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ALLTECH ELSD 2000ES
EVAPORATIVE LIGHT SCATTERING DETECTOR
OPERATING MANUAL

October, 2004
Manual Part No. 600100ESM

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TABLE OF CONTENTS

1. INTRODUCTION 1
   1.1 ABOUT THE ELSD 2000ES 1
   1.2 WHAT IS INCLUDED WITH THE ELSD 2000ES 1
   1.3 PRINCIPLE OF OPERATION 2
2. INSTALLATION 3
   2.1 WHAT YOU WILL NEED 3
   2.2 UNPACKING 3
   2.3 CONTROLS AND FEATURES 4
      2.3.1 FRONT PANEL 4
      2.3.2 LEFT SIDE PANEL 4
      2.3.3 RIGHT SIDE PANEL 5
      2.3.4 REAR PANEL 5
   2.4 MAKING ELECTRICAL AND FLUID CONNECTIONS 6
3. INSTRUMENT CONTROL 9
   3.1 ELSD 2000ES CONTROL OPTIONS 9
   3.2 USING THE ELSD 2000ES CONTROL PANEL 9
   3.3 NAVIGATING THE SCREENS 9
   3.4 POWERING UP 10
   3.5 OPERATION SCREEN 10
   3.6 INSTRUMENT STATUS 10
      3.6.1 STANDBY 10
      3.6.2 RUN 10
   3.7 MENU SCREEN 11
   3.8 SETTING UP A RUN 11
   3.9 METHOD SCREEN 12
   3.10 METHOD OPTIONS 12
      3.10.1 SELECT A PREVIOUSLY SAVED METHOD 12
      3.10.2 EDIT AN EXISTING METHOD 13
      3.10.3 CREATE A NEW METHOD 14
   3.11 CONFIGURATION SCREEN 14
   3.12 CONFIGURATION OPTIONS 15
      3.12.1 SET AUDIO ALARM 15
      3.12.2 SELECT FULL-SCALE VOLTAGE 15
      3.12.3 SET FAULT RELAY OVERRIDE 15
   3.13 DIAGNOSTICS 15

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4. ROUTINE OPERATION 15
4.1 SAFETY 15
4.2 OPERATION NOTES 16
4.3 IMPORTANT OPERATING PARAMETERS 16
4.4 SELECTING INITIAL OPERATING CONDITIONS 18
4.4.1 SELECTING INITIAL CONDITIONS FOR IMPACTOR 'OFF' MODE 18
4.4.2 SELECTING INITIAL CONDITIONS FOR IMPACTOR 'ON' MODE 19
4.5 START-UP SEQUENCE 20
4.6 SHUTDOWN SEQUENCE 21
4.7 OPTIMIZATION PROCEDURE 21
4.7.1 OPTIMIZATION FOR IMPACTOR 'OFF' MODE 21
4.7.2 OPTIMIZATION FOR IMPACTOR 'ON' MODE 22
5. DIAGNOSTICS AND TROUBLESHOOTING 23
5.1 OPERATION ERROR MESSAGES 23
5.2 DIAGNOSTICS OPTIONS 24
5.3 PERFORMING DIAGNOSTIC TESTS 24
5.3.1 OPTICS TEST 24
5.3.2 NEBULIZER GAS PRESSURE TEST 25
5.3.3 FLOW METER TEST 26
5.3.4 COMMUNICATION TEST 27
5.4 MANUAL CONTROL SCREEN 28
5.5 ERROR LOG 28
5.6 DIAGNOSING BASELINE NOISE 29
5.7 TROUBLESHOOTING CHARTS 30
6. APPENDICES 33
6.1 SPECIFICATIONS 33
6.2 REPLACEMENT PARTS 33
6.3 CONTACT INFORMATION 33
6.4 VOLATILE MOBILE PHASE MODIFIERS 34
6.5 ELSD 2000ES CLEANING PROCEDURE 35
6.5.1 OPTICS BLOCK, DRIFT TUBE, AND NEBULIZER CLEANING PROCEDURE 35
6.6 POWER MODULE ADJUSTMENTS 37
6.6.1 CHANGING THE INPUT VOLTAGE 37
6.6.2 FUSE REPLACEMENT 37
6.7 WARRANTY, RETURNS, AND REPAIRS 38
6.8 USEFUL REFERENCES 39

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1. INTRODUCTION

1.1 ABOUT THE ELSD 2000ES

The Alltech ELSD 2000ES (Evaporative Light Scattering Detector 2000—**E**nhanced **S**ensitivity) is designed for use with High Performance Liquid Chromatography (HPLC) systems to analyze any compound that has sufficiently lower volatility than the mobile phase. Some of its possible application areas include the analysis of carbohydrates, pharmaceuticals, lipids, triglycerides, underivatized fatty and amino acids, polymers, surfactants, nutraceuticals, and combinatorial libraries.

Evaporative light scattering detection eliminates the common problems associated with other HPLC detectors. RI detection can be complicated by solvent front interferences, baseline instability due to extreme temperature sensitivity, and incompatibility with gradients. RI can also have a less sensitive response than ELSD's. Low-wavelength UV can suffer baseline drift when using steep gradients and also requires that the analyte have a chromophore. The ELSD is not plagued by these limitations. Unlike these other detectors, the ELSD can achieve stable baselines with multisolvent gradients for improved resolution and faster separations. Also, since the ELSD response does not depend on the sample's optical characteristics, the sample does not require a chromophore or fluorophore for detection.

