must be stored in the DPM Library for the selected isotope. If using Dual or Triple Label DPM, the quench curves stored must have been set up as dual or triple label curves.

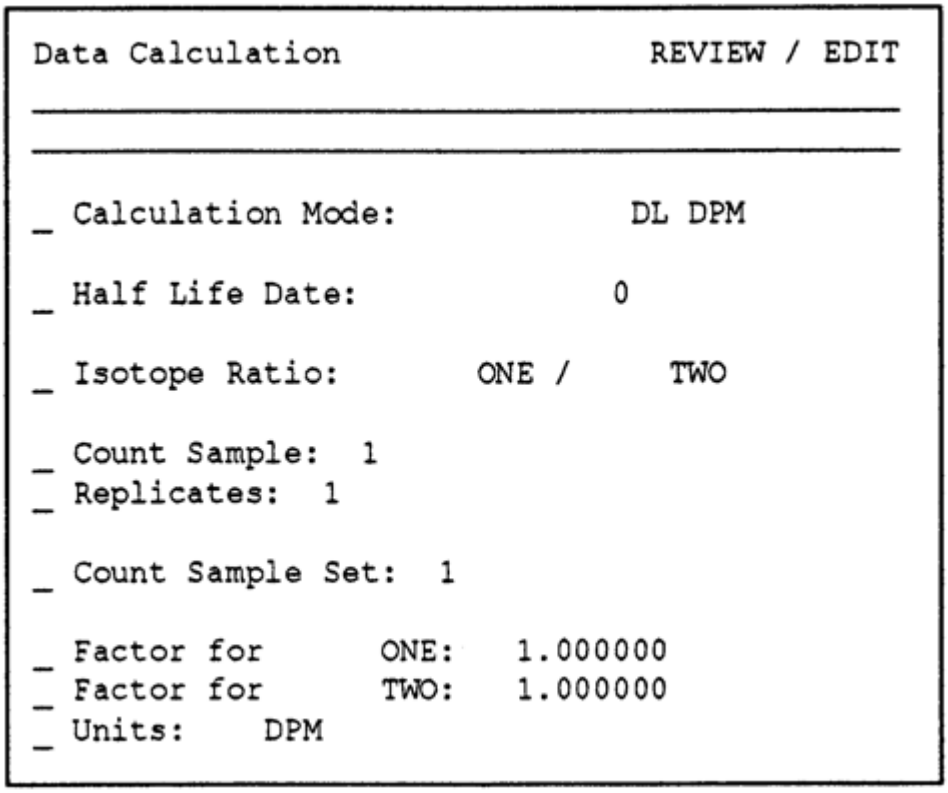
Setting Up DPM

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose SL DPM, DL DPM or TL DPM. The menu displayed for DL DPM is shown in Figure 5.7. The prompts for Units and Isotope Ratio (for Dual or Triple Label DPM) are discussed below. The other prompts are the same prompts described for the CPM program. Refer to Setting Up CPM/Xtal CPM Section 5 for information on setting these prompts.

If a quench curve for the selected isotope(s) is not stored, an error message is displayed when the User Program is stored. Return to the Data Calculation Menu and choose CPM. Press

MAIN MENU and refer to Section 6.2 for setting up a quench curve for the selected isotope(s).

Figure 5.7 Data Calculation Menu for DL DPM.



Isotope Ratio (Dual and Triple Label DPM)

The ratio between any of the isotopes can be calculated and printed when Dual or Triple Label DPM is selected.

To choose an isotope ratio, highlight “Isotope Ratio”. For dual label, the isotope chosen is the numerator and by default the other isotope is denominator. For triple label, the first isotope chosen is the numerator. The remaining two isotopes are then displayed. Choose the isotope desired for the denominator.

Units

Units allows you to enter units or any name you want printed as the final results. This name is used in place of the DPM heading in the printout.

To change the setting, highlight “Units” and enter in the desired name using up to 5 characters.

Loading Samples for DPM Program

The same loading sequence used for CPM is used for DPM. Refer to Loading Samples for CPM/Xtal CPM Section 5.

Results for DPM

To count the samples, refer to Section 3.2. A typical printout in standard format for Single Label DPM is shown in Figure 5.8. A typical printout in standard format for Dual Label DPM is shown in Figure 5.9. A typical printout in standard format for Triple Label DPM is shown in Figure 5.10.

5.6 Xtal DPM

The Xtal DPM program provides a measure of the absolute activity (dpm) for single label samples with constant quench. Xtalscint™ (pronounced crystalscint) is a solid scintillator used by Beckman Instruments, Inc. It is designed especially for use with Xtalscint products, Ready Cap and Ready Filter.

Figure 5.8 Typical Printout for Single Label DPM.

PAGE: 1

I D : S L D P M 3 H 16 AUG 1989 19:14
USER:10 COMMENT:EXP 1
PRESET TIME : 10.00
DATA CALC : SL DPM H# :YES SAMPLE REPEATS: 1 PRINTER : STD
COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : OFF
TWO PHASE : NO AQC : NO CYCLE REPEATS : 1
SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
LOW LEVEL : OFF HALF LIFE CORRECTION DATE: 21 AUG 1975 12:10

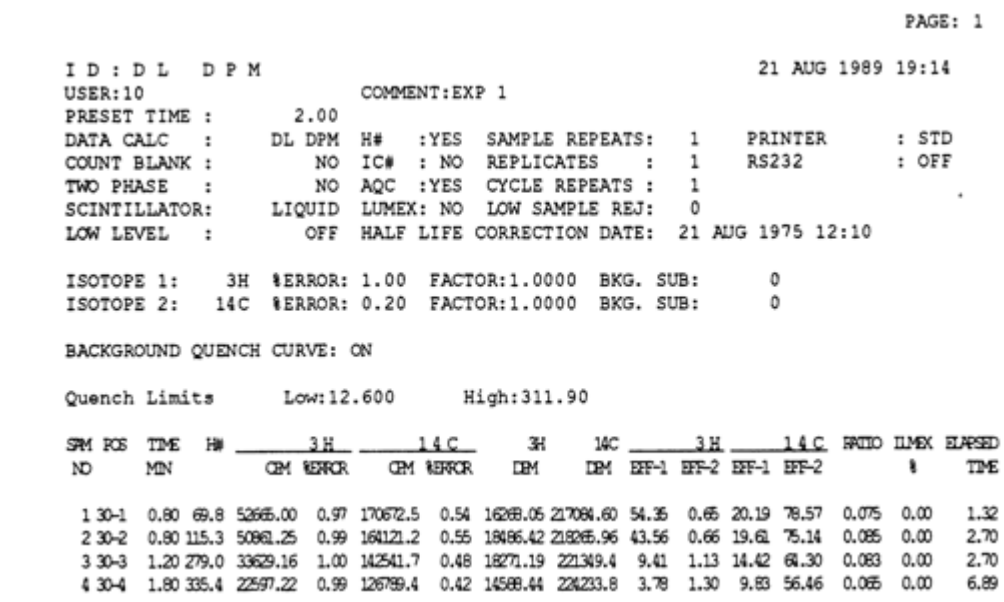
ISOTOPE 1: 3H %ERROR: 1.00 FACTOR:1.0000 BKG. SUB: 0

BACKGROUND QUENCH CURVE: ON

Quench Limits Low:12.600 High:311.90

SAM NO	POS	TIME MIN	H#	3 H CPM	3 H %ERROR	3H DPM	3 H EFF-1	LUMEX %	ELAPSED TIME
1	30-1	0.35	57.4	115534.3	0.99	200681.1	57.57	0.00	0.82
2	30-2	0.40	87.8	103780.0	0.98	204553.1	50.74	0.01	1.45
3	30-3	0.45	107.3	95586.67	0.86	208050.3	45.94	0.01	2.09
4	30-4	0.50	132.7	83686.00	0.98	211725.3	39.53	0.01	3.05

Figure 5.9 Typical Printout for Dual Label DPM.



PAGE: 1

I D : D L D P M 21 AUG 1989 19:14
USER:10 COMMENT:EXP 1
PRESET TIME : 2.00
DATA CALC : DL DPM H# :YES SAMPLE REPEATS: 1 PRINTER : STD
COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : OFF
TWO PHASE : NO AQC :YES CYCLE REPEATS : 1
SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
LOW LEVEL : OFF HALF LIFE CORRECTION DATE: 21 AUG 1975 12:10

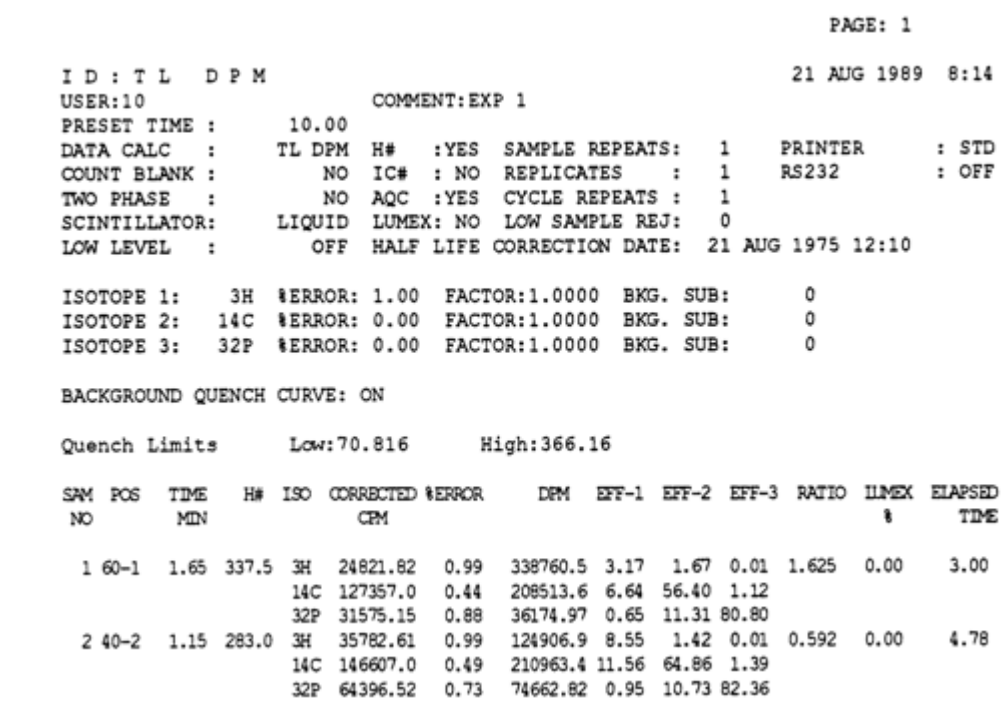
ISOTOPE 1: 3H %ERROR: 1.00 FACTOR:1.0000 BKG. SUB: 0
ISOTOPE 2: 14C %ERROR: 0.20 FACTOR:1.0000 BKG. SUB: 0

BACKGROUND QUENCH CURVE: ON

Quench Limits Low:12.600 High:311.90

SAM NO	POS	TIME MIN	H#	3H CPM	3H %ERROR	14C CPM	14C %ERROR	3H DPM	14C DPM	3H EFF-1	3H EFF-2	14C EFF-1	14C EFF-2	RATIO	LUMEX %	ELAPSED TIME
1	30-1	0.80	69.8	52665.00	0.97	170672.5	0.54	16268.05	217084.60	54.35	0.65	20.19	78.57	0.075	0.00	1.32
2	30-2	0.80	115.3	50861.25	0.99	164121.2	0.55	18486.42	218265.96	43.56	0.66	19.61	75.14	0.085	0.00	2.70
3	30-3	1.20	279.0	33629.16	1.00	142541.7	0.48	18271.19	221349.4	9.41	1.13	14.42	61.30	0.083	0.00	2.70
4	30-4	1.80	335.4	22597.22	0.99	126789.4	0.42	14588.44	224233.8	3.78	1.30	9.83	56.46	0.065	0.00	6.89

Figure 5.10 Typical Printout for Triple Label DPM.



PAGE: 1

I D : T L D P M 21 AUG 1989 8:14
USER:10 COMMENT:EXP 1
PRESET TIME : 10.00
DATA CALC : TL DPM H# :YES SAMPLE REPEATS: 1 PRINTER : STD
COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : OFF
TWO PHASE : NO AQC :YES CYCLE REPEATS : 1
SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
LOW LEVEL : OFF HALF LIFE CORRECTION DATE: 21 AUG 1975 12:10

ISOTOPE 1: 3H %ERROR: 1.00 FACTOR:1.0000 BKG. SUB: 0
ISOTOPE 2: 14C %ERROR: 0.00 FACTOR:1.0000 BKG. SUB: 0
ISOTOPE 3: 32P %ERROR: 0.00 FACTOR:1.0000 BKG. SUB: 0

BACKGROUND QUENCH CURVE: ON

Quench Limits Low:70.816 High:366.16

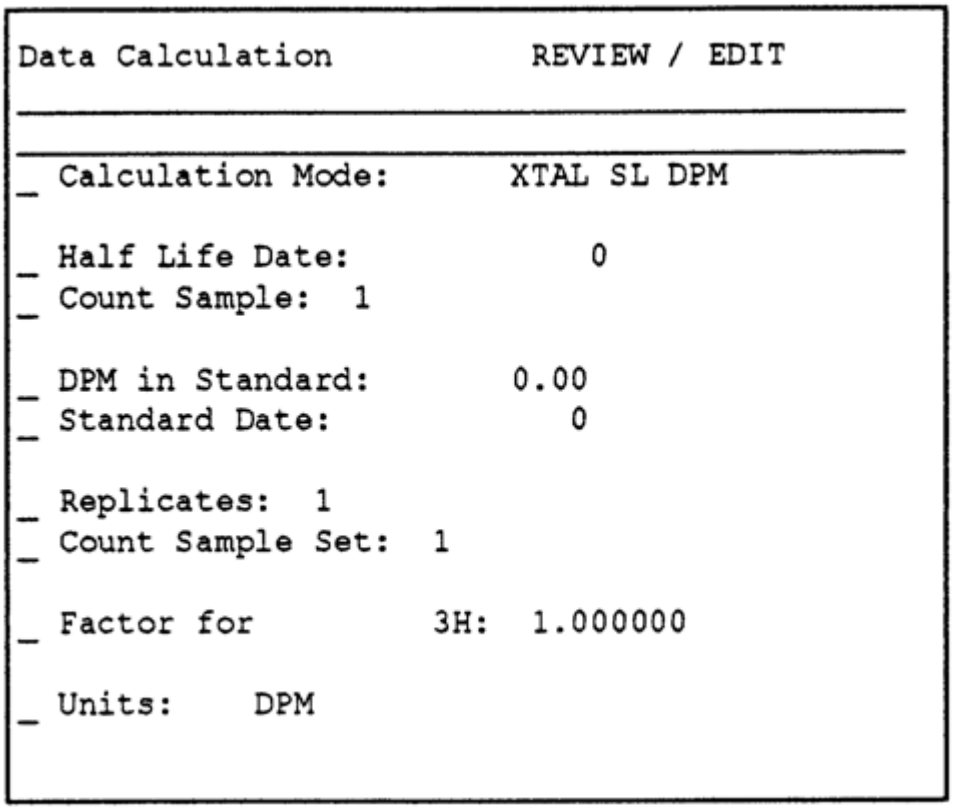
SAM NO	POS	TIME MIN	H#	ISO	CORRECTED CPM	%ERROR	DPM	EFF-1	EFF-2	EFF-3	RATIO	LUMEX %	ELAPSED TIME
1	60-1	1.65	337.5	3H	24821.82	0.99	338760.5	3.17	1.67	0.01	1.625	0.00	3.00
				14C	127357.0	0.44	208513.6	6.64	56.40	1.12			
				32P	31575.15	0.88	36174.97	0.65	11.31	80.80			
2	40-2	1.15	283.0	3H	35782.61	0.99	124906.9	8.55	1.42	0.01	0.592	0.00	4.78
				14C	146607.0	0.49	210963.4	11.56	64.86	1.39			
				32P	64396.52	0.73	74662.82	0.95	10.73	82.36			

The Xtalscint DPM program assumes the samples are counting to the same efficiency. Instead of a quench curve, only one dpm standard is required. The efficiency of this standard is deter-mined at the beginning of the sample set by counting a standard with a known dpm prepared in the same manner as the samples. This calculated efficiency is used to calculate the dpm of the remaining samples in the set.

Setting Up Xtal DPM

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose XTAL DPM. The menu displayed is shown in Figure 5.11. The prompts for the standard used to determine the dpm and for unit selection are described below. The remaining prompts are the same prompts described for the CPM program. Refer to Setting Up CPM/Xtal CPM Section 5 for information on setting these prompts.

Figure 5.11 Data Calculation Menu for Xtal DPM.



DPM in Standard

Calculate this dpm using the DPM of the Standard listed by the manufacturer on the label of the isotope container used to make the Xtalscint Standard. DPM for the standard must be entered.

To enter DPM of the Standard, highlight this prompt and enter the dpm using up to 7 digits and a decimal point.

Standard Date

Standard Date is used to correct the dpm of the standard for half-life decay. This date is given by the manufacturer on the label of the isotope container used to make the Xtalscint Standard. If a date is not entered here, the standard dpm is not corrected for half-life.

To enter the Standard Date, highlight "Standard Date", and enter the date in this format: dd mmm yyyy (2 digits for day, a 3 letter code for the month, and 4 digits for the year).

Units

Units allows you to enter units or any name you want printed as the final results. This name is used in place of the DPM heading in the printout.

To change the setting, highlight "Units" and enter in the desired name using up to 5 characters.

Loading Samples for Xtal DPM

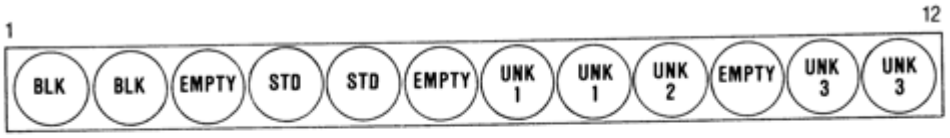
Since the instrument has no way of distinguishing among blanks, standards, and unknowns, a convention has been established for identifying them by the sequence in which they are loaded. An example loading sequence is shown in Figure 5.12.

If blanks are specified in the User Program as described in Background/Blank Subtraction Section 4, the blanks must be loaded first. Blanks are optional. Any number of blanks may be used. The average is printed. Leave an empty space between the last blank and first standard dpm; this indicates to the instrument that the next vial encountered is a standard.

Load the standard dpm after the empty space. One to ten standards may be loaded for each isotope. If more than one dpm standard is used, the system computes the average. Leave an empty space after the last dpm standard, signalling the instrument samples follow.

Load the samples after the empty space. If you are using replicates, the replicates must be loaded in adjacent positions. To indicate that one or more of replicates are missing from a group, leave one empty position; the system recognizes the vial following the empty space as being the first of the next set.

Figure 5.12 Loading Sequence for Xtal DPM



BLK = Blank
STD = Standard DPM
UNK = Unknown
EMPTY = No Vial in the Rack Position

Experiment in Duplicate with UNK 2 Missing One Replicate

Figure 5.13 Typical Printout for Xtal DPM

```
                                                                    PAGE: 1

I D : X T A L   D P M                                    21 AUG 1989 18:25
USER: 6                    COMMENT:EXP 1
PRESET TIME :        1.00
DATA CALC   :   XTAL DPM  H#   : NO  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :         NO  IC#  : NO  REPLICATES    :   1    RS232        : OFF
TWO PHASE   :         NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:       XTAL  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :        OFF  HALF LIFE CORRECTION DATE:  21 AUG 1975 12:10

ISOTOPE 1:    3H  %ERROR: 0.50  FACTOR:1.0000  BKG. SUB:      0

Standard for     3H  DPM :   645671.00    DATE : 15 APR 1986 00:00

SAM  POS   TIME  _________3 H___        3H   LUMEX  ELAPSED
 NO         MIN       CPM  %ERROR      DPM      %      TIME

STD 20-1    0.65  253232.3   0.49             0.01     0.95
            Standard Average CPM for     3H :  253232.3  COEF. OF VAR:   0.000

            Standard Efficiency for     3H :   39.22 %

  1 20-3    1.00  18004.00   1.49  45906.40   0.12     2.25
  2 20-4    1.00  114166.0   0.59  291099.2   0.03     3.59
  3 20-5    1.00  54313.00   0.86  138486.7   0.06     4.90
  4 20-6    1.00  136293.0   0.54  347518.5   0.02     6.23
```

NOTE Do not leave an empty space for each missing replicate. One empty space indicates to the system that a new group of replicates follows.

Results for Xtal DPM

To count the samples, refer to Section 3.2. A typical printout in standard format for Xtalscint DPM is shown in Figure 5.13.

5.7 DPM % of Reference

The DPM % of Reference program is used for any type of experiment that requires dMding each of the unknowns by a reference, yielding a percent value. The data is first corrected to dpm using the quench curves stored in the DPM Library. Refer to Section 5.5 for more information on DPM. Blanks and backgrounds can be subtracted if selected in the User Program.

$$\%\ \text{Ref} = \frac{\text{Sample DPM - Blank CDM x 100 x Factor}}{\text{Reference DPM - Blank DPM}}$$

Single and Dual Label DPM % of Reference (if installed) is available when a liquid scintillator is selected. Xtal SL DPM % of Reference (if installed) is available when Xtal is selected as the scintillator. Refer to Section 5.8 for information on Xtal SL DPM % of Reference.

Setting Up DPM % of Reference

When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose "SL DPM %REF~', or "DL DPM %REF". The prompts displayed on the menu are the same as described for the DPM program. Isotope Ratio is included for DL DPM % of Reference. Refer to Setting Up DPM Section 5 for information on these prompts.

