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Find the *Particle Sizing Systems 770-1* at our website: ***Click HERE***

C770 USER MANUAL

Table of Contents

Page Number

General Information

Registration 1
Technical Support 1
Safety Considerations 2
CE Mark 2

Introduction

Background of the SPOS Technique 1
Instrument Systems Design 4
Description of subsystems, summary of operation 4
Autodilution subsystem 5
Optical Particle Sensor Subsystem 5
Pulse-height Analyzer/Counter subsystem 10

Initial Hardware Setup

Computer And DMA Interface Board and Autodiluter 1
DMA Interface Board 1
C770 Software 1
Model 770 Optical Particle Sizer 1

C770 Software

C770 Files 1
Loading C770 Software 2
Accessing C770 Software 4

C770 Main Menu

[F1]: Sensor Output/Threshold Display 1
Incrementing and Decrementing the Vertical Scale 2
Incrementing and Decrementing the Horizontal Scale 2
Selecting Sensor Input 2
Incrementing and Decrementing the Voltage Threshold 3
Exit Sensor Display Function 3

[F2]: Edit Control Menu
Data Directory 5
Data File name 7
Edit Printout Caption 8
Edit of Printout Caption 8

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Table of Contents

Page Number

[F2]: Edit Control Menu (continued):

Overwrite old files ? 9
Overwrite old files (Default) 9
Overwrite old files 9
Data collection interval (seconds) 10
# of automatic collection intervals 10
Automatic data storage 11
Manual data storage 11
Select # of particle size bins 13
Start Measurement Fluid Volume (ml) 14
Sample Weight/Volume/None (W/V/N)? 15
Sample Weight (Mass Balance) 15
Sample Volume (Volume Balance) 18
Diluent Flow Rate (ml/min) 20
Subtract Background 21
Maximum Pulse Rate (1000-30000) 22
Maximum Vessel Flush Time (Min.) 23

[F3]: Collect Background 24

[F4]: Collect Data 25

[F5]: Load/Calibrate Sensor 27

[F1]: Sensor Calibration 28
[F1]: Sensor Output/Threshold display 31
[F2]: Start calibration: Autodilution 31
[M]: Move Cursor 34
[P]: Print 34
[ESC]: Exit 34
[F3]: Pump/Valve Control 36
[F4]: Vessel Fill 37
[F5]: Vessel Flush (continuous) 37
[F6]: Save/Show/Edit Data 37
[ESC]: Exit to main menu 38
[F2]: Show/Edit Sensor Table 39
Changing the Sensor Table 40
[F3]: Select Sensor 1 () 42
[F4]: Select Sensor 2 () 43

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Table of Contents

Page Number

[F6]: Display Distributions (continued):

[F1]: Differential Distribution 46
[F4]: Population Distribution 46
[F5]: Number-wt. Distribution 46
[F6]: Area-wt. Distribution 46
[F7]: Volume-wt. Distribution 50
[B]/[L]: Bar/Line 51
[M]: Mean 51
[F1]/[F2]: Inc/Dec Cursor Speed 51
[Left]/[Right]: Move Cursor 51
Isolating the Mean 52
[F]: File 53
[P]: Print 54
Print Distribution Plot 54
Print Distribution Channels 54
Print Cumulative Summary 54
Edit Printout Caption 54
Start to Print 54
[S]: Scale 60
Automatic Scaling 60
Increase Vertical Scale 60
Decrease Vertical Scale 60
Maximum Size Cut-Off 60
Minimum Size Cut-Off 60
[Alt_H]: Help 60
[ESC]: Exit 60

[F2]: Cumulative Distribution 61

[F3]: Display Distribution Channels 65
Bin Range 65

[F4]: Print Distribution Channels 66

[F5]: Save Distribution ASCII File 67

[Alt] [F6]: Edit Display Threshold 69

[F7]: Display Statistical Summary 70

[ESC]: Exit to Main Menu 71

Printout Description 72

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Table of Contents

	Page Number
[F7]: Printer Config. Setup	74
Horizontal Scale (Default =1.0)	76
Vertical Scale (Default = 1.0)	76
[F8]: Vessel Drain, Fill, Flush	77
[F9]: Exit to DOS	78
[F10]: Autodilution: Start Measurement	79
[ALT_S]: Suspend to DOS	80
[ALT_F1]: Vessel Drain	81
[ALT_F2]: Vessel Fill	82
[ALT_F3]: Vessel Flush (Continuous)	83

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Table of Contents

Page Number

C770 Help Menu

C770 Command Keys
[A]: File Addition 1
[B]: Bar Graphic Display 1
[D]: Select Population/Diff./Cum. Distribution 2
[E]: Edit Caption 2
[F]: Files 2
[L]: Line Graphic Display 3
[M]: Defined Peaks Range and Cal. Mean 3
[F1]/[F2]: Inc./Dec. Cursor Speed 3
[LEFT]/[RIGHT]: Move Cursor 3
[ENTER]: Select Start Point 3
Total #: 3
Size (um) 3
To Isolate a Region of a Sample Run 4
[P]: Print Plot/Summary/Detail Channels 5
Print Distribution Channels 5
Print Summary 5
Edit Printout Caption 5
Start to Print 5
[S]: Change Scale 5
Increase Vertical Scale 5
Decrease Vertical Scale 5
Maximum Size Cut Off 6
Maximum Size Display 6
[U]: File Subtraction 6
[W]: Change Weighting 7
[F5]: Save Data File 7
[F6]: Read Data File 8
[Alt_F6]: Edit Display Threshold 8
[Alt_S]: Save Data in ASCII File 8
[Cntl_A]: Show Cumulative Summary 9
[Cntl_B]: Change Number of Bins 9
[Cntl_V]: Mark Sample Volume Cal. Range 9
[Cntl_W]: Mark Sample Mass Cal. Range 9
[Cntl_F]: Print Files 9

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Table of Contents

Page Number

Sample Analysis

Power Up & Software Access	1
Running the System	1
Sample Injection	4
Review of Sample Results	4
Print Sample Results	5
New Sample	5
Power Down of the System	1

System Maintenance

Introduction	1
Maintenance	1

Sensor Maintenance 1

Sensor Cleaning	1

Sensor Calibration 1

Trouble-Shooting 1

AccuSizer Model 770 Parts List

Pumps	1
O Rings	1
Filters	1
Dilution Chambers	1
Fittings	2
Tubing	2
Groove Cutter	2
Valve	2
Assemblies	3
Cables	3
Power Supplies	3

Appendix A: DOS Commands
Appendix B: Solvent Compatibility
Appendix C: Mass Balance Derivation
Appendix D: Statistical Summary Calculations

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List of Screens

Page Number

C770 Software

Screen 1: AccuSizer 770 Main Menu 5

C770 Main Menu

Screen 2: Model 770 Control Menu 4

Screen 3: 770 Control Menu - Edit Printout Caption Window 8

Screen 4: Select # of Particle Size Bins 13

Screen 5: Calibration Menu 27

Screen 6: Sensor Calibration Control Menu 28

Screen 7: Sensor Calibration 30

Screen 8: Sensor Calibration Table 33

Screen 9: Sensor Calibration Curve 33

Screen 10: Sensor Calibration Curve Move Commands 34

Screen 11: Sensor Calibration Curve Move Commands 35

Screen 12: Pump/Valve Control 36

Screen 13: Calibration Data Screen 37

Screen 14: Show/Edit Sensor Tables 39

Screen 15: Select File for Display Distributions 44

Screen 16: Display Distribution Menu 45

Screen 17: Differential Distribution Menu 46

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List of Screens

	Page Number
Screen 18: Cumulative Distributions Menu	61
Screen 19: Select Printer Port	74
Screen 20: Select Printers	75
Screen 21: Printer Scale Warning	75
Screen 22: Graphic Printout Scale Screen	76
Screen 23: Pump/Valve Control Screen	77

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

List of Printouts

Page Number

C770 Main Menu

Printout 1: Population Distribution 47

Printout 2: Number-wt. Differential Distribution 48

Printout 3: Area-wt. Differential Distribution 49

Printout 4: Volume-wt. Differential Distribution 50

Printout 5: Distribution Channels 56

Printout 6: Distribution Channels (continued) 57

Printout 7: Distribution Channels (continued) 58

Printout 8: Print Summary 59

Printout 9: Number-weighted Cumulative Distribution 62

Printout 10: Area-weighted Cumulative Distribution 63

Printout 11: Volume-weighted Cumulative Distribution 64

Printout 12: Statistical Summary

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List of Figures

Page Number

Introduction

Figure 1: Autodilution[PAT.] System 5

Initial Hardware Setup

Figure 2: Front Panel of AccuSizer 3

Figure 3: Back Panel of AccuSizer 5

Figure 4: Back Panel of AccuSizer Counter 7

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General Information

Registration

Please register your software by taking a moment to fill out the registration card provided. In keeping with our promise, we can easily provide two years of free software upgrades.

Just call us if you need information about our other products, or information about upgrading your existing system.

Technical Support

If technical support is needed please contact one of the following offices:

Main Office:

Particle Sizing Systems
75 Aero Camino, Ste. B
Santa Barbara, CA 93117

Tel: 805-968-1497
Fax: 805-968-0361

Eastern Regional Office:

Particle Sizing Systems
668 Woodbourne Road, Ste. 104
Langhorne, PA 19047

Tel: 215-702-7088
Fax: 215-702-7099

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INTRODUCTION

Background of the SPOS Technique

The method of single-particle optical sensing (SPOS), also called optical particle counting (OPC), was originally developed for the field of particulate contamination analysis. Particles in gas or liquid suspension flow through a small "photozone" -- a narrow, slab-like region of uniform illumination, produced by light from a laser diode or incandescent bulb. The particle suspension is sufficiently dilute when the particles pass, one at a time, through the illuminated region, avoiding coincidences.