The ELSD 2000ES offers the most advanced evaporative light scattering detection technology available. The improved optical and electronic design of the ELSD 2000ES provides superior sensitivity for your HPLC analyses. Contact closure-based magnetic interlock switches provide an important safety feature by disabling the laser light source when optical components are accessed. The nebulizer is designed to be rugged and reproducible. Digital gas flow control makes it possible to adjust flow rate directly from the front panel or remotely via PC. The ELSD 2000ES provides two modes of operation: Impactor 'On' and Impactor 'Off'. Impactor 'Off' mode is ideal for analyzing non-volatile compounds with highly organic mobile phases or with highly aqueous/low flow rate (1.0mL/min or less) mobile phases. Impactor 'Off' mode maximizes sensitivity for these applications by sending the entire sample stream to the optical cell for detection. Impactor 'On' mode is best for analyzing non-volatile compounds with higher flow rates or highly aqueous mobile phases (up to 5.0mL/min, including steep gradients), and for analyzing semi-volatile compounds. In Impactor 'On' mode, larger droplets in the aerosol are removed, so optimum mobile phase evaporation can be obtained at significantly lower drift tube temperatures. Only the ELSD 2000ES offers the advanced optical design and dual-mode operation necessary to maximize sensitivity and baseline stability for all possible mobile phases and analytes.

Several instrument control options are available for the ELSD 2000ES. Instrument parameters can be displayed and controlled directly through the front panel using membrane-based screen keys and a numeric keypad. Built-in software provides an intuitive series of screens for storing and editing up to ten methods; configuring audio alarm, fault relay, and full-scale voltage settings; and performing diagnostic tests and troubleshooting functions. The ELSD 2000ES can also be PC controlled using the software included with the unit.

1.2 WHAT IS INCLUDED WITH THE ELSD 2000ES

The ELSD 2000ES shipping container should contain the following:

- *ELSD 2000ES Detector*
- *ELSD 2000ES Operating Manual*
- *Power Cord*
- *Signal Cable*
- *Tools:*
  Open-End Wrench, 3/8" x 7/16"
  Open-End Wrench, 1/4" x 5/16"
  Hex Ball Driver, 3/32" (long)
  Hex Ball Driver, 3/32" (short)
  Drift Tube Cleaning Brush
- *Replacement Fuses:*
  3 Amp and 6 Amp (1 each)
- *Flex Connect PEEK Tubing, 1' x 0.005" ID*
- *Nebulizer Gas Supply Line:*
  PTFE Tubing, 10' x 1/8" OD
  1/8" Brass Nuts and Ferrules (2 each)*
- *Drain Collection Materials:*
  Tygon® Drain Tubing, 4' x 3/8" OD
  SS Nut and PTFE Ferrule**
  SS Drain Tube, 6" x 3/8" OD
  3/8" SS Nut and 3/8" SS Ferrule
  Drain Waste Bottle with Lid, 500mL
- *Exhaust Trap Kit:*
  Exhaust Tubing, 20'
  Collection Flask, 500mL with Adaptor
  Exhaust Elbow
  Lead Stabilization Ring
- *ELSD 2000 PC Control Software:*
  ELSD 2000 Control Software CD-ROM
  ELSD 2000 Instrument Control Cable
  ELSD 2000 Control Software Operating Manual

* The detector is shipped with these parts attached to their respective ports.

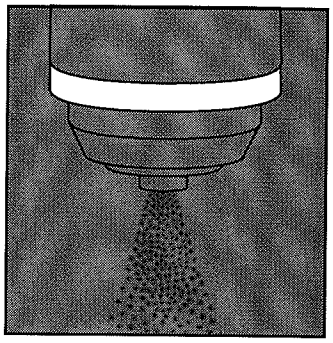
Refer to Section 6.2, Replacement Parts, for part numbers if replacement parts are needed.

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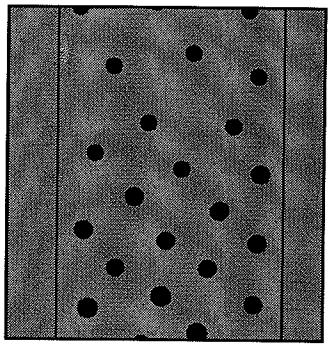
1.3 PRINCIPLE OF OPERATION

The unique detection principle of evaporative light scattering detectors involves nebulization of the column effluent to form an aerosol, followed by solvent evaporation in a heated drift tube, and then detection of the remaining non-volatile solute particles in the light scattering cell.

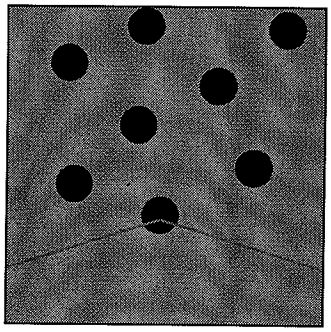
NEBULIZATION



EVAPORATION



DETECTION



NEBULIZATION

The column effluent from an HPLC separation enters the nebulizer, where it is mixed with a steady stream of nebulizing gas (usually nitrogen) to form an aerosol. The aerosol consists of a uniform distribution of droplets whose size is dependent on the gas flow rate used for the analysis. The lower the gas flow rate, the larger the resulting droplets will be. Larger droplets scatter more light and increase the sensitivity of the analysis, but they are also more difficult to evaporate in the drift tube. There will be an optimum gas flow rate for each method which will produce the highest signal-to-noise ratio.