Loading Samples for DPM % of Reference

The same loading sequence used for SL CPM % of Reference is used for DPM % of Reference. Refer to Loading Samples for DPM % of Reference Section 5.

Results for DPM % of Reference

To count the samples, refer to Section 3.2. A typical printout for Single Label DPM % of Reference in Standard Format is shown in Figure 5.14. A typical printout for Dual Label % of Reference in Standard Format is shown in Figure 5.15. The calculated result is shown under the % Ref column heading.

5.8 Xtal SL DPM % of Reference

The Xtal SL DPM % of Reference program is used for any type of experiment that requires dividing each of the unknowns by a reference, yielding a percent value. The data is first corrected to dpm using a standard counted at the beginning of the sample set. This standard with a known dpm prepared in the same manner as the samples, is used to determine the

efficiency. This calculated efficiency is used to calculate the dpm of the remaining samples in the set. Blanks and backgrounds can be subtracted if selected in the User Program.

Figure 5.14 Typical Printout for SL DPM % of Reference

```
                                                                        PAGE: 1

I D : S L   D P M   P C T R E F                          21 AUG 1989 19:19
USER: 2                    COMMENT:EXP 1
PRESET TIME :        0.10
DATA CALC   :SL DPM %REF  H#   : NO  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :          NO  IC#  :YES  REPLICATES    :   1    RS232        : OFF
TWO PHASE   :          NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:      LIQUID  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :         OFF  HALF LIFE CORRECTION DATE:  21 AUG 1975 12:10

ISOTOPE 1:    3H  %ERROR: 0.00  FACTOR:1.0000  BKG. SUB:      0

BACKGROUND QUENCH CURVE: OFF

Quench Limits      Low: 2.427      High:  8.474

SAM  POS   TIME   IC#        3H          3H        3H        3H   LUMEX  ELAPSED
 NO         MIN            CPM  %ERROR   DPM     EFF-1     %REF    %      TIME

R1  11-1   0.10 6.172  248580.0   1.27  452932.2  54.88            0.00     0.34
           Reference Average DPM for    3H :   452932.2  COEF. OF VAR:    0.000

  1 11-3   0.10 4.661  186810.0   1.46  453237.8  41.22   100.07   0.00     0.76
  2 11-4   0.10 4.294  164190.0   1.56  447156.6  36.72    98.72   0.01     1.16
  3 11-5   0.10 3.811  134330.0   1.73  448059.1  29.98    98.92   0.01     1.56
  4 11-6   0.10 3.548  108940.0   1.92  420576.2  25.90    92.86   0.01     1.96
```

Figure 5.15 Typical Printout for DL DPM % of Reference

```
                                                                    PAGE: 1

I D : D L   D P M   P C T R E F                          21 AUG 1989 19:19
USER: 2                  COMMENT:EXP 1
PRESET TIME :       0.10
DATA CALC   :DL DPM %REF  H#   :YES  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :         NO  IC#  : NO  REPLICATES    :   1    RS232        : OFF
TWO PHASE   :         NO  AQC  :YES  CYCLE REPEATS :   1
SCINTILLATOR:     LIQUID  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :        OFF  HALF LIFE CORRECTION DATE:  21 AUG 1975 12:10

ISOTOPE 1:    3H  %ERROR: 0.00  FACTOR:1.0000  BKG. SUB:      0
ISOTOPE 2:   14C  %ERROR: 0.00  FACTOR:1.0000  BKG. SUB:      0

BACKGROUND QUENCH CURVE: OFF

Quench Limits      Low:11.585      High:312.01

SAM  POS   TIME    H#   ISO  CORRECTED %ERROR     DPM   EFF-1  EFF-2  %REF  RATIO  LUMEX  ELAPSED
 NO        MIN              CPM                                                    %      TIME

R1  29-1   0.10  72.9    3H  10830.00   6.08    7999.25  50.98   0.62         0.216   0.00    0.52
                         14C 28090.00   3.77   37001.07  18.25  75.78
           Reference Average DPM for    3H :    7999.25  COEF. OF VAR:    0.000
           Reference Average DPM for   14C :   37001.07  COEF. OF VAR:    0.000

  1 34-3   0.10 196.8    3H   8270.00   6.95    6461.87  21.60   0.79  80.78   0.159   0.00    1.08
                         14C 28180.00   3.77   40709.03  16.89  69.10 110.02

  2 34-4   0.10 205.3    3H   7510.00   7.30    5947.57  19.84   0.82  74.35   0.155   0.00    1.65
                         14C 26240.00   3.90   38184.42  18.23  75.91  95.09
```

$$\% \text{ Ref} = \frac{\text{Sample DPM - Blank CDM x 100 x Factor}}{\text{Reference DPM - Blank DPM}}$$

Xtal SL DPM % of Reference (if installed) is available when Xtal is selected as the scintillator. Single and Dual Label DPM % of Reference (if installed) is available when a liquid scintillator is selected. Refer to Section 5.7 for information on DPM % of Reference.

Setting Up Xtal SL DPM % of Reference

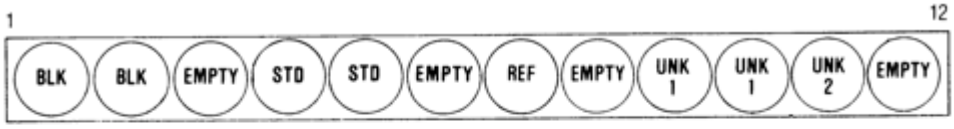
When editing a User Program, from the Data Calculation Menu (Figure 5.1), choose XTAL SL DPM%Ref. The prompts displayed on the menu are the same as described for the Xtal DPM program. Refer to Setting Up Xtal DPM Section 5 for information on these prompts.

Loading Samples for Xtal SL DPM% of Reference

Since the instrument has no way of distinguishing among blanks, standards, references, and unknowns, a convention has been established for identifying them by the sequence in which they are loaded. An example loading sequence is shown in Figure 5.16.

If blanks are specified in the User Program as described in Background/Blank Subtraction Section 4, load the blanks first. Blanks are optional. Any number of blanks may be used. The average is printed. Leave an empty space between the last blank and first standard; this indicates to the instrument that the next vial encountered is a standard.

Figure 5.16 Loading Sequence for Xtal DPM % of Reference.



BLK = Blank
STD = Standard DPM
REF = Reference
UNK = Unknown
EMPTY = No Vial in the Rack Position

Experiment in Duplicate with UNK 2 Missing One Replicate

Load the standard dpm after the empty space. One to ten standards may be loaded for each isotope. If more than one dpm standard is used, the system computes the average. Leave an. empty space after the last dpm standard, signalling the instrument references follow. Standards must be used.

References follow the standards. Any number of replicates of the reference may be used. If more than one reference is used, the system computes the average. Leave an empty space following the last reference. References must be used.

Unknowns follow the references. If you are using replicates, the replicates must be loaded in adjacent positions. To indicate that one or more of replicates are missing from a group, leave one empty position; the system recognizes the vial following the empty space as being the first of the next set.

NOTE Do not leave an empty space for each missing replicate. One empty space indicates to the system that a new group of replicates follows.

Figure 5.17 Typical Printout for Xtal DPM % of Reference.

```
                                                                    PAGE: 1

I D : X T A L   D P M   P C T                              21 AUG 1989 18:49
USER: 7                    COMMENT:
PRESET TIME :       1.00
DATA CALC   :XTALDPM%REF  H#   : NO  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :        YES  IC#  :YES  REPLICATES    :   1    RS232        : OFF
TWO PHASE   :         NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:       XTAL  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :        OFF  HALF LIFE CORRECTION DATE:  21 AUG 1975 12:10

ISOTOPE 1:    3H  %ERROR: 0.00  FACTOR:1.0000  BKG. SUB:      0

Standard for     3H  DPM :    502363.0    DATE :  15 APR 1989 00:00

SAM  POS   TIME   IC#            3 H          3H       3H  LUMEX  ELAPSED
 NO         MIN              CPM  %ERROR      DPM     %REF     %      TIME

B1  20-1    1.00 58.30     37.00  32.88                    13.64     1.26
B2  20-2    1.00 83.50     28.00  37.80                    11.14     2.74
           Blank Average CPM for     3H     32.50  COEF. OF VAR:   19.581

STD 20-4    1.00 8.324  252438.5   0.40                     0.01     4.15
           Standard Average CPM for     3H :  252438.5  COEF. OF VAR:   0.000

           Standard Efficiency for     3H :   48.95 %

R1  20-6    1.00 6.981  229570.5   0.42  468950.9           0.01     5.55

           Reference Average DPM for    3H :  468950.9  COEF. OF VAR:   0.000

  1 20-8    1.00 2.477  17892.50   1.49  36549.59    7.79   0.13     6.87
  2 20-9    1.00 3.829  113520.5   0.59  231892.0   49.45   0.03     8.32
  3 20-10   1.00 2.968  53918.50   0.86  110141.1   23.49   0.06     9.65
  4 20-11   1.00 4.580  136195.5   0.54  278211.1   59.33   0.02    11.25
```

Results for Xtal SL DPM % of Reference

To count the samples, refer to Section 3.2. A typical printout for Xtal SL DPM % of Reference in Standard Format is shown in Figure 5.17. The calculated result is shown under the % Ref column heading.

5.9 Single Photon Monitoring

The Single Photon Monitor is used for bioluminescence, chemlluminescence, or other studies where an accumulated total number of events seen by each photomultiplier tube during each period of counting is obtained and averaged. Therefore, during single photon monitoring, the coincidence circuit used for counting radioactivity is disabled.

Setting Up Single Photon Monitor

When Single Photon is selected as Isotope 1, the Data Calculation Program Is automatically set to Single Photon. Refer to Isotope 1 Section 4 for more information on how the other User Program parameters are affected. When the Data Calculation menu is displayed, the prompts for setting up Single Photon Monitor are displayed. The menu is shown in Figure 5.18.

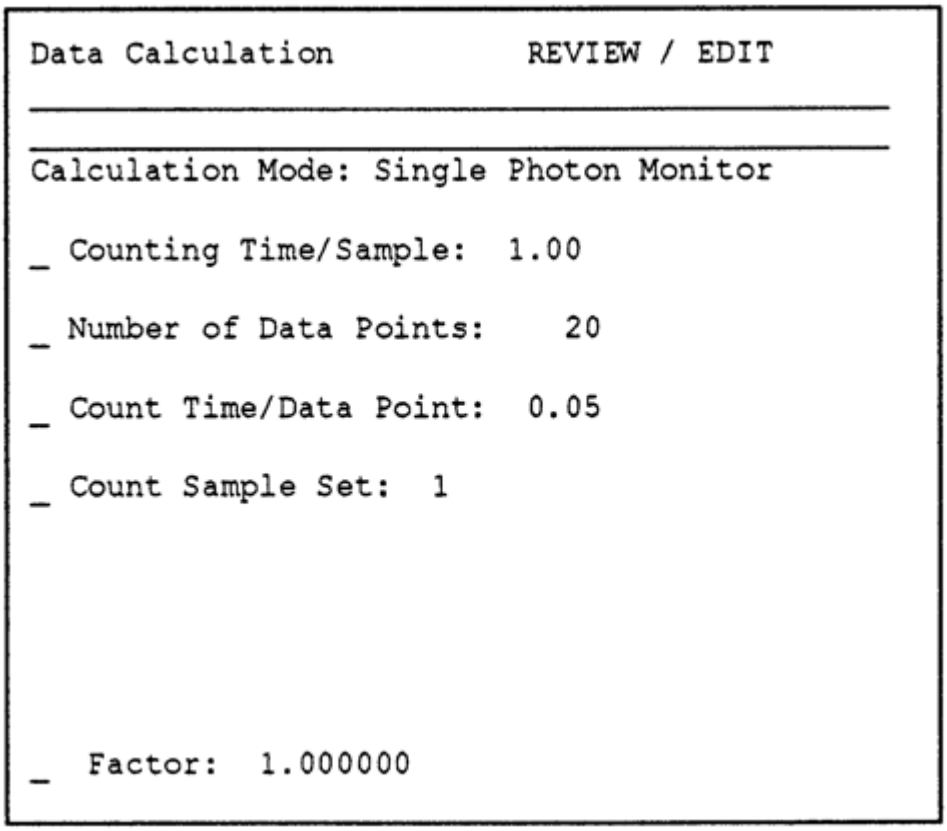
The Counting Time/Sample displayed is entered as the Counting Time described in Counting Time Section 4. However, this time is the elapsed time from the start of the count cycle instead of live time as in the other Data Calculation programs. The prompts for Single Photon are described below. Repeat counts and replicates are not used in the Single Photon Program.

Number of Data Points

This feature allows you to enter the number of data points you want to record and print over the sample counting time. The number of data points is limited to the number of count updates that can take place and be printed in the Counting Time/Sample and no more than one point every 0.05 mm (20 points/minute).

Count Time/Sample = Count Time/Point x Points/Sample

Figure 5.18 Data Calculation Menu - Single Photon Monitor.



For rapidly decaying samples, you may select many data points over a short period of time. For slower decaying samples, select fewer data points over a longer period of time. Refer to Count Time per Data Point for selecting the length of time to accumulate counts for each data point.

To change this setting, highlight “Number of Data Points”, and enter the number of data points.

Count Time per Data Point

This feature allows you to enter the amount of time to accumulate counts for each data point. This time is restricted by the Counting Time/Sample and Number of Data Points. The mini-mum count time is 0.05 minutes (3 seconds). The maximum count time is the Counting Time/Sample divided by the Number of Data Points. The Number of Data Points X the Count Time per Data Point cannot exceed Sample Counting Time.

To change this setting, highlight "Count Time/Data Point", and enter the counting time.

Count Sample Set

The entire set of samples can be recounted a number of times. When another User Number Card or Halt Card is detected, the sample changer backs up to the beginning of the sample set and recounts the samples. This is repeated until the entry for Count Sample Set is satisfied.

To change the number of times to count the sample set, highlight "Count Sample Set" and enter the desired number.

Factor

This feature enables you to obtain a printout in which the count data have been multiplied by a constant:

CPM X Factor = Final Answer Printed Out

To change the factor, highlight "Factor" and enter a new factor. The factor may have a maximum of nine digits and decimal point. Values greater than or less than this range may be entered as an exponential using a 10 character field. For example, the number 1.0623×10^{-23} is entered as 1 O623E^{-23}

Loading Samples for Single Photon

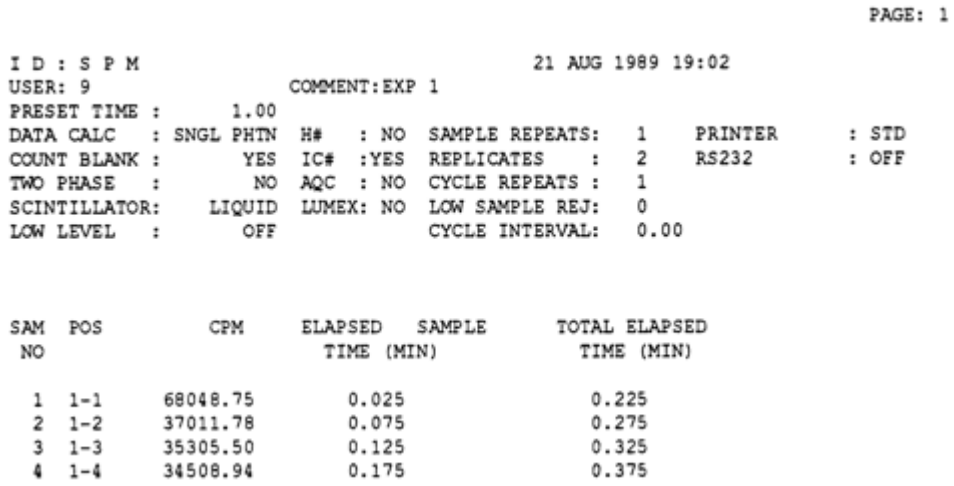
Samples are loaded into the racks in the order you wish to count them. The Single Photon Program does not recognize blanks or replicates.

Results for Single Photon

To count the samples, refer to Section 3.2 and Section 3.3. An adapted counting routine is present in the Count Single Rack mode, when a User Program with SPM is selected, which

starts the elapsed time before the sample count is initiated. A typical printout in standard format for Single Photon is shown in Figure 5.19.

Figure 5.19 Typical Printout for Single Photon.



```
                                                                    PAGE: 1

I D : S P M                                  21 AUG 1989 19:02
USER: 9                COMMENT:EXP 1
PRESET TIME :      1.00
DATA CALC   : SNGL PHTN  H#   : NO  SAMPLE REPEATS:   1    PRINTER      : STD
COUNT BLANK :       YES  IC#  :YES  REPLICATES    :   2    RS232        : OFF
TWO PHASE   :        NO  AQC  : NO  CYCLE REPEATS :   1
SCINTILLATOR:    LIQUID  LUMEX: NO  LOW SAMPLE REJ:   0
LOW LEVEL   :       OFF             CYCLE INTERVAL:   0.00


SAM  POS         CPM     ELAPSED   SAMPLE      TOTAL ELAPSED
 NO                        TIME (MIN)            TIME (MIN)

  1  1-1     68048.75        0.025                 0.225
  2  1-2     37011.78        0.075                 0.275
  3  1-3     35305.50        0.125                 0.325
  4  1-4     34508.94        0.175                 0.375
```

Isotope/DPM Libraries

6.1 The Isotope Library

Introduction

The Isotope Library stores the half-life and window *settings* for the isotopes you wish to count. These settings are accessed when the isotope(s) is specified during set up of a User Program. The Isotope Library is divided into two parts. One section stores the settings for liquid scintillators; the other section stores the settings for Xtalscint scintillators. Five common radioisotopes for liquid and Xtalscint scintillators are permanently stored in the system. They are ^{3}H, ^{14}C, ^{125}I, ^{35}S, and ^{32}P. Up to ten additional isotopes may be stored in the Isotope Library under either section.

The window settings for a new isotope may be entered in either of two ways; the system can count a sample of the isotope and record the settings automatically; or, if special settings for the isotope are desired, they may be entered manually.

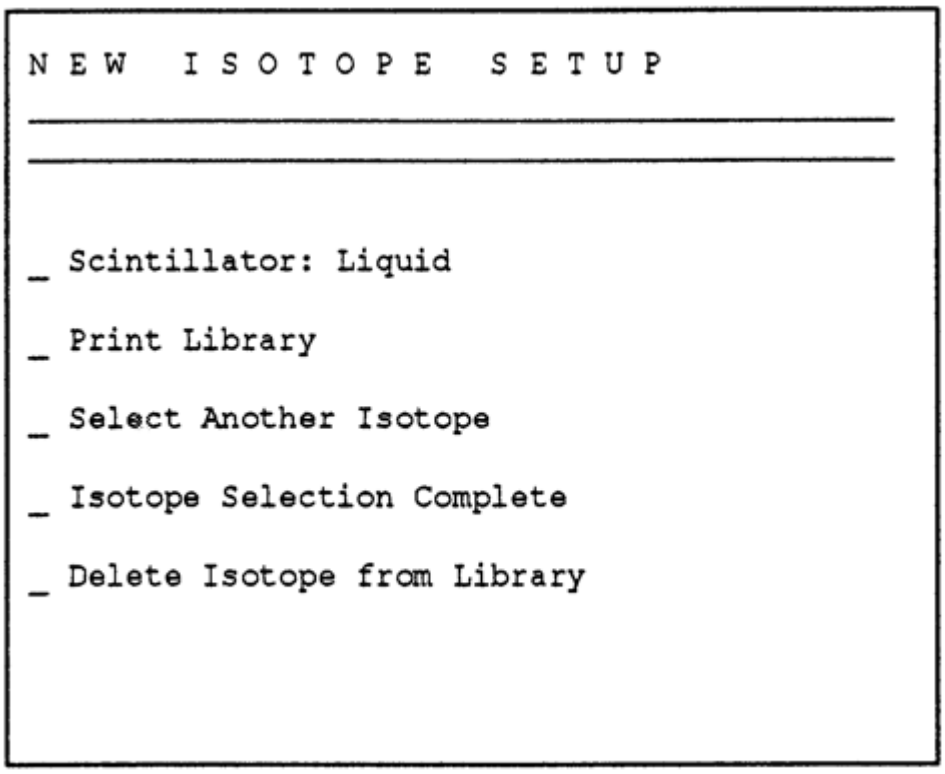
NOTE This section assumes you are familiar with the operating controls of the IS. If you are not familiar with the operating controls, refer to Section 2.3.

Accessing the Isotope Library

To use the Isotope Library:

1. From the Main Menu, highlight 'Isotope/DPM Libraries" and press **SELECT**. The Main Editing Window presents two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.

Figure 6.1 New Isotope Setup Menu.



2. With "Setup and Review Isotopes" highlighted, press **SELECT**. The New Isotope Menu is displayed. See Figure 6.1.

From this menu, you can print the Isotope Library, add an isotope to the library, or delete an isotope from the library. Refer to the following sections for more information on performing these functions.

Printing the Isotope Library

To obtain a printout of the Isotope Library:

Refer to Accessing the Isotope Library Section 6 for information on how to access the New Isotope Setup Menu.

1. From the New Isotope Setup Menu, with "Scintillator" high-lighted, choose Liquid or Xtal to specify the portion of the Isotope Library you wish to print.

2. Highlight "Print Isotope Library" and press **SELECT**. The list of isotopes presently stored in the Isotope Library for the specified scintillator type is printed. Figure 6.2 shows a typical printout.

Figure 6.2 Printout of Isotope Library.