The passage of a particle through the sensing zone causes a detected pulse, the magnitude of which depends on the mean diameter of the particle and the physical principle of detection -- light scattering or obscuration (blockage). The illumination/detection system in the sensor is designed to provide a monotonic increase in pulse height with increasing particle diameter. A particle size distribution (PSD) is constructed one particle at a time, by comparing the detected pulse heights with a standard calibration curve, obtained from a set of uniform particles of known diameters.

The SPOS technique possesses several characteristics which make it ideal for measuring the PSD of a wide variety of particle suspensions, emulsions and dispersions. These include exceptional resolution, wide dynamic range and high accuracy. The **AccuSizer™ 770** Optical Particle Sizer has refined the SPOS technique for general use in particle size analysis. Through the addition of a proprietary dilution method, called "Autodilution" (U.S. Patent # 4,794,806; foreign patents pending) and significant innovations in hardware and software design, this important measurement technology has become much more attractive for a variety of applications. Samples of arbitrary concentration can be measured quickly and automatically, without sacrificing any of the essential advantages inherent in the SPOS method.

The attractiveness of the SPOS approach for particle size analysis can be best appreciated by comparing its properties with those of alternative methods based on "ensemble" techniques, in which a large number of particles of different size contribute simultaneously to the measured signal. The most popular instruments in this category are based on the methods of sedimentation/turbidity or Fraunhofer laser diffraction. In the former case the raw signal is the optical (or x-ray) transmission through the sample, measured at a particular location in the suspension. The signal varies with time as the particles populate or depopulate that region

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INTRODUCTION

Background of the SPOS Technique

The popular ensemble techniques are poorly suited to characterizing relatively complex distributions like these. Instead, because of their speed, ease of use and good reproducibility, these methods have proven useful for determining the "end point" in a particle manufacturing process -- e.g. the approximate mean diameter, and perhaps the standard deviation. Ensemble techniques are much less useful for characterizing the quality of a product, in the sense of being able to detect and quantitate subtle features of the PSD, like the examples discussed above.

By contrast, the combination of Autodilution and SPOS techniques yields a powerful technique for particle size analysis. First, the use of Autodilution allows an SPOS-type instrument to characterize the essential features of the PSD as quickly, easily and reproducibly as competitive approaches based on ensemble techniques, such as Fraunhofer diffraction or sedimentation/turbidity. Second, the use of a single-particle sizing method offers the intrinsic advantages of high resolution, large dynamic range and excellent accuracy, allowing one to measure small, subtle features of the PSD that simply cannot be detected using ensemble techniques.

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Autodilution Subsystem

Our patented Autodilution system is shown schematically below. A few drops of concentrated liquid suspension or wet powder dispersion are manually introduced into the mixing chamber of the Autodiluter, consisting of a dilution chamber, filled with filtered diluent (typically water). The sample particles are mixed with diluent in the mixing chamber by means of a magnetic stirrer or a mechanical agitator.

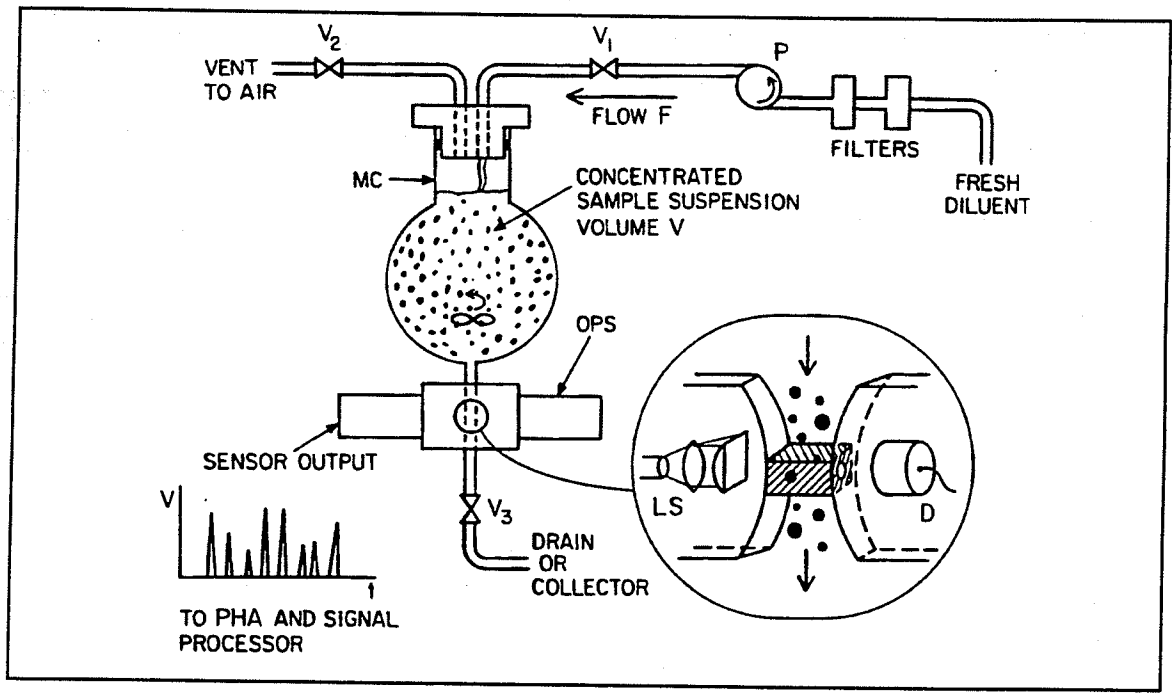


Figure 1 - Autodilution[PAT.] Subsystem

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which equals 419,283 for the example above. This represents about 70% of the total number of particles (equal to 600,000) which are present in the mixing chamber at the start of the measurement. If the measurement time is increased to 2 minutes, approximately 90% of the particles will be sized. Hence, in a relatively short time the system is capable of counting and sizing a very large number of particles, insuring excellent statistical accuracy and, hence, reproducibility.

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For a larger particle, having a diameter comparable to the width of the illuminated zone, the dependence of pulse height on particle diameter is closer to linear than quadratic. In any event, the pulse height should increase monotonically with particle diameter. Light blockage-type sensors are available in a variety of size ranges, including 1.3 to 400 and 5 to 2500 microns.

SENSOR MODEL #	DETECTION METHOD	PARTICLE SIZE RANGE
LE400-05SE	Light Extinction/Scattering	0.5 to 400 microns (nominal)
LE400-1SE	Light Extinction/Scattering	1.0 to 400 microns (nominal)
LE400-1	Light Extinction	1.0 to 400 microns (nominal)
LE400-1.3	Light Extinction	1.3 to 400 microns (nominal)
LE1000-3	Light Extinction	3.0 to 1,000 microns (nominal)
LE2500-5	Light Extinction	5.0 to 2,500 microns (nominal)

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INITIAL HARDWARE SETUP

Computer, DMA Interface Board and Autodiluter

DMA Interface Board

The DMA Interface printed circuit board is inserted into any 16-bit unused edge connector in the PC controller. The protective cabinet of the computer should then be reinstalled. In most cases the computer has been supplied as part of the AccuSizer™ 770 system; for these systems the circuit board will already be installed.

C770 Software

The system software **C770** is installed in the hard-disk memory drive of the PC controller. In cases in which a computer has been supplied with the system, **C770** software will already be installed on the hard-disk drive, with a backup copy of the software files provided on diskette.

Optical Particle Sizer

The 770 Optical Particle Sizer unit must be placed immediately next to the PC controller. The unit is connected to the DMA Interface board in the computer using the short ribbon cable provided (terminated at each end by a 25-pin DB-type male plug). Do not connect the sensor cable while power is applied to the power supply. The **Optical Particle Sizer** should then be connected to a source of AC power using the 3-prong cable provided.

CAUTION: *Before attaching the unit to AC power, verify that the correct line voltage has been selected on the 770 power receptacle. The POWER ON/OFF switch must be OFF (not pushed in).*

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Computer, DMA Interface Board and Autodiluter

IMPORTANT: *The two stainless steel flow tubes on the sensor are* ***not*** *equivalent; one serves as fluid input, the other as output. The direction of flow is indicated on the body of the flow cell.*

5. Connect the stainless steel flow tube with the teflon tube onto the top side of the sensor with the teflon tube extending into the hole on the bottom of the magnetic mixing device. This will require some effort to bend the ridged tube into the hole, the sensor may have to be moved to one side to accomplish this task.