Lower mobile phase flow rates require lower gas flow rates for proper nebulization. Substitution of a 2.1mm ID column for your standard 4.6mm ID column will allow you to greatly reduce the mobile phase flow rate while also increasing the sensitivity of the analysis.

EVAPORATION

Evaporation of the volatile components in the aerosol occurs in the heated stainless steel drift tube. The proper drift tube temperature setting for an application will depend on mobile phase composition and flow rate, and on sample volatility. Highly organic mobile phases require lower drift tube temperatures for evaporation than highly aqueous mobile phases. Lower mobile phase flow rates require lower drift tube temperature than higher mobile phase flow rates. Semi-volatile analytes require the use of much lower drift tube temperatures to obtain optimum sensitivity. The optimum temperature should be determined by observing the signal-to-noise ratio with respect to temperature.

In order to provide optimum sensitivity for all applications, the ELSD 2000ES' patented[1] design allows operation in two different modes. Depending on the application, the PTFE-coated stainless steel impactor is placed either parallel (Impactor 'Off' mode) or perpendicular (Impactor 'On' mode) to the flow path of the aerosol. In the Impactor 'Off' mode, the impactor does not disturb the flow of the aerosol as it travels through the drift tube. This allows the entire sample stream to reach the optical cell for maximum sensitivity. This mode is best for analyzing non-volatile compounds and/or compounds separated using volatile (mostly organic) mobile phases. In the Impactor 'On' mode, the aerosol contacts the impactor and larger droplets exit through the drain tube. The remaining droplets pass around the impactor and travel through the drift tube. The Impactor 'On' mode is best for analyzing semi-volatile analytes or for analyzing compounds separated using high flow rates (up to 5.0mL/min, including steep gradients) and/or highly aqueous mobile phases.

Non-volatile impurities in the mobile phase or nebulizing gas will produce noise. Using the highest quality gas, solvents, and volatile buffers (preferably filtered) will greatly reduce baseline noise. Noise will also increase if the mobile phase has not been completely evaporated. Detector settings must be carefully selected to ensure adequate mobile phase evaporation.

DETECTION

The sample particles emerge from the drift tube in the mobile phase vapor and enter the light scattering cell. In the optical cell, the sample particles scatter light emitted by a laser light source. The scattered light is detected by a silicon photodiode, generating a signal that is sent to the analog output for data collection. The advanced design of the ELSD 2000ES optical components[1] provides excellent sensitivity for your HPLC analyses.

1 US Patent #6229605; other patents pending

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2. INSTALLATION

2.1 WHAT YOU WILL NEED

In addition to the ELSD 2000ES detector and its accessories, you will need the following for installation of a complete chromatographic system:

Exhaust System:

- *A fume hood or other ventilation device located close to the detector to remove the detector exhaust from the laboratory. Use only the exhaust trap kit provided with the detector.*

Gas Supply:

- *A supply of clean, dry nebulization gas, preferably nitrogen, regulated from 65 to 80 psig. 99.9% purity or better is recommended. This can be a high pressure gas cylinder, a high pressure liquid tank, or a nitrogen generator.*

HPLC System Components:

- *An HPLC pump, isocratic or gradient, capable of low-pulsation solvent delivery at a flow rate ranging from at least 0.1 to 1.5mL/min against pressures of at least 3,000 psig. Lower flow rate capabilities may be necessary for microbore columns.*
- *An autosampler or manual injection valve.*
- *A column capable of separating the compounds of interest. If you are uncertain which column to use, contact your Alltech representative or the Alltech Technical Support Group for assistance (Phone: 1-800-33-SOLVE).*
- *A guard column or cartridge compatible with the separation column is recommended to prolong separation column lifetime.*
- *A column heater, if needed.*
- *A data system or integrator, capable of accepting analog voltage data. 0-10mV or 0-1000mV systems can be used.*

Other:

- *HPLC-grade mobile phase solvents.*

NOTE: Only volatile buffers may be used in the mobile phase. Refer to Section 6.4, Volatile Mobile Phase Modifiers, for a list of suitable buffers.

- *Solvent reservoirs, tubing, inlet filters, paper, etc.. required for pump and data system operation. Consult the appropriate manuals for requirements.*

2.2 UNPACKING

The ELSD 2000ES detector and its accessories are shipped in the same container. Unpack components carefully, making sure all items on the packing list have been included and are in good condition. Save the container and packing material for future use.

The ELSD 2000ES has been carefully shipped to ensure that it is received in proper condition. Any damage to the container or its contents should be reported immediately to your local distributor or to Alltech Associates. Please refer to Section 6.7, Warranty, Returns, and Repairs, for more information.