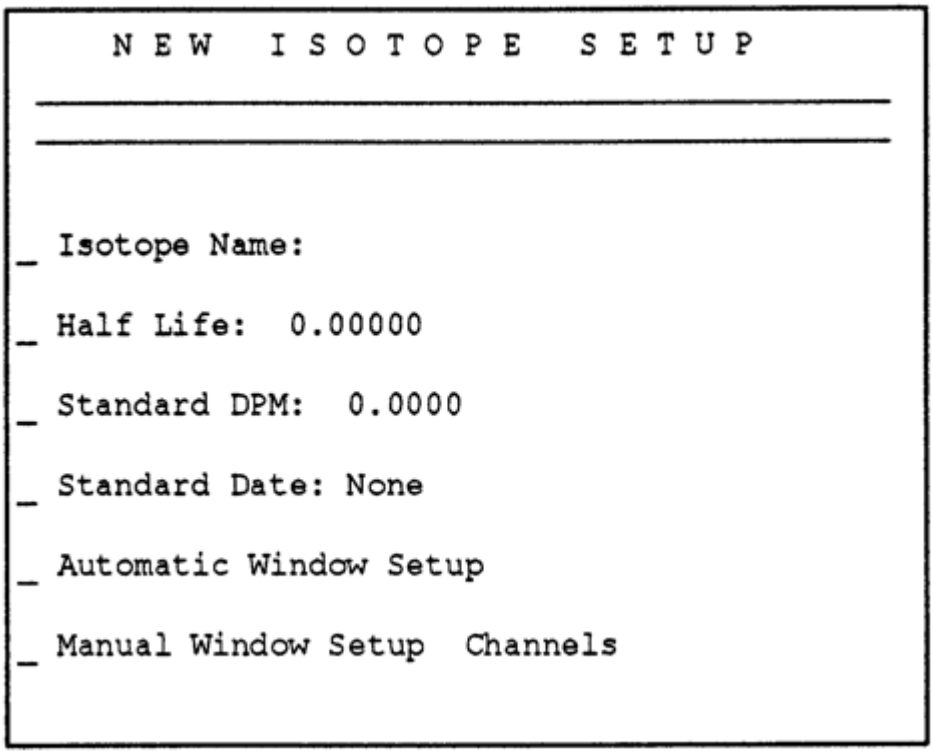
```
ISOTOPE LIBRARY SUMMARY
LIQUID SCINTILLATOR

ISOTOPE     HALF-LIFE        COUNT WINDOW
(channels)
Lower  Upper
-----------------------------------------

3H      12.330 Y          0.0  400.0
125I      60.248 D          0.0  567.0
14C      5730.0 Y          0.0  670.0
35S      87.368 D          0.0  688.0
32P      14.281 D          0.0  945.0


ISOTOPE LIBRARY SUMMARY
XTAL SCINTILLATOR

ISOTOPE     HALF-LIFE        COUNT WINDOW
(channels)
Lower  Upper
-----------------------------------------

3H       12.330 Y          0.0  499.0
125I     60.248 D          0.0  617.0
14C      5730.0 Y          0.0  699.0
35S      87.368 D          0.0  718.0
32P      14.281 D          0.0  975.0
```

Adding A New Isotope to the Isotope Library

Isotopes may be added to the New Isotope Library using an automatic window setup program or by manually entering the window settings. During Multi-Task, Isotopes may only be added manually. Isotopes are stored by type of sclntlllator.

Automatic Window Setup calculates an upper limit that covers 99% of the entire energy spectrum of the isotope, based on a sample of the isotope you have prepared. The sample must be the least quenched that you will count during actual experiments. If it is not, you may get lower counts from your experiments or the sample may be rejected *if* too much quench is present. When H# Plus is installed, the dpm for the sample used to determine the window settings can be entered, providing window settings for samples of higher quench levels. For good statistical accuracy, the samples should contain at least 10,000 cpm. The sample may be counted in either a miniature or standard vial if Versa-Rack is installed. Up to ten isotopes may be added in one session.

Figure 6.3 Menu to Set Up New Isotope.



Manual Window Setup allows you to input predetermined window settings of the isotope for either type of scintillator.

To add one or more isotopes to the Isotope Library:

Refer to Accessing the Isotope Library Section 6 for information on how to access the New Isotope Setup Menu.

1. With the New Isotope Setup Menu displayed and "Scintillator" highlighted, choose Liquid or Xtal to specify the portion of the Isotope Library you wish to store the window settings.
2. Highlight "Select Another Isotope" and press **SELECT**. The menu shown in Figure 6.3 is displayed.
3. With "Isotope Name" highlighted, enter the isotope name you wish to add. Type in the chemical symbol of the isotope, or up to five characters (letters, numbers, or symbols) and press **ENTER**. This name must not match the name of a previously stored isotope in the same part of the library.
4. Highlight "Half Life" and enter the appropriate half-life of the isotope in years or days and press **ENTER**. Half-life data for many of the common isotopes are provided in Appendix D.

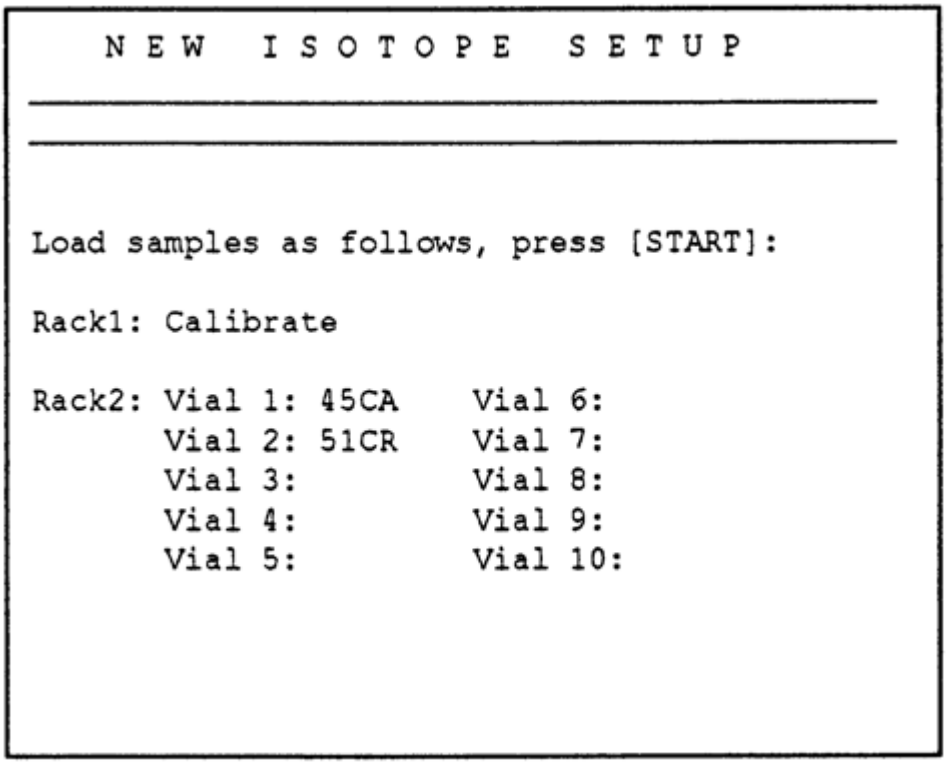
NOTE A half-life must be stored in the Isotope Library for the system to make half-life corrections.

5. Highlight "Standard DPM" and enter the dpm of the standard used for Automatic Window Setup if H# Plus is installed on your instrument and the dpm is known. When the dpm value is given, window settings for higher quenched samples can be obtained. This value is not required for Automatic Setup and is not available for Xtal window settings.

   If Standard DPM is entered, highlight "Standard Date" and enter the date of standardization in this format: dd mmm yyyy hr:min (2 digits for the day, a 3 letter code for the month, 4 digits for the year, and the time, if desired, based on a 24 hour clock.
6. If you want to have the instrument determine the window settings, highlight "Automatic Window Setup", and press **SELECT**. The New Isotope Setup Menu is displayed.

NOTE The windows determined by Automatic Setup are based on 1% spill values; not Emax values. When the energy scale is set to KeV, the window settings are lower than the published Emax values for the isotopes. Refer to Figure 6.2 for the predetermined window settings for the five isotopes permanently stored in the library.

Figure 6.4 Loading Instructions for New Isotope Setup.



If you want to enter the window settings for the isotope, high-light "Manual Window Setup". Enter the lower and upper window settings, pressing [ENTER] between each entry. Press **PREVIOUS MENU** to display the New Isotope Setup Menu.

7. If you wish to set up more than one isotope, repeat steps 1-6 for each isotope.
8. When all the desired isotopes are specified, highlight "Isotope Selection Complete" and press **SELECT**. If the windows were set up manually, the Main Menu is displayed.

   If Automatic Window Setup was selected for any of the isotopes entered, the loading instructions shown in Figure 6.4 is displayed.
9. Load the Calibrate Rack. If the Calibrate Rack is not loaded, the samples will not be counted. After the Calibrate Rack, load the Sample Rack containing a single vial for each new isotope entered in step 3 above. The order of the vials must correspond to the order in the list presented on the display.

10. With both racks in position in the sample changer, press **START**. The instrument performs a calibration and counts each sample for 5 minutes.

Figure 6.5 Printout for Setup of New Isotope.

```
                                                    PAGE: 1


PERFORMING ISOTOPE CALIBRATION
INSTRUMENT CALIBRATION: Maxi Rack

INSTRUMENT CALIBRATION: MAXI RACK
Calibration successful


ISOTOPE CALIBRATION:  Liquid Scintillator  Maxi Rack

ISOTOPE  POS     TIME      H#      IC#     COUNT WINDOW (chan)
(QUENCH-CORRECTED)
Lower  Upper

45CA  62-1     3.75    71.3   4.5031          0.0  648.2
51CR  62-2     2.55    71.5   4.2028          0.0  105.2
```

11. On completion of the count, the instrument stores data for the new isotope(s) in the library, including type of scintillator, the name, half-life, and window settings. The data being stored for each isotope is printed. A typical printout is shown in Figure 6.5. The Main Menu is displayed. The isotopes added are now available for use in any User Program.

Deleting Isotopes from the Isotope Library

When an isotope entered in the library is no longer used, or new window settings for an isotope are desired, delete the isotope from the library. The five isotopes permanently stored in the Isotope Library cannot be deleted.

To delete an isotope:

Refer to Accessing the Isotope Library Section 6 for information on how to access the New Isotope Setup Menu

1. From the New Isotope Setup Menu, with “Scintillator” high-lighted, choose Liquid or Xtal to specify the portion of the Isotope Library you wish to delete from.
2. Highlight “Delete Isotope from Library”. A list of isotopes for the selected scintillator is displayed in the Data Entry Window.
3. Highlight the isotope to delete and press **DELETE**.
4. The isotope is deleted from the Isotope Library. That Isotope is no longer available for use in any User Program.

6.2 Setting Up A Quench Curve

The DPM Library

The DPM Library can store the quench curves for any isotope stored in the Isotope Library under liquid scintillator. The stored quench curves are available for use by any User Program. If Low Level is present on the instrument, a separate DPM Library is created for Low Level Standards. Up to 30 sets of quench curves can be stored between these two libraries.

A single label quench curve for ^{3}H, a single label quench curve for ^{14}C, and a dual label quench curve for $^{3}H/^{14}C$ are stored in the Standard DPM Library. These factory installed quench curves give results accurate to ±5%. If more accurate results are required, then additional quench curves ^{3}H and ^{14}C can be stored in the DPM Library under a different name or the factory installed curves can be deleted.

A quench curve must be set up for each isotope for which dpm calculations are desired. If the same isotopes are used in single, dual and triple label experiments, the quench curves can be set up and stored at the same time. The standards for each isotope are counted only once and quench curves for single, dual and triple label studies are stored. A background quench curve may also be stored. This background quench curve is subtracted from the standard quench curves set up at the time the back-ground curve is set up. A separate background quench curve may be stored for each quench curve, provided the quench curves are set up at separate times.

Color Quench Correction (if installed) is calibrated at the factory. This monitor is always on and is applied to the single label quench curves for the 5 factored isotopes in the Isotope Library: ^{3}H, ^{14}C, ^{32}P, ^{35}S, and ^{125}I. It automatically corrects for any color quench in samples of these isotopes.

Setting Up a New Quench Curve

Setting up a quench curve is done infrequently and care must be taken to ensure its accuracy. Quench curves for up to ten isotopes can be set up and stored in the DPM Library at a single session. Prepare standards for each isotope desired.

A brief review of the steps for storing a quench curve are:

1. Prepare a set of standards with a known amount of dpm.
2. Count the standards before addition of the quenching agent, using the preset counting program in DPM Setup program in the instrument.
3. Remove any standards that are not within a statistically acceptable range.
4. Add quenching agent to each standard.
5. Set up the DPM program on the instrument and count the quenched standards using the preset counting program.
6. Edit the resulting curve as necessary.

Preparing the Standards

Standard quench sets are available from Beckman Instruments, Inc. for ^{3}H and ^{14}C. Do not use commercial quench sets to set up low level quench curves. If you are using a prepared

standard set, refer to Counting the Standards Section 6, “Counting the Standards”. If you wish to prepare your own standards, follow the steps below.

NOTE Pipette accurately to ensure an accurate quench curve.

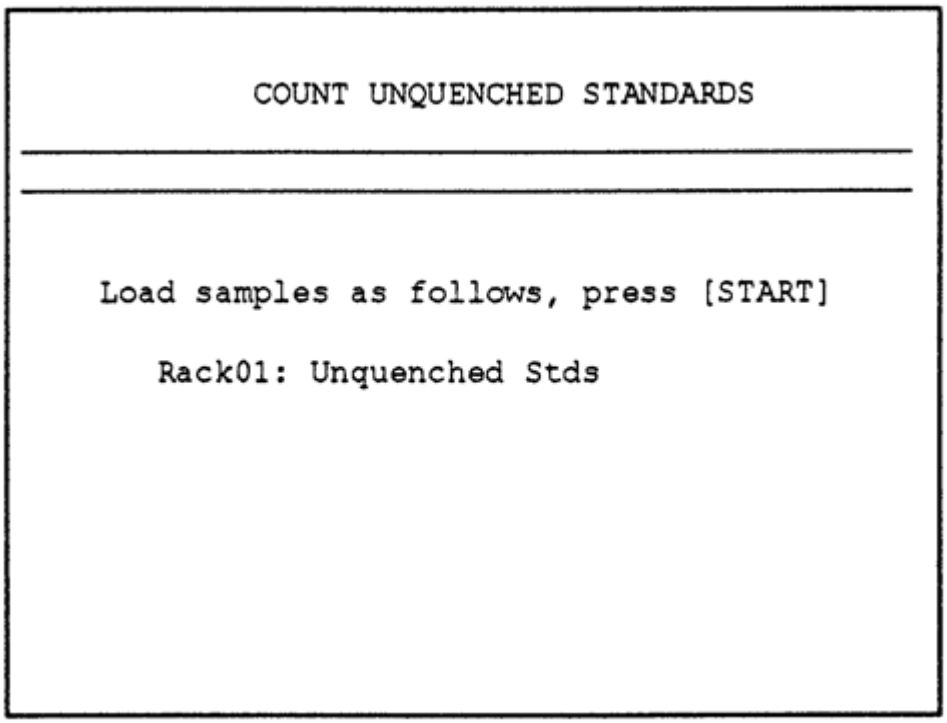
To prepare the standards:

1. Pipette the same amount of cocktail into each of 12 vials, using the same type of cocktail used to count your samples. Either standard vials or miniature vials can be used. H# Plus is independent of cocktail volume.

NOTE For low level dpm determinations, standards must be identical to the unknown samples. Use the same cocktail, vial, and quenching agent to prepare the standards as are in the unknowns.

2. Pipette a precise amount of DPM of the isotope you will use into each vial. It is important that each vial contain the same amount of DPM. A volume of isotope that provides approximately 200,000 dpm in each vial ensures against excessive counting times.

Figure 6.6 Menu to Count Unquenched Samples.



3. From the Main Menu, highlight “Isotope/DPM Libraries” and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.
4. Highlight “Set Up and Review DPM Quench Curves” and press **SELECT**. The Main Editing Window displays two prompts: Normal Quench Curves and Low Level Quench Curves.

5. If setting up quench curves for applications other than low level studies, highlight "Normal Quench Curves". The quench curves are stored in the Standard DPM Library. If setting up standards for low level studies, highlight "Low Level Quench Curves". The quench curves are stored in the Low Level DPM Library. Press [SELECT]. The Main Editing Window displays two prompts again: Setup Quench Curves and Review/Edit/Delete Quench Curves.
6. Highlight "Setup Quench Curves" and press **SELECT**. The Main Editing Window displays two prompts: Check Precision of Unquenched Std's and Setup Quench Curve.
7. Highlight "Check Precision of Unquenched Std's" and press **SELECT**. The menu shown in Figure 6.6 is displayed.

8. Load the samples to count into the rear most position on the right side of the sample changer. When ready to begin counting, press **START**.

Figure 6.7 Printout of Standards From Precision Check.

EFFICIENCY STANDARD PRECISION CHECK: Maxi Rack

Precision Check used Standard DPM Counting Mode

SAM NO.	POS	TIME	H#	CPM
1	1-1	1.00	69.3	13549.00
2	1-2	1.00	67.9	13759.00
3	1-3	1.00	68.3	14400.00
4	1-4	1.00	68.0	13670.00
5	1-5	1.00	68.3	10255.00
6	1-6	1.00	68.8	14313.00
7	1-7	1.00	68.4	13861.00
8	1-8	1.00	68.1	9753.00
9	1-9	1.00	67.9	13816.00
10	1-10	1.00	68.5	14276.00

ANALYSIS OF UNQUENCHED STANDARDS

SAM NO.	CPM	RETAIN SAMPLE
1	13549.00	YES
2	13759.00	YES
3	14400.00	NO
4	13670.00	YES
5	10255.00	NO
6	14313.00	NO
7	13861.00	YES
8	9753.00	NO
9	13816.00	YES
10	14276.00	NO

9. Each standard is counted for 1 minute. After counting the standards, the cpm of the standards are printed. After all samples are counted, they are analyzed to determine which samples fall within a statistically acceptable range. This analysis is printed after the standards data. See Figure 6.7. Standards listed with NO under RETAIN SAMPLES are statistically out of range and will cause quench curve errors. Remove these standards

from the set and properly dispose of them. A valid quench curve can be obtained using as few as five standards. Ten is the maximum number of standards allowed.

10. Add quenching agent to each standard in increasing amounts, making sure the quench range of the standards covers the full quench range expected in the experimental samples.

    The same quenching agent present in the experiment or any quenching agent may be used. Nitroethane or nitromethane are commonly used quenching agents. Figure 6.8 gives the volume of nitromethane required for H#'s of *45* to 285 in Ready-Solv™ HP cocktail.

Figure 6.8 Volume of Nitromethane To Use For Quenching.

Volume of Nitromethane vs Counting Efficiency*

Volume uL	Counting Efficiency: 3H	125I	14C	35S	32P	H#
0	47	77	95	95	98	45
10	35	71	93	94	98	100
20	25	66	90	93	98	140
30	19	61	86	92	98	175
40	15	57	83	89	98	200
50	11	53	78	87	98	225
60	7	50	74	83	98	260
70	5	46	68	79	98	285

* In 10 mL of Ready-Solv HP. For lower or higher volumes, change the volume of nitromethane in proportion to the cocktail volume.

*In 10 mL of Ready-Solv HP. For lower or higher volumes, change the volume of nitromethane in proportion to the cocktail volume.

You are now ready to count the standards and store the quench curve in the DPM Library. Refer to the following section to count the standards.

Counting the Standards

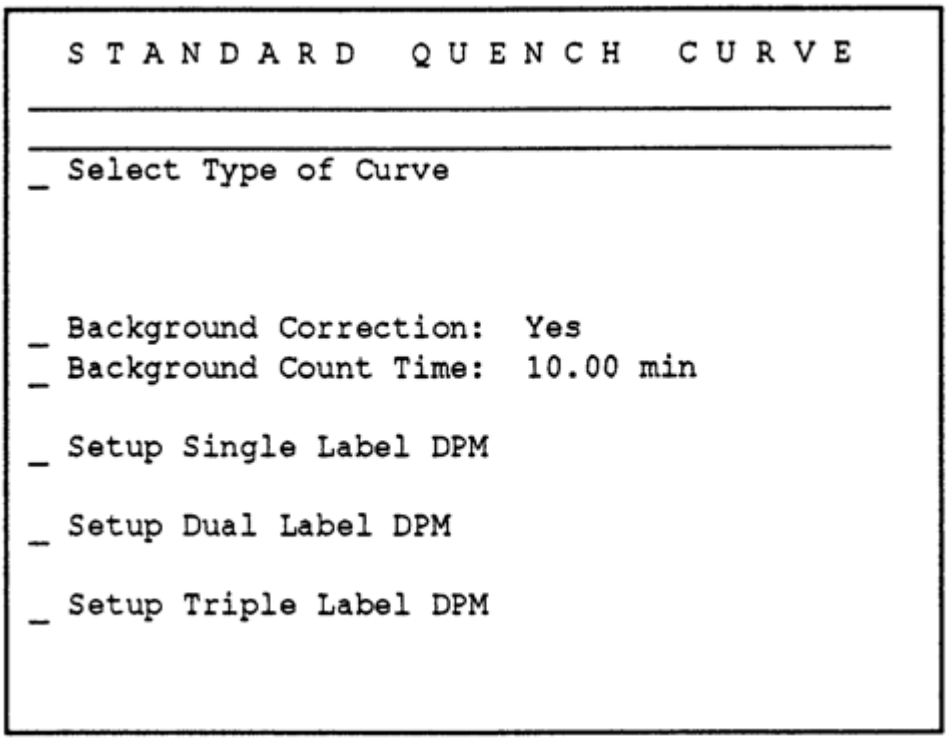
Up to ten sets of standards may be counted and stored in the DPM Library at once. Use the standards prepared in the section above, sets of standards previously prepared, or purchased quench standard sets. When single, dual, or triple label studies using the same isotopes are performed, all quench curves for these isotopes can be set up together. The standards are counted once and all quench curves calculated.