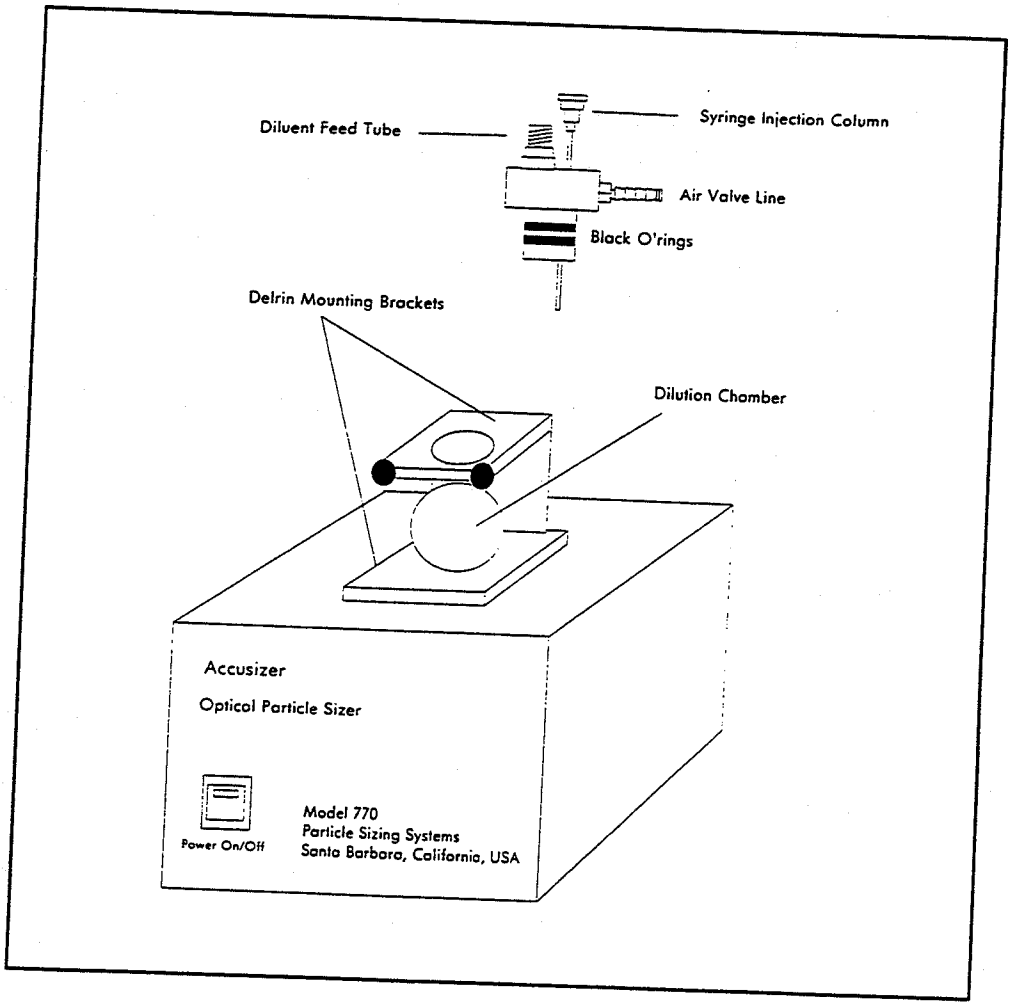


Figure 2: Front of AccuSizer

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Computer, DMA Interface Board and Autodiluter

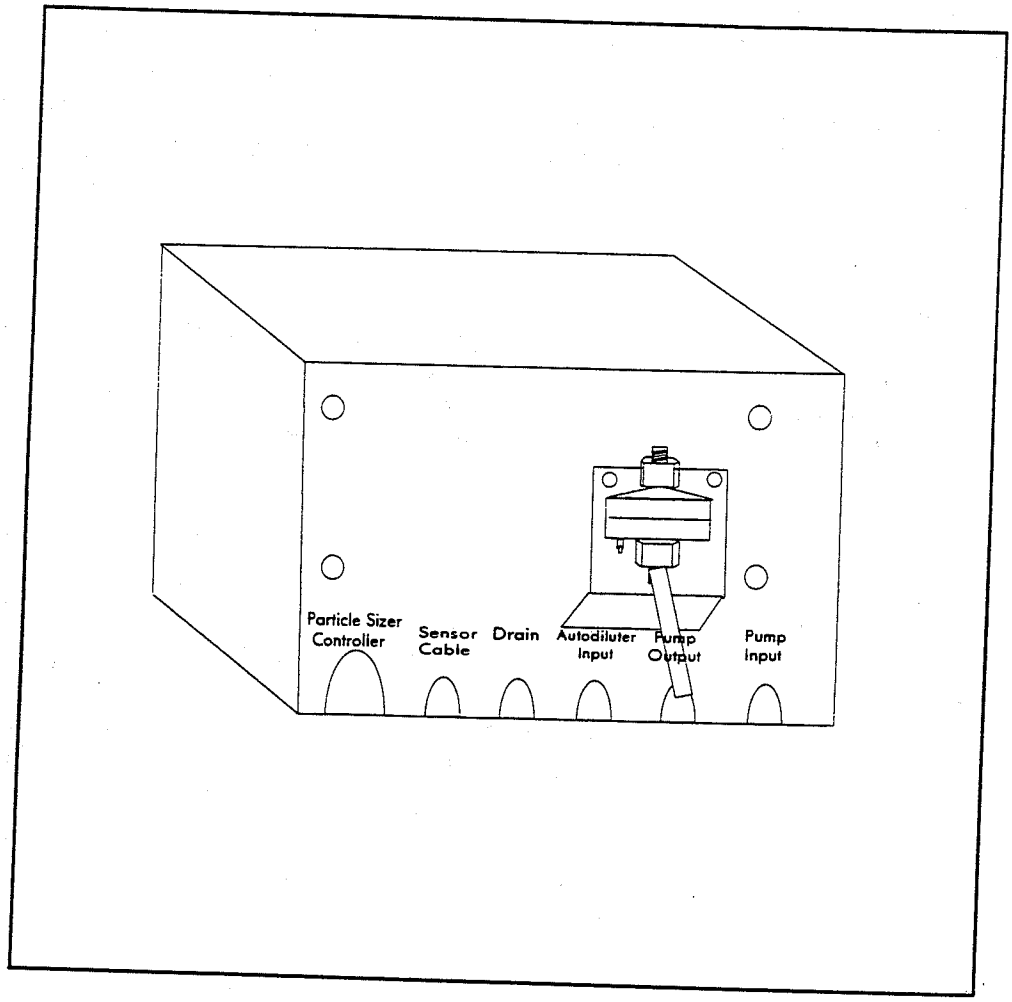


Figure 3: Back Panel of AccuSizer

14. Firmly secure all tubing connections, to prevent leakage of fluid. Failure to secure all tubing connections will result in accidental disconnection at some future time.

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Computer, DMA Interface Board and Autodiluter

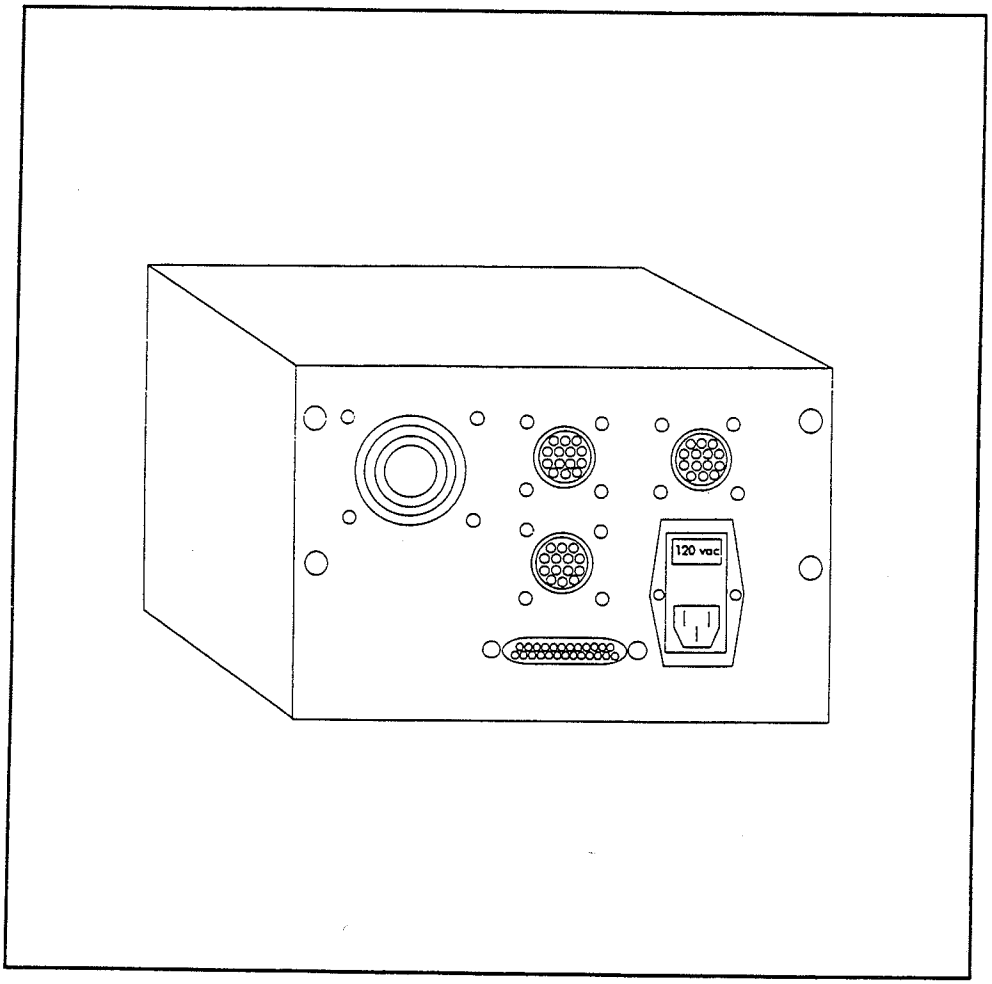


Figure 4: Back Panel of AccuSizer Counter

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LOADING C770 SOFTWARE (continued):

g. Copy **C770** files from floppy-disk drive **A** to hard drive **C**, by typing the following at a-prompt:

COPY *.* C:\C770

The following will display:

A:\>COPY *.* C:\C770

h. Press **ENTER**. The following filenames and message will display on the screen:

C770.EXE
C770.CFG
BD.PDT
XXXXXXXX.SNS
4 File(s) copied

The A-prompt will re-display

A:\>

The **C770** software files are installed in the hard disk drive **C**, in subdirectory C770. The software is ready to run.

