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CI-500 *Innovation*
LASER PARTICLE COUNTER
OPERATIONS MANUAL
1.0 CFM

REVISION 4.20 - January 1999
4.21 – May 1999
4.22 – March 2002

CI-500, Innovation
ADDENDUM
24 June 2003

This Addendum to the CI-500, Innovation user's manual is to clarify some of the details of using the Serial Port of the CI-500, Innovation.

On page 4-1 of this manual, in section 4.1.1, the text suggests that it is possible to send multiple commands at once, terminated by a carriage return character. Some users ignore the next part of that paragraph, which states that a ***10-character receive buffer*** limits the length of command strings. Ignoring this fact can lead to problems with Remote Control programs.

If you intend to implement a program to control your particle counter via the Serial Port, you should observe the following rules:

1. DO NOT send more than a single command at a time, terminated by a carriage return.

2. DO compare the characters echoed by the particle counter with the command you sent to be sure that no mistakes were made.

Observing these rules will make your control program as reliable as it is possible to make it.

ADDENDUM TO CI-500 MANUAL

02/14/01

This unit, along with all CI-500 models using firmware version 4.43 or higher, has been updated by three additional alarm settings in software: 6, 60, and 570.

NOTICE

To insure proper performance the CI-500 Innovation should be operated in a well ventilated area.

CAUTION

THE POWER CORD SUPPLIED WITH THIS UNIT IS THE MAINS DISCONNECT FOR THE AC POWER AND MUST BE ACCESSIBLE IF THE UNIT IS GOING TO BE MOUNTED IN A PERMANENT LOCATION.

THIS IS A CLASS 1 LASER DEVICE AS SHIPPED FROM THE FACTORY. NO LASER RADIATION FROM THE LASER DIODE IS ACCESSIBLE BY THE USER.

USE OF CONTROLS OR ADJUSTMENTS OF PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.[1]

[1] Federal Register 21 CFR 1040.10 h iv

FEDERAL STANDARD 209E AND INTERNATIONAL STANDARDS ORGANIZATION 14644-1 CALCULATIONS

This particle counter has the ability to calculate the Federal Standard 209E and International Standards Organization (ISO) 14644-1 calculations for clean room cleanliness certifications. These calculations will produce a PASS or FAIL result based on the particle counts at each location and the number of sample locations.

However, there are limitations to these calculations. The particle counters do not know what the minimum sampled volume of air at each location should be for a particular room nor do they know the minimum number of locations that have to be sampled in a particular room. These parameters can be found in the Federal Standard 209E and ISO 14644-1 documents.

It is up to the user to determine, from the applicable Federal Standard 209E and ISO 14644-1 specifications the appropriate parameters. These parameters involve both the minimum sample volume per location and the minimum number of locations which need to be sampled to meet the requirements of these specifications for each area to be certified.

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SECTION I INTRODUCTION

1.1 DESCRIPTION

The Climet Instruments CI-500 is a laser diode based aerosol particle counter. It is a fully self contained, battery powered 1 CFM (cubic foot per minute sample flow rate) instrument in a stainless steel enclosure. The built-in battery provides approximately 3 hours of continuous operation on a single charge. The particles are sized and counted in six channels: 0.3, 0.5, 1, 5, 10 and 25 microns. Other standard built-in features include a HEPA filtered pump, backlit LCD display, thermal printer and a relative humidity and temperature sensor.

Counts may be displayed and printed in a variety of formats including Total Count, Differential Count, Concentration per Cubic Foot, Concentration per Cubic Meter and Distribution Histograms. Alarm settings are available for each channel including a Beep On Count setting useful in filter scanning applications. Alarms may also be assigned to the Temperature, Relative Humidity and Flow Rate. Up to 500 samples may be stored in the internal memory. All samples are date and time stamped. Each sample may also be assigned one of 100 user entered identification labels. Once data is taken, the user can view or print a variety of reports such as Alarm Violations, Averages and Federal Standard 209E clean room classification.

A variety of choices are provided for sample volumes. Delays are programmable that enable the user to set the CI-500 for a distinct initial delay independent of subsequent delays between samples. This feature gives the operator extra time to clear the area before the particle counter begins sampling. Other sample settings program the CI-500 to take a certain number of samples then stop or take samples once every given time period. The pump is turned off during long delays to conserve battery power.

Operation is made uncomplicated through the use of a 5 button "soft" keyboard in conjunction with a simple menu system. This system provides the user with the ability to utilize the many features of the CI-500 without being overwhelmed by choices. Once all of the settings are determined, they may be saved under a program name determined by the user. Up to 3 groups of settings may be saved, each under its own program name.

The particle sensor (patent pending) operates on the light scattering principle utilizing an elliptical mirror collection system and a 50 mw solid state laser diode. The scattered light is detected by a solid state photo detector. The highly efficient optical system and detection electronics provide the means for this instrument to correctly size and count 0.300 μm particles based on NIST traceable standards.

The CI-500 has been designed to provide rugged long term performance. The laser diode light source is controlled with a closed loop drive circuit to maintain a constant intensity over time and temperature variations. The status of of the laser power is monitored and displayed as "OK" or "LOW" on the main menu. If the laser power falls below 84% a "LOW" status is displayed and particle counting is stopped. The rugged laser diode light source along with the stability of the optics and detection electronics provides for overall consistent performance. In normal use, the CI-500 requires routine calibration only once every 12 months.

1.2 SPECIFICATIONS

Illumination Source:	Laser Diode, 50 mW
Optics:	Elliptical Mirror
Detection:	Silicon Photo Diode
Size Sensitivity:	0.300 micron
Particle Channel Sizes (6)	0.3, 0.5, 1.0, 5.0, 10.0, 25.0 micron
Size Resolution:	.03 micron @ 0.33µm
Concentration Limit:	1,000,000 Particles/ft^3
Sample Flow Rate:	1.0 Cubic Feet per Minute (28.3 Liters per Minute)
Flow Rate Control:	Electronic, Closed Loop
Sample Tube Extension (Optional)	3/8" (9.53 mm) I.D. x 40' (12.2 meters) max.
Signal/Noise ratio:	2:1 absolute peak
Zero count:	0 as per ASTM F-50
Temperature and Humidity probe:	Temperature Range = 23-123°F or 0-50°C Temperature Accuracy = ± 0.4°C Humidity range = 10 - 90% Humidity Accuracy = ± 2%
Battery	12 Volt, 7.0 Amp Hour Sealed / Maintenance Free Rechargeable Lead Acid
Operation time on Fully Charged Battery:	3.0 Hours Continuous Operation
Time to Charge Battery:	3.5 Hours
Display:	CFL Backlit Graphic 240 x 128 LCD
Printer	Thermal Dot Matrix
Memory:	500 Samples: Date, Time, 6 Particle Channels, RH, Temperature, Flow, ID, Sample Volume
Input/Output:	RS-232, RS-485
Sample Volume:	0.1, 0.2, 0.7, 1.0, 2.0, 7.0, 10.0 Cubic Feet, 0.01, 0.02, 0.1, 0.2 and 1.0 Cubic Meter

1.2 SPECIFICATIONS (cont.)

Sample Delays:	Initial: 1 sec, 5 sec, 1 min., 5 min. End to Start: 0, 1 sec, 15 sec. Start to Start: 5 min., 15 min., 30 min. 60 min.
Beep on Count	Selectable for 0.3 µm and greater.
Audible Alarm	Built-in
Alarm Limits:	Programmable for all particle channels, Temperature, Humidity and Flow.
Dimensions: (H x W x D)	13.75 x 8 x 7.75 inches 34.9 x 20.3 x 19.7 cm
Weight:	23.5 lb., 10.7 Kg.
Power (AC):	100, 115, 230 VAC ±10% 50/60 Hz (Factory set)
Fuses (AC):	115 VAC, one 5 x 20 mm, T 250V/1.0A 230 VAC, two 5 x 20 mm T 250V/0.5A
Fuse (DC)	10A 6.3 x 32 mm
Operating Temperature:	32 - 100°F
Storage Temperature:	32 - 155°F
Operating Humidity:	10 - 90%, non-condensing
Line Noise Rejection:	± 400V transverse impulse ± 200V common mode impulse
Calibration:	Factory Prime Calibration with monodisperse polystyrene latex spheres traceable to NIST
Calibration Frequency:	Recommended every 12 months.
Gas Compatibility:	Consult Factory

SECTION II UNPACKING, SAFETY, AND POWER REQUIREMENTS

2.1 UNPACKING

The CI-500 is packed in a specially designed shipping container which has been tested to withstand normal amounts of shock and vibration in accordance with the National Safe Transit Association (NSTA). After inspection should the CI-500 or any of the accessories be damaged, file a claim with the shipping company and contact Climet Instruments.

2.2 SAFETY

The operator or maintenance person should not remove any of the covers on the CLiMET Particle Counter except in accordance with the procedures herein. Unauthorized disassembly can result in exposure to laser light.

The CI-500 contains a 12 Volt, 7.0 Amp Hour maintenance free rechargeable sealed lead acid battery which is replaceable by the user. When replacing the battery, care should be taken to prevent the battery terminals from being shorted together by any metal or tools.

CAUTION

"Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure."[1]

[1] Federal Register 21 CFR 1040.10 h iv

The CI-500 comes with a three prong grounded AC power cord. Failure to make a proper earth ground connection may result in a shock hazard or may damage the instrument. When using a two to three prong adapter, ensure to make a proper ground connection.

2.3 POWER REQUIREMENTS

The CI-500 is factory set for 115 VAC, 230 VAC or 100 VAC ±10% operation. A label located on the rear panel states the line voltage requirement for each specific unit.

2.4 PACKAGING FOR SHIPMENT

The packing container used for shipping the CI-500 has been tested according to the standards of the National Safe Transit Association. For this reason it is recommended that the original packing container be saved for reuse if it has no obvious damage. The packing container consists of an outer double walled cardboard box, two foam inserts and an internal cardboard box used to hold accessories. This internal box also serves the important function of tightening the inserts against the CI-500. If for any reason the internal box cannot be used, there are score lines along the edge of the outer box that allow the flaps to be folded even with the inserts, thereby tightening them against the CI-500.

SECTION III OPERATION

3.1 OVERVIEW

Front, rear and side views of the CI-500 are shown in Figure 3.1, 3.2 and 3.3 respectively. On the front view, the inlet tube, protective cap plug, LCD display, membrane keypad, battery charge indicators and printer may by seen. The AC receptacle and RS-232 and RS-485 connectors are located on the rear panel. The relative and humidity sensor vent is located in the left side.

3.1.1 Sample Inlet

The inlet, located at the top of the unit, may sample air directly or have a sample tube extension and isokinetic probe attached. An aerosol filter (optional) may be attached to the inlet for periodic testing of zero count performance. Air that is drawn into the inlet passes through the sensor and pump, continuing through a HEPA filter before being exhausted inside the enclosure. There is no manual flow rate adjustment provided since the pump speed is automatically adjusted electronically to maintain a constant 1 CFM flow rate.

Note: The protective cap plug on the inlet is supplied by the factory for protection during shipment. This should be removed before operation.

3.1.2 Relative Humidity and Temperature Sensor

Relative humidity and temperature are measured by a sensor located on the left side of the instrument behind a perforated plug. A small fan draws outside air in over the RH and temperature sensor and also exhausts the HEPA filtered sample air out through the bottom of the unit.

3.1.3 Battery Charger

When AC power is applied to the CI-500, the CHARGER ON indicator will light. Additionally either the CHARGING or READY indicator will light. When the battery is fully charged, READY will be indicated. If the battery is not yet fully charged, the CHARGING indicator will be lit. If the unit is turned on with AC power applied, the unit will usually indicate CHARGING even if the battery is fully charged.

3.1.4 Power Button

Pressing the POWER button will turn the CI-500 on and off. When the unit is turned on, the LCD display will light up and the main screen will appear. The VIEW ADJUST buttons may be used to give the screen its best contrast.