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2.3 CONTROLS AND FEATURES

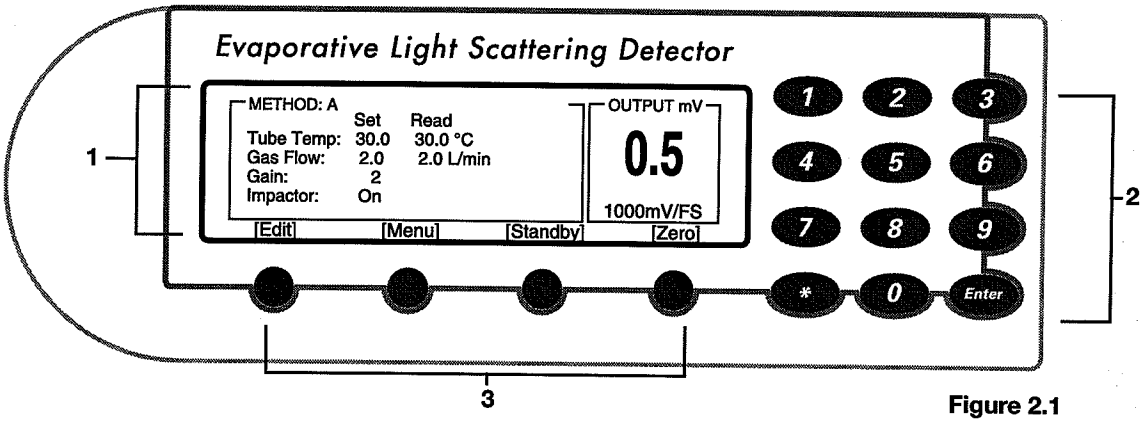


Figure 2.1

2.3.1 FRONT PANEL (FIGURE 2.1)

All instrument parameters for the ELSD 2000ES can be displayed and controlled through the front panel:

1. **LCD (Liquid Crystal Display):** The main screen displayed on the LCD panel during use of the instrument is the Operation screen. The Operation screen lists instrument status and parameters such as method name, drift tube temperature, gas flow rate, impactor position, gain, signal output, full-scale voltage setting, and the total number of operation errors occurring (if any). The LCD panel also displays all screens related to method, configuration, and diagnostic functions.
2. **Numeric Keypad:** Membrane-based keypad provides values 0 through 9, ' * ' (asterisk), and 'Enter' for adjusting instrument parameters.
3. **Screen Keys:** Four circular, membrane-based screen keys are located on the front panel. The function of each key is screen-dependent, with its current function listed immediately above it on the LCD panel if the key is active in that screen.

2.3.2 LEFT SIDE PANEL (FIGURE 2.2)

1. **Liquid Inlet:** The column effluent tubing connects to the LIQUID INLET with a 1/16" male fingertight fitting.
2. **Gas Inlet:** The GAS INLET consists of a 1/8" CPI Parker fitting that accepts the nebulizer gas supply line.

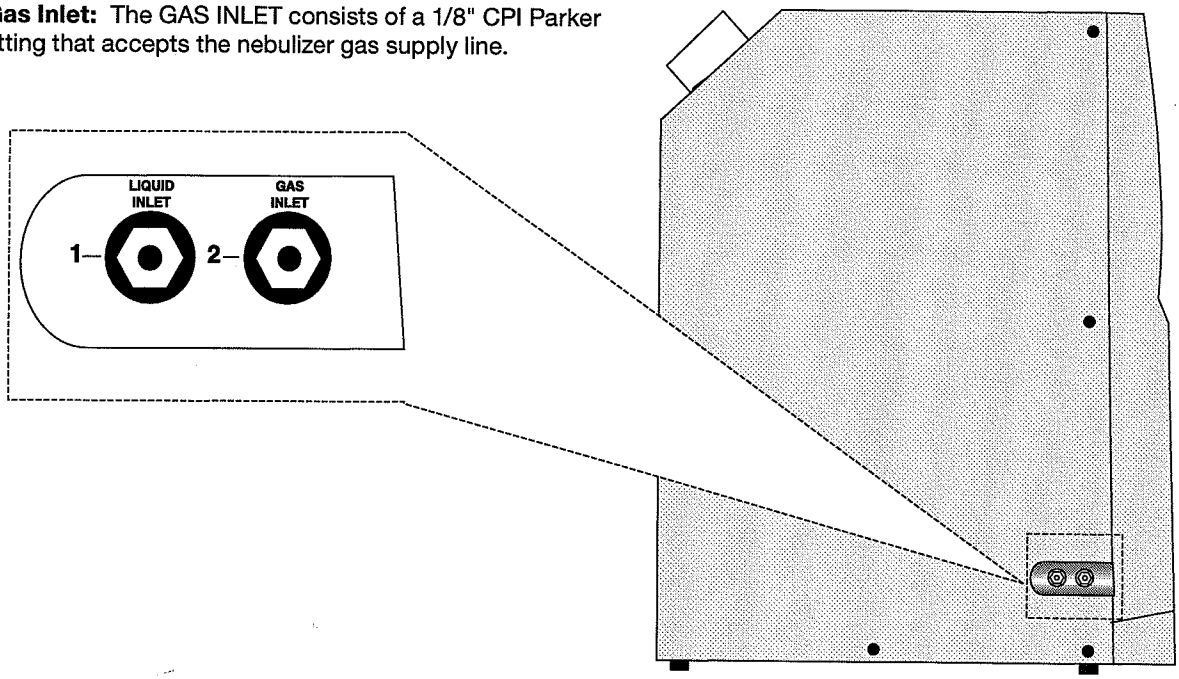


Figure 2.2

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2.3.3 RIGHT SIDE PANEL (FIGURE 2.3)

1. Drain: The DRAIN bulkhead accepts either the 3/8" OD Tygon® tubing (for standard mobile phases) or the 3/8" OD SS drain tube (for harsher mobile phases, such as THF) which is then extended into the 500mL drain waste container provided.

NOTE: The waste container must ALWAYS contain enough liquid to cover the end of the drain tube during operation of the detector. Otherwise, nebulizer gas may escape through the drain tube, causing improper nebulization.