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Accessing C770 Software

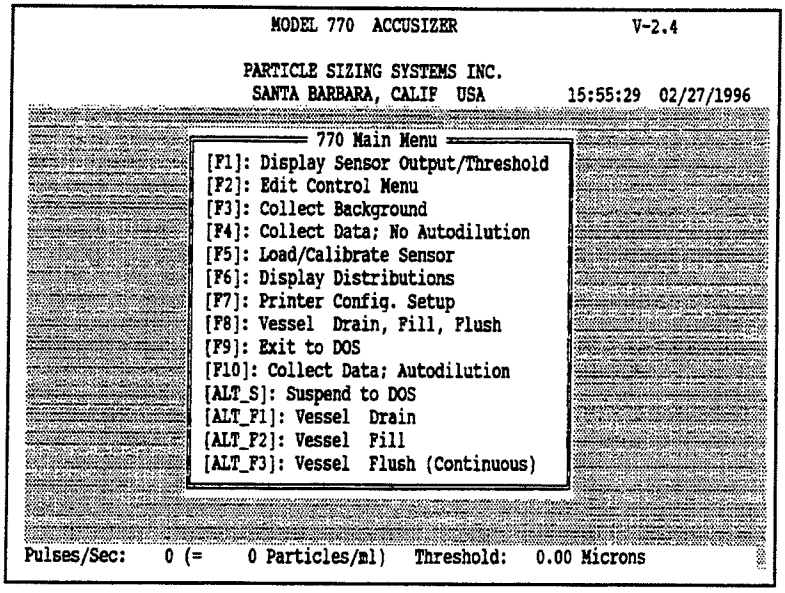
When the **770** system is accessed, the following message will display on the screen:

```
Loading Sensor Table
```

After a few seconds, this next message displays:

```
*** IMPORTANT ***
Please turn on the AccuSizer
power, then press any key
```

Apply power to the **770 Optical Particle Sizer** by pushing in the **POWER ON/OFF** switch (illuminated red) and pressing any key (see Figure 1: AccuSizer Front Panel). The **AccuSizer Model 770 MAIN MENU** will display.



Screen 1: AccuSizer 770 Main Menu

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C770 MAIN MENU

[F1]: Sensor Output/Threshold Display

The Sensor Output/Threshold display option is used to monitor the output voltage wave-form produced by the sensor. When the **770A Autodiluter** is used in conjunction with the sensor, selecting **F1** will initiate the process of Autodilution. Autodilution is the process by which filtered diluent is pumped into the top of the dilution chamber at a constant rate. At the same time the particle/fluid mixture contained in the dilution chamber will flow out of the bottom of the chamber (at the same rate) and pass through the optical sensor, which is mounted directly below the magnetic stirrer and dilution chamber.

Any particles which are suspended in the fluid contained in the dilution chamber, whether they are "sample" particles or contaminants (e.g. dirt, air bubbles, etc.), will eventually flow through the sensor, thereby contributing to the sensor signal. The signal consists of a very low baseline voltage level, upon which are superimposed pulses of varying heights, produced by particles passing through the active sensing region of the sensor. The vertical axis of the display is **Sensor Output Voltage** (Volts), expressed as a positive-going signal. The horizontal axis is **Time** (microseconds). The output waveform of the sensor will be displayed as a black curve, while the threshold level will be shown as a horizontal white line.

The low-level irregular waveform at the bottom of the display is the underlying noise output of the sensor. Its typical peak value is 5-10 millivolts (mV). The much larger, discrete pulses which occur randomly in time correspond to individual particles which pass through the sensing zone. The height, or magnitude, of a given pulse increases with the diameter of the particle which produces it.

Example: The pulse height corresponding to a 2-micron particle is approximately 50 mV, while the height for a 20-micron particle is about 620 mV. The maximum pulse height for any sensor is designed to be 10 Volts (i.e. 10,000 mV).

The width of the pulses is a function of the flow rate through the sensor (typically 50-60 cc/min) and the width of the active sensing zone in the sensor. For the "standard" sensor designed to cover the approximate size range of 1 to 400 microns, the typical pulse width will be in the range 10-20 microseconds. Only those pulses which rise above the threshold will be measured by the pulse-height analyzer in the **770** electronic module.

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[F1]: Sensor Output/Threshold Display

Incrementing and Decrementing the Voltage Threshold:

UP ARROW: will *increment* the *voltage* threshold level.

DOWN ARROW: will *decrement* the *voltage* threshold level.

The voltage threshold is the level below which pulses will not be counted or included in the final particle size distribution. The threshold level will be shown as a horizontal white line, while the output waveform of the sensor will display as a black curve -- discrete pulses superimposed on a black, nearly-smooth, horizontal line.

The sensor output consists of pulses which occur randomly in time. The software will cause them to appear and disappear on the screen at a relatively rapid rate. The **Spacebar** key can be used to freeze the display, allowing for the examination of the individual pulse shapes which occurred during the particular time interval (e.g. 2000 microseconds wide) which was captured by pressing the **Spacebar** key.

Pressing the **Spacebar** will "unfreeze" the display, showing again a moving, random sequence of pulses, which appear and disappear as particles flow into and out of the active detection zone in the sensor.

IMPORTANT: *Appreciate the fact that only a relatively small portion of the sensor signal can be captured and displayed at any given time. Technically speaking, the "duty cycle" of the sensor display function is relatively low. (The duty cycle depends on the speed of the computer; typically less than 10%). This is why only an occasional pulse can be seen on the screen when "clean" water is flowing through the sensor, even though the average pulse rate which is displayed below the MAIN MENU may be 100/sec or higher. For example, if a single pulse occurs on the display screen, during an elapsed time "frame" of 2000 microseconds (2 milliseconds), this is equivalent to an average count rate of 500/sec. With an average pulse rate of 100/sec, there would be a pulse displayed on only every fifth screen which is displayed. However, the low duty cycle of the process means that the actual rate of display of pulses will be even lower than this example.*

Exit Sensor Display Function

ESC: will exit the sensor display function and return to the **MAIN MENU**. **ESC** will also turn the pump off. This will stop the flow of fresh diluent into the dilution chamber, and close the drain valve, which stops the flow of particles/diluent through the sensor.

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[F2]: Edit Control Menu

Data Directory:

The data directory is used to specify the path (drive,directory) where the raw data obtained from a measurement, using either the automatic or manual save-data mode will be stored in memory. The path includes the disk drive allocation as well as any subdirectory path which is desired.

Example 1:

To store data blocks on floppy disk drive **A**, without using a subdirectory:

a. Type **A:**

b. Press **ENTER**.

Example 2:

To store data blocks on floppy disk drive **A**, using a subdirectory, "data":

a. Type **A:\DATA**

b. Press **ENTER**.

The screen will display this as **a:\data** and the cursor and highlight bar will advance to the next line, **Data filename**.

Example 3:

To store data blocks on floppy disk drive **C**, using the directory C770 and the sub-directory, "data123":

a. Type **C:\C770\DATA123**

b. Press **ENTER**.

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[F2]: Edit Control Menu

Data File name

Specifies the desired filename for the file of raw data which will be created when a save-data instruction is initiated, either automatically or manually. The usual rules of MS/DOS apply here: the filename must be specified in the form of **FILENAME.EXT**, where the **FILENAME** is a string containing a maximum of 8 alphanumeric positions, and the **EXT** is an extension, containing 3 numbers.

IMPORTANT: *After every save-data operation the EXT value is automatically incremented by one.*

Typically, the **FILENAME** for the data file indicates the sample which is being analyzed (e.g. a lot number or date). It is usually convenient to use a starting extension value of 700. Sample results that have been collected using the AccuSizer 770 are easily distinguished. Each time data is saved for a particular sample run, the filename extension is incremented by one.

a. Type the filename in the field provided. Use the **Backspace** key to make any typing corrections.

b. Press **ENTER**. The filename will be saved to the **[F2]: Edit Control Menu** file C770.CFG in memory.

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[F2]: Edit Control Menu

Overwrite old files ?

Overwriting old files enables the saving of new data files over old, no longer needed, data files and conserves on memory usage. Before overwriting old data files, save the files on floppy disk for a data library.

Overwrite old files (Default)

The default choice is set to **N** (= No). If this choice is not changed then any save-data operation which attempts to create a data file having the same **NAME.EXT** as an existing one will cause the new **NAME** to be changed, by adding the character "**!**" (exclamation point) automatically to **NAME**. In this way, a new data file will be saved, having the new filename, **NAME!.EXT**, instead of **NAME.EXT**.

If a second attempt is taken to create a new file having the same name as the original, **NAME.EXT**, another new file will be created, this time using the added characters "**!!**", resulting in the new filename, **NAME!!.EXT**. This procedure will be invoked yet a third time, resulting in the new filename, **NAME!!!.EXT**. After three such substitutions, a new data file will no longer be saved. Also note that there is no error message when this happens.

Overwrite old files

Press **Y**. An existing file in the data directory which has the same **NAME** and **EXT** values will be overwritten. The cursor and highlight bar will then automatically advance to the next line.

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[F2]: Edit Control Menu

Automatic data storage ?

Automatic storage of data from sample runs allows for the running of samples to be unattended. During each sample run the filename extension specified in the **Control Menu** [F2], will automatically be incremented by one.

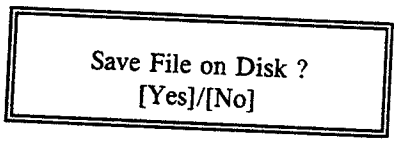
Automatic data storage

a. Type **Y**. The data which has been collected during each of the automatic collection intervals will automatically be stored in the data directory and filename specified in the **[F2]: Edit Control Menu**. The data blocks will be stored under the filenames, **Name.Ext**, **Name.Ext+1**, **Name.Ext+2**, etc., for data collection intervals # 1, 2, 3, etc.