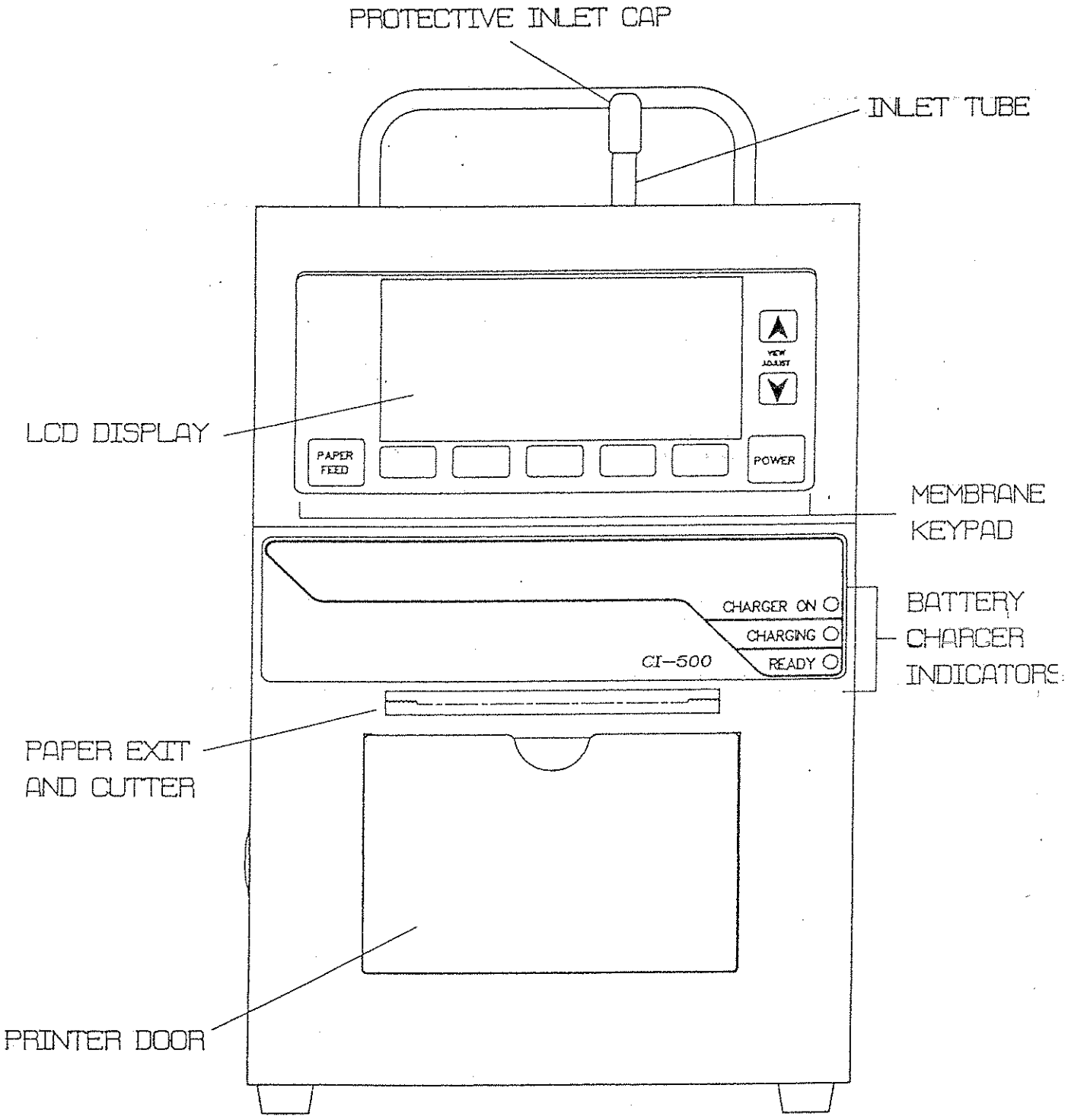


FIG. 3-1. CI-500 FRONT VIEW

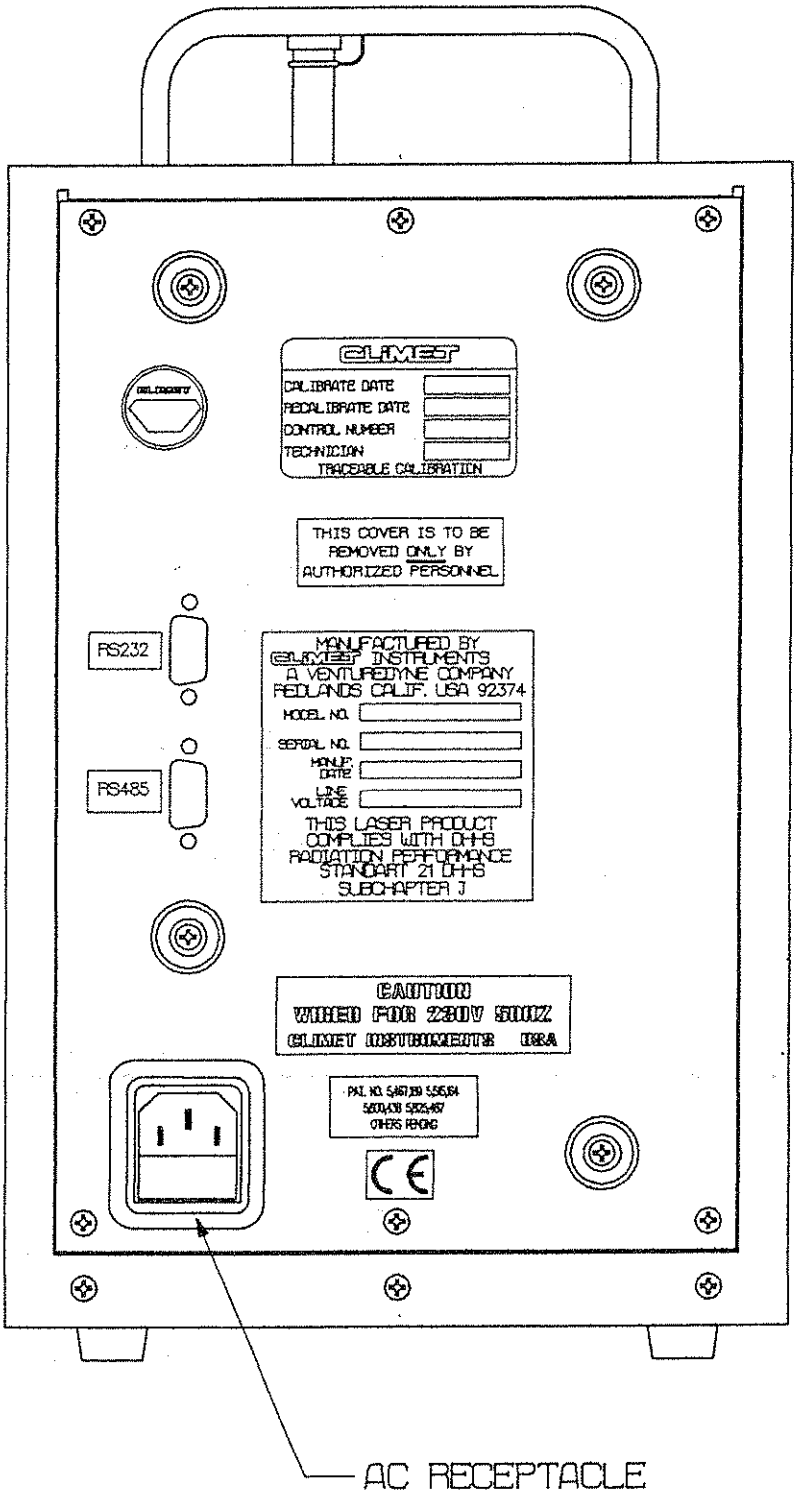


FIG. 3-2. CI-500 REAR VIEW

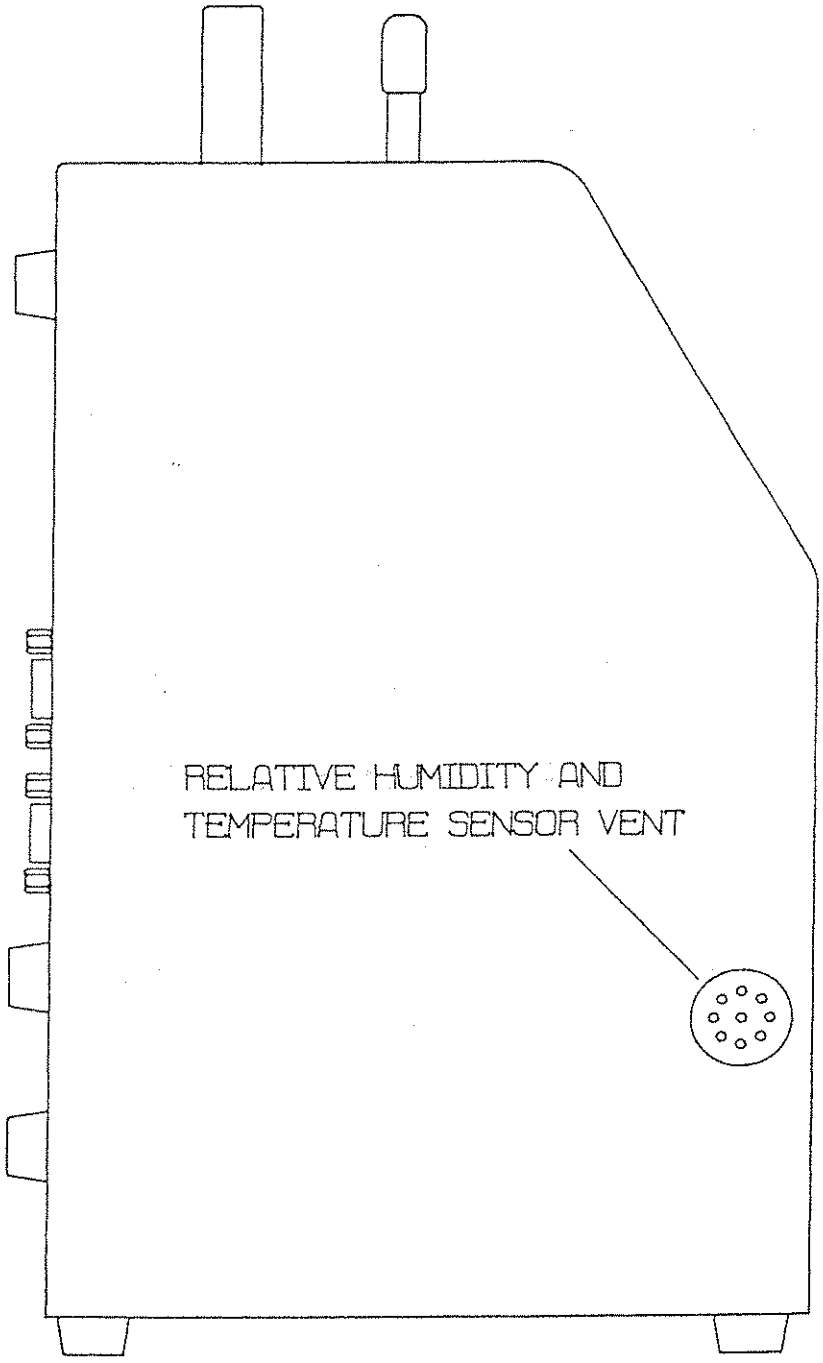


FIG. 3-3. CI-500 SIDE VIEW

3.1.5 Main Screen and Menu System

The main screen of the CI-500 that appears upon power up will display data for the 6 particle channels, and other operational information depending on the display mode. Five (5) menu choices will also be displayed across the bottom of the display above a row of keys . As these keys are depressed, a particular function occurs depending on the selection. Certain selections will cause another set of choices to be presented to the user . This "menu system" presents the user with only those choices relevant to the previous selection, thereby simplifying operation. The menu tree of the CI-500 is shown in Figure 3-8.