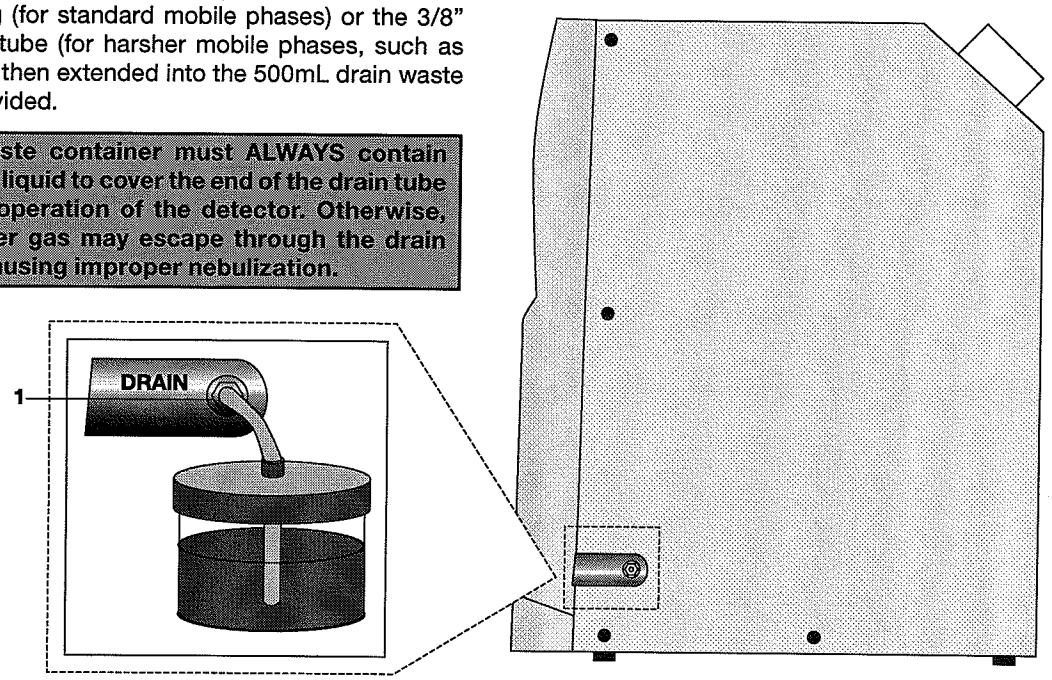


Figure 2.3

2.3.4 REAR PANEL (FIGURE 2.4)

1. Power Module: Contains a socket for the incoming power cord, which can be adjusted to a voltage of 120V (US standard) or 240V (European Standard). It also contains the main power switch, which is used to turn the system power On/Off, and the line fuse.

CAUTION: Operation at the wrong input voltage may damage the detector. Refer to Section 6.6, Power Module Adjustments, for details on changing the voltage setting and line fuse. The fuse value will depend on the line voltage (6A for 120V, 3A for 240V).

2. Twelve-Pin Connector: Outputs TTL/contact closure signals or accepts signals from peripheral equipment. Only pins 1 through 7 currently have programmed functions.

Remote Gas		Autozero		Fault Relay		
				NO	C	NC
-	+	-	+	+	-	+
1	2	3	4	5	6	7

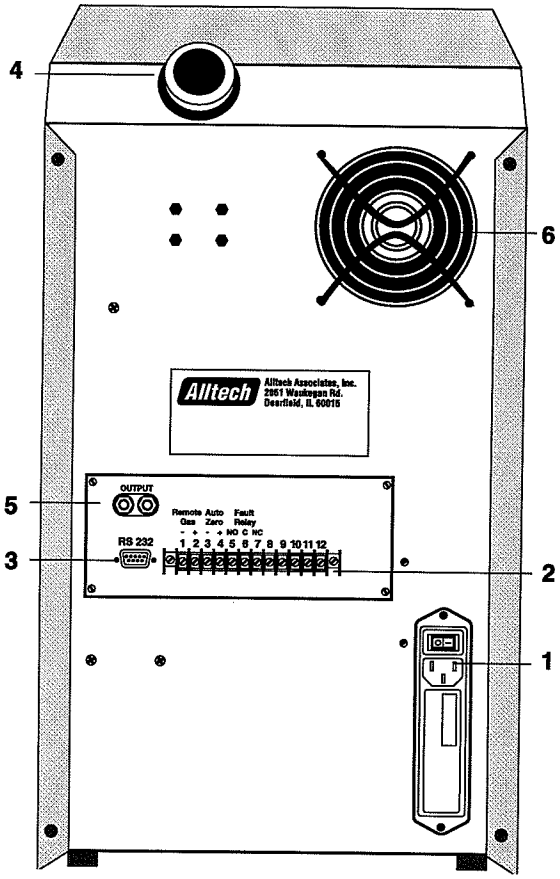


Figure 2.4

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Remote Gas Control: Pin 1: Ground (-) Pin 2: Signal (+)
A momentary TTL/contact closure input signal toggles the gas supply solenoid On/Off.

Autozero: Pin 3: Ground (-) Pin 4: Signal (+)
A momentary TTL/contact closure input signal activates the autozero. It mimics the function of the **[Zero]** key.

Fault Relay: Pin 5: Normally Open (NO) (+)
Pin 6: Common (-)
Pin 7: Normally Closed (NC) (+)

Outputs a TTL/contact closure signal to shut down pump flow when any operation error occurs on the detector. Normally Open (NO) or Normally Closed (NC) will be used, depending on the instrument.