To count the standards:

If you have just finished preparing the standards, proceed to step 5. The desired menu is already displayed.

1. From the Main Menu, highlight “Isotope/DPM Libraries” and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.

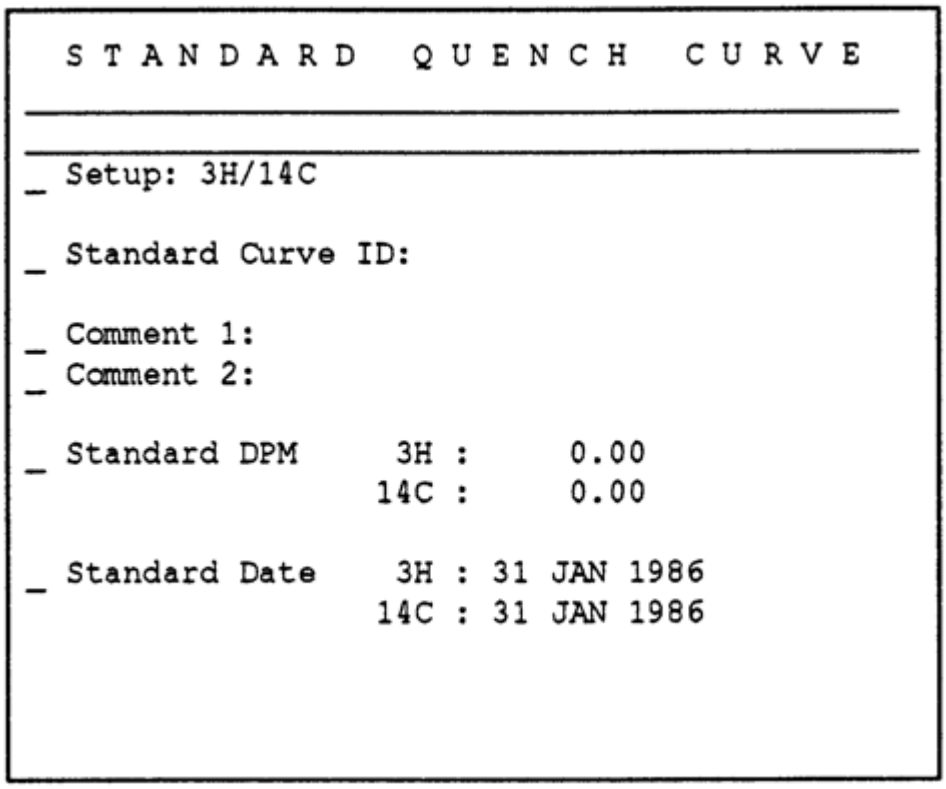
Figure 6.9 Menu To Select Type of Curve.



2. Highlight ‘Set Up and Review DPM Quench Curves” and press **SELECT**. The Main Editing Window displays two prompts: Normal Quench Curves and Low Level Quench Curves.
3. If setting up quench curves for applications other than low level studies, highlight “Normal Quench Curves”. The quench curves are stored in the Standard DPM Library. If setting up standards for low level studies, highlight “Low Level Quench Curves.” The quench curves are stored in the Low Level DPM Library. Press **SELECT**. The Main Editing Window displays two prompts again: Setup Quench Curves and Review/Edit/Delete Quench Curves.
4. Highlight “Setup Quench Curves” and press **SELECT**. The Main Editing Window displays two prompts: Check Precision of Unquenched Std’s and Setup Quench Curve.
5. Highlight “Setup Quench Curves” and press **SELECT**. The menu shown in Figure 6.9 is displayed.
6. If you want to count a background curve, highlight “Back-ground Correction” and choose Yes. A prompt appears to enter the length of time to count the background standards. Highlight “Background Count Time” and enter the desired time.

If you do not wish to count a background quench curve, choose No.

Figure 6.10 Menu to Setup Quench Curves.

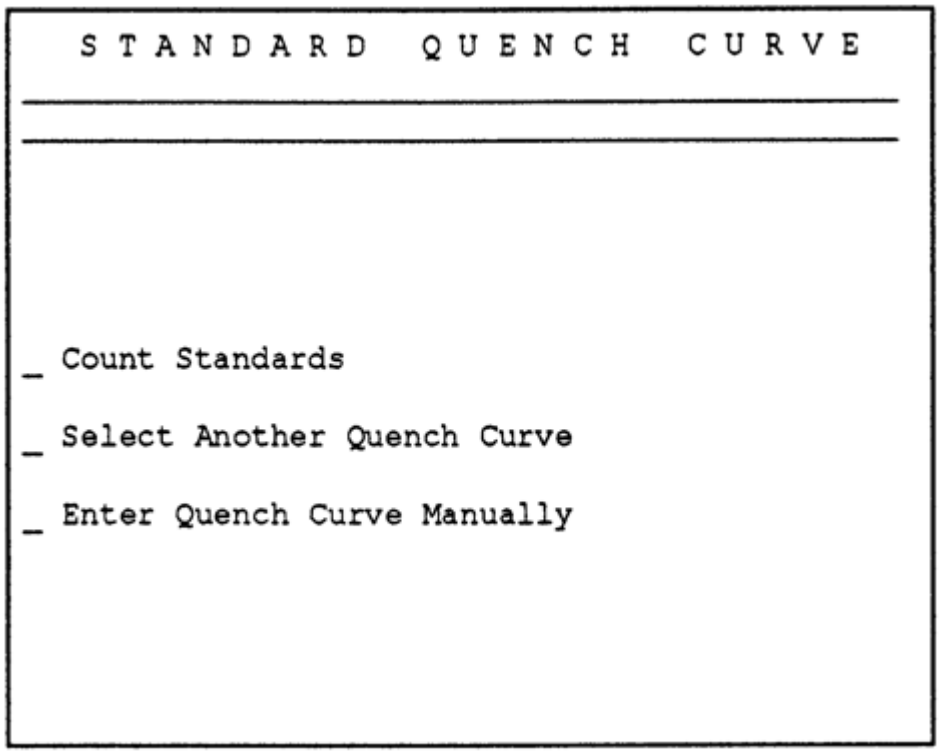


7. Select the type of quench curve you wish to set up. Highlight "Setup Single Label DPM", "Setup Dual Label DPM", or "Setup Triple Label DPM" and press **SELECT**. The Main Editing Window displays prompts to select the isotope(s).
8. The isotopes stored in the Isotope Library are displayed in the Data Entry Window. Choose the desired isotope. If setting up dual or triple label quench curves, prompts are presented for each isotope.

   If the desired isotope is not displayed, the isotope is not stored in the Isotope Library. Exit the DPM program by pressing **MAIN MENU**. Highlight "New Isotope Setup" and press **SELECT**. Add the isotope to the library. Refer to Section 6.1 for information on the Isotope Library.
9. After the appropriate number of isotopes are selected, press the Down Cursor Arrow key. The menu shown in Figure 6.10 is displayed. The isotope(s) selected is displayed in the top left side of the menu for your reference.

NOTE A message is displayed if a quench curve already exists for the selected isotopes. Choose No if you wish to retain the stored quench curve. Choose Yes to overwrite the stored quench curve.

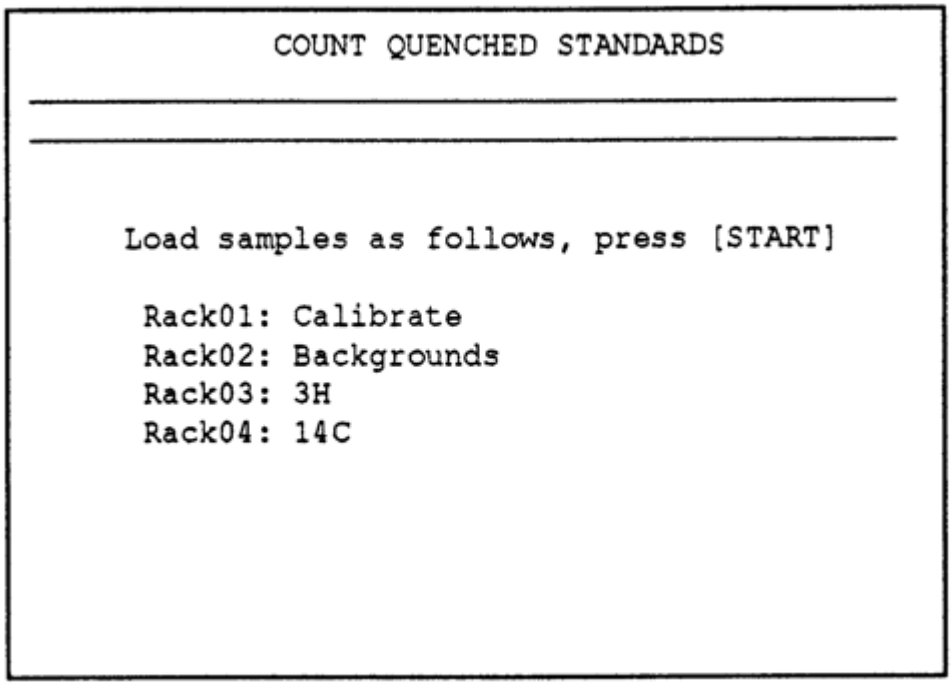
Figure 6.11 Menu to Count Standards.



10. With 'Standard Curve ID "highlighted, enter an identification name using up to 18 characters in any combination of numbers, letters and symbols. Standard Curve ID is informational only and is printed as part of the Program Summary. It is not required.
11. Highlight "Comment 1" and then "Comment 2" to enter additional information using up to 28 characters In any combination of numbers, letters and symbols per comment. Comments are Informational only. They are printed as part of the Program Summary. It is not required.
12. Highlight "Standard DPM" and enter the dpm of the standards using up to 7 digits and a decimal point. The dpm Is listed by the manufacturer on the label of the isotope container. Standard DPM must be entered for each isotope displayed.
13. Highlight "Standard Date" and enter the date of standardization in this format: dd mmm yyyy hr:mln (2 digits for the day, a 3 letter code for the month, 4 digits for the year and, If desired, the time can be entered in hours and minutes based on a 24 hour clock). This date is given by the manufacturer on the label of the isotope container. This date must be

entered for each isotope. If the dpm in the standards has already been half-life corrected, enter today's date.

Figure 6.12 Loading Sequence To Count Standards.



14. Press the Down Cursor Arrow Key to display the menu shown in Figure 6.11. If you want to set up more than one quench curve, highlight "Select Another Quench Curve" and press **SELECT**. Repeat steps 7—14 for each quench curve. If a background quench curve is selected, that curve is subtracted from each of the curves set up at this time.

    If you are setting up quench curves for the same isotopes for single, dual, and triple label, repeat steps 7—14. Select Dual and Triple Label as the type of quench curve.

    When the information for the desired quench curves is entered, proceed to step *15.*

15. When you are ready to count the standards, highlight "Count Standards" and press **SELECT**. The loading instructions are displayed in the Main Editing window. See Figure 6.12. The name and order of the isotopes to load into the instrument are shown.
16. Load the racks into the right side of the sample changer in the order shown. The Calibrate Rack must be first rack or the standards will not be counted. Each set must be

in one rack and contain at least five and no more than 10 quenched standards of the particular isotope. The vials in a set need not be in order of quench.

Figure 6.13 Typical Printout of Correlation Table.

PAGE: 4

SL Calibration: 3H STANDARD COUNT 21 NOV 1990 13:07

Standard Curve Id:
Comment1:
Comment2:
3H DPM: 495200.0 Date of Standardization: 5 OCT 1989

H# Efficiency Curve Correlation Table

Quench Curve Coefficients
A: 4.207839 B: -0.001838 C: -0.000020 D: -0.00000000128

STD. No.	H#	Measured Efficiency	Calculated Efficiency	Percent Difference	Flag
1	7.9	66.36	66.16	-0.3	
2	46.2	58.93	59.23	0.5	
3	100.3	45.78	45.98	0.4	
4	121.4	40.69	40.39	-0.7	
5	161.0	30.26	30.28	0.1	
6	197.3	22.04	22.07	0.1	
7	219.3	17.89	17.77	-0.7	
8	246.2	13.27	13.32	0.4	
9	275.9	9.35	9.39	0.4	
10	323.1	5.05	5.03	-0.2	

Quench Limits Low: 7.9 High:323.07

IC# Efficiency Curve Correlation Table

Quench Curve Coefficients
Lower A: -16.61835 B: -7.186310 C: 10.24119 D: -1.289805
Upper A: -74.17785 B: 43.82986 C: -4.831041 D: 0.1945095
Joining Point: 3.384779

STD. No.	IC#	Measured Efficiency	Calculated Efficiency	Percent Difference	Flag
1	7.871	66.36	66.36	0.0	
2	6.312	58.93	58.91	-0.0	
3	4.755	45.78	45.92	0.3	
4	4.304	40.69	40.48	-0.5	
5	3.615	30.26	30.32	0.2	
6	3.154	22.04	22.13	0.4	
7	2.931	17.89	17.82	-0.4	
8	2.700	13.27	13.25	-0.2	
9	2.504	9.35	9.34	-0.0	
10	2.286	5.05	5.06	0.2	

Quench Limits Low: 2.286 High: 7.871

17. When the racks are loaded into the sample changer, press **START**. The samples are counted to 0.5% 2 sigma or for 20 minutes each.

18. The standard data and a quench correlation table (the data of the quench curves in tabular form) is printed. Figure 6.13 shows an example of a correlation table for a single label ~ quench curve. The quench curve(s) are stored in the DPM Library and can be selected for use in any User Program.

Editing Quench Curves

Any quench curve stored in the DPM Library can be reviewed and erroneous data points can be deleted or new points added.

NOTE Edit stored quench curves carefully, as the changes affect the quench curves stored for all User Programs.

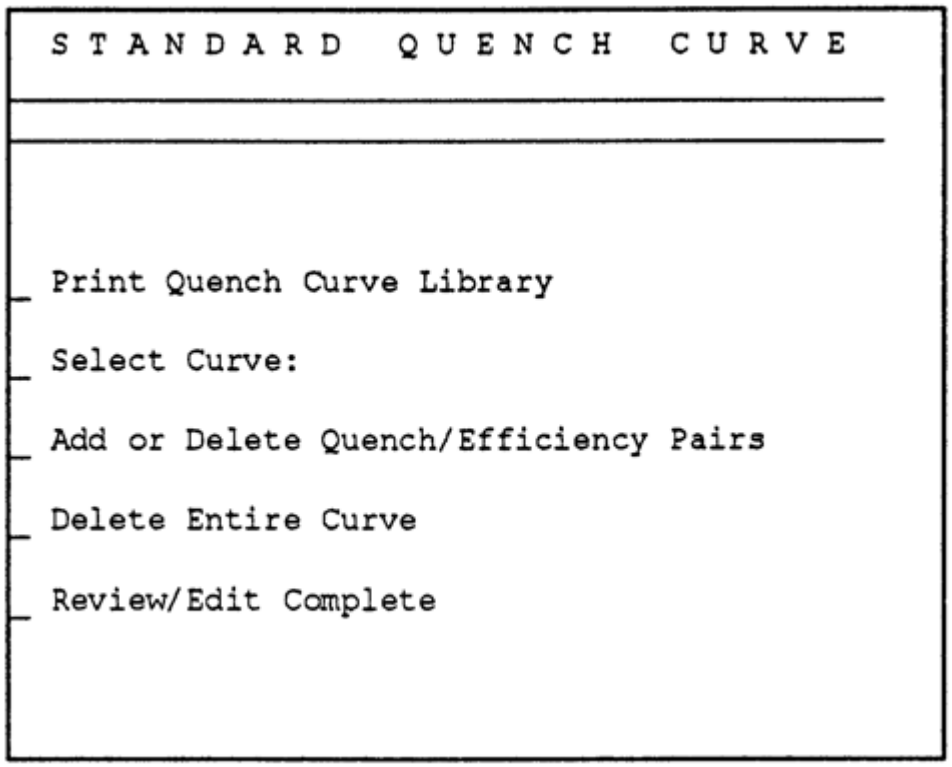
To edit **a** curve:

1. From the Main Menu, highlight "Isotope/DPM Libraries" and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.

2. 2. Highlight "Set Up and Review DPM Quench Curves" and press **SELECT**. The Main Editing Window displays two prompts: Normal Quench Curves and Low Level Quench Curves.
3. Highlight "Normal Quench Curves" if the quench curve to edit is stored in the Standard DPM Library. Highlight "Low Level Quench Curves" If the quench curve to edit is stored in the Low Level DPM Library. Press **SELECT**. The Main Editing Window displays two prompts: Setup Quench Curves and Re-view/Edit/Delete Quench Curves.

4. Highlight "Review/Edit/Delete Quench Curves" and press **SELECT**. The menu shown in Figure 6.14 is displayed.

Figure 6.14 Menu To Edit Quench Curve



5. If you wish to print a summary of the quench curves stored, highlight "Print Quench Curve Library" and press **SELECT**. The library summary Is printed. A typical printout of the DPM Library is shown in Figure 6.15.

6. To select the quench curve to edit, highlight “Select Quench Curve”, and choose from the list of quench curves available.

Figure 6.15 TypicaL Printout of DPM Library

EFFICIENCY CALIBRATION: STANDARD LIBRARY

SL Calibrations:

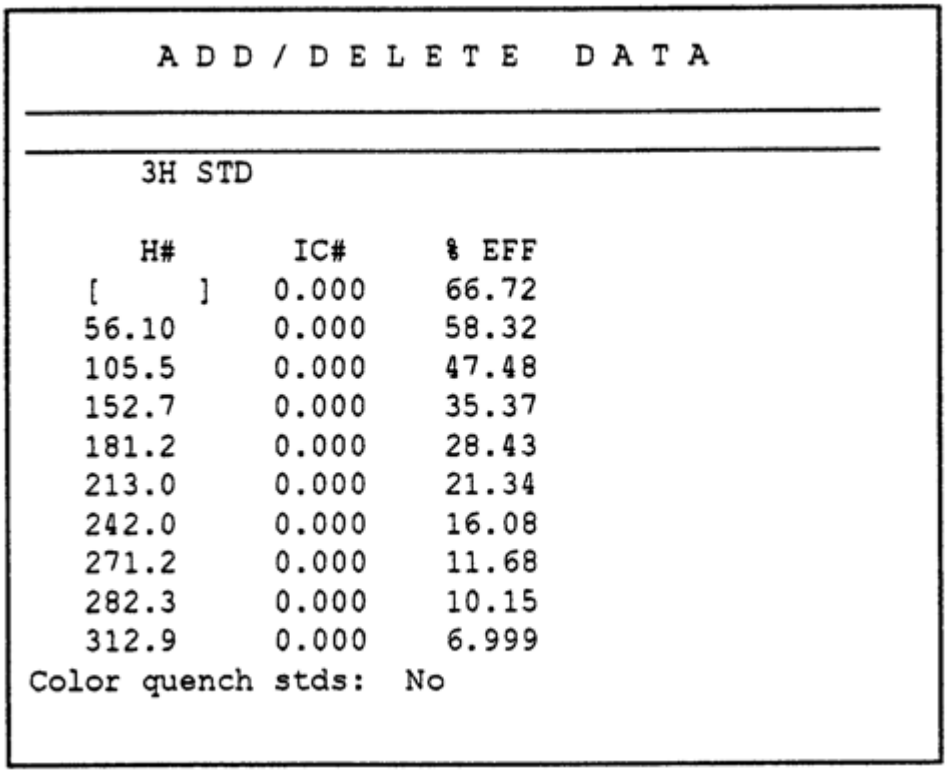
Isotopes	Quench	ID	Calib. Date	Backg.
3H	H# only		31 JAN 1986	No

DL Calibrations:

Isotopes	ID	Calib. Date	Backg.
3H/14C		31 JAN 1986	No

No TL Calibrations Stored

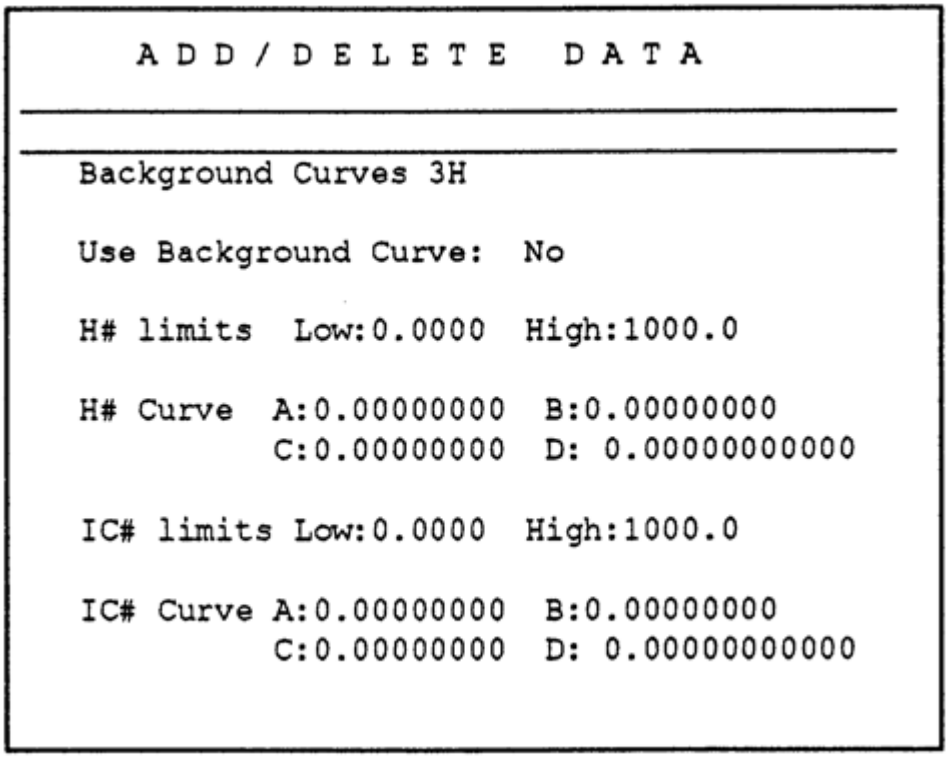
Figure 6.16 Menu To Add/Delete Points From Quench Curve.