Experimenting with the display mode is a good way for the user to become familiar with the use of the menu system and to view the results of various display mode choices. Press DSPLY to display the DISPLAY MODE menu screen.

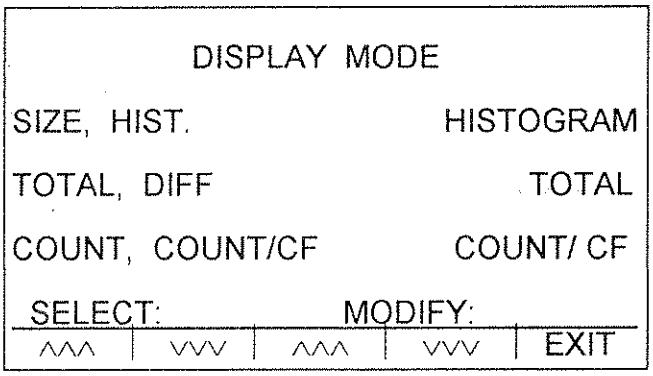


FIG. 3-4. DISPLAY MODE MENU SCREEN

Use the SELECT arrow keys to highlight the setting to be modified. Then, use the MODIFY arrow keys to change it.

Examples of the various main display screens are shown in Figures 3-5 through 3-7.

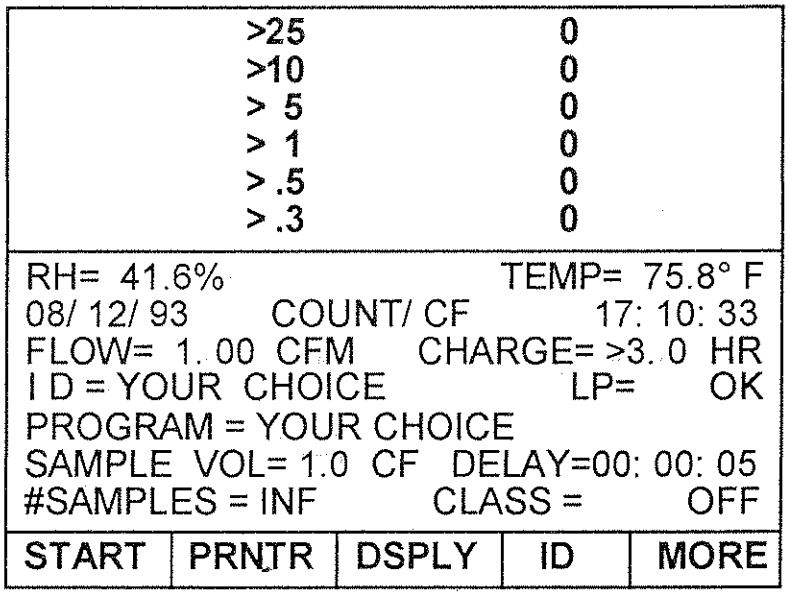


FIG. 3-5. CI-500 MAIN SCREEN (SMALL)

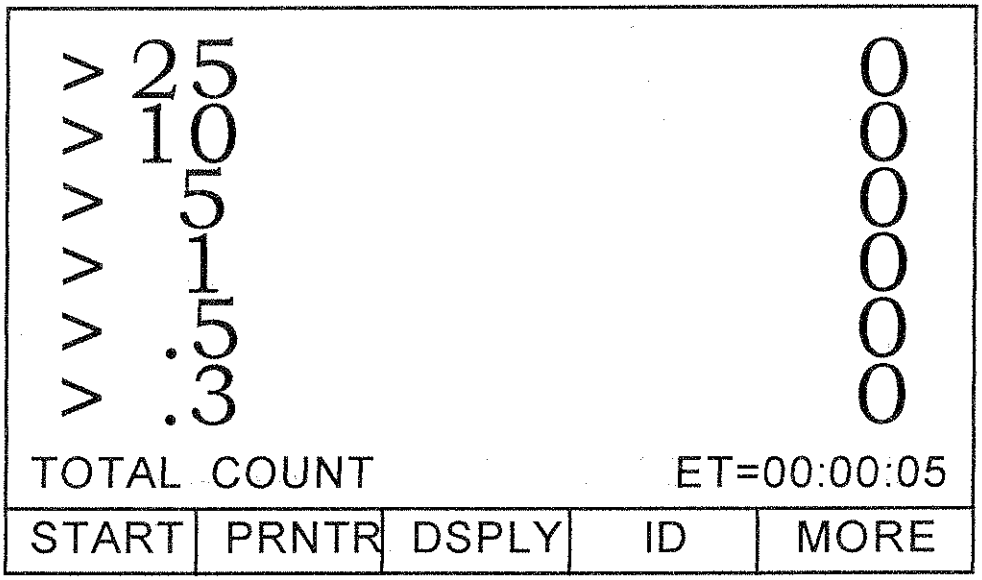


FIG. 3-6. CI-500 MAIN SCREEN (LARGE)

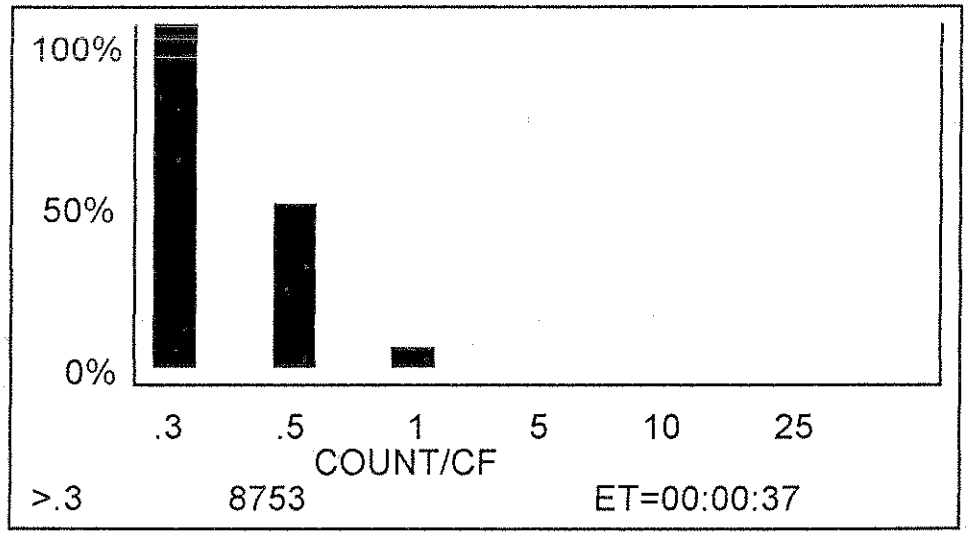


FIG. 3-7. CI-500 MAIN SCREEN (HISTOGRAM)

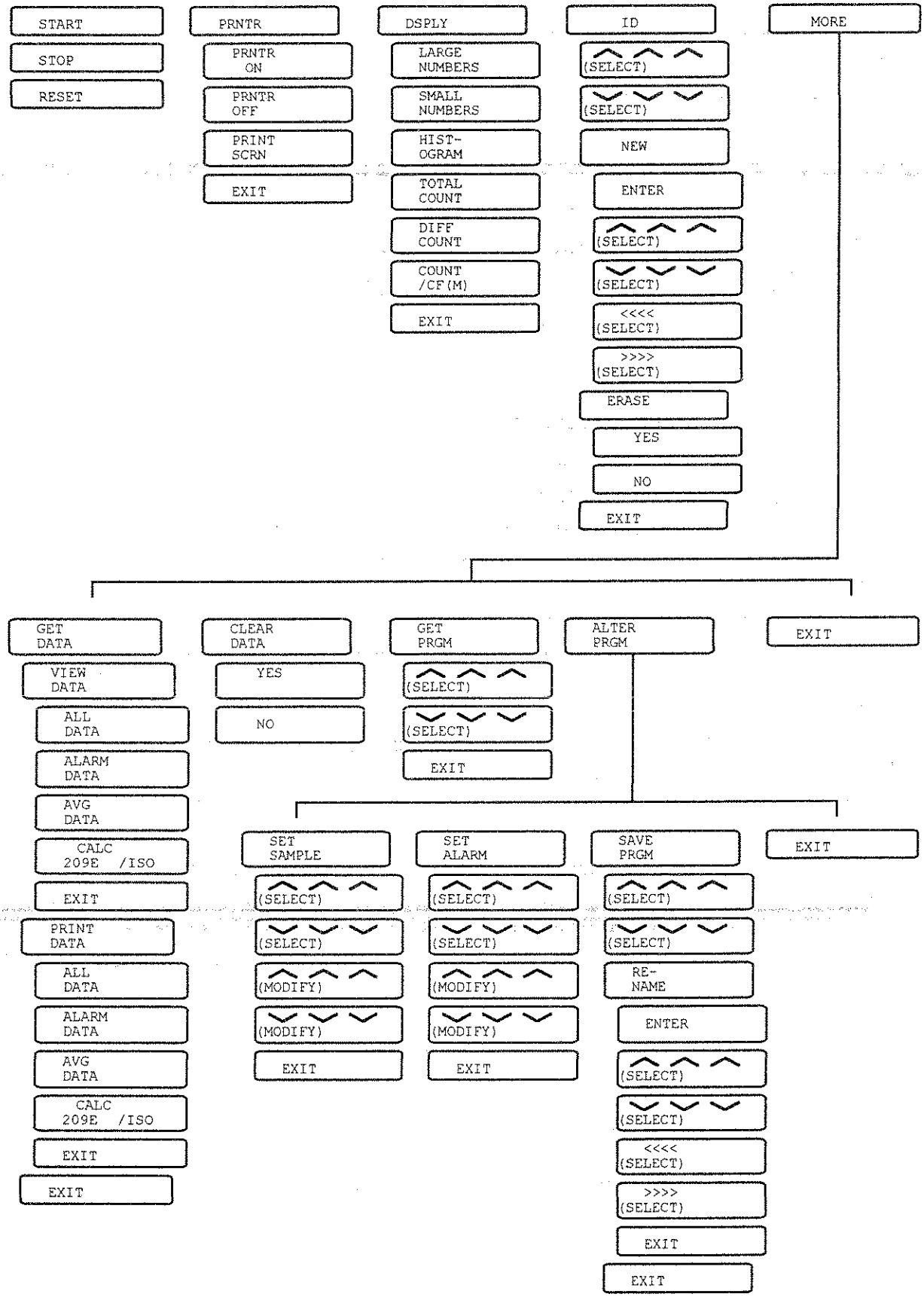


FIG. 3-8. CI-500 MENU SYSTEM

3.1.6 Loading Paper

To load the printer paper see Figure 3-9. With the unit turned on, open the printer door and push the edge of the paper through the slot below the printer while pressing PAPER FEED. The rotating printer roller will grab the paper and feed it through the slot below the paper cutter. Once the paper is through, straighten it if necessary and close the door.