Manual data storage

a. Type **N**. Data blocks will NOT automatically be stored in the specified data directory. Rather, at the end of each measurement interval, or cycle, the accumulated Population Size Distribution will appear on the screen. This is also true for data files that are manipulated.

b. Press the **ESC** key, to save the sample result on a run by run basis. The following message will appear on the screen:



[Yes]: The filename which was last stored in the **[F2]: Edit Control Menu** will display. If the **ENTER** key is pressed, the data will be stored under that particular filename.

Another filename may be typed followed by pressing **ENTER**. This sequence will be repeated at the end of each measurement interval, or cycle, thus allowing for a determination of whether the data will be saved and under what filename. In most cases of typical operation, it is prudent to choose **YES** for automatic data storage.

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[F2]: Edit Control Menu

Select # of particle size bins

The number of channels, or "bins", which will be contained in the Population Distribution (PD) produced by the **770** is indicated in this field. These bins are spaced uniformly on a **logarithmic** diameter scale, which ranges typically, from 0.5 to 500 microns.

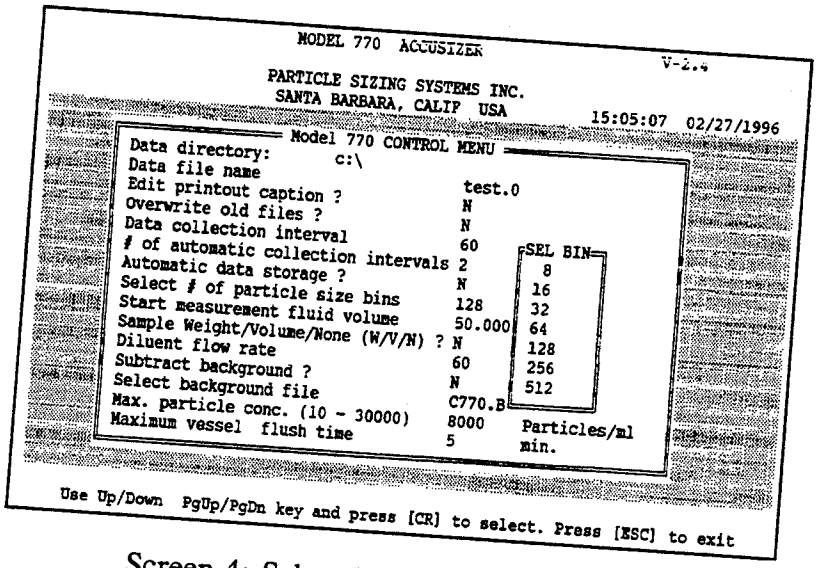
In order to change the number of bins in the measurement:

a. Press the **ENTER** key. A small menu will appear, displaying the choices which are available for the # of bins. These are: 8, 16, 32, 64, 128, 256 and 512.

b. Use the **UP** and **DOWN ARROW** keys to move the highlight bar to the desired value.

c. Press **ENTER** to select the value.

The data is stored in 512 channels but displayed in the number of bins selected in this field. Using the **Ctrl B** function in the display mode allows for the changing of the number of channels. The system will automatically recombine the channels to the desired number whether it be 8, 16, 32, 64, 128, 256 or 512. For most measurements, a choice of 64 or 128 bins represents a good compromise between resolution and ease of handling of the raw data numbers.



Screen 4: Select # of Particle Size Bins

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[F2]: Edit Control Menu

Sample Weight/Volume/None (W/V/N) ?

A mass balance on a sample may be performed using this option. If 10 grams of material were placed into the dilution chamber and the number of particles at each size was obtained, the volume could be calculated and using the density the weight distribution could be calculated. By summing up the mass, the actual amount of material sized could be determined. If the mass of the material injected does not equal the mass of the particles sized it can be inferred that a small population of particles in the sample exists below the lower size limit of the sensor.

Sample Weight (Mass Balance):

a. Press **W**.

b. Press **ENTER**. The following will display at the bottom of the screen:

Press [ENTER] to Enter Sample Mass/Density

c. Press **ENTER**. The following window will display:

Particle Mass Parameters	
Particle Density	g/cc
Particle Mass Injected	g

d. Enter the particle density in terms of grams per milliliter.

IMPORTANT: *If the sample is already suspended in diluent and is not a free standing powder, the density to be entered as described above must be the density of the solids not the average density of the suspension.*

e. Press **ENTER**.

f. Weigh out an appropriate amount of material (about 1 to 10 micrograms) using a balance that is able to measure $\pm$ micrograms (or $\pm$ $1x10^{-6}$ grams).

IMPORTANT: *If a micro-balance is not available, weigh out an aliquot of powder on a top loading balance (able to measure $\pm$ 0.1 milligrams or $\pm$ 0.0001 grams) and disperse in a known volume of diluent. This suspension can be dispersed with a precision pipet.*

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[F2]: Edit Control Menu

Sample Weight (Mass Balance) (continued):

u. Press **F4** [Population Distribution].

v. Press **CTRL** and **W**. A red cursor will appear on the display graph.

w. Press the **LEFT** and **RIGHT ARROW** keys to position the cursor to choose a window of the distribution. The percent mass that the particle size distribution in this window contributes can be determined.

x. Press **ENTER**. A red line will display at the position of the cursor to define one side of the window.

y. Position the cursor as stated to define the other side of the window.

z. Press **ENTER**. The window is defined to the system. Text will appear underneath the display graph detailing the percent mass, number of particles and additional information pertaining to the mass balance in the window selected.

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[F2]: Edit Control Menu

Sample Volume (Volume Balance)(continued):

m. Press the **UP** and **DOWN ARROW** keys to position the highlight bar over the data filename.

n. Press **ENTER**.

o. Press **F3** [Display Distribution Channels] to view the sample volume in terms of channel data. The last line of the text section will display the percent volume that the 770 measured. The preceding lines contain information concerning the volume balance calculation.

p. Press **CTRL** and **V** to change the original parameters.

q. Press **ESC** to return to the Distribution Menu.

r. Press **F1** [Differential Distribution].

s. Press **F4** [Population Distribution].

t. Press **CTRL** and **V**. A red cursor will display at the position of the cursor on the graph.

u. Press the **LEFT** and **RIGHT ARROW** keys to position the cursor to choose a window of the graph. The percent volume that the particle size distribution in this window contributes can be determined.

v. Press **ENTER**. A red line will display at the position of the cursor to define one side of the window.

w. Position the cursor as stated to define the other side of the window.

x. Press **ENTER**. The window is defined to the system. Text will appear underneath the display graph detailing the percent volume, number of particles and additional information pertaining to the volume balance in the window selected.

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[F2]: Edit Control Menu

Subtract background ?

In situations where the level of background particulate contamination is relatively high and similar from measurement to measurement, it may be useful to subtract the typical Population Distribution (PD) of the "background" diluent from the sample distribution suspended in the same diluent. In order to choose to make this background subtraction, it will have been necessary first to collect data in one or more background files (using the same collection time).

a. Type **Y** in this field.

b. Press **ENTER**. The cursor will advance to the next line and the following message will display at the bottom of the screen:

Press [ENTER] to select background file

A window will display containing the names of the various background data files which have previously been saved. These files are distinguished by the extension **BKG** (i.e. **NAME.BKG)** and the filename using up to eight alphanumeric positions.

c. Press the **UP** or **DOWN ARROW** key to move the highlight bar over the desired **BKG** file.

d. Press **ENTER** to commit the background file to memory for this particular sample run.

It is good practice to collect 2 to 3 background files and average them together then save the average file using it as the background subtraction file. This reduces the effect of statistical discrepancies in channels where you may have very few background particles may be present.

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[F2]: Edit Control Menu

Maximum Vessel Flush Time (Min.)

This is the length of time during which the dilution chamber will continuously be flushed once **Vessel Flush (continuous) [ALT_F3]** from the Main Menu is executed.

The purpose of setting this parameter is to avoid a situation in which a continuous-flush operation is initiated and then left unattended for a period of time, thus neglecting to terminate the flushing operation. This stored parameter stops the flushing cycle after the specified time (typically 4-5 minutes), thus saving filtered water.

To terminate the flushing operation prior to the time set, press **ESC**.

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[F4]: Collect Data

Measurement of the particle size distribution **without Autodilution** can be initiated using this option. This mode of operation is appropriate for sample suspensions which are sufficiently dilute and do **not** require dilution, or which have already been pre-diluted.

When **F4** is pressed. The **Drain Valve** and **Air Valve** (vent to the atmosphere) are both **opened**. This condition can be established by verifying that the green **Drain Valve** switch and red **Air Valve** switch are both illuminated. (Also listen for the two pinch valves inside the **770A Autodiluter** unit to "click" open.) The particle/fluid mixture in the dilution chamber will pass through the sensor and out the drain line by the force of gravity alone.

The flow rate can be established for this mode by timing the drop in the level of fluid in the dilution chamber (e.g. between the 50-cc and 10-cc marks), using a stopwatch. The flow rate can then be adjusted to the desired value, typically 50 or 60 cc/min, by partially constricting the flow through the drain tubing, using an adjustable pinch clamp.

Immediately after **F4** is pressed, a plot of the size distribution appears on the display screen. The Population Distribution, expressed as particle counts (vertical axis) versus particle diameter, on a log scale (horizontal axis), then builds up and is displayed approximately in real time.

Although the measurement is made in a time mode it is important to remember to manually stop the data collection cycle using the ESC key when most of the diluent has left the dilution chamber. Allowing the dilution chamber to drain will result in false particle counts made by the water/air interface as it is passing through the sensing zone.

Use **F1** to increment and **F2** to decrement the vertical scale (particle counts).