NOTE: Use of the fault relay override will prevent the pump flow from being shut down when errors occur on the detector. Refer to Section 3.12.3, Set Fault Relay Override, for more information.

3. **RS-232 Port:** The ELSD 2000 PC control cable included with this unit can be connected to this port for PC control of the ELSD detector. PC control will also require the use of the ELSD 2000 Control Software CD-ROM included with the unit.
4. **Exhaust Outlet:** Nebulizer gas, mobile phase vapor, and solute mist or particles produced during an analysis will exit the detector through this outlet. The exhaust outlet accepts the provided exhaust tubing, which must then be connected to the exhaust trap kit and a fume hood.
5. **Signal Output:** The signal cable is connected to the OUTPUT on the rear panel of the detector and is used to send analog signal to your data collection device.
6. **Fan:** Provides cooling airflow through the instrument. Do not block.

2.4 MAKING ELECTRICAL AND FLUID CONNECTIONS

1. **Unpacking the Unit:** Remove the ELSD from its shipping container and position it near the column outlet of your HPLC system and the fume hood. Make sure there is free flow of air to the bottom of the ELSD and to the cooling fan at the rear panel of the ELSD. Allow the detector to warm to ambient temperature if necessary. Save the shipping container for future use.
2. **Power Connection:** Plug the power cord provided with the unit into the power module on the rear panel of the detector. Make sure the unit is set to the proper voltage. The voltage is field selectable for operation at 120V (US standard) or 240V (European Standard).

CAUTION: Operation at the wrong input voltage may damage the detector. Refer to Section 6.6.1, Changing the Input Voltage, for details on adjusting the voltage setting.

3. **Gas Connection:** Connect the gas supply (preferably nitrogen) to the GAS INLET on the left side panel. Gas supply should be regulated from 65 to 80 psig. This inlet accepts a 1/8" CPI Parker fitting. A stable gas flow and pressure are necessary for reproducible results. The gas must be free of contaminants, such as oil, water, particulates, or any other non-volatile substances. A 0.1µm gas filter is built into the instrument.
4. **Liquid Connection:** Connect the column effluent line to the LIQUID INLET with a 1/16" male fitting. The ID and length of the tubing between the column and the detector should be kept as small as possible to avoid band broadening. We recommend 0.005" ID tubing for best results.
5. **Drain Setup: For standard mobile phases,** Tygon® tubing can be used. Using a tubing cutter, cut an appropriate length of the 3/8"OD Tygon® tubing included with the unit for use in the drain setup. Attach the tubing to the DRAIN OUTLET on the right side panel using the stainless steel nut and PTFE ferrule attached to the DRAIN port. Submerge the drain tube into the drain container filled with enough liquid (water initially) to cover the end of the tube and secure with the lid to prevent solvent fumes from escaping. Use the 500mL waste container provided at the bench level, or use a larger container at the floor level (with drain tube submerged in liquid) for longer or overnight runs. Monitor the liquid level in the drain collection container during Impactor 'On' applications, and decant excess liquid when the level approaches the top of the container. Remember to leave enough liquid at all times for the tube to be submerged. Also remember that the waste container will contain solvents from your mobile phase and should be disposed of properly. **For harsher mobile phases such as those containing tetrahydrofuran or chloroform,** the stainless steel drain tube provided in the accessory kit should be used since it is more chemically resistant. Attach the stainless steel drain tube to the DRAIN port on the right side of the ELSD using the stainless steel nut and stainless steel ferrule. Submerge the drain tube into the waste collection container provided with enough liquid to cover the end of the tube. The liquid level inside the container should be monitored and excess liquid should be decanted as it approaches the top of the container.

CAUTION: The liquid level in the drain container must remain lower than the level of the nebulizer for proper drainage and detector operation. To ensure this, only the 500mL waste container provided may be used at bench level. A larger container may be substituted for longer and/or unattended (i.e. overnight) runs but it must be placed at floor level.

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CAUTION: The liquid level in the drain container must be monitored during Impactor 'On' mode, and excess liquid should be removed when the level approaches the top of the container. When removing excess liquid, remember to leave enough liquid in the container so the drain tubing remains submerged. There is no need to monitor liquid levels during Impactor 'Off' mode because no liquid drains during this mode.

CAUTION: Do not allow the drain container to completely fill during operation as this will cause spillage and/or improper drainage.

6. **Exhaust Connection:** Connect the exhaust elbow provided to the EXHAUST outlet on the rear panel of the unit. Attach the tubing from the elbow to the condensation trap. The tubing should permit continuous downward flow of any condensate into the collection flask. The lead ring provided can be placed on the collection flask for stability. Connect the exhaust tubing provided in the accessory kit to the condensation trap and direct to a fume hood or other ventilation system. There should be no low spots in the tubing where condensate can collect. If necessary, the exhaust tubing can be shortened by cutting with a razor to the desired length. See Figure 2.5 below.

NOTE: The liquid level in the collection flask should be monitored and emptied when half full.

7. **Signal Output:** Connect a signal cable from your data collection device to the OUTPUT port on the rear panel of the detector.
8. **RS-232 Connection:** Connect the ELSD 2000 PC Control cable to the RS-232 port on the rear panel of the detector and to the PC (if desired). Refer to the ELSD 2000 PC Control Manual for more details.