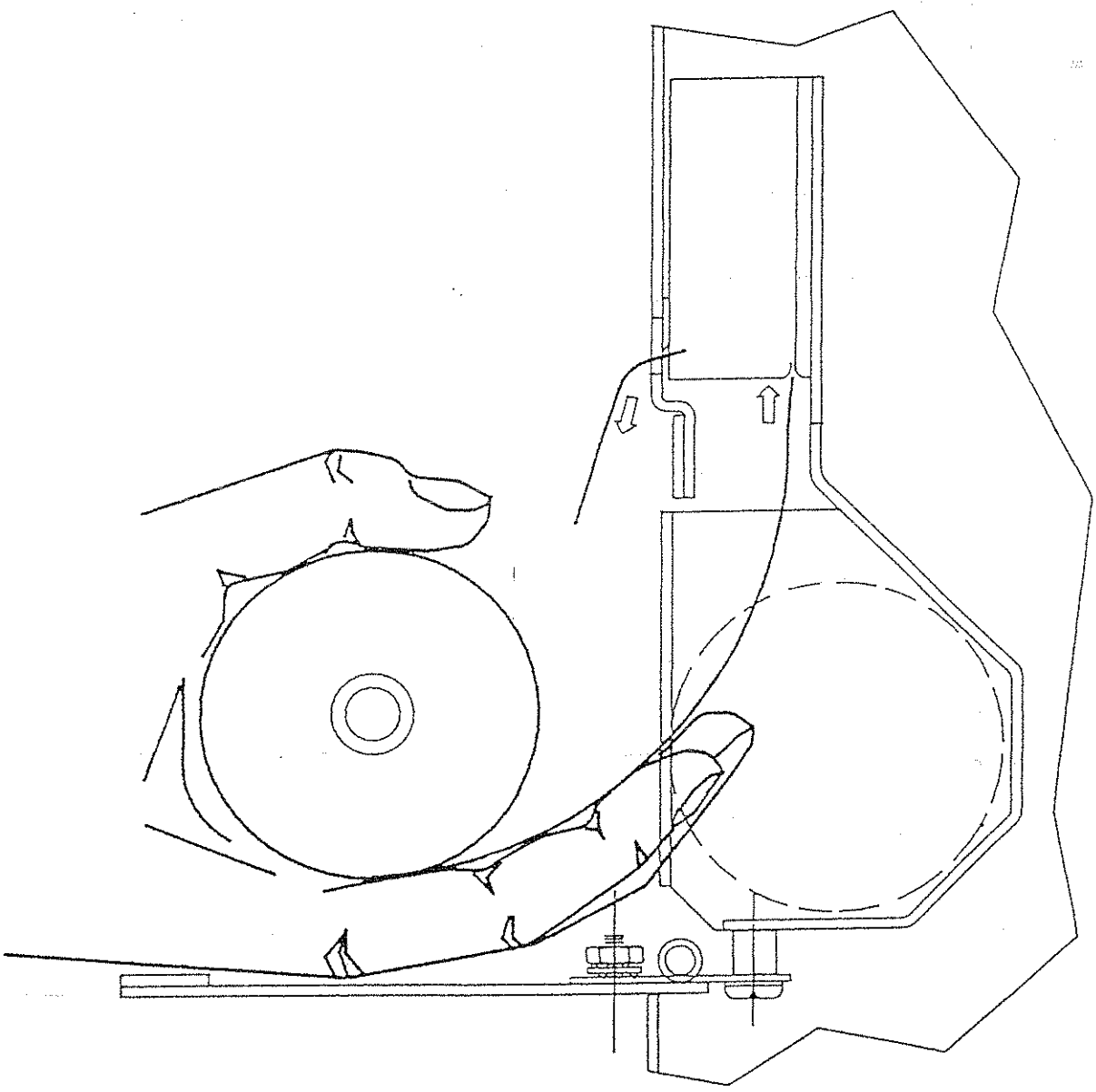


FIG. 3-9. LOADING PAPER

3.2 SETTING UP THE CI-500

3.2.1 Setting Sample Parameters

After the sample parameters are set, the menu choices presented on the main screen are all that are required to collect particle count data with the CI-500. However to get started, it is first necessary to set the sample parameters of the CI-500. To do this press the MORE button from the main display. Then ALTER PRGM followed by SET SAMPL. A display similar to Figure 3.10 will appear.

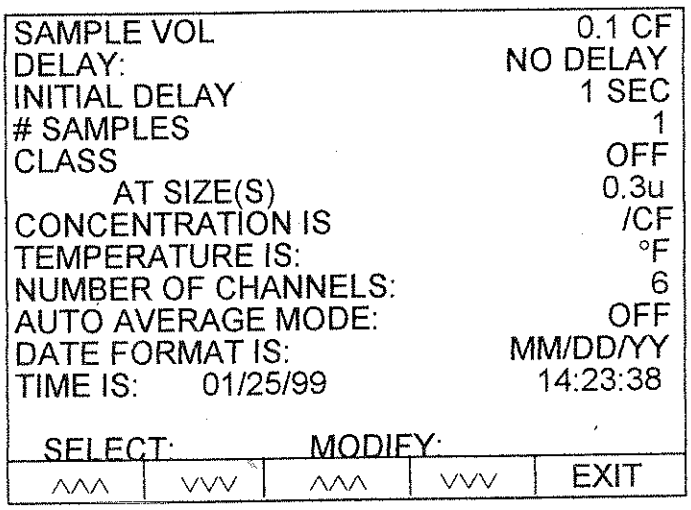


FIG. 3-10. SET SAMPLE SCREEN

Use the SELECT arrow keys to highlight the setting to be modified. Then, use the MODIFY arrow keys to change it.

SAMPLE VOL: This determines how much volume will be sampled. The choices are in cubic feet (CF) or cubic meters (CM).

DELAY: This determines how much time will elapse between samples. Choices allow short delays to occur between the end of a sample and the beginning of the next or longer delays between the start of a sample and the start of the next.

INITIAL DELAY: This sets an initial delay that occurs only after the START button is pressed. The initial delay can allow the user time to get out of the area before the unit begins to sample.

SAMPLES: This can program the unit to take a given number of samples after the START button is pressed, then stop. The INF setting (infinite) will cause to unit to continuously take sample after sample.

CLASS: If the user intends to have the CI-500 classify a clean room according to Federal Standard 209E or ISO 14644-1 it will be necessary to select the target class and AT SIZE to be used. This can be done before or after data has been collected. ***Note: The 'Auto Average Mode' feature must be turned off in order for this feature to work correctly.***

AT SIZE(S): If the user intends to have the CI-500 classify a clean room according to Federal Standard 209E or ISO 14644-1 it will be necessary to select the target class size. Optional sizes are 0.3µM, 0.5µM, 1.0µM and 5.0µM These sizes can be selected before or after data has been collected. ***Note: The 'Auto Average Mode' feature must be turned off in order for this feature to work correctly.***

CONCENTRATION IS: This selection determines if concentrations will be presented per cubic foot (/CF) or per cubic meter (/CM). This selection can be changed at any time. The data in memory will be displayed in the appropriate unit based on the concentration selected. When running ISO report calculations CONCENTRATION is automatically set to /CM. CONCENTRATION is automatically returned to its' previous state at the end of the ISO calculation.

TEMPERATURE IS: Select either °C, °F or OFF. The calculation is done by software and requires no additional adjustment. To disable the RH and Temperature readout select OFF.

NUMBER OF CHANNELS: If "6" is selected the operation is normal. If "2" is selected, the display and printouts will show only the counts for >0.5µM and >5.0µM. Histograms and Differential Counts do not operate in the two channel mode.

AUTO AVERAGE MODE: Select either OFF, STOP AFTER #, or CONTINUOUS. If OFF is selected the auto average mode is inactive. The STOP AFTER # option stops sampling after the entered # SAMPLES and then prints the average counts. The CONTINUOUS mode will print the average particle count after the # of SAMPLES have been collected but does not stop the sampling process. Auto averaging is started by pressing START, ***this will clear all of the data stored in memory***, followed by any INITIAL DELAY then counting will begin. The average particle counts will be printed on the printer regardless if the printer is turned on or not.

DATE FORMAT IS: The choices are month / day / year (MM/DD/YY) or day / month / year (DD/MM/YY). This can be changed at any time without adversely affecting data stored in memory.

TIME IS: The highlight bar steps six times through this field allowing the date and time to be set. When a field is highlighted, use the MODIFY keys to change it. If date or time are changed, use SELECT to increment completely through the date and time fields before pressing EXIT otherwise the changes will not be made to the clock.

EXIT: When all of the selections have been made, press EXIT to exit this screen.

3.2.2 Setting Alarms

To set alarms one must enter the SET ALARM screen. If the user has just exited the SET SAMPL screen, the choice for SET ALARM is showing on the menu screen. Otherwise, from the main screen press MORE ALTER PRGM SET ALARM.

Setting alarms is done in the same manner as setting sample parameters by using the SELECT and MODIFY arrow keys. The OFF choice is scattered among the numeric values for alarm levels. Pass through the OFF choice as many times as necessary to reach the alarm level desired. An alarm violation will occur if the particle count is greater than or equal to the alarm level set. Low alarms are provided for the RH and temperature channels. Low alarms will occur if the temperature or humidity is less than or equal to the alarm level.

The alarm choices for FLOW are ±5% and ±10%. These will sound the alarm if the flow rate varies more that these percentages from 1 CFM. If a flow alarm is set, the INITIAL DELAY must be set to at least 5 seconds to allow the flow rate **reading** to stabilize before sampling begins.

3.2.3 Saving a Program

Saving a program allows a group of sample and alarm settings to be retrieved at a later time. Up to three programs may be saved, each with its own unique name.

If the user has just exited the SET SAMPL or SET ALARM screen, the choice for SAVE PRGM is showing on the menu screen. Otherwise press MORE, ALTER PRGM, SAVE PRGM.

After pressing SAVE PRGM, three choices for program names appear. At this point the user may use the arrow keys to highlight one of them. If one of the program names is highlighted when EXIT is pressed, the current sample and alarm settings will be saved under that program name. If NONE is highlighted when EXIT is pressed, no programs are changed.

Pressing RE-NAME on this menu will allow the user to enter a 16 character program name of their own. Pressing the arrow keys will highlight a particular letter, number or symbol to build the name. The BACK choice works like a backspace key to erase the previous entry. The SPACE choice works like a space bar. Notice that there is no EXIT on the bottom line. To exit this menu, use the arrow keys to highlight EXIT then press ENTER.

Entering this screen from the previous screen with NONE highlighted will prevent any of the three program names from being affected. However, if the user enters this screen, with one of the existing program names highlighted, they are committed. When the RE-NAME screen is exited, the program name will be changed to whatever is appearing on the NAME= line even if it is blank.

3.2.4 Selecting a Sample I.D.

From the main screen press ID. A screen similar to Figure 3-11 will appear with a selection of ID's from a list entered previously. If no ID's have been previously entered, only one line "BLANK (NO ID)" will be displayed.

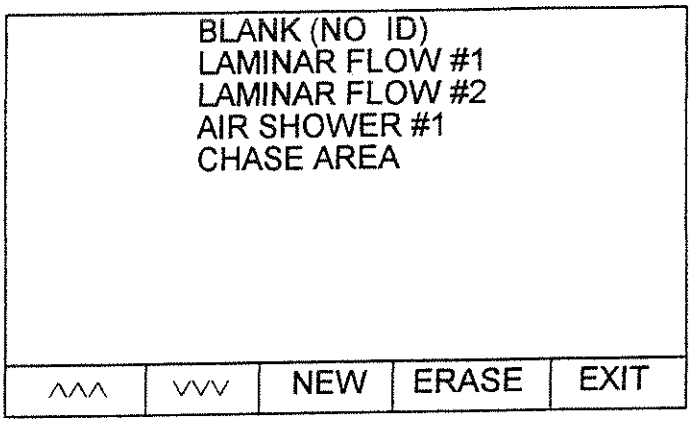


FIG. 3-11. ID SELECTION SCREEN

Use the arrow keys to highlight one of the ID's. When EXIT is pressed, the highlighted ID will become selected and will appear on the main screen after ID=.

3.2.5 Entering and Erasing ID's

To enter a new ID, press NEW from the ID selection screen. Another screen will appear that can be used to enter a new 16 character ID. Pressing the arrow keys will highlight a particular letter, number or symbol to build the name. The BACK choice works like a backspace key to erase the previous entry. The SPACE choice works like a space bar. Notice that there is no EXIT on the bottom line. To exit this menu, use the arrow keys to highlight EXIT then press ENTER.

If a list already exists, the new ID will be inserted just below the ID that was highlighted when NEW was pressed **unless** sample data is stored in memory. **If** sample data is stored in memory, the new ID will be inserted at the end of the list. If NEW is pressed and the user decides to immediately exit without entering any characters, no change will occur to the existing list.