7. Highlight "Add or Delete Quench/Efficiency Pairs" and press **SELECT**. The Main Editing Window displays the menu shown in Figure 6.16.
8. To add points to the quench curve, type in the H# or IC# value and the Efficiency for each point you wish to add. Press **ENTER** after each value is typed in. Use the Cursor Arrow keys to move to the next entry. A maximum of ten points for each quench curve may be stored.
9. 9. To delete points from the quench curve, highlight any value of the point you wish to delete, and press **DELETE**. Delete other values in the same manner. At least five points must remain after all desired points have been deleted.
10. A prompt at the bottom of the menu allows you to specify whether the data was generated using standards that are colored. If the standards are colored, highlight the prompt and choose Yes.
11. The background quench curve may also be edited. Highlight "Color Quench Stds" and press the Down Cursor Arrow key. The menu shown in Figure 6.17 is displayed. You may choose to use the background curve or not. Highlight "Use Background Curve" and choose the desired setting. To change or input a background quench curve, highlight the

appropriate prompts and enter the values. To display the previous menu, highlight the first prompt and press the Up Cursor Arrow key.

Figure 6.17 Menu to Edit Background Quench Curve



12. Once all points are added or deleted and the background quench curve Is edited, press **START** to print the new correlation table. Figure 6.13 shows a typical correlation table for a SL ^{3}H quench curve.
13. Press **PREVIOUSMENU**] to store the edited quench curve. After storing the edited curve, the menu shown in Figure 6.14 Is displayed.

    If you do not want to store the changes after editing, press **CANCEL**. The changes are not stored.
14. HighlIght “Review/Edit Complete” when you are finished editing and press **SELECT**. Press **MAIN MENU** if you are finished using the DPM Library.

Deleting A Quench Curve

If a quench curve Is no longer required or if a new curve Is to be generated for a particular Isotope, the existing curve may be deleted from the library. Deleting a quench curve affects all User Programs using that quench curve.

To delete a quench curve:

1. From the Main Menu, highlight "Isotope/DPM Libraries" and press **SELECT**. The Main Editing Window displays two prompts: Setup and Review Isotopes and Setup and Review DPM Quench Curves.
2. Highlight "Set Up and Review DPM Quench Curves" and press **SELECT**. The Main Editing Window displays two prompts: Normal Quench Curves and Low Level Quench Curves.
3. Highlight "Normal Quench Curves" if the quench curve to delete is stored in the Standard DPM Library. Highlight "Low Level Quench Curves" if the quench curve to delete is stored in the Low Level DPM Library. Press **SELECT**. The Main Editing Window displays two prompts: Setup Quench Curves and Review/Edit/Delete Quench Curves.
4. Highlight "Review/Edit/Delete Quench Curves" and press **SELECT**. The menu shown in Figure 6.14 is displayed.
5. Highlight "Select Quench Curve" and choose the quench curve to delete.
6. Before you delete a quench curve, you may want to save a printout of the curve. To print the quench curve, highlight "Add or Delete Quench/Efficiency Pairs" and press **SELECT**. With the menu shown in Figure 6.16 displayed, press **START**. When the quench curve is printed, press **PREVIOUS MENU** to display the menu shown in Figure 6.14 again.
7. Highlight "Delete Entire Curve".

NOTE Before proceeding, ensure that the curve selected and displayed next to "Select Quench Curve:" is the curve you want to delete. Once the delete action is taken, all the parameters for this curve are lost.

NOTE A curve deleted accidentally can be restored, point by point, from the printout of the original quench correlation table, if available. Refer to Manual Entry of Quench Curves Section 6 for information on manually entering a quench curve.

Once you are assured this is the correct quench curve, press **DELETE**. The curve is deleted.

8. If no further editing is required, highlight "Review/Edit Complete" and press **SELECT**. If you are finished using the DPM Library, press **MAIN MENU**.

Manual Entry of Quench Curves

A quench curve that is no longer stored in the DPM Library can be re-entered If a printout or other record of the quench curve (H#'s or IC#'s and efficiencies) is available. The curve is entered by adding each data point and quench monitor value. Five to ten points may be added.

To manually enter a quench curve:

1. Follow steps 1-12 given in Counting the Standards Section 6, Counting the Standards.
2. Press the Down Cursor Arrow key to display the menu shown in Figure 6.11. Highlight "Enter Quench Curve Manually" and press **SELECT**. The menu shown in Figure 6.16 is displayed. All values are zero.
3. To enter points to the quench curve, type in the H# or IC# value and the % Efficiency for each point you wish to add. For dual and triple label quench curves, enter values for Eff-1, Eff-2 and Eff-3. Press **ENTER** after each value is typed in. Use the Cursor Arrow keys to move to the next entry. A maximum often points for each quench curve may be stored.

4. A prompt at the bottom of the menu allows you to specify whether the data was generated using standards that are colored. If the standards were colored, highlight the prompt and choose Yes.
5. A background quench curve may also be entered. Highlight "Color Quench Stds" and press the Down Cursor Arrow key. The background quench curve shown in Figure 6.17 is displayed.
6. Type in the values, pressing **ENTER** after each value is typed in. Use the Cursor Arrow keys to move to the next entry. To display the previous menu, highlight the first prompt and press the Up Cursor Arrow key.
7. Press **START** to print the correlation table.
8. Press **PREVIOUS MENU** to store the quench curve. Prompts are displayed to enter another quench curve manually, if de-sired.
9. If no further editing is required, press **MAIN MENU**.

How Sample Preparation Affects Results

This chapter discusses several factors that can interfere with accurate results: chemiluminescence, statics, two-phase separation, and counting solid samples such as filters.

7.1 Chemiluminescence

Introduction

Investigators who work with liquid scintillation instruments have long been plagued by a problem that occurs with certain types of scintillation mixtures in which light-producing events take place that are not the result of radioactivity of the sample. The light-producing events in question may be caused by one of several types of reactions - photoluminescence, chemiluminescence, or bioluminescence.

These sources of light all have in common the fact that they produce only one photon per event—hence the common term “single photon events” to describe them.

This phenomenon becomes significant because of the “coincident detection” method used in LS counting. The sample being counted is monitored simultaneously by two photomultiplier tubes, and only those events observed by both tubes are counted. The two tubes must each observe an event within some very brief “resolving time”, for the event to be considered coincident, and included in the count. Typical resolving times are on the order of 20 X 1O~ sec. Since one “singles” event releases only one photon, it cannot be observed by both tubes simultaneously, and therefore will not be counted.

However, with a sample in which a large number of singles events occur, the probability increases that the two tubes will each observe two different singles events at approximately the same instant, thus producing a count. This type of “random coincidence event” can be significant enough to produce erroneous cpm.

Lum-Ex Correction provides a means of determining when the results of counting are being distorted by random coincidence events.

Sources of Single Photon Events

Some very common sample preparations can cause so many single photon events that hundreds of thousands of these photons are coincident and look like real cpm.

Some of these sample conditions are:

1. Samples with an alkaline pH.
2. Samples with peroxides (either organic peroxides or hydrogen peroxide used for dissolving polyacrylamide gels or bleaching hemoglobin). Peroxides with alkaline solutions cause particularly severe chemilumlnescence.
3. Use of tissue solubilizers, especially with emulsifier cocktails. Tissue solubilizers are designed for use with nonaqueous cock-tails.
4. Samples, cocktails or vials exposed to sunlight or UV light from sterilization lamps or UV lamps for detecting fluorescent molecules.

5. Plant extracts containing chlorophyll.

Interpretation of Results

Lum-Ex values provide an indication of what percent of the total CPM's are due to non-radioactive events. The significance of this Lum-Ex% depends on a number of factors that you must evaluate. For example: How accurate must your answer be? Is the Lum-Ex% the same in all the samples? Are small CPM differences between samples critical?

Figure 7.1 Chemiluminescence and Statics

Sample Preparation 7-3

Reducing Chemiluminescence and Statics

Time after treatment (minutes)	Chemiluminescence:* $KOH + H_2O_2$	$KOH+H_2O_2$ +Acetic Acid	Statics:* Untreated	Wiped with antistatic cloth
0	8,330	18	3,717	6
1	3,487	11	268	4
5	1,213	6	193	5
10	639	4	207	6
20	195	5	148	6
30	108	6	122	6
60	48	6	68	5

* Counts in 0.1 minutes

As a general rule, If the Lum-Ex value is 5% to 10% or greater, steps should be taken to eliminate the problem (see the following section).

Reducing Single Photon Events

Many single photon events can be eliminated from samples by some very simple techniques. Chemiluminescence from peroxides and alkaline pH can almost always be eliminated by the addition of glacial acetic acid. Usually, 100 µL in 10 mL of cocktail is sufficient.

This same treatment sometimes works for chemiluminescence from tissue solubilizers. If this does not eliminate the chemiluminescence, set the samples aside and monitor them hourly until the chemiluminescence is sufficiently low.

Figure 7.11 shows the counts of a sample with chemiluminescence. This sample has no radioactivity. Notice how the addition of acetic acid completely eliminates the random coincidence counts after 5 minutes.

While there is no corresponding method for reducing photoluminescence, the effects fortunately decay rather quickly. Generally, avoid exposing samples to sunlight or ultraviolet light. If photoluminescence is suspected, let the vials sit in the counter for 30 to 60 minutes before counting.

If you are unable to eliminate the source of single photon events, Lum-Ex Correction (if installed) can subtract all contributions from single events from each isotope window.

7.2 Recognizing And Avoiding Statics

Statics are a common source of erratic high counts, resulting from a static charge on the surface of the sample vial discharging in the counting chamber.

Static charges accumulate on sample vials when the vials are handled during sample preparation. The instrument is equipped with an electronic ion source that will neutralize static charges under most circumstances.

Certain conditions, however, may cause such large static build-ups that an appreciable charge remains on the vial. The problem is most prominent in hot, dry weather or in the winter when the indoor air is heated and dry. However, statics can also be seen in rainy, damp weather. The use of plastic vials, especially when handled while wearing latex gloves, is another major source of static build-up.

To check for the presence of statics, count one of your own samples (not an unquenched standard) repeatedly over a period of time. If the count rate is erratic (increasing and decreasing cpm) the presence of statics is likely.

The following steps should be taken when a statics problem is encountered:

1. Use vinyl or polyethylene gloves, not latex.
2. Treat the gloves with anti-static spray and/or wipe them with an anti-static cloth. Treatment with an anti-static type fabric softener cloth, such as the type commonly used with a house-hold clothes dryer, is particularly useful since it can prevent statics for many days.
3. Wipe each vial completely with the anti-static cloth. Statics is very localized on a vial so the entire vial must be wiped-sides, top and bottom.

Figure 7.1 shows how the effect of statics and how wiping a vial can immediately reduce statics to normal background.

7.3 Two Phase Samples

A two-phase sample—that is, one that has separated into two distinct phases before or during counting—may yield variable and highly inaccurate data from the counting process. In addition, accurate quench monitoring is not possible. A sample may be thoroughly emulsified when placed in the instrument, but may separate while waiting to be counted. Although the two phases are sometimes visually distinct, in other cases the only difference that can be seen is a slight haze, noticeable only on close observation. When plastic vials are used, even a distinct separation would, of course, not be visible.

Samples separate into two phases because the sample exceeds the ability of the emulsifier to make all of the aqueous samples soluble with the organic solvent of the cocktail. This overload could be from too much sample, high salt concentrations, or extreme pH's which degrade the emulsifier. If there is a change in room temperature (sometimes only a few degrees), a single phase sample can become two phase.

This phase problem can often be eliminated by using less sample, more cocktail, or switching to a cocktail with better sample holding characteristics. Sometimes diluting the sample with water or neutralizing the pH will work.

If you are not sure whether your sample is separating into two phases, a simple test can be done. Prepare a glass vial of the cocktail and sample you use for the experiment. Observe the sample over the time and temperature range it is exposed to during counting. If the sample stays single phase, there is no problem. If it becomes two phase, try some of the procedures outlined above on fresh preparations. The 2 Phase Monitor (if installed) flags any samples detected as two phase.

7.4 Counting Filters And Precipitates

Any sample that is not intimately mixed with the cocktail will count with a low efficiency and with unpredictable and varying results. Quench monitors are not accurate, DPM are difficult to calculate, and even comparisons of CPM between samples may give misleading results.

Counting precipitates on filters or as pellets from centrifugation is a very common procedure. It can be used effectively if certain precautions are taken. There are two main problems in getting accurate and reproducible results from filters or precipitates. First, the amount of physical precipitate will affect the CPM recorded. More sample material will absorb more of the radio-active decay events. This beta absorption results in decreased CPM with increasing amount of precipitate. The second problem results from the precipitate dissolving in the cocktail over a period of time. This results in variability between repeat counts and between different samples.

There are two ways to avoid these problems. The less desirable method is to have samples with approximately the same amount of precipitate and to select a cocktail in which the precipitate will not dissolve. While DPM cannot be calculated for these samples, at least the CPM between samples can be compared.

The other, and better, method is to dissolve the sample completely before counting. In the case of proteins or nucleic acid precipitates, this is a very simple procedure. Add enough 0.05 to 0.1 M KQH (100 µL is a good starting volume) to wet the filter or dissolve the pellet. After mixing, add a cocktail such as Beckman Ready-Solv HP. This will emulsify the KOH along with the sample. It is not necessary for the filter to dissolve. This type of preparation is not affected by the amount of precipitate, and DPM calculations are easily done in the usual manner.

7.5 Distinguishing Sample And Instrument Variability

Introduction

The sample preparation problems discussed in this chapter can lead to counts that are too high, too low, that increase with time, decrease with time, or go up and down in a random pattern. This is often mistaken for instrument malfunction. However, there are instrument problems that can cause similar symptoms. This section outlines how sample problems and instrument problems can be distinguished. These tests are not 100% conclusive but they do form good grounds for you to analyze the most common problems encountered and to communicate valuable information to the service representative.

Procedures

First, calibrate the instrument as outlined in Section 2.7. If a note is printed out that calibration is not successful, be sure an unquenched ^{14}C standard was used for the calibration. If upon a repeat attempt the calibration is still unsuccessful call an Authorized Beckman Service Representative. If the calibration is successful, proceed.

Set up a rack with the ^{3}H, ^{14}C, and background unquenched standards that were supplied with the instrument. Follow these samples with three or four of your own samples that are giving questionable results.

Set up a User Program as follows:

Count Time: *5* minutes
Isotope 1: ^{3}H
Isotope 2: Wide
Data Calculation: CPM
Count Sample: 3 times
H# (if installed): ON
Lum-Ex:ON
^{3}H and ^{14}C precision: 1%

The count time may be increased or the precision decreased if the problem you are evaluating takes place over a longer period of time. Count the samples and review the date as explained in the next section.

Analysis of Data

Unquenched Standards

Look at the sample repeat values for the unquenched standards. Since the ^{3}H and ^{14}C were counted to a 1% error, the cpm should be +/-1% of the average 95 out of 100 times. The coefficient of variation should be less than 0.01. The Lum-Ex value should be less than 1%. Check the counting efficiencies, H#'s and backgrounds as described in ^{3}H Counting Efficiency Section 7 and ^{14}C Counting Efficiency Section 7.

Samples

The sample repeat cpm's should be stable and within the counting statistics as discussed for the standards. The Lum-Ex values should be less than 1%. The H# repeats for any one sample should be within a fairly narrow range, depending on the value of the H#. In general, lower H#'s have less variation. In either case they should not vary by more than +1-10 over the entire quench range of the instrument. If you should ever encounter a real H# problem you will find the variations are in the 100's.

The tests could give different conclusions. These are:

1. The standards and your samples both meet the above criteria. This means the instrument is working. There is still the possibility of an intermittent problem that did not arise over this test period. Further long term study is required.
2. The standards check out but your samples vary: This means the instrument is working and your sample preparation procedures must be reviewed.
3. The standards don't meet the criteria: Regardless of how your samples perform, if the standards do not meet the criteria outlined within some small limits, then the instrument is not performing properly. In this case, a Authorized Beckman Service Representative should be contacted.

^{3}H Counting Efficiency

For ^{3}H it is necessary to correct for the radioactive decay since the samples were prepared. This can be done by using the half life table (Appendix D). The ^{3}H standard will have the date of calibration and the dpm on that date printed on the vial. Calculate t (current date minus date of calibration, in years). Divide t by the half life T (12.35 years ^{3}H). Find this value in the t/T column of the half life table. Use the corresponding fraction remaining value to multiply the standard DPM. The result is the DPM remaining on the selected date.

Use the CPM for Isotope 1 for the ~ standard, and the CPM for Isotope 1 for the background sample. The background for this calculation is insignificant compared to the CPM of the standard but is given for completeness. Calculate the ~ efficiency from the equation:

$$\% \text{ Efficiency} = \frac{\text{CPM - Background x 100}}{\text{DPM}}$$

^{14}C Counting Efficiency

For the ^{14}C efficiency, use the ^{14}C CPM for Isotope 2, Wide. Calculate the efficiency as described for ^{3}H.

Acceptable values meet these system specifications:

^{3}H: ≥ 59% in wide open window

^{14}C: ≥ 95%

H#: 0 ±5

If any results fall to meet these values, check the following:

1. Inspect the sample vials to ensure they are securely sealed.
2. Ensure the instrument is calibrated and set up properly.
3. Verify that you have accurately corrected for decay using the Half-Life Tables, and that your computations are correct.

If it appears that system efficiency is less than the specifications, contact your Authorized Beckman Service Representative.

Background

The background in the Wide window should be less than 60 CPM. The background in an LS counter is influenced by the noise within the system (phototubes, electronics), naturally occurring radioactivity, and cosmic rays. The background also varies with the size and type of vial (plastic has lower back-ground than glass), and the altitude (about a 7% increase in background for each 1000 feet above sea level).

7.6 Other Factors That May Affect Accurate Results

Contamination

High backgrounds are often the result of radioactive contamination of the instrument (sample changer, elevator, counting chamber) as a result of a spill, leaking vials, improperly closed vials, evaporation of radioisotopes, or contamination on the outside of the vials.

High background may also result from a radioactive source stored in the vicinity of the instrument. If this is suspected, then swab tests in and near the instrument, and a Geiger counter survey of the area, should be performed. The radiation safety officer at your facility should be contacted for further advice on these procedures.

Noise

If repeated counts of a background reference standard yield results that vary beyond the appropriate statistical limits, the problem may be due to some form of noise. This may be occurring in one of three ways: generated within the system;

entering through the AC power line; or radiated from some source within the vicinity.

Powerful RF transmission stations, even at some distance, can cause interference with instrument operation. However, this situation, as well as problems due to AC line noise, is fairly easy to detect and correct.

Good electrical grounding is important with these instruments, and an inadequate ground connection may give rise to instrument noise. When an instrument that has been operating properly becomes noisy, the cause may be an increase in the noise rate of the photomultiplier tubes.

Instrument Specifications

a.1 Efficiency

^{3}H:	≥ 60% in a wide window
^{14}C:	≥ 95% in a wide window

These specifications are applicable only for Beckman calibrated standards traceable to the National Bureau of Standards. The LS counter must be properly calibrated.

a.2 H# Plus

Reproducibility	±1% Counting Efficiency

H# Plus reproducibility is measured relative to a ^{3}H quench curve set up with a wide open window.

a.3 Maximum Count Rate For Reproducible H#

Isotope	Standard Vials (18-5 mL)	Miniature Vials (6-1 mL)	Microfuge Tubes (1.5-0.2 mL)
^{3}H:	10×10^{6} dpm	4×10^{6} dpm	4×10^{6} dpm
^{14}C:	6×10^{6} dpm	2×10^{6} dpm	10×10^{4} dpm
^{32}P:	2.8×10^{6} dpm	18×10^{4} dpm	3×10^{4} dpm

These values are for the minimum allowable volume for each of the three ranges.

a.4 Maximum Count Rates

The hot sample reject will not allow the counting of samples that are so radioactive (“hot”) that they will give incorrect CPM. The hot sample reject criteria are:

Total singles:	26×10^{6} CPM
Coincident counts (in 3H window):	10×10^{6} CPM
Coincident counts (in ^{14}C window):	13×10^{6} CPM
Coincident counts (in window above ^{14}C):	5×10^{6} CPM

a.5 Power Requirements

Electrical Requirements: (50/60 Hz)	**120V**	**240V**	**BTU/HR**
Instrument	3A	1.5A	1230
Temperature Control Accy	7.5A	3.8A	3060
Inrush Current:	5A at 120V 2.5A at 240V		
Power Failure Recovery	With a fully charged battery, the system returns to a disrupted Automatic Count for several weeks.		

a.6 Dimensions

	Width cm(in.)	**Height cm(in.)**	**Depth cm(in.)**	**Weight kg(lbs.)**
Instrument:	91.5(36)	66(26)	80(31.5)	210(460)
Monitor:	33(13)	34.3(13.5)	35.6(12)	8.2(18)
Printer:	39(15.5)	10(4)	30.5(12)	5(11)
Temperature:	35.5(14)	56(22)	73.7(29)	45.4(100)
Control Accy.*				

*Temperature Control Accessory attaches to right side of instrument.

a.7 Ambient Temperature Range

15°C to 35°C. Calibration must be performed within 5°C of operating temperature.

a.8 Temperature Control Accessory

Maximum Relative Humidity:	85%
Ambient Temperature Range:	15^0 to 30^0
Maximum Pull Down Time:	8 Hours
Set Point 1:	12°C +3°C

Set Point 2:	15°C +3°C
Set Point 3:	18°C +3°C

Set Point must be within 10°C of the operating ambient temperature.