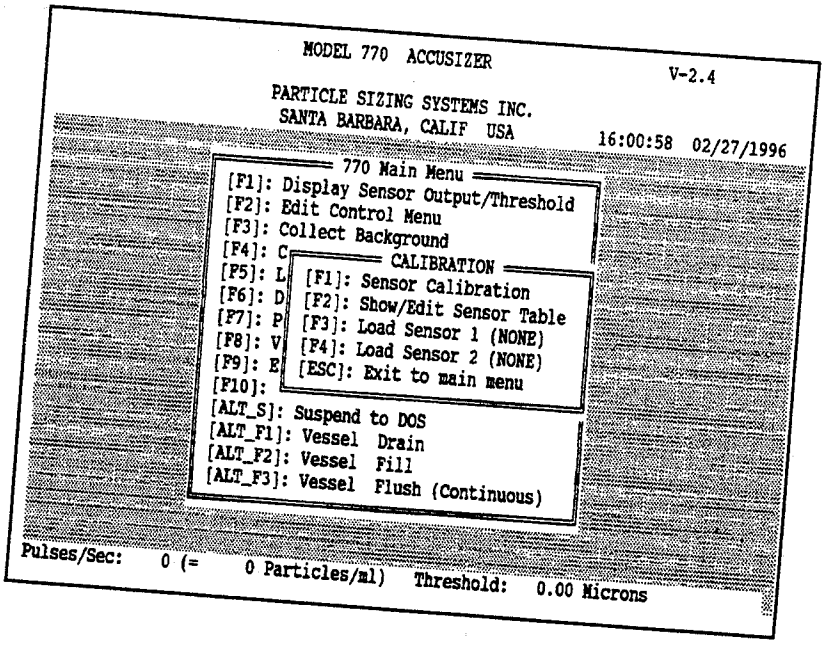
When the **ESC** key is pressed, the flow through the sensor will be stopped, and data collection will be terminated. The **Drain Valve** and **Air Valve** are closed (lights are no longer illuminated). The Population Distribution representing the accumulated data is displayed. When **ESC** is pressed again, the Population Distribution disappears and the following message appears:

```
Save File on Disk ?
[Yes]/[No]
```


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[F5]: Load/Calibrate Sensor

Calibration of the Sensor or related functions can be accomplished using this option. When **F5** is pressed, the available functions are displayed in a separate menu, labeled **CALIBRATION**:



Screen 5: Calibration Menu

[F1] Sensor Calibration: allows for the calibration of a sensor, using a set of particle standards.

[F2] Show/Edit Sensor Table: allows for the display and/or edit of the calibration table and corresponding curve for a particular sensor.

[F3] Load Sensor 1: enables the assignment of a particular sensor table/calibration curve to either sensor input of the **770 Optical Particle Sizer**.

[F4] Load Sensor 2: enables the assignment of a second sensor table/calibration curve to either sensor input of the **770 Optical Particle Sizer**.

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[F1]: Sensor Calibration (continued):

[F5]: Load/Calibrate Sensor

f. Type in the **Sensor Filename** which consists of a file format where the **Filename** obeys the rules of MS/DOS (i.e. a maximum of eight alphanumeric positions) and an extension of **SNS**, which cannot be changed.

g. Press **ENTER** or the **DOWN ARROW** key to store the filename to memory.

h. Type in the **Sample Period (seconds)** which is the length of time during which standard particles will be counted and the pulse height distribution measured. Typically, 10 to 20 seconds works well, assuming a reasonably concentrated sample.

i. Press **ESC** after all parameter values have been properly entered. The following prompt displays:

> Exit the Calibration table ?

j. Type **Y**. The actual sensor table displays.

k. Type in the sensor calibration values to be assigned to this particular sensor.

l. Press **ESC** to display sensor calibration curve. The following **Sensor Calibration** menu displays (see Screen 7: Sensor Calibration)

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[F5]: Load/Calibrate Sensor

[F1]: Sensor Output/Threshold display

F1 is used to observe the output waveform of the sensor (i.e. the pulses produced by particles flowing through the sensor). This function is identical to that which is listed in the **Main Menu** and which is also activated by **[F1]:** Sensor Output/Threshold Display. This option causes the **Drain Valve** to switch to **OPEN** and the **Pump** to turn **ON**. A steady-state flow of fluid through the dilution chamber and the sensor will be created. This is equivalent to the Autodilution operation, but without data collection. A representative display of output pulses from the sensor, plotted as Voltage vs. Time, is displayed on the screen, as described earlier. This function is **not** used to calibrate the sensor, but simply to observe its output waveform.

[F2]: Start calibration: Autodilution

F2 is used to initiate Autodilution on the contents of the dilution chamber after a sample of standard particles has been added to the dilution chamber. When **F2** is pressed, the message "**Start Autodilution**" will display on the screen. The flow of fluid will be the same as for the first function (above). However, in this case, the particle counting rate will automatically be monitored. When the count rate drops below the value which was entered into the **[F2]: Edit Control Menu** (**Main Menu**), the system will start to collect and display data -- i.e. count pulses/particles and measure the height of each pulse.

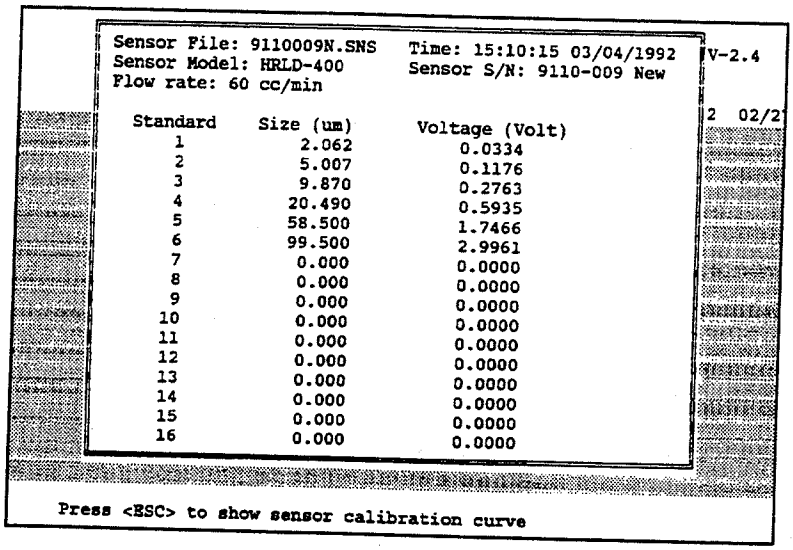
After the **Sample Period** (which was preset in the **Sensor Calibration Control Menu**) has elapsed, the Autodilution operation will be terminated (i.e. the flow of fluid is stopped) and a completed plot of the number of particles (Y-axis) vs pulse height (X-axis) will display on the screen. If the standard particles are narrow in size distribution and located within the effective size range of the sensor, a smooth, single-peak distribution will display on the screen. A "cross-hair" symbol (referred to as a "cursor" below) will be located at, or very close to, the peak of the distribution.

At the bottom of the screen displays a summary of useful key commands:

[RIGHT]/[LEFT]:	Move Cursor to Select Peak
[F1]/[F2]:	Inc/Dec Cursor Speed
[ENTER]:	Enter Size
[ESC]:	Exit

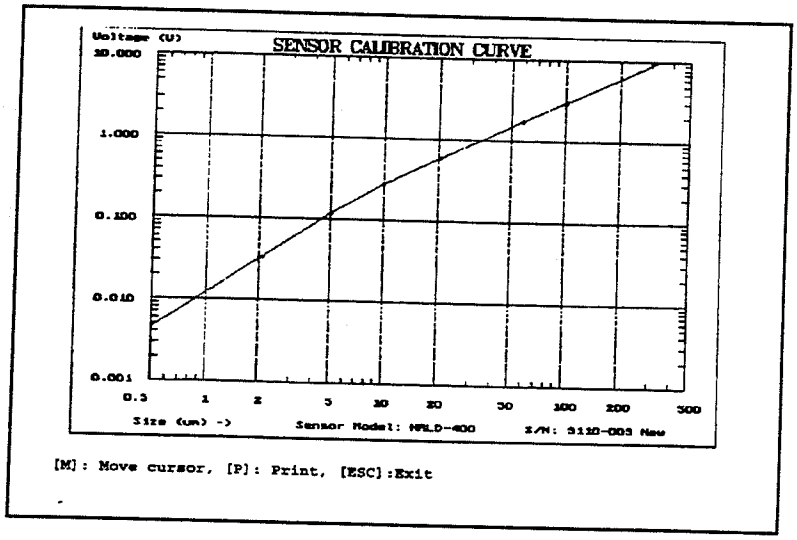
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[F2]: Start Calibration: Autodilution (continued):



Screen 8: Sensor Calibration Table

As indicated at the bottom of the screen, the **ESC** key is used to exit the **Sensor Table** and to display the **Sensor Calibration Curve**. The following calibration curve corresponds to the sensor table displayed in Screen 8: Sensor Calibration Table.