To erase an ID simply highlight it and press ERASE. Another screen will appear to confirm that the selected ID is really to be erased. Pressing YES or NO at this point will carry out the appropriate action. **ID's cannot be erased** if there is stored data in memory.

3.2.6 Selecting a Display Format

The CI-500 allows several choices for display formats. To select one press DSPLY from the main display. The following display choices will appear.

TOTAL COUNT:	Counts represent the number of particles detected having a size greater than or equal to the given size for that channel.
DIFF COUNT:	Counts represent the number of particles detected having a size greater than or equal to the given size channel and less than the next size channel.
COUNT /CF or /CM	Counts represent the concentration of particles per cubic foot (CF) or cubic meter (CM). This number is mathematically calculated based on the counts accumulated while the sample is in progress as if that concentration was uniform for one cubic foot or cubic meter.
HISTOGRAM	Displays a histogram of the particle distribution of the sample in progress. The vertical scale displays each channel as a percentage of counts greater than or equal to 0.3 µm.

3.2.7 Printing Data at the End of the Sample

The user can select to print data at the end of each sample or not. Regardless of this selection, data will be stored in the internal 500 run sample memory. To make this selection, press PRNTR from the main display. Another set of choices will appear. Pressing PRNTR ON or PRNTR OFF will enable or disable printing of data at the end of each sample.

Pressing PRINT SCRN will immediately cause the display on the main screen to be printed. Using this feature is a convenient way to get a quick printout of the current data.

3.3 TAKING DATA WITH THE CI-500

3.3.1 Selecting a sample program

Before taking data with the CI-500, the user should select one of the sample programs that were saved previously or verify that the current settings satisfy their needs. (See Section 3.2.) To select a previously saved program, press MORE then GET PRGM. Use the arrow keys to highlight the program name desired then press EXIT. Press EXIT again to get to the main screen.

3.3.2 Clearing stored data

To clear data from samples taken previously, press MORE then CLEAR DATA. The choices YES and NO are presented. Press YES then EXIT to return to the main screen.

3.3.3 Pressing START

Pressing the START key will start the pump. Counting will begin after the initial delay has elapsed. The initial delay time remaining will be shown by DELAY= on the main

screen. When the delay time has decremented down to zero, the CI-500 will begin to count particles. At this time, the DELAY= field on the display will be replaced by ET=. ET will indicate the elapsed time of the sample in progress. After START is pressed, the menu legend above the left key will change from START to STOP. Pressing STOP will cause the particle counting or delay countdown in progress to stop.. When this happens, the CI-500 will beep four times and the pump will turn off in a couple of seconds. If STOP is pressed before the sample is complete, data for that sample is NOT stored in the 500 run sample memory.

When the sample volume has been completed, the data will be stored in the 500 run sample memory. At the end of the sample, the next delay begins counting down. After the next delay has decremented down to zero, counting begins for the next sample unless the programmed number of samples (# SAMPLES) has been completed. If the programmed number of samples have been completed, the CI-500 will beep four times and the pump will turn off.

3.3.4 End of Sample Printouts

If the printer is turned on, the data will be printed along with the date, time, ID count mode, and sample volume. Printing data will not affect the collection of data. Even if the printer is busy printing out previous samples, new data will continue to be collected without additional delays. Since it takes about 17 seconds for the printer to complete an end of sample printout, it is possible for the printer to fall behind when short sample volumes are selected. When this happens, the internal printer buffer will eventually fill up and some samples will not be printed. With 0.1 CF (six second) samples and a 0 second delay, this condition occurs after 19 samples. This condition does not affect the actual collection of data and all samples will continue be stored in the 500 run sample memory regardless.

3.3.5 Alarm Occurrences

If an alarm condition occurs while sampling, the CI-500 will sound its internal beeper. The alarming channel will flash and the STOP button will change to RESET. Pressing RESET will silence the beeper for the duration of the sample period. After pressing RESET, the button will revert back to STOP. Alarmed data will continue to be collected and stored in a normal fashion whether RESET is pressed or not.

3.4 VIEWING DATA WITH THE CI-500

Once data has been collected, it is possible to view the results using the reporting features of the CI-500. To get to the view data menu screen where these reports may be selected, press MORE followed by GET DATA followed by VIEW DATA.

3.4.1 Viewing All Data

From the view data menu screen, select ALL DATA. A screen similar to Figure 3.12 will appear. The first sample displayed will be the most recent one taken. Press PREV to view the previous sample. If a previous sample is displayed, pressing NEXT will display the sample that occurred next. If NEXT is pressed while the most recent sample is displayed, the next memory location will be displayed which will have no data unless the memory is full in which case the oldest data in memory will be displayed.

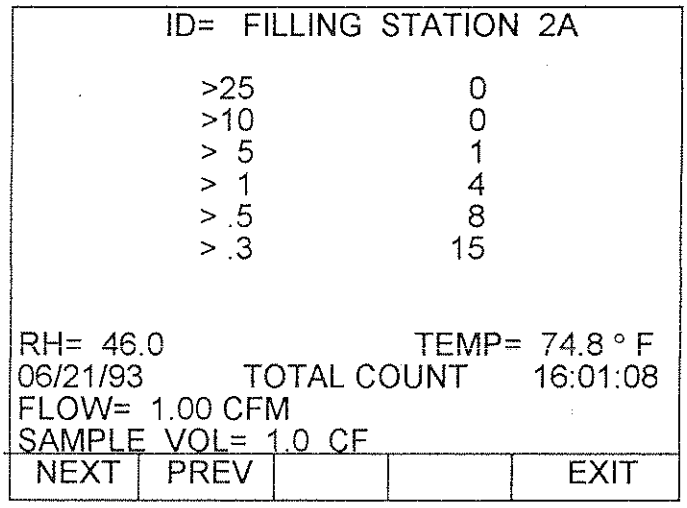


FIG. 3-12. VIEW ALL DATA SCREEN

3.4.2 Viewing Alarm Data

From the view data menu screen select ALARM DATA. A screen similar to Figure 3.13 will appear. The first sample displayed will be the most recent sample that had an alarm condition occur. Press PREV to view the previous sample that had an alarm condition occur. If a previous sample is displayed, pressing NEXT will display the sample that occurred next. If NEXT is pressed while the most recent sample is displayed, the oldest data in memory in which an alarm condition occurred will be displayed. Alarm violations are based on comparisons to the **current** alarm settings so alarm levels can be entered or changed retroactively.

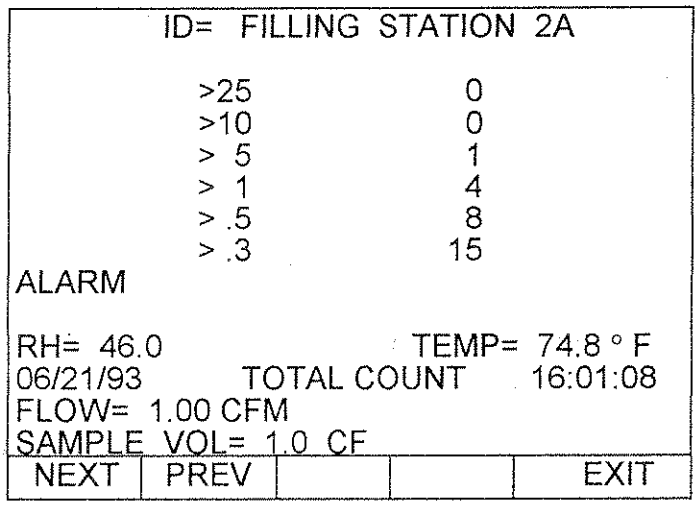


FIG. 3-13. VIEW ALARM DATA SCREEN

3.4.3 Viewing Average Data

From the view data menu screen select AVG DATA. A screen similar to Figure 3.14 will appear. The first screen displayed will show the average of the location most recently sampled based on its ID. The number of samples taken at that location will also be shown. Press PREV to view the averages at the previous location. If a previous location is displayed, pressing NEXT will display the location that was sampled next. If NEXT is pressed while the most recent location average is displayed, the average for the first location in memory will be displayed.

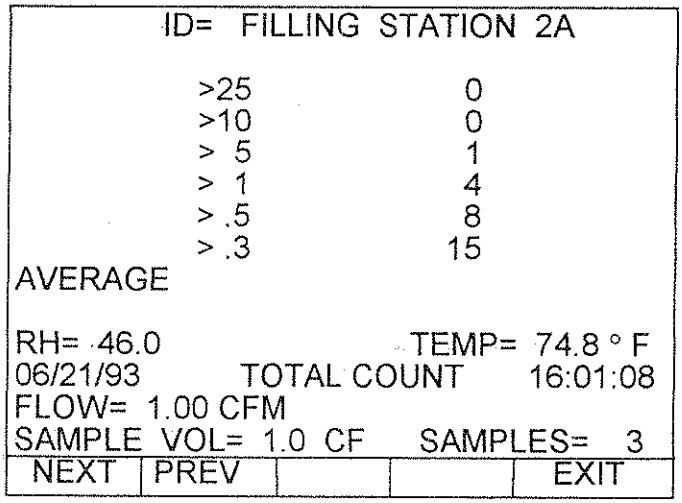


FIG. 3-14. VIEW AVERAGE DATA SCREEN

It is possible to take a group of samples at a location several times during the day, which would then cause an ID to be repeated for separate blocks of time in the 500 run sample memory. This is not a problem. Data sharing the same ID will be averaged together for this report UNLESS it is separated in time by data which is assigned a different ID. In this case, the averages will be based on each group of data collected for each ID in each separate block of time. Therefor the same ID would appear in more than one average data screen.

3.4.4 Viewing a Federal Standard 209E Report

From the view data menu screen select CALC 209E. A screen similar to Figure 3.15 will appear. The first screen displayed will show the average of the 7 locations most recently sampled. If more than 7 locations were sampled, pressing NEXT will go to the next page showing the next 7 locations. Pressing PREV from one of these pages will display the previous page.

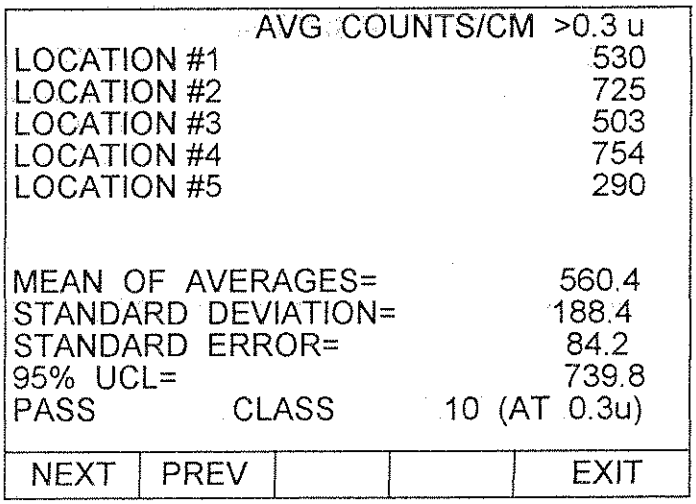


FIG. 3-15. VIEW FS-209E REPORT SCREEN

Each location in the FS-209E report must have a unique ID. The FS-209E report calculates averages based on the ID's assigned to each sample. Data sharing the same ID will be averaged together for this report EVEN IF it is separated in time by data which is assigned a different ID. In this case, the averages will be based on the ID assigned to each sample regardless of when it was collected.

All samples must share the same sample volume. If the memory contains samples taken for more than one sample volume, only those samples that match the most recent sample volume will be included in the report.

3.4.5 Viewing a ISO 14644-1 Report

From the view data menu screen select CALC ISO. A screen similar to Figure 3.16 will appear. The first screen displayed will show the average of the 7 locations most recently sampled. If more than 7 locations were sampled, pressing NEXT will go to the next page showing the next 7 locations. Pressing PREV from one of these pages will display the previous page.