Recommended Set-Up for Exhaust Trap and Drain Collection

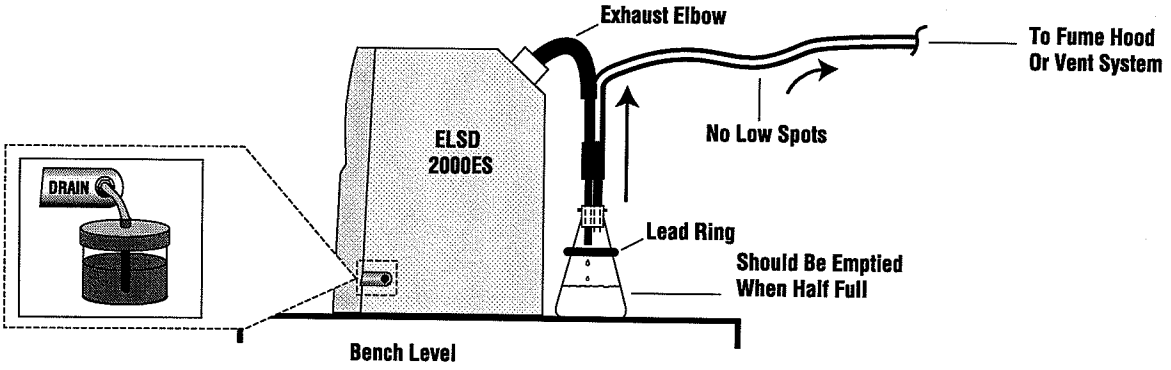


Figure 2.5

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9. **12-Pin Connections:** Make connections to the 12-pin terminal strip on the rear panel of the detector depending on which of the following functions are needed:

Remote Gas Control: Pin 1: Ground (-)
Pin 2: Signal (+)

Pins 1 and 2 on the ELSD 2000ES can accept a TTL/contact closure signal to turn gas flow on/off. It is especially useful for turning off gas flow at the end of a run. This signal is typically sent from an autosampler or a data collection system. Consult the appropriate manuals for wiring information.

Autozero: Pin 3: Ground (-)
Pin 4: Signal (+)

Pins 3 and 4 on the ELSD 2000ES can accept a TTL/ contact closure signal from a start signal cable to autozero the detector after each injection. This signal is typically sent from an autosampler or a manual injection valve with a position-sensing switch. Consult the appropriate manuals for wiring information.

Fault Relay: Pin 5: Normally Open (NO) (+)
Pin 6: Common (-)
Pin 7: Normally Closed (NC) (+)

Pins 5, 6, and 7 on the ELSD 2000ES can output a TTL/contact closure signal to stop pump flow whenever an operation error occurs on the detector. Consult the appropriate manuals for wiring details.

NOTE: The fault relay override function can be used to temporarily disable the fault relay without disconnecting the wiring. Refer to Section 3.12.3, Set Fault Relay Override, for more details.

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3. INSTRUMENT CONTROL

3.1 ELSD 2000ES CONTROL OPTIONS

The ELSD 2000ES may be controlled either directly through the front panel or remotely using a PC.

NOTE: Only the ELSD 2000 PC Control software included with the unit can be used for PC control of the ELSD 2000ES. The ELSD 2000ES is not compatible with any other PC control software.

This section of the manual describes operation of the ELSD 2000ES directly through the front control panel. For details on PC control of the ELSD 2000ES, please consult the ELSD 2000 Control Software Manual for instructions.

3.2 USING THE ELSD 2000ES CONTROL PANEL

The ELSD 2000ES can be controlled directly from the front control panel using the screen keys, numeric keypad, and LCD display. Refer to Section 2.3.1, Front Panel, for a diagram and more details.