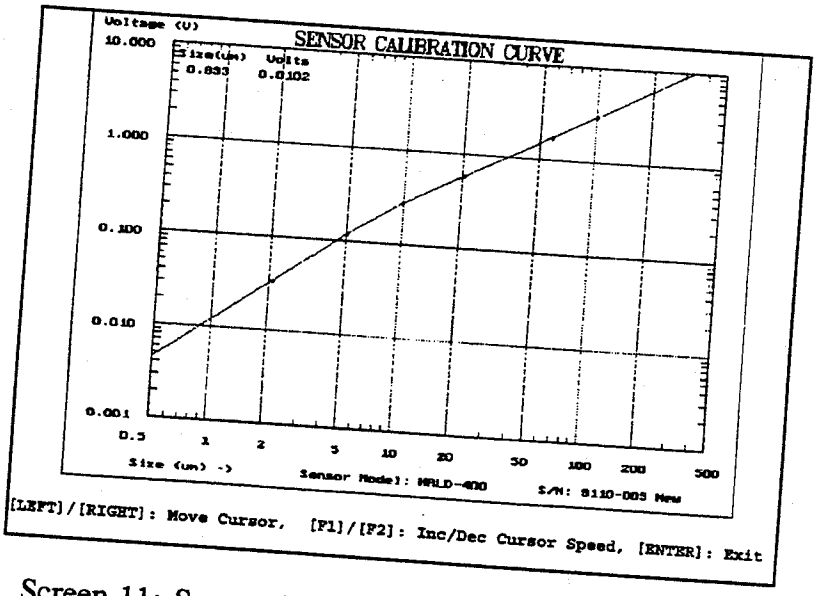


Screen 9: Sensor Calibration Curve

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[F2]: Start Calibration: Autodilution (continued):

Calibration curve move commands:



Screen 11: Sensor Calibration Curve Move Commands

[LEFT]/[RIGHT]: used, respectively, to move the cursor to the left or right, along the calibration curve.

[F1]/[F2]: used, respectively, to increase or decrease the speed of movement of the cursor. The coordinates of the cursor -- particle diameter (um) and pulse height (V) -- are shown in a highlighted area in the upper left-hand corner of the display.

[ENTER]: used to close examination of the calibration curve and return to the Sensor Calibration Curve Key Commands screen (see Screen 11).

IMPORTANT: *When using the Autodilution mode [F2] for sensor calibration, it will be good to introduce a series of samples in the order of* ***decreasing*** *diameter. The reason for this is that the particle concentration (number/cc) for particle standards generally decreases with increasing diameter. Therefore, if measuring the largest particles first, no flushing or additional dilution will be required before introducing the next sample. The resulting new pulse height distribution will dominate over the one for the previous sample. Several size standards can be measured quickly and easily.*

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[F5]: Load/Calibrate Sensor

[F4]: Vessel Fill

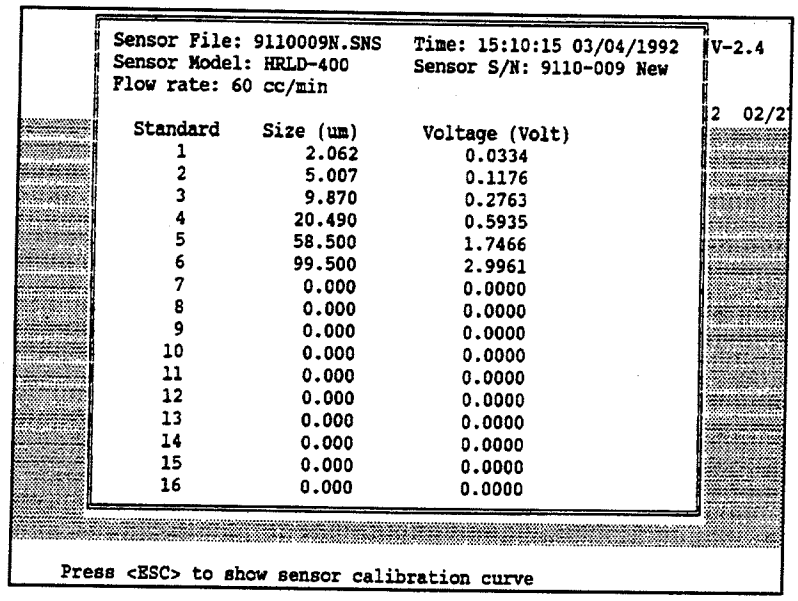
Manual filling of the dilution chamber of the **770A Autodiluter** with filtered diluent during the sensor calibration procedure can be initiated using this option.

[F5]: Vessel flush (continuous)

Continuous flushing of the dilution chamber of the **770A Autodiluter** with filtered diluent during the sensor calibration procedure can be initiated using this option. Flushing is accomplished automatically, consisting of **Opening** the **Drain Valve** and turning **ON** the **Flow Pump** (with the **Air Valve Closed**). The current particle counting rate will be displayed in real time at the bottom of the display. This will allow for the determination of whether the particle suspension is overly concentrated before proceeding with the function of **Autodilution: Start calibration [F2]**.

[F6]: Save/Show/Edit data

The **Sensor Table**, containing the calibration points (particle diameter vs pulse height), during the sensor calibration procedure displays. The instruction at the bottom of the screen indicates how to return to the **Sensor Calibration** menu, in order to measure additional samples:



Sensor File: 9110009N.SNS Time: 15:10:15 03/04/1992 V-2.4
Sensor Model: HRLD-400 Sensor S/N: 9110-009 New
Flow rate: 60 cc/min

Standard	Size (um)	Voltage (Volt)
1	2.062	0.0334
2	5.007	0.1176
3	9.870	0.2763
4	20.490	0.5935
5	58.500	1.7466
6	99.500	2.9961
7	0.000	0.0000
8	0.000	0.0000
9	0.000	0.0000
10	0.000	0.0000
11	0.000	0.0000
12	0.000	0.0000
13	0.000	0.0000
14	0.000	0.0000
15	0.000	0.0000
16	0.000	0.0000

Press <ESC> to show sensor calibration curve

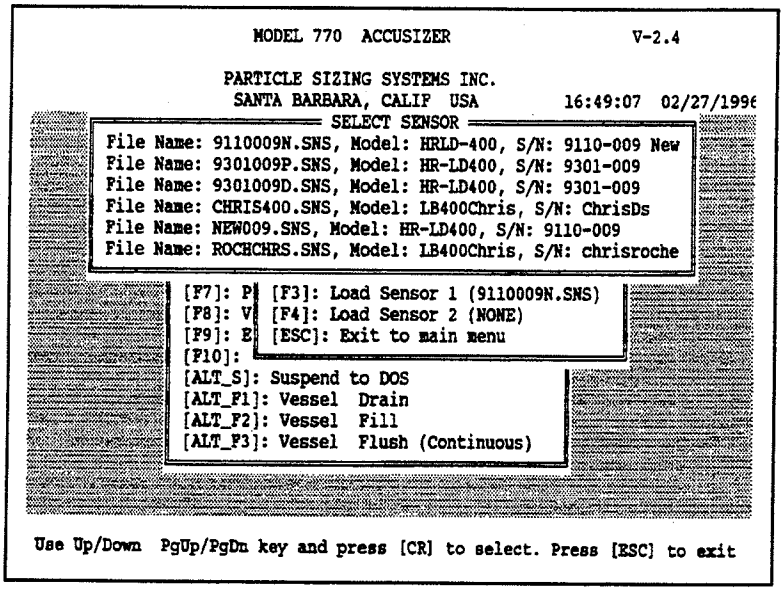
Screen 13: Calibration Data Screen

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[F5]: Load/Calibrate Sensor

[F2]: Show/Edit Sensor Table

The **Sensor Table** which belongs to a particular sensor calibration file (**FILENAME.SNS**) of interest displays using this option. When **F2** is pressed, all of the sensor calibration files which have been stored in memory where the main program **C770.EXE** is located will display. An example is shown below:



Screen 14: Show/Edit Sensor Table

a. Select any sensor calibration file by positioning the highlight bar, using the **UP** and **DOWN ARROW** keys, over the desired calibration.

b. Press **ENTER**. The **Sensor Table** corresponding to the sensor filename will display, showing the pairs of calibration values: particle diameter (um) vs pulse height. Refer to Screen 8: Sensor Calibration Table.

c. Press **ESC** to see the **Sensor Calibration Curve**, without changing any of the individual calibration points. Refer to Screen 9: Sensor Calibration Curve.

d. Press **P** to obtain a printout of both the **Sensor Table** and the **Sensor Calibration Curve**.

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[F5]: Load/Calibrate Sensor

Changing the Sensor Table (continued):

Waiting for Table Creation

will momentarily appear, followed by a display of the **Sensor Calibration Curve**, as before.

[No]

a. Press **N** so the previously existing **Sensor Table** will not be replaced with the new, changed version. The prompt,

"Enter Filename: XXXXXXXX.SNS"

will display where **XXXXXXXX.SNS** is the sensor filename corresponding to the previously existing **Sensor Table**.

b. Enter the new filename which will represent the new, edited sensor calibration. A new **Sensor Table** will then be created, and the corresponding **Sensor Calibration Curve** will display as before.

c. Press **ESC** to exit and return to the main **Calibration Menu**.

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[F5]: Load/Calibrate Sensor

[F4]: Select Sensor 2 ( )

This function, is essentially a duplicate of the previous one, except that a **Sensor Table** is selected for **SENSOR 2** input of the **Optical Particle Sizer**, rather than **SENSOR 1**.

Follow these steps to select Sensor 2 calibration file:

a. Select any sensor calibration file of interest by positioning the highlight bar, using the **UP** and **DOWN ARROW** keys.

b. Press **ENTER**. The selected **Sensor Table** will then be loaded and assigned to the **SENSOR 2** input.