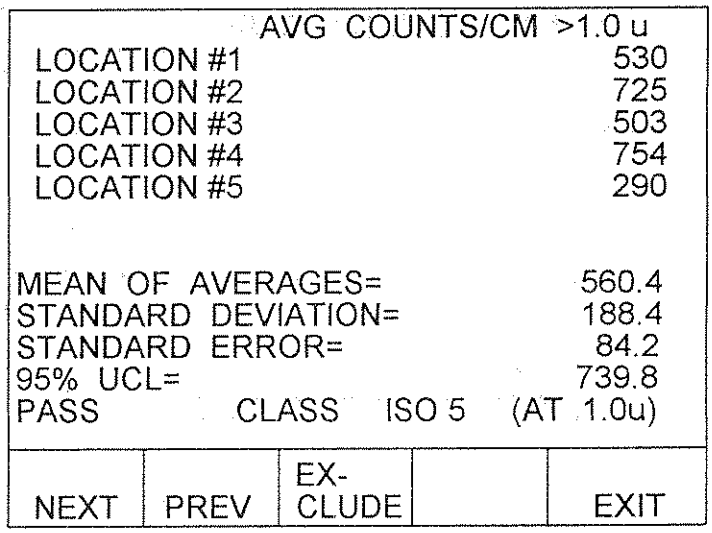


FIG. 3-16. VIEW ISO 14644-1 REPORT SCREEN

Each location in the ISO report must have a unique ID. The ISO report calculates averages based on the ID's assigned to each sample. Data sharing the same ID will be averaged together for this report EVEN IF it is separated in time by data which is assigned a different ID. In this case, the averages will be based on the ID assigned to each sample regardless of when it was collected.

All samples must share the same sample volume. If the memory contains samples taken for more than one sample volume, only those samples that match the most recent sample volume will be included in the report.

In accordance with ISO 14644-1 you may exclude one location from the calculation if there are at least four locations involved. To exclude a location, select EXCLUDE from the menu. A screen similar to Figure 3.17 appears. If there are less than four locations the EXCLUDE option is disabled.

You may use the up and down arrows to select a location from the exclude screen. Selecting EXCLUDE with the location highlighted will select it. Pressing EXIT will bring you back to the VIEW DATA screen. Select CALC ISO again to re-calculate the ISO report with the location excluded.

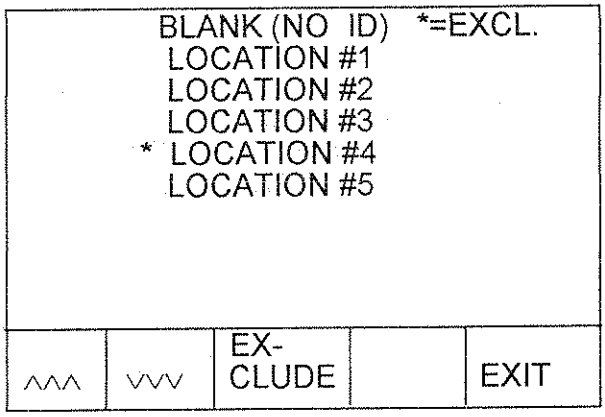


FIG. 3-17. ISO 14644-1 EXCLUDE SCREEN

The ISO calculation is performed with the marked location excluded. In the example shown in Figure 3-18 LOCATION #4 is excluded. The number of locations is reduced to four and the Mean of Averages, Standard Deviation, Standard Error, and the 95% UCL are recalculated. The PASS/FAIL results are posted below the 95% UCL.

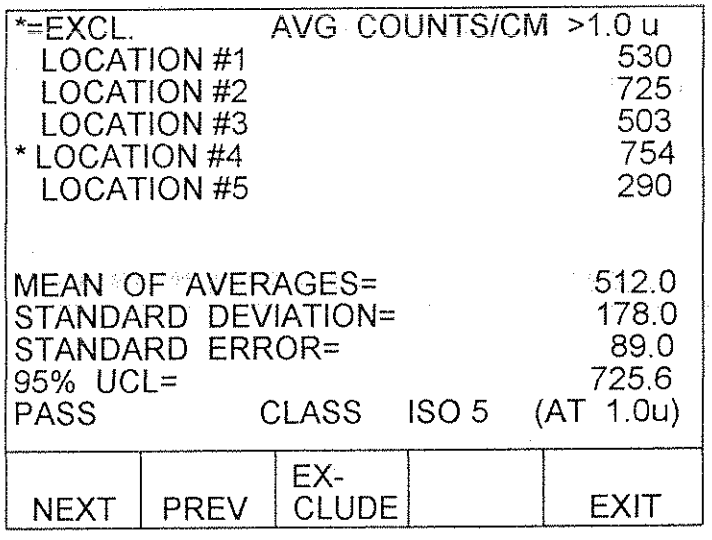


FIG. 3-18. VIEW ISO 14644-1 REPORT SCREEN

3.5 PRINTING DATA WITH THE CI-500

Once data has been collected, it is possible to print the results using the reporting features of the CI-500. To get to the print data menu screen where these reports may be selected, press MORE followed by GET DATA followed by PRINT DATA.

3.5.1 Printing All Data

From the print data menu screen select ALL DATA. The CI-500 will print a report similar to Figure 3-19. The first sample printed, will be the most recent one taken.

```
*******************************************************************************
              STORED DATA    # LOCATIONS =  2    # SAMPLES = 6
*******************************************************************************

06/22/93     ID=  WINDOWS DOWN      TOTAL COUNT    SAMPLE VOL= 0.1 CF

TIME         >0.3     >0.5     >1.0     >5.0     >10.0    >25.0     RH   TEMP  FLOW
09:00:05   118291     3101      308       30        2        0   40.8   77.9  1.00
09:00:11   118175     2935      262       18        2        0   40.8   77.8  0.99
09:00:17   118414     2888      258       22        3        0   41.2   77.8  0.99

06/22/93     ID=  SUN ROOF OPEN      TOTAL COUNT    SAMPLE VOL= 0.1 CF

TIME         >0.3     >0.5     >1.0     >5.0     >10.0    >25.0     RH   TEMP  FLOW
09:00:31   118219     2878      273       24        3        0   41.2   77.8   .99
09:00:37   118973     3143      263       20        0        0   41.2   77.8   .99
09:00:43   120375     3255      273       16        1        0   40.8   77.8  1.00
```

FIG. 3-19. ALL DATA PRINTOUT

3.5.2 Printing Alarm Violations

From the print data menu screen select ALARM DATA. The CI-500 will print a report similar to Figure 3-20. The first sample printed, will be the most recent one taken that had an alarm violation. Alarm violations are based on comparisons to the **current** alarm settings so alarm levels can be entered or changed retroactively.

```
**********************************************************************************
                ALARM DATA    # LOCATIONS =  2    # ALARMS = 2
**********************************************************************************
HIGH          >0.3    >0.5    >1.0    >5.0    >10.0    >25.0    RH   TEMP  FLOW
ALARMS=        OFF     OFF     OFF     OFF      3       OFF     OFF  OFF   OFF
LOW
ALARMS=                                                        OFF  OFF
--------------------------------------------------------------------------------
06/22/93      ID=  WINDOWS DOWN      TOTAL COUNT    SAMPLE VOL= 0.1 CF
--------------------------------------------------------------------------------
TIME          >0.3    >0.5    >1.0    >5.0    >10.0    >25.0    RH   TEMP  FLOW
--------------------------------------------------------------------------------
09:00:17    118414    2888     258      22       3        0   41.2  77.8  0.99
--------------------------------------------------------------------------------
06/22/93      ID=  SUN ROOF OPEN      TOTAL COUNT    SAMPLE VOL= 0.1 CF
--------------------------------------------------------------------------------
TIME          >0.3    >0.5    >1.0    >5.0    >10.0    >25.0    RH   TEMP  FLOW
--------------------------------------------------------------------------------
09:00:31    118219    2878     273      24       3        0   41.2  77.8  .99
```

FIG. 3-20. ALARM DATA PRINTOUT

3.5.3 Printing Averages

From the print data menu screen select AVG DATA. The CI-500 will print a report similar to Figure 3-21. The first sample printed, will be the most recent one taken.

```
**********************************************************************************
              AVERAGE DATA    # LOCATIONS = 2    # SAMPLES = 6
**********************************************************************************

ID= WINDOWS DOWN                    # SAMPLES = 3          START 06/22/93 09:00:05
SAMPLE VOL= 0.1 CF                  TOTAL COUNT            END 06/22/93 09:00:17

      >0.3    >0.5    >1.0    >5.0    >10.0   >25.0    RH  TEMP  FLOW
    118293  2974.6   276.0    23.3      2.3     0.0  40.8  77.8  0.99

ID= SUN ROOF OPEN                   # SAMPLES = 3          START 06/22/93 09:00:31
SAMPLE VOL= 0.1 CF                  TOTAL COUNT            END 06/22/93 09:00:43

      >0.3    >0.5    >1.0    >5.0    >10.0   >25.0    RH  TEMP  FLOW
    119189  3092.0   269.6    20.0      1.3     0.0  40.8  77.8  0.99
```

FIG. 3-21. AVERAGE DATA PRINTOUT

3.5.4 Printing Federal Standard 209E Reports

From the print data menu screen select CALC 209E.

If less than 10 locations have been sampled, the CI-500 will print a report similar to the one shown in Figure 3-22. In this case, the area will pass the selected class if the average concentrations at each location **and** the 95% upper confidence limit are all less than the class limit for the selected size.

FEDERAL STANDARD 209E REPORT
CLASS 10 (AT 0.3uM)
06/22/93 09:09:04

START 06/22/93 09:00:05 END 06/22/93 09:45:09

SAMPLE VOL= 0.7CF	#SAMPLES	AVG COUNTS >0.3u	AVG CONC. /CF
#5	3	10.0	14.3
#4	3	4.3	6.1
#3	3	5.7	8.1
#2	3	4.7	6.7
#1	3	4.3	6.1
MEAN OF AVERAGES			8.3
STANDARD DEVIATION			3.5
STANDARD ERROR			1.6
95% UCL			27.3

****
* PASS *
****

FIG. 3-22. FS-209E REPORT FOR LESS THAN 10 LOCATIONS

If 10 locations or more have been sampled, the CI-500 will print a report similar to the one shown in Figure 3-23. In this case, the area will pass the selected class if the average concentrations at each location are all less than the class limit for the selected size.

FEDERAL STANDARD 209E REPORT
CLASS 10 (AT 0.3uM)
06/22/93 14:35:01

START 06/22/93 09:00:05 END 06/22/93 13:34:23

SAMPLE VOL= 0.7CF	#SAMPLES	AVG COUNTS >0.3u	AVG CONC. /CF
#10	3	20.3	29.0
#9	3	19.3	27.6
#8	3	18.3	26.1
#7	3	15.7	22.4
#6	3	15.3	21.9
#5	3	10.0	14.3
#4	3	4.3	6.1
#3	3	5.7	8.1
#2	3	4.7	6.7
#1	3	4.3	6.1

****
* PASS *
****

FIG. 3-23. FS-209E REPORT FOR 10 LOCATIONS OR MORE

Naturally, if the calculated results of the FS-209E Report exceed the limits for the selected class, then FAIL will appear in the box. The report will also FAIL if less than two locations have been sampled or an invalid size has been chosen for the selected class. The table below lists the valid sizes for selected classes.

CLASS NAME		VALID SIZES		
SI	ENGLISH	0.3 µm	0.5 µm	5.0 µm
M 1		OK	OK	NO
M 1.5	1	OK	OK	NO
M 2		OK	OK	NO
M 2.5	10	OK	OK	NO
M 3		OK	OK	NO
M 3.5	100	OK	OK	NO
M 4		OK	OK	NO
M 4.5	1,000	NO	OK	OK
M 5		NO	OK	OK
M 5.5	10,000	NO	OK	OK
M 6.0		NO	OK	OK
M 6.5	100,000	NO	OK	OK
M 7		NO	OK	OK

Complete copies of Federal Standard 209E are available from the Government Printing Office, the Institute of Environmental Sciences or Climet Instruments Company.