Installation Requirements

This appendix describes the electrical power, space and environmental conditions required for installation of a Beckman Liquid Scintillation instrument. Proper preparation of the installation site will minimize installation time and allow optimum performance from your Beckman LS System.

NOTE For proper warranty validation, all Beckman Liquid Scintillation Systems must be installed by an Authorized Beckman Field Service Representative. Installation is included in the purchase price of the instrument. When the instrument arrives at your facility, contact your local Beckman Sales and Service Office for an installation appointment.

b.1 Electrical Requirements

Electrical Requirements: (50/60 Hz)	**120V**	**240V**	**BTU/HR**
Instrument	3A	1.5A	1230
Temperature Control Accy	7.5A	3.8A	3060
Inrush Current:	5A at 120V 2.5A at 240V		

Beckman Liquid Scintillation Systems require a minimum of two power outlets; one for the basic counter and one for the printer. All power cords are 2.2m (86 inches) long.

For proper function and reliable *test* results from any laboratory instrument, certain power line requirements must be satisfied. the following are excerpts from the NCCLS Power Source Standard *5*, POWER REQUIREMENTS FOR LABORATORY INSTRUMENTS.[1]

Power Supply

Power Lines that supply clinical laboratory instruments should be reserved exclusively for service within the clinical laboratory. Each power line to a clinical laboratory should connect directly from a main power line transformer at a power source known to be clear of erratic power loads, spikes, and electromagnetic interference.

1 Power Requirements for Clinical Laboratory Instruments and Laboratory Power Lines," NCCLS TENTATIVE STANDARD: TSI-5.

Power lines within the laboratory should provide at minimum, three-wire single phase power with one wire neutral/ground. Provision of three-phase service to the laboratory is desirable, since electrical service may be required for larger instruments.

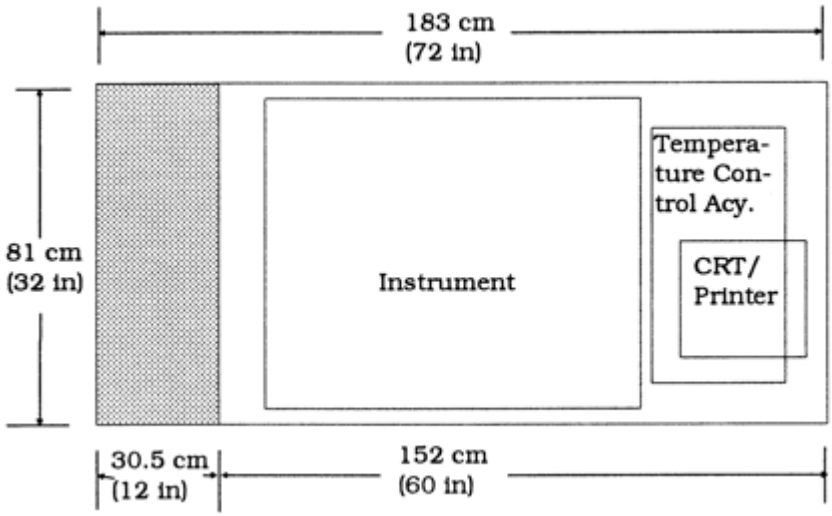
For electrical safety, suppression of electromagnetic interference and proper performance, this instrument should be operated from a supply source that incorporates a third wire protective grounding which conforms to local codes and ordinances.

Power lines reserved for instrument use within the clinical laboratory shall have adequate reserve capacity. Normal contemplated loading should not exceed *50%* of nominal capacity to allow for start-up loads and the addition of new instruments.

Power *Outlets*

All single-phase electrical outlets to which instruments are to be attached must provide standard 3-prong receptacles war-ranted by the manufacturer to the expected power demand. All receptacles must be properly connected to the power line ground. The use of extension cords or of multiple outlet adapters is prohibited. Bad practice in these regards can be a source of poor electrical contacts that are likely to counteract the specified grounding system. The use of such cords and adapters also provides a potential source of erratic instrument performance or of shock hazards.

Figure b.1 Recommended Installation Dimensions.



Power outlets, each with two to four receptacles, should be placed every *0.5* to 1.0 m in instrument usage areas. As an alternative, power strips may be installed. Receptacles shall be at least 8 cm above the counter top to protect against liquid spills.

Adjacent outlets or power strips should be connected to different “hot lines” from the main supply. The outlets should be labeled so the same code appears on all outlets to the same hot line.

Equipment that operates intermittently and thereby creates wide fluctuations in power demand, such as refrigerators, water baths, and centrifuges, should be plugged into power

lines that are separate from those used to supply power to instruments requiring a constant power supply.

b.2 Space Requirements

Dimensions:	Width cm(in.)	Height cm(in.)	Depth cm(in.)	Weight kg(lbs.)
Instrument:	91.5(36)	66(26)	80(31.5)	210(460)
Monitor:	33(13)	34.3(13.5)	35.6(12)	8.2(18)
Printer:	39(15.5)	10(4)	30.5(12)	5(11)
Temperature Control Accy	35.5(14)	56(22)	73.7(29)	45.4(100)

A minimum bench or table space of 132 cm (52 in.) wide and 71 cm (28 in.) deep is required for the instrument. The surface must be level and flat and capable of supporting 275 kg. (600 lbs.) without bowing or flexing. To allow for optimal air circulation and ease of service, a recommended space of 152 cm (60 in.) wide and 81 cm (32 in.) deep should be dedicated to the instrument, an additional 30.5 cm (12 in.) of width (shaded area in Figure b.1) should be free of permanent structures to allow for installation and service. The area 91 cm (36 in.) above the bench or table must be clear of shelves or cabinets.

b.3 Environment Requirements

Counting specifications are based on a minimum of i5^{0}C (54^{0}F) and a maximum of 30^{0}C (86^{0}F) ambient temperature, providing calibration has been performed within 5^{0}C (9^{0}F) on the operating temperature. Relative humidity must be less than 85% without condensation. Avoid placing instrument where it is exposed to direct sunlight or severe temperature fluctuations such as near windows, heaters or air conditioning outlets.

RS232

c.1 Specifications

Standard ASCII format, upper case only, is used throughout. The LS is configured at the factory to transmit at a baud rate of 1200. The Word Format is defined as: 1 start bit; 8 data bits (with no parity bit); 1 stop bit.

To match the default settings of the instrument, any device connected to the RS232 port must be configured as:

1200 Baud

1 Start Bit

7 Or 8 Data Bits

No Parity

1 Stop Bit, Minimum

Half Duplex

The instrument arrives configured as Data Communications Equipment (DCE) which means it behaves like a modem. An external device connected to the LS should be configured as Data Terminal Equipment (DTE). A standard RS232 cable is used. (If the external device is configured as DCE, then a "Modem Bypass" or "Null Modem Cable" must be used.)

The default parameters for the RS232 port may be changed under System Setup. Refer to Alarm Section 2.

c.2 Handshaking

XON-XOFF handshaking has been implemented. The LS will respond to the control characters:

XON: Control-Q; Hex 11; Decimal 17, ASCII

XOFF: Control-S; Hex 13; Decimal 19, ASCII

Figure c.1 RS232 Pin Designation.

Pin Number	Signal Name	Direction
2	TXD	Input (to LS 6000)
3	RXD	Output (to external device)
4	RTS	Input
5	CTS	Output (Handshake)
6*	DSR	Output
7	GND	Output

Figure c.1 RS232 Pin Designation.

Pin Number	Signal Name	Direction
8*	DCD	Signal Ground
20	DTR	Output
*These lines are held high by the instrument.		Input (Handshake)

When XOFF is received, data transmission stops until an XON is received. Data transmission starts automatically after 30 minutes have elapsed unless XON is sent prior to that time. If the printer is not ON after the 30 minute time out, the LS counter itself stops.

There is no ACK/NAK (acknowledge/no acknowledge) or re-transmit protocol in the data output mode.

CTS and DTR are used as handshake lines as summarized in Figure c.1. Note that the output lines DSR and DCD are always held high by the LS.

c.3 RS232 Data Output

General Format of Messages

The basic unit of transmission is a message of up to 96 characters terminated by a carriage Return-Line Feed (CR,LF). Each message contains a code to identify the type of message being sent. If the message contains data, each data item is coded to identify the particular datum being sent followed by its actual value. The actual value may be boolean, an integer, a real number or text depending upon the specific datum.

RS232 Session: Definition and Message Format

The LS signals the start of any operation that involves RS232 transmission by sending a Send Initiate message, message Type S. If the LS is terminating RS232 transmission, then it sends a Break Transmission message, message Type B. These messages require no response by the external device. The period between Send Initiate and Break Transmission messages is called an RS232 Session.

During an R5232 Session involving Output, a specific format is used for messages as given below.

<Message> = <SOH> <Length> <Sequence Number><Message Type>{<Data Item>{<Seml-colon> <Data Item>}) <Checksum> <CR> <LF>

where <Data Item> = <Data ID> <Data Type> <Space> <Data Value>

Each item of the message is explained in the following para-graphs.

<SOH>, Start of Message

<SOH> = Control-A (Hex 01 or ASCII decimal 1)

<Length> is one printable ASCII character (Hex 20 through 7E or the decimal equivalents 32-126).

The message length includes all characters in the message except <SOH>, <Length>, <CR> and <LF>. The maximum number of characters on one line is 96, or 94 after <Length>. Message Length is obtained by subtracting 20 Hex from the <Length> character. For example, a message with 5 characters would have <Length> =

<Sequence Number> numbers each message line serially with ASCII characters starting with <Space>, and ending with

<Message Type> is one printable ASCII character. It identifies the purpose of the message or its contents as described by the codes in Figure c.2.

Figure c.2 Codes for Message Type.

Message Code	Purpose/Contents of the Message
D	Data
E	Error
S	Send Initiate (Start of Session)
B	Break Transmission (End of Session)
F	File Header
Z	End of file

File Headers are identical in the Datum ID Table.

<Data Item> = <Data ID> <Data Type> <Space> <Data Value>

Data ID, type and value are printable ASCII characters as defined below. Data IDs are three digit numbers and are listed in Figure c.5 at the end of this section. There are six Data Types coded by a single letter as defined in Figure c.3.

One or more data items or no data items can be present in a single message. Multiple data items are separated by semi-co-lons.

Checksum—The checksum is a printable ASCII character, Hex 20 through 7E (or decimal equivalents 32-126). It is always the lowest two hexadecimal digits of the sum of the ASCII values of all the characters in the message except <SOH>, <Checksum>, <CR> and <LF>. The decimal value of the checksum may be computed from the transmitted ASCII characters as: (ASCII Character of the first value-20 Hex)*64 + (ASCII Character of the second value-20 Hex).

Carriage Return (CR) is OD, Hex (or 13 decimal). Line Feed (LF) is OA, Hex (or 10, decimal). Each line closes with CR, LF.

File Header/End of File (F/Z)—During an RS232 session, the LS will indicate the beginning and end of groups of data with the File Header, F, and the End of File, Z, messages. The File

Header message includes a data item giving the type of file. There are 4 possible file types which are listed in Figure c.5 at the end of this section.

Figure c.3 Data Type Description and Codes.

Data Type	Type of Data	Description
B	Boolean	3 ASCII Characters YES(True), NO(Space), FALSE
H	Hex	1 or more Hex Digits: 0-9, A-F
I	Integer	1 or more decimal digits (0-9), with an optional preceding minus sign. May not include spaces.
R	Real	1 or more decimal digits (0-9), plus '.', '-', '+',l and 'E'. May be in scientific notation. The decimal point may be omitted. May not include spaces.
T	Text	1 or more printable ASCII characters (20-7E Hex). Is not of fixed length, unless explicitly indicated otherwise.
N	None	No data values in this item.

Start and End of Sample Data (910/91 1)—If an RS232 message includes the transmission of sample count data, then the first data item in the first data message for each sample is the Data ID value 910.

After all data for a sample have been transmitted, then the last data item in the last data message for a sample is the Data ID value 911.

Consequently, the IDs 910 and 911 signal the start and end of data transmission for each sample. The END ID of 911 is literal. This means that all sample repeats, repeat averages, everything for a given sample has been transmitted before the 911 code is sent.

XON is Control-Q or 11, Hex. XOFF is Control-S or 13, Hex.

Datum IDs

Each datum transmitted in an RS232 message is identified by its own 3 digit code, so all data items can be recognized and processed without prior knowledge of which messages contain which data items. In addition, it isn't necessary to know the position of data items in the message. The Data Codes, together with their meaning and value type, are listed in Figure c.5 and Figure c.6 (if Alpha-Beta Discrimination is installed).

The datum codes are transmitted as ASCII characters, not as decimal digits. The original three digit code may be computed from the ASCII characters according to:

(Decimal value of the first ASCII character~32)*64 + (Decimal value of the second ASCII character-32).

For example, !D is the ASCII character representation for 100, the three digit code for the User Number. ASCII decimal for! is 33 and for D, 68. Therefore, (33~32)*64 + (68-32) = 100.

c.4 RS232 Input Mode

The Input Mode of the LS functions as a remote keyboard. All operations on the keyboard of the LS itself can be initiated by a remote device with the exceptions of the HELP and INTER-RUPT functions.

Each command from the remote keyboard is a two letter code. Figure c.4 lists the two character codes for the INPUT mode. Each letter is acknowledged with ACK and NAK, indicating that the command received is being interpreted. No indication is given on the state of the instrument. Prior to beginning control of the counter by a remote keyboard, it is necessary to give the RESET command (RS) and wait for the LS to reset.

After sending each two letter command, wait for that command to be performed before sending the next command. The system does not provide for a command queue. Figure c.4 lists the time needed for the counter to perform each of the commands. If one letter of a command is sent in error, the synchronization may be re-established by sending the single character *. As an example, sending *RS always RESETS the LS.

If the LS is counting samples, the only active commands are Stop Count (SC), Enter/Select (ES), and Reset (RS).

Figure c.4 Codes for the Input Commands.

Codes for Input Commands

Command	Key/Function Simulated	Approximate Time For Completion of The Command
Alpha-numerics		
AA...AZ	A...Z	1 sec
A, A+, A-, A. Space, +, -, comma		1 sec
NO...N9	0.....9	1 sec
Start/Stop		
ST	Start	11 sec
SC	Stop Count	8 sec
Reset		
RS	Reset	7 sec
Obtain Menus		
MM	Main Menu	2 sec from Standby
		5 sec from Diagnostics
PM	Previous Menu	2 sec
Enter/Delete/Erase		
ES	Enter/Select	2 sec, Alpha-Numeric Entry

Figure c.4 Codes for the Input Commands.

Codes for Input Commands

Command	Key/Function Simulated	Approximate Time For Completion of The Command
		5 sec, Screen Selection
BS	Back Space	1 sec
DL	Delete	2 sec
Printer		
PR	Print	5 sec
LF	Line Feed	1 sec
Sample	Movement	
SR	Sample Right	11 sec, Belts and sample
SL	Sample Left	1 sec, Sample only
Cursor Movement		
CU	Cursor up	1 sec
CD	Cursor down	1 sec
CR	Cursor Right	1 sec
CL	Cursor Left	1 sec

Figure c.5 Datum Ids.

Setup Parameters

Data Id Values: 100 - 199

ID	Data Value Meaning	Data Value Type
100	User Number	Integer
101	User Id Text	Text (15 Chars)
102	User Comments	Text (28 Chars)
103	Preset Count Time	Real
104	Calculation Mode	Text (11 Chars)
105	Sample Repeats Requested	Integer
106	Replicates Requested	Integer
107	Norm Multiplier Isotope	Real
108	Blank Count (on Or Oil)	Boolean
109	Requested Counting Precision,	Real

Figure c.5 Datum Ids.

	Percent, Window 1	
110	Requested Counting Precision, Percent, Window 2	Real
111	Requested Counting Precision, Percent, Window 3	Real
112	Background (CPM), Window 1	Real
113	Background (CPM), Window 2	Real
114	Background (CPM), Window 3	Real
115	Quench Monitor Selected (None I H#<Space><Space> I IC#<Space>)	Text (4 Chars)
116	Lum-Ex Selected	Boolean
117	Isotope 1 Name	Text (6 Chars)
118	Isotope 2 Name	Text (6 Chars)
119	Isotope 3 Name	Text (6 Chars)
120	IC# Or 8CR Selected	Text (3 Chars)
121	Printer Output Mode	Text (4 Chars)
122	RS232 Output Mode	Text (4 Chars)
123	Rack Size	Text (4 Chars)
124	H# Selected	Text (3 Chars)
125	Two Phase Selected	Text (3 Chars)
126	Lum-Ex Selected	Text (3 Chars)
127	Data Buffer Output Mode	Text (4 Chars)
128	Scintillator Choice	Text (6 Chars)
129	Static Correction Selected	Text (3 Chars)
130	Cycle Repeats	Integer
131	Low Sample Reject Count	Integer
132	Data Transporter Output Mode	Text (4 Chars)
133	Norm Multiplier Isotope 2	Real
134	Norm Multiplier Isotope 3	Real
135	Quench Limit Low	Real
136	Quench Limit High	Real
137	Half Life Isotope 1	Real
138	Half Life Isotope 2	Real
139	Half Life Isotope 3	Real
140	DPM Ratio: Top Isotope Name	Text (6 Chars)
141	DPM Ratio: Bottom Isotope Name	Text (6 Chars)
142	Half Life Correction Date	Text (11 Chars)

Figure c.5 Datum Ids.

143	SPM: Number Of Data Points	Integer
144	SPM: Time Per Data Points (Min)	Real
145	SPM: Time Per Data Point	Real
146	SPM: Interval Between Pts	Real
147	Xtal DPM Standard DPM	Real
150	Xtal DPM Standard Date	Text (17 Chars)

General Count Data

Data Id Values: 200 - 299

ID	Data Value Meaning	Data Value Type
200	Sample Id Text	Text (5 Chars)
202	Rack Position (II-II)	Text (5 Chars)
203	Elapsed Live Count Time (Mm) for Current Sample	Real
204	Elapsed Clock Time (mm) Since Start of Current User (or Current Rack For Single Rack And Interrupt Counts)	Real
205	Quench Value (h# Or IC#)	Real
206	Scr# Value	Real
207	RCM Value (Percent)	Real
208	Count Error (Percent), Isotope 1	Real
209	Count Error (Percent), Isotope 2	Real
210	Count Error (Percent), Isotope 3	Real
211	Average Blank CPM Value, Isotope 1	Real
212	Average Blank CPM Value, Isotope 2	Real
213	Average Blank CPM Value, Isotope 3	Real
214	Average Blank Coeff Variation, Isotope 1 Real	Real
215	Average Blank Coeff Variation, Isotope 2 Real	Real
216	Average Blank Coeff Variation, Isotope 3 Real	Real
217	Units Isotope 1	Text (5 Char)

Figure c.5 Datum Ids.

218	Units Isotope 2	Text (5 Char)
219	Units Isotope 3	Text (5 Char)

ID	Data Value Meaning	Data Value Type
220	Two Phase Flag (' 'Or '2P')	Text (2 Chars)
221	Static Correction%	Real
222	Lum-Ex Correction %	Real
223	Cycle Number	Integer

CPM Results

Data Id Values: 300 - 399

These ID's are used whenever CPM values are generated, regardless of the Data Calculation Program.

ID	Data Value Meaning	Data Value Type
300	CPM, Isotope 1	Real
301	CPM, Isotope 2	Real
302	CPM, Isotope 3	Real
303	Repeat Average CPM, Isotope 1	Real
304	Repeat Average CPM, Isotope 2	Real
305	Repeat Average CPM, Isotope 3	Real
306	Number Of Sample Repeats Used to Compute The Repeat Avg.	Integer
307	Replicate Average CPM, Isotope 1	Real
308	Replicate Average CPM, Isotope 2	Real
309	Replicate Average CPM, Isotope 3	Real
310	Number Of Sample Replicates Used to Compute Replicate Average	Integer
311	Repeat Average CPM Coeff. of Variation, Percent, Isotope 1	Real
312	Repeat Average CPM Coeff. of Variation Percent, Isotope 2	Real
313	Repeat Average CPM Coeff. of Variation Percent, Isotope 3	Real

Figure c.5 Datum Ids.