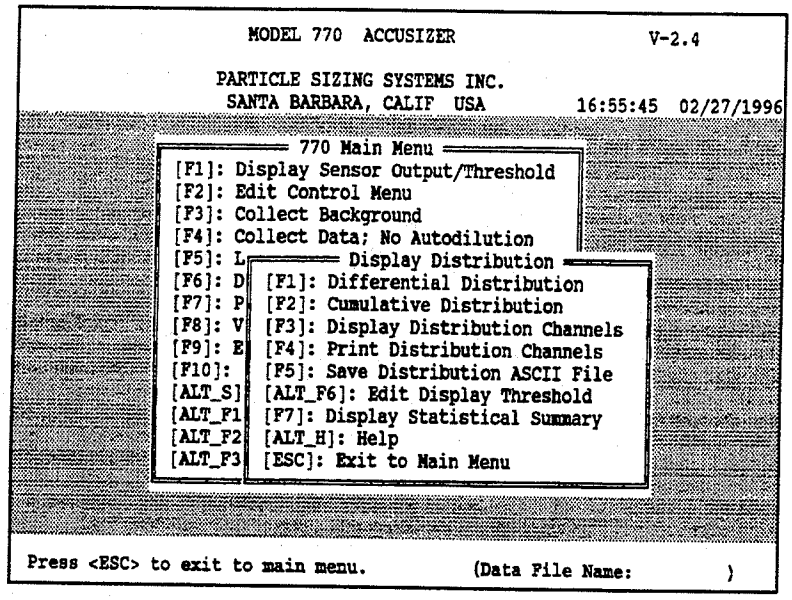
c. Verify from line #4 of the main **Calibration Menu** that the correct sensor assignment has been made.

d. Press **ESC** to exit the **Calibration Menu** and return to the **Main Menu**.

If no sensor is connected to Sensor 2 put in the same calibration file used in sensor 1 for this position.

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[F6]: Display Distributions



Screen 16: Display Distribution Menu

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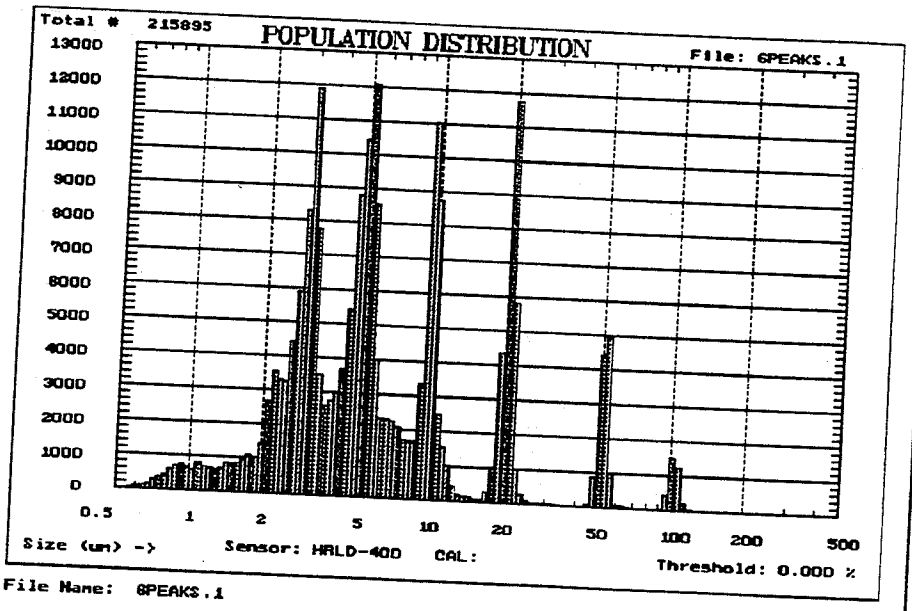
[F6]: Display Distributions

PARTICLE SIZING SYSTEMS
Santa Barbara, California

Model 770 AccuSizer

Six latex standards: 3.00, 5.01, 9.87, 20.5, 50.2 and 100 microns
File Name = 6PEAKS.1 Time Date = 07:09 6/21/1990
Sensor Model: HRLD-400 S/N: 9110-009 Cal. File:

Elapsed Time of Data Collection (min:sec)= 0:30
Background File = NONE
Actual No. of Particles Sized = 215895
Approximate Total No. of Particles in Sample = 586522
Dilution Factor (approx.) = 2.717
Total Fluid Volume Sampled = 30.1 ml
Number of Diameter Channels = 128
Num. Wt. Mean = 11.55 um Vol. Wt. Mean = 94.51 um (0.000 % Threshold)



File Name: 6PEAKS.1

Printout 1: Population Distribution

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[F6]: Display Distributions

[F6]: Area-wt. Distribution.

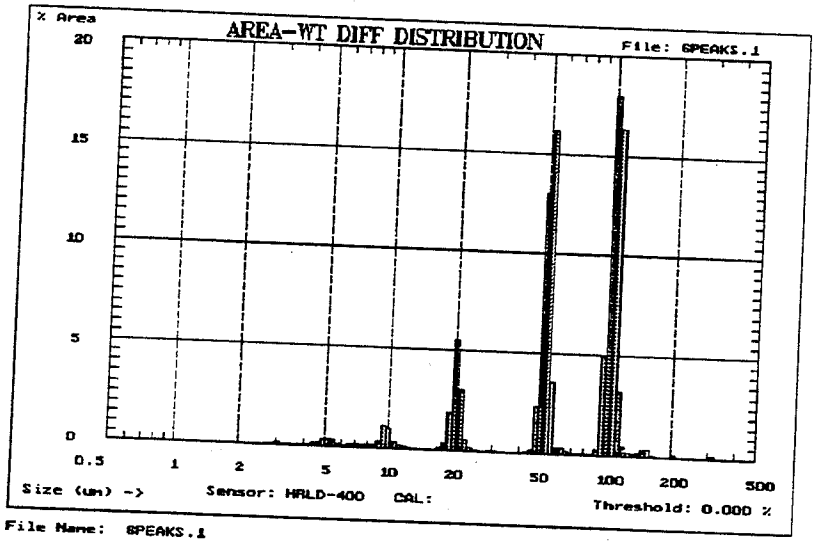
In the **Area-wt. Distribution** the height of each diameter bin/slice is expressed as a percentage of the total surface area of all the particles counted. The surface area of a spherical particle is proportional to the **square** of its diameter. The **Area %** value for each bin is equal to the number of particles counted in that bin (obtained from the **Population Distribution**), multiplied by the square of the diameter for that bin, divided by the sum of all such products for the entire distribution. An example is shown below:

PARTICLE SIZING SYSTEMS
Santa Barbara, California

Model 770 AccuSizer

Six latex standards: 3.00, 5.01, 9.87, 20.5, 50.2 and 100 microns
File Name = 6PEAKS.1 Time Date = 07:09 6/21/1990
Sensor Model: HRLD-400 S/N: 9110-009 Cal. File:

Elapsed Time of Data Collection (min:sec) = 0:30
Background File = NONE
Actual No. of Particles Sized = 215895
Approximate Total No. of Particles in Sample = 586522
Dilution Factor (approx.) = 2.717
Total Fluid Volume Sampled = 30.1 ml
Number of Diameter Channels = 128
Num. Wt. Mean = 11.55 um Vol. Wt. Mean = 94.51 um (0.000 % Threshold)



File Name: 6PEAKS.1

Printout 3: Area-wt. Differential Distribution

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[F6]: Display Distributions

For each of the **differential** and **cumulative distributions** there are several single-key commands at the bottom of each display. Following is a summary for using these keys:

[B]/[L]: Bar/Line will toggle between the two modes of display distributions.

[B]: will select the "bar" form of display, in which the PSD is shown as a bar-graph, or histogram.

[L]: will select the "line" form of display, in the which the PSD is shown as a line-graph, without the individual bars.

[M]: Mean will isolate a peak in a distribution, in order to determine its **mean diameter** and **peak diameter**. The following commands will display once this option is selected:

[F1]/[F2]: Inc/Dec Cursor Speed

The **F1** and **F2** keys will increase or decrease, respectively, the speed of the cursor movement. For each location of the cursor, the Y-axis value and X-axis value (diameter in microns) are displayed at the bottom right-hand corner of the screen. The Y-axis value depends on the type of differential distribution chosen; it will be expressed as one of the following:

Total No.	(Population Distribution)
% Number	(Number-wt Distribution)
% Area	(Area-wt Distribution)
% Volume	(Volume-wt Distribution)

[LEFT]/[RIGHT]: Move cursor

The **LEFT** and **RIGHT ARROW** keys will move the cursor from one end of the distribution to the other, along the tops of the histogram bars.

[ENTER]: Select starting point

The **ENTER** key is used to select a starting and ending point to isolate a part of the distribution.

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[F6]: Display Distributions

[F]: File will display a list of all of the data files which have previously been created in the same drive and subdirectory allowing overlays of data files.

a. Press the **UP** and **DOWN ARROW** keys or the **PAGE UP** and **PAGE DOWN** keys to select any data file on the list.

b. Press **ENTER** to select the desired data file and to display the corresponding distribution on the screen. The selected distribution will overlay on the existing one, using a different color. In general, it is advisable to switch the display from the **bar**-graph mode to the **line**-graph mode, using **[L]: Line**. In this way, the first distribution will not be hidden by the second.

Additional distributions corresponding to other data files can be accessed using this option. Each distribution curve on the screen can be identified by matching its color with that of the data **filename** displayed at the bottom of the screen. A maximum of eight data files can be overlaid.

c. Press **ESC** to return to the **Differential Distribution** menu.

If one of the following keys: **F4**, **F5**, **F6** or **F7** is pressed, the appropriately-weighted distribution will display, with the overlapping distributions.

If, the **ESC** key is pressed while in the **Differential Distribution** menu, the display will revert to the main **DISPLAY DISTRIBUTIONS** menu.

Press **F5** to display the list of data files.

Press **ENTER** to select one of these files. Only the distribution corresponding to that file will display (i.e. the additional overlapping files which were selected by key **F** will have disappeared).

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[F6]: Display Distributions

Check Printer

Printouts displaying a **Distribution Plot**, **Channels** and **Summary** for representative data file are shown in that order on the following pages.

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