3.5.5 Printing ISO 14644-1 Reports

From the print data menu screen select CALC ISO. If less than 10 locations have been sampled, the CI-500 will print a report similar to the one shown in Figure 3-24. In this case, the area will pass the selected class if the average concentrations at each location **and** the 95% upper confidence limit are all less than the class limit for the selected size.

ISO 14644-1 REPORT
CLASS ISO 7 (AT 0.5uM)
01/25/99 09:09:04

START 01/25/99 09:00:05 END 01/25/99 09:45:09

SAMPLE VOL= 0.2CF	#SAMPLES	AVG COUNTS >0.5u	AVG CONC. /CM
8	3	22.7	4006.6
7	3	24.0	4236.0
6	3	24.3	4289.0
5	3	23.3	4112.5
4	3	22.3	3936.0
3	3	23.0	4059.5
2	3	24.7	4359.6
1	3	16.7	2947.6
MEAN OF AVERAGES=			3988.9
STANDARD DEVIATION=			446.4
STANDARD ERROR=			157.8
95% UCL=			4289.0

****
* PASS *
****

FIG. 3-24. ISO REPORT FOR LESS THAN 10 LOCATIONS

While printing the ISO report the Figure 3-25 screen appears. From this screen you may HALT the report, HALT/RESUME the report, EXCLUDE a location or EXIT. The exclude option is disabled if there are less than four locations.

In accordance with ISO 14644-1 you may exclude one location from the calculation if there are at least four locations of data. To exclude a location, select EXCLUDE from the menu. A screen similar to Figure 3.26 appears. If there are less than four locations the EXCLUDE option is disabled.

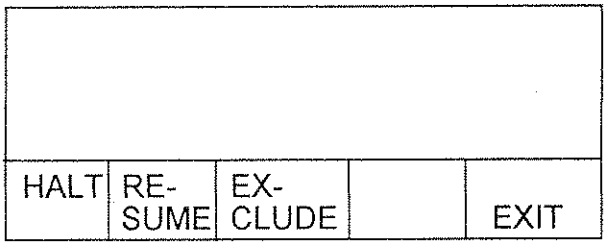


FIG. 3-25. ISO 14644-1 CALC ISO SCREEN

You may use the up and down arrows to select a location from the exclude screen. Selecting EXCLUDE with the location highlighted will select it. Pressing EXIT will bring you back to the PRINT DATA screen. Select CALC ISO again to re-calculate the ISO report with the location excluded.

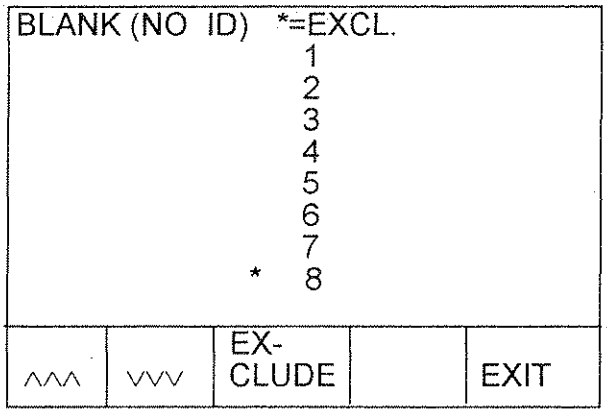


FIG. 3-26. ISO 14644-1 EXCLUDE SCREEN

The ISO calculation is performed with the marked location excluded. In the example shown in Figure 3-27 location "8" is excluded. The number of locations is reduced to seven and the Mean of Averages, Standard Deviation, Standard Error, and the 95% UCL are recalculated. The appropriate PASS/FAIL results are printed.

ISO 14644-1 REPORT
CLASS ISO 7 (AT 0.5uM)
*=EXCLUDED 01/25/99 09:09:04

START 01/25/99 09:00:05 END 01/25/99 09:45:09

SAMPLE VOL= 0.2CF	#SAMPLES	AVG COUNTS >0.5u	AVG CONC. /CM
*8	3	22.7	4006.6
7	3	24.0	4236.0
6	3	24.3	4289.0
5	3	23.3	4112.5
4	3	22.3	3936.0
3	3	23.0	4059.5
2	3	24.7	4359.6
1	3	16.7	2947.6
MEAN OF AVERAGES=			3988.9
STANDARD DEVIATION=			482.6
STANDARD ERROR=			182.3
95% UCL=			4341.9

****
* PASS *
****

FIG. 3-27. ISO REPORT WITH EXCLUDED LOCATION

If 10 locations or more have been sampled, the CI-500 will print a report similar to the one shown in Figure 3-28. In this case, the area will pass the selected class if the average concentrations at each location are all less than the class limit for the selected size.

ISO 14644-1 REPORT
CLASS ISO 7 (AT 0.5uM)
01/25/99 09:09:04

START 01/25/99 09:00:05 END 01/25/99 09:45:09

SAMPLE VOL= 0.2CF	#SAMPLES	AVG COUNTS >0.5u	AVG CONC. /CM
10	3	24.3	4289.0
9	3	18.0	3177.0
8	3	22.7	4006.6
7	3	24.0	4236.0
6	3	24.3	4289.0
5	3	23.3	4112.5
4	3	22.3	3936.0
3	3	23.0	4059.5
2	3	24.7	4359.6
1	3	16.7	2947.6

****
* PASS *
****

FIG. 3-28. ISO REPORT FOR 10 LOCATIONS OR MORE

If the calculated results of the ISO Report exceed the limits for the selected class, a FAIL will appear in the PASS/FAIL box. The table below lists the valid sizes for the ISO 14644-1 classes.

ISO 14644-1 VALID SIZES				
CLASS	0.3 µm	0.5 µm	1.0 µm	5.0 µm
1	NO	NO	NO	NO
2	YES	YES	NO	NO
3	YES	YES	YES	NO
4	YES	YES	YES	NO
5	YES	YES	YES	YES
6	YES	YES	YES	YES
7	NO	YES	YES	YES
8	NO	YES	YES	YES
9	NO	YES	YES	YES

Complete copies of ISO 14644-1 specification will be available from the International Standards Organization, the Institute of Environmental Sciences or the Climet Instruments Company.

3.6 BATTERY POWERED OPERATION

3.6.1 Indicated Battery Charge

The CI-500 has been designed to operate for approximately 3 hours continuous sampling time. CHARGE= field on the main screen provides an estimate of time available before the unit shuts down. Because of uncontrollable variations in the battery discharge curve that occur with different usage, the estimated time can only be used as a rough guide until <.5 HR is indicated. At this point there is indeed less than half an hour of use remaining plus or minus 15 minutes.

3.6.2 Orderly Shut-Down Under Low Battery Conditions

To preserve the settings and stored data in the 500 run sample memory, steps have been taken in the design to insure an orderly shut-down when the battery is nearly discharged. If the pump is off and the CHARGE= <0.5 HR, the pump is not allowed to turn on. This prevents the pump starting current from momentarily reducing the battery voltage an excessive amount.

When the measured battery voltage indicates that the battery charge is totally used up, the microprocessor blanks the screen except for the indication LO BATT HALT. In this condition, only the POWER key is operational.

Eventually, if the unit is still left on, an internal circuit will open a relay to disconnect the battery and prevent it from being damaged by a deep discharge.

3.6.3 Changing the Battery

The CI-500 contains a maintenance free rechargeable sealed lead acid battery which is replaceable by the user. When replacing the battery, care should be taken to prevent the battery terminals from being shorted together by any metal or tools.

To change the battery, turn the unit off and remove the power cord. Then tilt the unit back on to its rear panel. Use a flat blade screwdriver to apply a ¼ counter-clockwise turn to the two screw heads holding the battery door. Remove the battery door.

Use fingers to pull the wire terminals from the battery terminals. After this is done, move the wires out of the way and tilt the unit slightly forward so that the battery slides out of the opening.

Slide the new battery into the opening and push the wire terminals on to the battery terminals. The unit will make a short beep when the terminals are first connected.

WARNING: OBSERVE POLARITY. RED TO RED. BLACK TO BLACK

WARNING: DO NOT APPLY AC POWER IF THE BATTERY IS NOT CONNECTED.

If by accident, the polarity is reversed, it will be necessary to replace the 12 volt fuse inside the unit. See Section VI.

Put the battery door back on and give the slotted screw heads ¼ turn clock-wise to fasten.

SECTION IV AUXILIARY OUTPUTS

4.1 RS-232 INTERFACE

The RS-232 interface conforms to the EIA standard as a DCE device with a 9-pin "D" connector. The BAUD (bits per second) rate is fixed at **9600 BAUD** . Figure 4.1 shows the signal pin-outs and their designations. The protocol is:

8 data bits
1 stop bit
no parity

The output drivers are tri-state with the DTR receive line enabled. At the end of the sample period, the microprocessor looks at the DTR line for a high signal, and will output the end of sample data. The DTR line has a pull- up resistor to default to a high state if hand-shaking is not necessary. The DTR line is the only signal line that is used for hand-shaking for out going data. The DCD, DSR, and CTS are held in the high state as the serial port is interrupt driven and is always ready to receive.

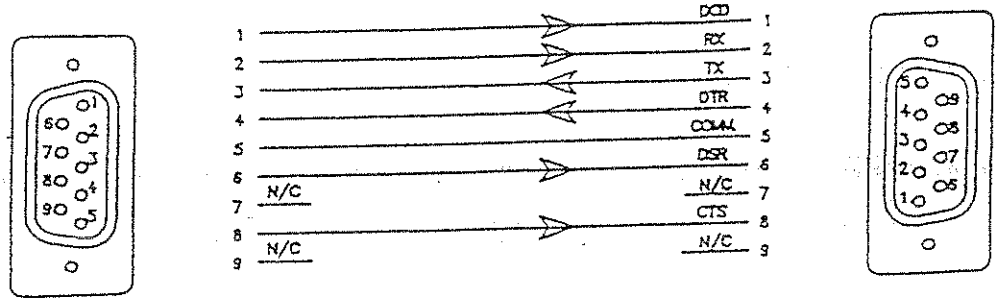
4.1.1 Remote Control

The CI-500 can be programmed and operated by means of the RS-232 port. The CI-500 will respond to external commands by sending it ASCII letters or combinations of letters and numbers. The table of Section 4.1.2 lists the ASCII command characters and their functions.

To invoke a function, send an ASCII letter and then a carriage return to execute the function. Multiple commands may be sent with only one carriage return as the last character. The receive buffer is 10 characters long and if overfilled, will ignore all commands except the "space" character. The "space" character (20 hex) is used to clear the receive buffer and should be sent at the beginning of each ASCII command string. If a command is sent with and invalid 'n' or 'nn', the command will execute as if n was 0.

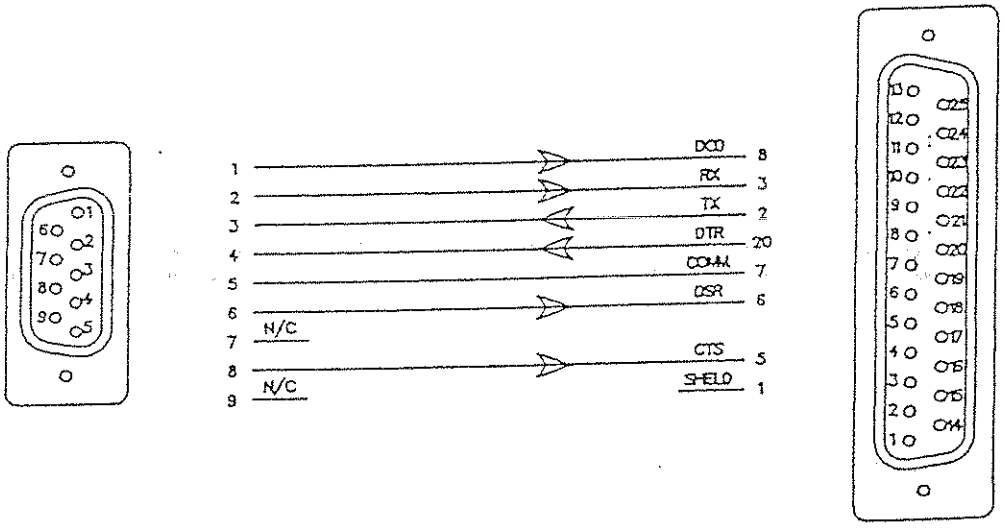
All data transmissions from the CI-500 are terminated with a <BELL> character (07hex).