314	Replicate Average CPM Coeff. of Variation, Percent, Isotope 1	Real
315	Replicate Average CPM Coeff. of Variation, Percent, Isotope 2	Real
316	Replicate Average CPM Coeff. of Variation, Percent, Isotope 3	Real
317	Raw CPM Isotope 1	Real
318	RawCPMIsotope2	Real
319	RawCPMIsotope3	Real

Percent Reference Data

Data Id Values: 400 - 499

Id	Data Value Meaning	Data Value Type
400	Average Reference Value, Isotope 1	Real
401	Average Reference Value, Isotope 2	Real
402	Average Reference Value, Isotope 3	Real
403	Percent Reference, Isotope 1	Real
405	Percent Reference, Isotope 3	Real
406	Repeat Average Percent Reference, Isotope 1	Real
407	Repeat Average Percent Reference, Isotope 2	Real
408	Repeat Average Percent Reference, Isotope 3	Real
409	Replicate Average Percent Reference, Isotope 1	Real
410	Replicate Average Percent Reference, Isotope 2	Real
411	Replicate Average Percent Reference,	Real

Figure c.5 Datum Ids.

	Isotope 3	
412	Average Reference Value, Isotope 1	Real
	Coeff, of Variation	
413	Average Reference Value, Isotope 2	Real
	Coeff, of Variation	
414	Average Reference Value, Isotope 3	Real
	Coeff. of Variation	

DPM Data

Data Id Values: 500 - 599

These EIYS are used whenever DPM values are generated, regardless of the Data Calculation Program.

ID	Data Value Meaning	Data Value Type
500	DPM, Isotope 1	Real
501	DPM, Isotope 2	Real
503	DPM, Isotope 3	Real
504	Efficiency, Percent, Isotope 1, Window 1	Real
505	Efficiency, Percent, Isotope 1, Window 2	Real
506	Efficiency, Percent, Isotope 1, Window 3	Real
507	Efficiency, Percent, Isotope 2, Window 1	Real
508	Efficiency, Percent, Isotope 2, Window 2	Real
509	Efficiency, Percent, Isotope 2, Window 3	Real

ID	Data Value Meaning	Data Value Type
510	Efficiency, Percent, Isotope 3, Window 1	Real
511	Efficiency, Percent, Isotope 3, Window 2	Real
512	Efficiency, Percent, Isotope 3, Window 3	Real

Figure c.5 Datum Ids.

513	DPM Ratio, Isotope 1 Over Isotope 2	Real
514	DPM Ratio, Isotope 3 Over Isotope 1	Real
515	DPM Ratio, Isotope 3 Over Isotope 2	Real
516	Repeat Average DPM, Isotope 1	Real
517	Repeat Average DPM, Isotope 2	Real
518	Repeat Average DPM, Isotope 3	Real
519	Replicate Average DPM, Isotope 1	Real
520	Replicate Average DPM, Isotope 2	Real
521	Replicate Average DPM, Isotope 3	Real
522	Repeat Average DPM Coeff. of Variation, Isotope 1	Real
523	Repeat Average DPM Coeff. of Variation, Isotope 2	Real
524	Repeat Average DPM Coeff. of Variation, Isotope 3	Real
525	Replicate Average DPM Coeff. of Variation, Isotope 1	Real
526	Replicate Average DPM Coeff. of Variation, Isotope 2 Variation, Isotope 3	Real
528	Average Blank DPM, Isotope 1	Real
529	Average Blank DPM, Isotope 2	Real
530	Average Blank DPM Coeff. of Variation, Isotope 1	Real
531	Average Blank DPM Coeff. of Variation, Isotope 2	Real
532	Average Blank DPM, Isotope 3	Real
533	Average Blank DPM Coeff. of Variation, Isotope 3	Real
534	Xtal DPM Standard Average CPM, Isotope 1	Real
535	Xtal DPM Standard Average CPM, Isotope 2	Real
536	Xtal DPM Standard Average CPM, Isotope 3	Real

Figure c.5 Datum Ids.

537	Xtal DPM Standard Average Efficiency (%)	Real

MCA Spectrum Data

Data Id Values: 700 - 799

ID	Data Value Meaning	Data Value Type
700	Spectrum Start Channel	Real
701	Spectrum Stop Channel	Real
702	Spectrum Sum (Start To Stop)	Real
703	Spectrum Type (1 = Log Counts, 2 = Log CPM, 3 = Linear Counts, 4 = Linear CPM, 7 = High-Res Counts, 8 = High-Res CPM)	Integer
704	Channel Count Values One-Five Values Per Data ID.	Integer
705	Overflow	Integer
706	Channel CPM Values One-Five Values Per Data ID.	Real
707	Tubes (1=Left, 2=Rtght, 3=Soth)	Integer

File Headers

Data ID Values: 900 - 909

File Header Messages Are Message Type — F

ID	Data Value Meaning For User Select Mode [2]	Data Value Type
900	File Type Data Values: 1: Auto-Count User 2: Single Rack Count 3: Sample Spectrum 4: Compton Spectrum	Integer
904	System Information	

Figure c.5 Datum Ids.

905	Current System Status	
906	User Files (Data 0, .30, or 99 for all)	Integer
907	Calibration	
	Data Values:	
	1: History (Upload Will Set Gain)	
	2 + Name: Isotope	
	3 + Name: Efficiency	
908	System History	
909	Entire EEROM	

Sample Start/Stop Data Items

Data ID Values: 910-919

These data Items are used to Indicate the beginning and end of each sample and each sample repeat when sample count data Is transmitted. ID 910 and ID 911 are sent once for each sample, not for each sample repeat.

ID	Data Value Meaning	Data Value Type
910	Start Of New Sample	None
911	End Of Current Sample	None
912	Start Of Sample Repeat Count	None
913	End Of Sample Repeat Count	None

Error Messages

Data ID Values: 990-999

Error Messages Have Message Type = E.

ID	Data Value Meaning	Data Value Type
996	Warning Message	Integer
	Indicates some problem with the	
	current sample that does not require	
	the sample to be aborted.	
	This includes power failures when the	
	current count can be resumed.	
997	Sample Fatal Message	Integer
	The current sample count must be	

Figure c.5 Datum Ids.

	stopped, but counting will continue for the remaining samples in this set.	
998	Process Fatal Message The current function must be stopped. In Automatic Counting, the current user is aborted, but the count will continue with the next user, if any.	Integer
999	Instrument Fatal Message A hardware failure prevents further instrument operation. This Includes power failures when the current function cannot be resumed.	Integer

Figure c.6 Datum ID's for Alpha-Beta Discrimination.

Setup Parameters

Data Id Values: 100 - 199

ID	Data Value Meaning	Data Value Type
164	Alpha-Beta Calibration Name	Text (20 Char)
165	Alpha-Beta Selection On/Off	Text (3 Char)
166	Left Rvalue Limits (2 Reals Separated by the Following 3 Character String: '-')	Text (15 Char)
167	Right Rvalue Limits (2 Reals Separated by the Following 3 Character String: '-')	Text (15 Char)
168	Pulse Height Limits (2 Reals Separated by the Following 3 Character String: '-')	Text (15 Char)
169	Beta Half-Life Correction Date	Text (17 Char)

Figure c.6 Datum ID's for Alpha-Beta Discrimination.

170	Beta Norm Multiplier Isotope 1	Real
171	Beta Norm Multiplier Isotope 2	Real
172	Beta Norm Multiplier Isotope 3	Real
173	Beta Background (CPM), Window 1	Real
174	Beta Background (CPM), Window 2	Real
175	Beta Background (CPM), Window 3	Real
199	System Date at Start of AutoCount	Text (17 Char)

General Count Data

Data Id Values: 200 - 299

ID	Data Value Meaning	Data Value Type
227	Beta Count Error (%), Isotope 1	Real
228	Beta Count Error (%), Isotope 2	Real
229	Beta Count Error (%), Isotope 3	Real
230	Beta Average Blank CPM Value, Isotope 1	Real
231	Beta Average Blank CPM Value, Isotope 2	Real
232	Beta Average Blank CPM Value, Isotope 3	Real
233	Beta Average Blank Coeff. of Var., Isotope 1	Real
234	Beta Average Blank Coeff, of Var., Isotope 2	Real
235	Beta Average Blank Coeff. of Var., Isotope 3	Real

Isotope Settings and Half-Life

Isotope Setting and Half-Life

Figure d.1 Isotope Settings and Half-Life.

Isotope	Channel	Half-life	
^{3}H	400	12.35	years
^{14}C	670	5730	years
^{22}Na	1000	2.602	years
^{24}Na	1000	15.03	hours
^{32}P	1000	14.28	days
^{33}P	750	25.3	days
^{35}S	700	87.39	days
^{36}Cl	860	3.002	x 10 years
^{45}Ca	750	165.2	days
^{51}Cr	800	27.7	days
^{54}Mn	850	312.2	days
^{55}Fe	350	2.685	years
^{57}Co	750	271.65	days
^{59}Fe	900	44.56	days
^{60}CO	950	5.272	years
^{63}Ni	560	100.1	years
^{64}Cu	860	12.7	hours
^{65}Zn	1000	244	days
^{75}Se	800	118.45	days
^{86}Rb	990	18.82	days
^{90}Sr-^{90}Y	990	28.82	years-Sr; 2.67 days-Y
^{99}Tc	760	2.14	X 10 years
^{99}Mo-^{99}Tc	940	2.14	X 10 years
^{109}Cd	600	453	days

Figure d.1 Isotope Settings and Half-Life.

Isotope	Channel	Half-life	
^{113}Sn-^{113}mIn	800	115.1	days-Sn; 99.48 minutes-In
^{125}I	550	60.25	days
^{131}I	900	8.04	days
^{133}Ba	850	10.66	years
^{137}Cs	850	30.174	years
^{141}Ce	820	32.55	days
^{153}Gd	700	241.6	days
^{195}Au	700	182.9	days
^{207}Bi	920	38.3	years
^{210}Pb-^{210}Bi-^{210}Po	750	22.26	years-Pb: 5.0 13 days-Bi
		138.38	days-Po
^{222}Rn	950	3.824	days
^{226}Ra	950	1599	years
^{233}U	820	1.591	x 10^5 years
^{238}U	750	4.468	x 10^9 years
^{241}Am	850	432	years
^{241}Pu	850	14.36	years

Figure d.2 Universal Half-Life Correction Table.

I/T	FRACTION REMAINING	t/T	FRACTION REMAINING	I/T	FRACTION REMAINING	t/T	FRACTION REMAINING
0	1,0000	0,52	0,6974	1,54	0,3439	3,80	0,0718
0,01	0,9931	0,54	0,6878	1,56	0,3391	3,85	0,0693
0,02	0,9862	0,56	0,6783	1,58	0,3345	3,90	0,0670
0,03	0,9794	0,58	0,6690	1,60	0,3299	3,95	0,0647
0,04	0,9726	0,60	0,6597	1,62	0,3253	4,00	0,0625
0,03	0,9659	0,62	0,6507	1,64	0,3209	4,10	0,0583
0,06	0,9593	0,64	0,6417	1,66	0,3164	4,20	0,0544

Figure d.2 Universal Half-Life Correction Table.

I/T	FRACTION REMAINING	t/T	FRACTION REMAINING	I/T	FRACTION REMAINING	t/T	FRACTION REMAINING
0,07	0,9526	0,66	0,6329	1,68	0,3121	4,30	0,0508
0,08	0,9461	0,68	0,6242	1,70	0,3078	4,40	0,0474
0,09	0,9395	0,70	0,6156	1,75	0,2973	4,50	0,0442
0,10	0,9330	0,72	0,6071	1,80	0,2872	4,60	0,0612
0,11	0,9266	0,74	0,5987	1,85	0,2774	4,70	0,0385
0,12	0,9202	0,76	0,5903	1,90	0,2679	4,80	0,0359
0,13	0,9138	0,78	0,5824	1,95	0,2588	4,90	0,0335
0,14	0,9075	0,80	0,5744	2,00	0,2500	5,00	0,0312
0,15	0,9013	0,82	0,5664	2,05	0,2415	5,10	0,0292
0,16	0,8950	0,84	0,5586	2,10	0,2333	5,20	0,0272
0,17	0,8888	0,86	0,5509	2,15	0,2253	5,30	0,0254
0,18	0,8827	0,88	0,5434	2,20	0,2176	5,40	0,0237
0,19	0,8766	0,90	0,5359	2,25	0,2102	5,50	0,0221
0,20	0,8703	0,92	0,5285	2,30	0,2031	5,60	0,0206
0,21	0,8645	0,94	0,5212	2,35	0,1961	5,70	0,0192
0,22	0,8586	0,96	0,5141	2,40	0,1895	5,80	0,0179
0,23	0,8526	0,98	0,5070	2,45	0,1830	5,90	0,0167
0,24	0,8467	1,00	0,5000	2,50	0,1768	6,00	0,0156
0,25	0,8409	1,02	0,4931	2,55	0,1708	6,20	0,0136
0,26	0,8351	1,04	0,4863	2,60	0,1649	6,40	0,0118
0,27	0,8293	1,06	0,47%	2,65	0,1593	6,60	0,0103
0,28	0,8236	1,08	0,4730	2,70	0,1539	6,80	0,0090
0,29	0,8179	1,10	0,4665	2,75	0,1487	7,00	0,0078
0,30	0,8122	1,12	0,4601	2,80	0,1436	7,20	0,0068
0,31	0,8066	1,14	0,4538	2,85	0,1387	7,40	0,0059
0,32	0,8011	1,16	0,4475	2,90	0,1340	7,60	0,0052
0,33	0,7955	1,18	0,4413	2,95	0,1294	7,80	0,0045
0,34	0,7900	1,20	0,4353	3,00	0,1250	8,00	0,0039
0,35	0,7846	1,22	0,4293	3,05	0,1207	8,20	0,0034

Figure d.2 Universal Half-Life Correction Table.

I/T	FRACTION REMAINING	t/T	FRACTION REMAINING	I/T	FRACTION REMAINING	t/T	FRACTION REMAINING
0,36	0,7792	1,24	0,4234	3,10	0,1166	8,40	0,0030
0,37	0,7738	1,26	0,4175	3,15	0,1127	8,60	0,0026
0,38	0,7684	1,28	0,4118	3,20	0,1088	8,80	0,0022
0,39	0,7631	1,30	0,4061	3,25	0,1051	9,00	0,0020
0,40	0,7579	1,32	0,4005	3,30	0,1015	9,20	0,0017
0,41	0,7526	1,34	0,3950	3,35	0,0981	9,40	0,0015
0,42	0,7474	1,36	0,38%	3,40	0,0948	9,60	0,0013
0,43	0,7423	1,38	0,3842	3,45	0,0915	9,80	0,0011
0,44	0,7371	1,40	0,3789	3,50	0,0884	10,00	0,0010
0,45	0,7320	1,42	0,3737	3,55	0,0854	10,50	0,0007
0,46	0,7270	1,44	0,3685	3,60	0,0825	11,00	0,0005
0,47	0,7220	1,46	0,3635	3,65	0,0797	11,50	0,0006
0,48	0,7170	1,48	0,3585	3,70	0,0770	12,00	0,0002
0,49	0,7120	1,50	0,3536	3,75	0,0743	13,00	0,0001
0,50	0,7071	1,52	0,3487				

Figure d.3 Conversion Factors.

1 becquerel (Bq) therefore,	= 1 nuclear transformation/second (DPS)
1 curie (Cl)	= 2.22 x 10^{12} DPM
	= 3.7 x 10^{10} DPS
	= 37 glgabecquerels (GBq)
1 millicurle (mCi)	= 2.22 x 10^{9} DPM
	= 3.7 x 10^{7} DPS
	= 37 kilobecquerels (kBq)
1 microcurie (µCl)	= 2.22 x10^{6} DPM
	= 3.7x 10^{4} DPS
	= 37 kilobecquerels (kBq)
1 glgabecquerel (GBq)	= 27.027 millicuries (mCl)
1 megabecquerel (MGq)	= 27.027 microcuries (µCi)
1 kilobecquerel (kGq)	= 27.027 nanocuries (nCi)

Figure d.4 ^{3}H Hydrogen-3(Tritium) Half-Life: 12.35 years.

Years	Months 0	1	2	3	4	5	6	7	8	9	10	11
0	1.0000	0.9953	0.9907	0.9860	0.9814	0.9768	0.9723	0.9677	0.9632	0.9587	0.9542	0.9498
1	0.9453	0.9409	0.9365	0.9321	0.9278	0.9235	0.9191	0.9148	0.9106	0.9063	0.9021	0.8979
2	0.8937	0.8895	0.8853	0.8812	0.8771	0.8730	0.8688	0.8648	0.8608	0.8568	0.8528	0.8488
3	0.8448	0.8409	0.8369	0.8330	0.8291	0.8252	0.8214	0.8176	0.8137	0.8099	0.8061	0.8024
4	0.7987	0.7949	0.7912	0.7875	0.7838	0.7801	0.7765	0.7729	0.7692	0.7656	0.7621	0.7585
5	0.7550	0.7514	0.7479	0.7444	0.7410	0.7375	0.7340	0.7306	0.7272	0.7238	0.7204	0.7170
6	0.7137	0.7104	0.7070	0.7037	0.7005	0.6972	0.6939	0.6907	0.6875	0.6842	0.6810	0.6779
7	0.6747	0.6715	0.6684	0.6653	0.6622	0.6591	0.6560	0.6529	0.6499	0.6468	0.6438	0.6408
8	0.6378	0.6348	0.6319	0.6289	0.6260	0.6230	0.6201	0.6172	0.6143	0.6115	0.6086	0.6058
9	0.6029	0.6001	0.5973	0.5945	0.5917	0.5890	0.5863	0.5835	0.5808	0.5780	0.5753	0.5727
10	0.5700	0.5673	0.5647	0.5620	0.5594	0.5568	0.5542	0.5516	0.5490	0.5464	0.5439	0.5414
11	0.5388	0.5363	0.5338	0.5313	0.5288	0.5263	0.5239	0.5214	0.5190	0.5166	0.5142	0.5118

Figure d.5 Iodine-125 Half-Life: 60.25 days

Days	Days 0	2	4	6	8	10	12	14	16	18
0	1.0000	0.9773	0.9550	0.9333	0.9121	0.8913	0.8711	0.8512	0.8319	0.8129
20	0.7945	0.7764	0.7587	0.7415	0.7246	0.7081	0.6920	0.6763	0.6609	0.6459
40	0.6312	0.6168	0.6028	0.5891	0.5757	0.5626	0.5498	0.5373	0.5250	0.5131
60	0.5014	0.4900	0.4789	0.4680	0.4573	0.4469	0.4368	0.4268	0.4171	0.4076
80	0.3984	0.3893	0.3805	0.3718	0.3633	0.3550	0.3470	0.3391	0.3314	0.3239
100	0.3165	0.3093	0.3022	0.2954	0.2887	0.2829	0.2757	0.2694	0.2633	0.2573
120	0.2514	0.2457	0.2401	0.2347	0.2293	0.2241	0.2190	0.2140	0.2092	0.2044
140	0.1998	0.1952	0.1908	0.1864	0.1822	0.1780	0.1740	0.1700	0.1661	0.1624
160	0.1587	0.1551	0.1516	0.1481	0.1447	0.1415	0.1382	0.1351	0.1320	0.1290
180	0.1261	0.1232	0.1204	0.1177	0.1150	0.1124	0.1098	0.1073	0.1049	0.1025
200	0.1002	0.0979	0.0956	0.0935	0.0914	0.0893	0.0873	0.0853	0.0833	0.0814
220	0.0796	0.0778	0.0760	0.0743	0.0726	0.0709	0.0693	0.0677	0.0662	0.0647
240	0.0632	0.0618	0.0604	0.0590	0.0577	0.0564	0.0551	0.0538	0.0526	0.0514
260	0.0502	0.0491	0.0480	0.0469	0.0458	0.0448	0.0438	0.0428	0.0418	0.0408
280	0.0399	0.0390	0.0381	0.0372	0.0364	0.0356	0.0348	0.0340	0.0332	0.0324

Figure d.6 Sulpher-35 Half-Life: 87.39 days

Days	Days 0	2	4	6	8	10	12	14	16	18
0	1.0000	0.9843	0.9688	0.9535	0.9385	0.9237	0.9092	0.8949	0.8807	0.8669
20	0.8533	0.8398	0.8266	0.8136	0.8008	0.7882	0.7758	0.7636	0.7516	0.7397
40	0.7281	0.7166	0.7053	0.6942	0.6833	0.6726	0.6620	0.6515	0.6413	0.6312
60	0.6213	0.6115	0.6019	0.5924	0.5831	0.5739	0.5648	0.5559	0.5472	0.5386
80	0.5301	0.5216	0.5135	0.5055	0.4975	0.4897	0.4820	0.4744	0.4669	0.4596
100	0.4523	0.4452	0.4382	0.4313	0.4245	0.4178	0.4112	0.4048	0.3984	0.3921
120	0.3860	0.3799	0.3739	0.3680	0.3622	0.3565	0.3509	0.3454	0.3400	0.3346

Figure d.6 Sulpher-35 Half-Life: 87.39 days

	Days									
	0	2	4	6	8	10	12	14	16	18
140	0.3293	0.3242	0.3190	0.3140	0.3091	0.3043	0.2994	0.2947	0.2901	0.2855
160	0.2810	0.2766	0.2722	0.2680	0.2637	0.2596	0.2555	0.2515	0.2475	0.2436
180	0.2398	0.2360	0.2323	0.2286	0.2250	0.2215	0.2180	0.2146	0.2112	0.2079
200	0.2046	0.2014	0.1982	0.1951	0.1920	0.1905	0.1890	0.1875	0.1860	0.1845
220	0.1831	0.1816	0.1802	0.1788	0.1774	0.1760	0.1746	0.1732	0.1718	0.1705
240	0.1691	0.1678	0.1665	0.1651	0.1638	0.1626	0.1613	0.1600	0.1587	0.1575
260	0.1562	0.1550	0.1538	0.1526	0.1514	0.1502	0.1490	0.1478	0.1466	0.1455
280	0.1443	0.1432	0.1420	0.1409	0.1398	0.1387	0.1376	0.1365	0.1354	0.1344