The "ECHO" feature is used to send back the command characters as verification that they have been received. When in doubt, hook up a "dumb" terminal and try each command to test the instrument.



CI-2XXX
CI-4XXX
MALE
DCE

PC/AT
DTE



PC/XT
SERIAL PRINTERS
DTE

CABLE DIAGRAMS FOR SERIAL PRINTERS / COMPUTERS

FIG. 4-1. RS-232 CONNECTIONS

4.1.2 RS-232 Command List

This is the list of commands which may be received via the RS-232 port.

ASCII	FUNCTION
'S'	Start sample
'T'	Stop sample (Beeps four times)
'A'	Transmit all data in 500 run sample memory Same format as PRINT ALL DATA
'Z'	Clear all data in 500 run sample memory
'V'	Turn pump on independent of sample
'W'	Turn pump off if sample is not in progress
'R'	Enable echo (will send back each character)
'N'	Disable echo (carriage return not required)
'L'	Force total count mode
'C'	Force concentration / cubic foot count mode
'H'	Force concentration / cubic meter count mode
'E'	Enable keyboard
'D'	Disable keyboard
'F'	Print current time, and data on the fly.
' '	Clear command buffer no 'CR' required
'Y'	Print model number, software revision date, header, available sample volumes, delays, initial delays and particle alarm levels.
'Bnn'	Program sample volume

nn	Sample Volume
00	0.1 CF
01	0.2 CF
02	0.7 CF
03	1.0 CF
04	2.0 CF
05	7.0 CF
06	10.0 CF
07	0.01 CM
08	0.02 CM
09	0.1 CM
10	0.2 CM
11	1.0 CM

4.1.2 RS-232 Command List (cont.)

ASCII	FUNCTION

'Pn' Program delay between samples

n	Delay
0	No delay
1	1 sec end to start
2	15 sec end to start
3	5 min. start to start
4	15 min. start to start
5	30 min. start to start
6	60 min. start to start

'In" Program initial delay

n	Initial delay
0	1 second
1	5 seconds
2	1 minute
3	5 minutes

'Gnn' Program number of samples

nn	Number of samples
01	1
02	2
03	3
04	4
05	5
06	6
07	7
08	8
09	9
10	10
11	Infinite

'M01nnn' Program alarm setting for 0.3 µm channel

nnn	Alarm level	nnn	Alarm level
000	Off	017	350
001	Beep	018	450
002	2	019	500
003	3	020	570
004	4	021	1000
005	5	022	2000
006	6	023	3000
007	10	024	3500
008	20	025	4500
009	30	026	5000
010	35	027	10000
011	45	028	20000
012	50	029	30000
013	60	030	35000
014	100	031	45000
015	200	032	50000
016	300	033	100000

4.1.2 RS-232 Command List (cont.)

ASCII	FUNCTION
'M02nnn' through 'M06nnn'	Program alarm setting for upper 5 particle channels

nnn	Alarm level	nnn	Alarm level
000	Off	017	350
001	1	018	450
002	2	019	500
003	3	020	570
004	4	021	1000
005	5	022	2000
006	6	023	3000
007	10	024	3500
008	20	025	4500
009	30	026	5000
010	35	027	10000
011	45	028	20000
012	50	029	30000
013	60	030	35000
014	100	031	45000
015	200	032	50000
016	300	033	100000

'M07nnn' Program alarm setting for high temperature

nnn	Alarm level
000	Off
001	0.5
002	1.0
003	1.5
...	...
100	50.0
101	50.5
...	...
200	100.0

'M08nnn' Program alarm setting for low temperature

nnn	Alarm level
000	Off
001	0.5
002	1.0
003	1.5
...	...
100	50.0
101	50.5
...	...
200	100.0

4.1.2 RS-232 Command List (cont.)

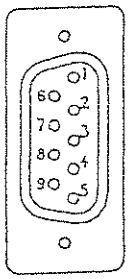
ASCII	FUNCTION
'M09nnn'	Program alarm setting for high humidity
	nnn — Alarm level
	000 — Off
	001 — 0.5
	002 — 1.0
	003 — 1.5
	... — ...
	100 — 50.0
	101 — 50.5
	... — ...
	200 — 100.0
'M10nnn'	Program alarm setting for low humidity
	nnn — Alarm level
	000 — Off
	001 — 0.5
	002 — 1.0
	003 — 1.5
	... — ...
	100 — 50.0
	101 — 50.5
	... — ...
	200 — 100.0
'M11nnn'	Program alarm settings for flow
	nnn — Flow tolerance
	000 — Off
	001 — ±5%
	002 — ±10%

4.2 RS-485 INTERFACE

The RS-485 interface is a balanced differential transceiver that is used for communication and control over extended distance (up to 4000 feet). The electrical interface complies with EIA-485 and EIA-422. The protocol is the same as the RS-232 interface.

8 data bits
1 stop bit
no parity

The advantage of RS-485 is that communications can occur over distances of several thousand feet compared to RS-232 which is limited to 50 feet unless line drivers are used. The connections for the RS-485 are shown in Figure 4.2. The use of RS-485 is generally reserved for custom programs designed to work with multi-drop networks of RS-485 devices. Climet provides such programs for particle monitoring systems. For further information, contact Climet Instruments Company.



PIN	FUNCTION
1 and 4	Rx/Tx (-)
2 and 3	Rx/Tx (+)
5	Common
6 through 9	No Connection

FIG. 4-2. RS-485 CONNECTIONS

SECTION V THEORY OF OPERATION

5.1 OPTICAL SYSTEM

The CI-500 counts particles by detecting light scattered by the particles as they pass through a laser beam which is focused directly under the inlet nozzle. The amount of light scattered is proportional to the size of the particle passing through the laser beam. An elliptical mirror based optical system (patent pending) collects the scattered light over a wide solid angle and reflects it on to a solid state photo detector. Since the detector receives scattered light from a wide solid angle, variation in response due to particle shape and refractive index is minimized. The response is also monotonic as compared to sensors based on narrow forward or right angle collection.

The solid state photo detector and associated electronic circuitry convert the collected light to an electrical pulse with an amplitude proportional to particle size. These electrical pulses are sent to voltage comparators which compare the amplitude of each voltage pulse to a reference voltage determined at calibration. If the amplitude of the voltage pulse is greater than the predetermined reference voltage, the pulse will be counted as a particle greater than or equal to the size threshold assigned to the comparator.

5.2 AIR FLOW SYSTEM

The CI-500 utilizes a unique air flow system (patent pending) that minimizes power consumption, weight and size. Particles that enter the inlet tube are trapped in a HEPA filter after passing through the sensor so that they are not exhausted into the enclosure. A mass flow sensor measures the inlet flow and continuously adjusts the pump speed to maintain a constant 1 CFM flow rate even if the battery voltage changes or inlet restrictions such as filters, probes and sample tubing are attached. While the pump is running and flow drops below 20% of nominal for more than two minutes, the unit will turn off the pump to prevent damage to the pump. Testing has shown that the CI-500 can maintain a 1 CFM flow rate with up to 40' of 3/8" ID tubing attached to the inlet.

5.3 RELATIVE HUMIDITY AND TEMPERATURE SENSOR

Outside air is drawn in through a vent and over the temperature and humidity sensor by a small fan. The CI-500 utilizes a monolithic integrated circuit containing the temperature and humidity sensor Humidity is measured by detecting changes in the capacitance of a thin polymer film as it absorbs water molecules. Temperature is measured by a precision thin film platinum RTD element.

SECTION VI SERVICE

When performing service on the CI-500, care should be taken to follow the procedures as described and follow normal precautions associated with the service of electronic instrumentation. If these precautions are understood and followed, there is no warranty violation in removing the rear panel to accomplish service tasks.

6.1 12 VOLT FUSE REPLACEMENT

Before attempting to replace the 12 volt fuse, first remove the battery. To remove the battery, turn the unit off and remove the power cord. Then tilt the unit back on to its rear panel. Use a flat blade screwdriver to apply a ¼ counter-clockwise turn to the two screw heads holding the battery door. Remove the battery door.

Use fingers to pull the wire terminals from the battery terminals. After this is done, move the wires out of the way and tilt the unit slightly forward so that the battery slides out of the opening.

Set the unit back upright. Using a Phillips screwdriver, remove the six (6) screws that fasten the rear panel. Carefully tilt the rear panel back and lift it away from the unit. It will remain attached to the unit by several electrical cables. Without disconnecting any cables, lay the rear panel down.

Locate the yellow tubular fuse holder near the top of the battery compartment. Use fingers to pull each end of the fuse holder to separate the two halves. Replace the 10A 32V fuse with one of the same type and push the two halves of the fuse holder back together. Put the fuse holder back in its original location.

Lift the rear panel and position the electrical connectors so that they are out of the way of the circuit board as the rear panel is repositioned on the unit. Do not force the rear panel in place.

CAUTION: MAKE SURE THAT NO CONNECTORS WILL BE JAMMED BETWEEN THE CIRCUIT BOARD AND THE BATTERY BOX OR SENSOR ASSEMBLY WHEN THE REAR PANEL IS PUT BACK ON.

Fasten the rear panel back in place with the six (6) Phillips head screws.

Tilt the unit back on to its rear panel. Slide the battery back into the opening and push the wire terminals on to the battery terminals. The unit will make a short beep when the terminals are first connected.

WARNING: OBSERVE POLARITY. RED TO RED. BLACK TO BLACK

WARNING: DO NOT APPLY AC POWER IF THE BATTERY IS NOT CONNECTED.

If by accident, the polarity is reversed, it will be necessary to replace the 12 volt fuse again.

Put the battery door back on and give the slotted screw heads ¼ turn clock-wise to fasten.

6.2 LONG TERM STORAGE

If the CI-500 is to be stored for more than three (3) months without use, steps should be taken to prevent damage to the battery from deep discharge. To do this, disconnect the battery following the instructions given in Section 6.1. Reconnect the battery again before use.

6.3 SOFTWARE RESET

The CI-500 has a software reset feature that will cause all data and user settings to be cleared and replaced with factory default settings. To cause a software reset, turn the unit off. Then, while pressing the down arrow key of the VIEW ADJUST, press POWER.

EU Declaration of Conformity

Measurement, Control and Laboratory Equipment

EU Directives Covered by this Declaration:	89/336/EEC EMC Directive 73/23/EEC Low Voltage Directive IEC 825 Safety of Laser Products
Product:	Laser Particle Counter Model: CI-500 Innovation Serial Numbers: 970000+
Standards Which Product Conforms To:	EN61010-1(1993): AM2(1995) EN55011 A & EN50082-2 IEC 825

The technical documentation required to demonstrate that this product meets the requirements of the "EMC", "Low Voltage Directives" and "Safety of Laser Products" has been compiled by the signatory below and is available for inspection by the relevant authorities. The CE mark was first applied in 1996.

European Contact: Mike LeGrys
Thermotron
3 Heard Way
Eurolink Industrial Estate
Sittingbourne
Kent ME10 3SA England

I the undersigned hereby declare that the equipment specified above conforms to the above directives and standards.

Place: Redlands California USA
Date: 12-18-96

David L. Chandler
Engineering Manager

Attention

The attention of the purchaser, installer or user is drawn to the special measures and limitations which must be observed when the product is taken into service, in order to maintain compliance with the above directives. Details of the special measures and requirements are detailed in this product user manual.

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