Figure d.7 Phosphorus-32 Half-Life: 14.28 days

		Hours									
		0	12	24	36	48	60	72	84	96	108
Days	0	1.0000	0.9760	0.9526	0.9293	0.9075	0.8857	0.8645	0.8438	0.8235	0.8038
	5	0.7845	0.7657	0.7474	0.7294	0.7120	0.6949	0.6782	0.6620	0.6461	0.6306
	10	0.6155	0.6007	0.5863	0.5723	0.5585	0.5451	0.5321	0.5193	0.5069	0.4947
	15	0.4829	0.4713	0.4600	0.4490	0.4382	0.4277	0.4174	0.4074	0.3977	0.3881
	20	0.3788	0.3697	0.3609	0.3522	0.3438	0.3355	0.3275	0.3196	0.3120	0.3045
	25	0.2972	0.2901	0.2831	0.2763	0.2697	0.2632	0.2569	0.2508	0.2447	0.2389
	30	0.2332	0.2276	0.2221	0.2168	0.2116	0.2065	0.2016	0.1967	0.1920	0.1874
	35	0.1829	0.1785	0.1742	0.1701	0.1660	0.1620	0.1581	0.1543	0.1506	0.1470
	40	0.1435	0.1401	0.1367	0.1334	0.1302	0.1271	0.1241	0.1211	0.1182	0.1153
	45	0.1126	0.1099	0.1072	0.1047	0.1022	0.0997	0.0973	0.0950	0.0927	0.0905
	50	0.0883	0.0862	0.0841	0.0821	0.0802	0.0782	0.0764	0.0745	0.0727	0.0710
	55	0.0693	0.0676	0.0660	0.0644	0.0629	0.0614	0.0599	0.0585	0.0571	0.0557
	60	0.0544	0.0531	0.0518	0.0505	0.0493	0.0484	0.0470	0.0459	0.0448	0.0437
	65	0.0426	0.0416	0.0406	0.0397	0.0387	0.0378	0.0369	0.0360	0.0351	0.0343
	70	0.0335	0.0327	0.0319	0.0311	0.0304	0.0296	0.0289	0.0282	0.0276	0.0269

Figure d.8 Carbon-14 Half-Life: 5730 years

Years	Years 0	10	20	30	40	50	60	70	80	90
0	1.0000	0.9988	0.9976	0.9964	0.9952	0.9940	0.9928	0.9916	0.9904	0.9892
100	0.9880	0.9868	0.9856	0.9844	0.9832	0.9820	0.9808	0.9797	0.9785	0.9773
200	0.9761	0.9749	0.9737	0.9726	0.9714	0.9702	0.9690	0.9679	0.9667	0.9655
300	0.9644	0.9632	0.9620	0.9609	0.9597	0.9586	0.9574	0.9562	0.9551	0.9539
400	0.9528	0.9516	0.9505	0.9493	0.9482	0.9470	0.9459	0.9447	0.9436	0.9425
500	0.9413	0.9402	0.9390	0.9379	0.9368	0.9356	0.9345	0.9334	0.9322	0.9311
600	0.9300	0.9289	0.9277	0.9266	0.9255	0.9244	0.9233	0.9222	0.9210	0.9199
700	0.9188	0.9177	0.9166	0.9155	0.9144	0.9133	0.9122	0.9111	0.9100	0.9089
800	0.9078	0.9067	0.9056	0.9045	0.9034	0.9023	0.9012	0.9001	0.8990	0.8979
900	0.8968	0.8958	0.8947	0.8936	0.6925	0.8914	0.8904	0.8893	0.8882	0.8871
1000	0.8861	0.8950	0.8940	0.9829	0.8818	0.8807	0.8797	0.8786	0.8775	0.8765
1100	0.8754	0.8744	0.8733	0.8722	0.8712	0.8701	0.8691	0.8680	0.8670	0.8659
1200	0.8649	0.8638	0.8628	0.8618	0.8607	0.8597	0.8586	0.8576	0.8566	0.8555
1300	0.8545	0.8535	0.8524	0.8514	0.8504	0.8493	0.8483	0.8473	0.8463	0.8452
1400	0.8442	0.8432	0.9422	0.8412	0.8401	0.8391	0.8381	0.8371	0.8361	0.8351

Radioactive Material Licensing

The following excerpts from the U.S. Code of Federal Regulations, 10CFR3 1.5 are applicable to Beckman Coulter, Inc., liquid scintillation counters distributed in Non-Agreement States of the United States. Substantially similar regulations are applicable in all other states as regulations of the particular Agreement State. For further information, please contact the appropriate State or Federal Regional Office at the address or telephone number listed at the end of this excerpt.

NOTE The user is responsible for notification of appropriate authorities which require registration of radiation sources in their jurisdiction.

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US NRC RULES AND REGULATIONS TITLE 10,

CHAPTER 1, PART 31

§31.5 Certain Measuring, Gauging or Control-lung Devices.*

(a) A general license is hereby issued to commercial and industrial firms and research, educational and medical institutions, individuals in the conduct of their business, and Federal, State or local government agencies to acquire, receive, possess, use or transfer, in accordance with the provisions of paragraphs (b), (c) and (d) of this section, by product material contained in controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.

(b) The general license in paragraph (a) of this section applies only to by-product material contained in devices which have been manufactured or initially transferred and labeled in accordance with the specifications contained in a specific license issued pursuant to *§32.51* of this chapter or in accordance with the specifications contained in a specific license issued by an Agreement State which authorizes distribution of the devices to persons generally licensed by the Agreement State.

(c) Any person who acquires, receives, possesses, uses or transfers by-product material in a device pursuant to the general license in paragraph (a) of this section:

(1) Shall assure that all labels affixed to the device at the time of receipt and bearing a statement that removal of the label is prohibited are maintained thereon and shall comply with all instructions and precautions provided by such labels;

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* Persons possessing by-product material in devices under the general license in §3 1.5 before Jan. *15, 1975,* may continue to possess, use or transfer that material in accordance with the requirements of §31.5 in effect on Jan. 14, 1975.

(2) Shall assure that the device is tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals or at such other intervals as are specified in the label; however:

(i) Devices containing only krypton need not be tested for leakage of radioactive material, and

(ii) Devices containing only tritium or not more than 100 microcuries of other beta and/or gamma emitting material or 10 microcuries of alpha emitting material and devices held in storage in the original shipping container prior to initial installation need not be tested for any purpose;

(3) Shall assure that the tests required by paragraph (c)(2) of this section and other testing, installation, servicing, and removal from installation involving the radioactive materials, its shielding or containment, are performed;

(i) In accordance with the instructions provided by the labels; or

(ii) By a person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to perform such activities;

(4) Shall maintain records showing compliance with the requirements of paragraphs (c)(2) and (c)(3) of this section. The records must show the results of tests. The records also must show the dates of performance of, and the names of persons performing, testing, installing, servicing, and removing from the installation radioactive material and its shielding or containment. The licensee shall retain these records as follows:

(i) Each record of a test for leakage or radioactive material required by paragraph (c)(2) of this section must be retained for three years after the next required leak test is performed or until the sealed source is transferred or disposed of.

(ii) Each record of a test of the on-off mechanism and indicator required by paragraph (c)(2) of this section must be retained for three years after the next required test of the on-off mechanism and indicator is performed or until the sealed source is transferred or disposed of.

(iii) Each record that is required by paragraph (c)(3) of this section must be retained for three years from the date of the recorded event or until the device is transferred or disposed of.

(5) Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding of the radioactive material or the on-off mechanism or indicator, or upon the detection of 0.0005 microcurie or more removable radioactive material, shall immediately suspend operation of the device until it has been repaired by the manufacture or other person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to repair such devices, or disposed of by transfer to a person authorized by a specific license to receive the by-product material contained in the device and, within 30 days, furnish to the Administrator of the appropriate Nuclear Regulatory Commission, Regional Office listed in appendix D of part 20 of this chapter, a report containing a brief description of the event and the remedial action taken;

(6) Shall not abandon the device containing by-product material;

(‘1) Shall not export the device containing by-product material except in accordance with part 110 of this chapter;

(8) Except as provided in paragraph (c)(9) of this section, shall transfer or dispose of the device containing by-product material only by transfer to per-sons holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to receive the device and within 30 days after transfer of a device to a specific licensee shall furnish to the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC *20555* a report containing identification of the device by manufacturer’s name and model number and the name and address of the person receiving the device. No report is required if the device is transferred to the specific licensee in order to obtain a replacement device;

(9) Shall transfer the device to another general licensee only:

(i) Where the device remains in use at a particular location. In such case the transferrer shall give the transferee a copy of this section and any safety documents identified in the label of the device and within 30 days of the transfer, report to the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC *20555,* the manufacturer’s name and model number of device transferred, the name and address of the transferee, and the name and/or position of an individual who may constitute a point of contact between the Commission and the transferee; or

(ii) Where the device is held in storage in the original shipping container at its intended location of use prior to initial use by a general licensee.

10) Shall comply with the provisions of §20.2201, and §20.2202 of this chapter for reporting radiation incidents, theft or loss of licensed material, but shall be exempt from the other requirements of parts 19, 20, and 21, of this chapter.

(d) The general license in paragraph (a) of this section does not authorize the manufacture or import of devices containing by-product material.

Regional USNRC & State Office Addresses & Telephone Numbers

The following list of States in alphabetical order, including the appropriate regulatory agency for that state, with their address and telephone number, is provided here for your convenience in the event that one of these agencies has to be contacted as required by regulations governing that respective state. All information provided is believed to be accurate at the time of publishing, but Beckman Coulter, Inc., does not guarantee its accuracy and disclaims any responsibility or liability for its use.

Because some states have not entered into an agreement with the U.S. Nuclear Regulatory Commission, the regulatory agency governing the use of by-product material is still the U.S.N.R.C. For this reason the appropriate agency to contact in these particular states will be the regional office of the U.S.N.R.C. In most cases however, the user must still register its instrument with the state and/or local agency. If you reside in one of these states, we recommend that you contact your local or state Department of Health for further information.

e.1 Regional USNRC Office and Telephone Numbers

Region I

US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406-1415

Switchboard Telephone #: (610) *337-5000*
Switchboard Hours: 7:30 a.m. to *4:15* p.m. Monday through Friday (EST)
Includes:CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT

Region II

US Nuclear Regulatory Commission
Atlanta Federal Center (AFC) Tower
61 Forsyth Street, NW, Suite 23T85
Atlanta, GA 30303

Switchboard Telephone #: (404) 562-4400
Switchboard Hours: 7:30 a.m. to 4:15 p.m. Monday through Friday (EST)
Includes:AL, FL, GA, KY, MS, NC, PR, SC, TN, VA, VI, WV

Region III

US Nuclear Regulatory Commission
801 Warrenville Road
Lisle, IL 60532-435 1

Switchboard Telephone #: (630) 829-9500
Switchboard Hours: 7:30 a.m. to 4:15 p.m. Monday through Friday (CST)
Includes:IL, IN, IA, MI, MN, MO, OH, WI

Region IV

US Nuclear Regulatory Commission
Harris Tower
611 Ryan Plaza Drive, Suite 400
Arlington, TX 7601 1-8064

Switchboard Telephone #: (817) 860-8100
Switchboard Hours: 7:30 a.m. to *4:15* p.m. Monday through Friday (CST)
Includes: AK, AZ, AR, CA, CO, HI, ID, KS, LA, MT, NE, NV, NM, ND, OD, OR, SD, TX, UT, WA, WY

e.2 State Telephone & Address Numbers

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Alabama	Director Division of Radiation Control The Alabama Dept. of Public Health The RSA Tower, Suite 700 P0. Box 303017 Montgomery, AL 36130-3017 PH (334) 206-5391
Alaska	Chief Radiological Health Program Department of Health & Social Services P0. Box 110613 Juneau, AK 99811-0613 PH (907) 465-3256
Arkansas	Director Division of Radiation Control & Emergency Management. Dept. of Health 4815 West Markham Street, Slot 30 Little Rock, AR 72205-3867 PH (501) 661-2301
California	Chief Radiological Health Branch Food, Drugs & Radiation Safety Division State Dept. of Health Services P0. Box 942732 Sacramento, CA 94234-7320 PH (916) 322-3482
Colorado	Director Laboratory & Radiation Services Division Dept. of Public Health & Environment 8100 Lowry Boulevard Denver, CO 80220-6928 PH (303) 692-3038

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Connecticut	Director Monitoring & Radiation Division Dept. of Environmental Protection 79 Elm Street Hartford, CT 06106-5 127 PH (860) 424-3029
Delaware	Program Administrator Office of Radiation Control Division of Public Health Plan Review, Permitting & Enforcement Federal & Water Streets, Room 224 P0 Box 637 Dover, DE 19903 PH (302) 739-3787
District of Columbia	Program Manager Pharmaceutical, Radiological & Medical Devices
Control Division	Department of Consumer & Regulatory Affairs 614 H Streets, N.W., Room 1116 Washington, DC 20001
Florida	Chief Bureau of Radiation Control Dept. of Health 1317 Winewood Blvd. Tallahassee, FL 32399-0700 PH (850) 478-1004
Georgia	Manager Radioactive Materials Program Dept. of Natural Resources 4244 International Parkway, Suite 114 Atlanta, GA 30354 PH (404) 362-2675
Hawaii	Supervisor Noise, Radiation & Indoor Air Quality Branch Dept. of Health 591 Ala Moana Bvld. Honolulu, HI 96813-4921 PH (808) 586-4700

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Idaho	Radiation Physicist 900 N. Skyline, Suite C Idaho Falls, ID 83402 PH (208) 528-2621
Illinois	Director Dept. of Nuclear Safety 1035 Outer Park Drive Springfield, IL 62704 PH (217) 785-9868
Indiana	Director Indoor & Radiological Health Division State Dept. of Health 2 N. Meridian Street Indianapolis, IN 46204-3003 PH (317) 233-7146
Iowa	Chief Bureau of Radiological Health Iowa Dept. of Public Health Lucas State Office Building Des Moines, IA 50319 PH (515) 281-3478
Kansas	Chief Radiation Control Program Kansas Dept. of Health & Environment Bureau of Air & Radiation Forbes Field, Building 283 Topeka, KS 66620 PH (913) 296-1561
Kentucky	Manager Radiation & Toxic Agents Control Section cabinet for Health Services 75 East Main Street Frankfort, KY 4062 1-0001 PH (502) 564-3700
Louisiana	Administrator Radiation Protection Division Office of Air Quality & Radiation Protection Dept. of Environmental Quality 7220 Bluebonnet Road P0. Box 82135 Baton Rouge, LA 70884-2 135 PH (504) 765-0160

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Maine	Nuclear Engineering Specialist Radiation Control Program Division of Health Engineering 10 State House Station Augusta, ME 04333 PH (207) 287-5698
Maryland	Manager Radiological Health Program Air & Radiation Management Administration Maryland Dept. of the Environment 2500 Broening Highway Baltimore, MD 21224 PH (410) 631-3300
Massachusetts	Director Radiation Control Program Dept. of Public Health 305 South Street, 7th Floor Jamaica Plain, MA 02130 PH (617) 727-6214
Michigan	Chief Radiological Protection Section Drinking Water & Radiological Protection Division Michigan Dept. of Environmental Quality 3423 N. Martin Luther King Jr. Blvd. P0. Box 30630 Lansing, MI 48909-8 130 PH (517) 335-8204
Minnesota	Manager Section of Radiation Control Division of Environmental Health Dept. of Health 121 E. Seventh Place, Suite 220 P0. Box 64975 St. Paul, MN 55 164-0975 PH (612) 215-0945
Mississippi	Director Division of Radiological Health State Dept. of Health 3150 Lawson Street P0. Box 1700 Jackson, MS 392 15-1700 PH (601) 354-6657

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Missouri	Chief Bureau of Environmental Epidemiology Dept. of Health P0. Box 570 Jefferson City, MO 65109 PH (573) 751-6102
Montana	Coordinator Radiological Health Program Licensure Bureau Dept. of Public Health & Human Services P0 Box 202951 Helena, MT 59620-295 1 PH (406) 444-5266
Nebraska	Director Dept. of Regulation and Licensure Nebraska Health & Human Services System 301 Centennial Mall South P0. Box 95007 Lincoln, NE 68509-5007 PH (402) 471-2133
Nevada	Supervisor Radiological Health Section Health Division Dept. of Human Resources 1179 Fairview Drive, Suite 102 Carson City, NV 89701-5405 PH (702) 687-5394
New Hampshire	Administrator Radiological Health Bureau Division of Public Health Services Health & Welfare Building 6 Hazen Drive Concord, NH 03301-6527 PH (603) 271-4588
New Jersey	Assistant Director Radiation Protection Program Division of Environmental Safety, Health & Analytical Programs Dept. of Environmental Protection CN 415 Trenton, NJ 08625-0415 PH (609) 984-5636

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
New Mexico	Chief Bureau of Hazardous & Radioactive Materials Water & Waste Management Division Dept. of Environment 2044 Galisteo Road P0. Box 26110 Santa Fe, NM 87502 PH (505) 827-1557
New York	Principal Radiophysicist Radiological Health Unit Division of Safety and Health New York State Dept. of Labor New York State Office Campus Building 12, Room 457 Albany, NY 12240 PH (518) 457 1202
	Director Radioactive Waste Policy and Nuclear Coordination New York State Energy Research & Development Authority Corporate Plaza West 286 Washington Ave. Extension Albany, NY 12203-6399 PH (518) 862-1090 Ext. 3302
	New York (cont'd) Chief Bureau of Pesticides and Radiation Division of Solid & Hazardous Materials Dept. of Environmental Conservation *50* Wolf Road, Room 402 Albany, NY 12233-7255 PH (518) 485-8981

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
	Director Bureau of Environmental Radiation Protection New York State Dept. of Health Two University Place, Room *375* Albany, NY 12203 PH (518) 458-6461 Deputy Director Bureau of Radiological Health New York City Dept. of Health Two Lafayete Street, 11th Floor New York, NY 10007 PH (212) 676-1558
North Carolina	Director Division of Radiation Protection Dept. of Environment & Natural Resources 3825 Barrett Drive Raleigh, NC 27609-7221 PH (919) 571-4141
North Dakota	Director Division of Environmental Engineering Dept. of Health 1200 Missouri Avenue, Room 304 P0. Box 5520 Bismarck, ND 58506-5520 PH (701) 328-5188
Ohio	Chief Bureau of Radiation Protection Ohio Dept. of Health 35 East Chestnut Street Columbus, OH 43266 PH (614) 644-7860
Oklahoma	Environmental Program Administrator Radiation Management Section Dept. of Environmental Quality 1000 Northeast Tenth Street Oklahoma City, OK 73 117-1212 PH (405) 702-5257
Oregon	Manager Radiation Protection Services Oregon State Health Division 800 N.E. Oregon Street, Suite 260 Portland, OR 97232 PH (503) 731-4014 Ext. 660

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Pennsylvania	Director Bureau of Radiation Protection Dept. of Environmental Protection Rachel Carson State Office Building P0. Box 8469 Harrisburg, PA 17105-8469
Rhode Island	Director Division of Occupational & Radiological Health Dept. of Health 3 Capitol Hill, Room 206 Providence, RI 02908-5097 PH (401) 277-2438
South Carolina	Director Division of Radioactive Waste Management Bureau of Solid and Hazardous Waste Dept. of Health & Environmental Control 2600 Bull Street Columbia, SC 29201 PH (803) 896-4244 Chief Bureau of Radiological Health Dept. of Health & Environmental Control 2600 Bull Street Columbia, SC 29201 PH (803) 737-7400
South Dakota	Public Health Advisor Office of Health Care Facility Licensure & Certification Systems Development & Regulations 615 East 4th Street, do 500 East Capitol Pierre, SD 57501-5070 PH (605) 773-3356
Tennessee	Director Division of Radiological Health Dept. of Environment & Conservation L&C Annex, Third Floor 401 Church Street Nashville, TN 37243-1532 PH (615) 532-0360

Figure e.1 State Telephone & Address Numbers.

State/Telephone	Address
Texas	Director Industrial & Hazardous Waste Division Texas Natural Resource Conservation Commission P0. Box 13087 Austin, TX 78711-3087 PH (512) 239-6592 Chief Bureau of Radiation Control Texas Dept. of Health 1100 West 49th Street Austin, TX 78756-3 189 PH (512) 834-6679
Utah	Director Division of Radiation Control Dept. of Environmental Quality 168 North 1950 West P0. Box 144850 Salt Lake City, UT 84114-4850 PH (801) 536-4250
Virginia	Director Bureau of Radiological Health Division of Health Hazards Control Dept. of Health Main Street Station 1500 East Main, Room 240 Richmond, VA 23219 PH (804) 786-5932
Vermont	Director Division of Occupational & Radiological Health Dept. of Health 108 Cherry Street P0. Box 70 Burlington, VT 05402 PH (802) 865-7730
Washington	Director Division of Radiation Protection Dept. of Health Airdustrial Center Building #5 P0. Box 47827 Olympia, WA 98504-7827 PH (360) 664-4536

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State/Telephone	Address
West Virginia	Chief Radiological Health Program 815 Quarrier Street Charleston, WV 25301 PH (304) 558-3526
Wisconsin	Manager Bureau of Public Health Dept. of Health & Family Services P0. Box 309 Madison, WI 53701-0309 PH (608) 267-4792
Wyoming	Administrator Solid & Hazardous Waste Division Dept. of Environmental Quality Herschler Building, 4W Cheyenne, WY 82002 PH (307) 777-7753