3.3 NAVIGATING THE SCREENS (FIGURE 3.1)

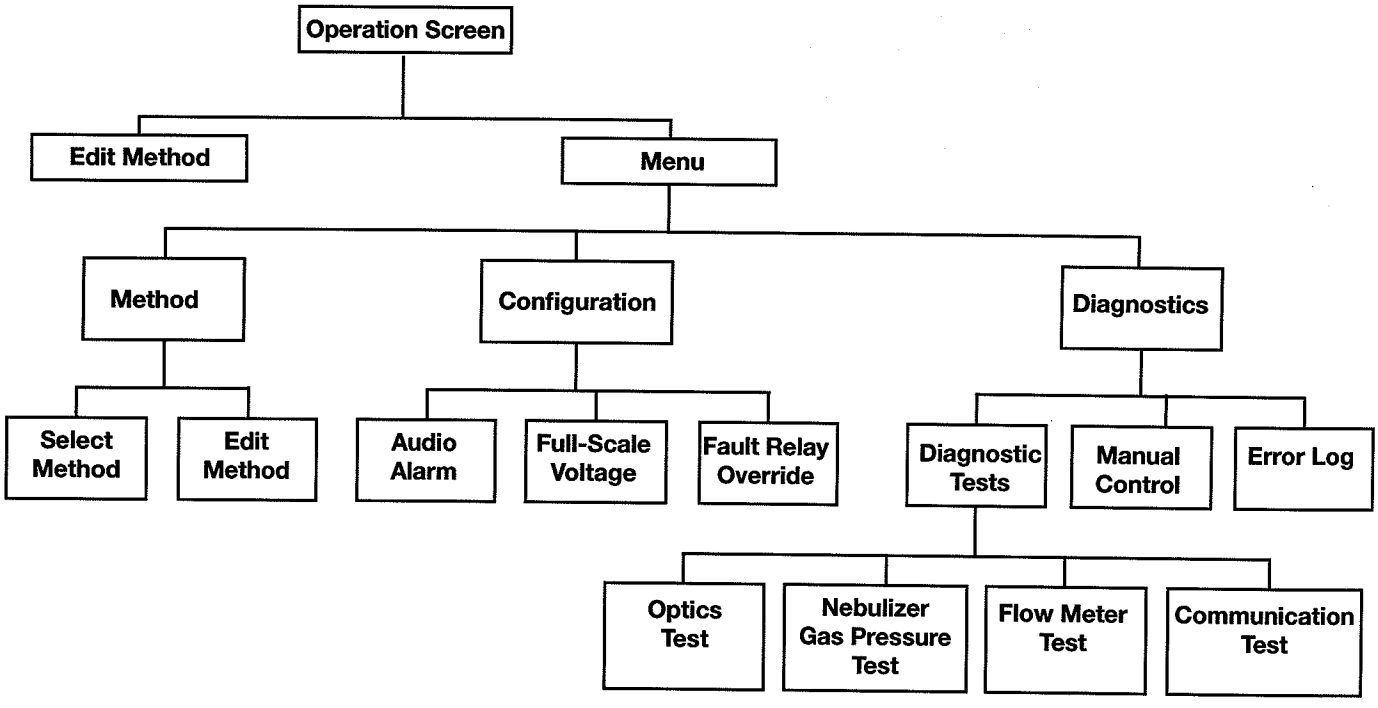


Figure 3.1

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3.4 POWERING UP

The ELSD 2000ES is powered up using the power switch on the rear panel of the instrument.

The Operation screen will then appear displaying a message indicating the unit is in 'Standby' mode and a timer indicating how long the instrument has been in this mode. The unit will automatically display the settings for the last method that was in use before shutdown.

3.5 OPERATION SCREEN

The Operation screen is the main screen displayed during use of the instrument. This screen provides the following information for the currently loaded method:

- **Method:** Currently loaded method name.
- **Tube Temp:** Setpoint and current reading of the drift tube temperature in °C.
- **Gas Flow:** Setpoint and current reading of the nebulizer gas flow rate in L/min.
- **Gain:** Current gain setting. Possible values are 1, 2, 4, 8, and 16. A gain setting of 1 produces an unamplified signal, and each gain increase will produce a twofold signal amplification over the previous value.
- **Impactor:** Current position of the impactor. Either 'Off' or 'On' depending on your application.
- **Output:** The signal output in mV is displayed when the instrument is in 'Run' mode. A 'Standby' message with time elapsed is displayed when the instrument is in 'Standby' mode.
- **Full-Scale Voltage:** Full-scale voltage setting. Either 10mV or 1000mV, depending on the data collection system used.
- **Total Errors:** The total number of operation errors currently occurring on the instrument (if any).
- **Screen Keys:** Used to change instrument status or to access functions from other screens.

  [Edit]: Shortcut that takes you directly from the 'Run' screen to the <<Edit Method>> screen.

  [Menu]: Brings up the <<Menu>> screen from either the 'Standby' or 'Run' screens.

  [Standby]: Puts the instrument into 'Standby' mode from the 'Run' screen.

  [Zero]: Autozeros the signal output from the 'Run' screen.

  [Run]: Runs the currently loaded method settings, taking the unit out of 'Standby' mode.

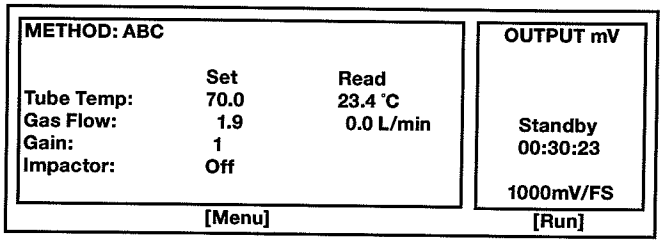
3.6 INSTRUMENT STATUS

The ELSD 2000ES has two different operational states: 'Standby' and 'Run'. Current status of the instrument is displayed on the Operation screen:

3.6.1 STANDBY

The detector enters 'Standby' mode immediately after powering up. In this mode, the laser, gas flow, and drift tube heaters are turned off. The Operation screen will display a 'Standby' message with a timer indicating how long the instrument has been in this state. Screen key options are **[Menu]** and **[Run]**.

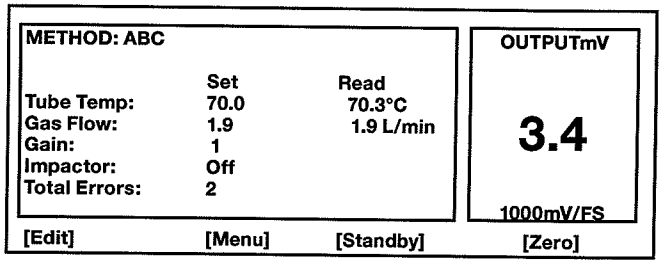
Operation Screen in 'Standby' Mode



3.6.2 RUN

In 'Run' mode, the laser, gas flow, and drift tube heaters are turned on and impactor position will match its setpoint. The signal output will now be displayed. The Operation screen will display signal output in mV, and screen key options **[Edit]**, **[Menu]**, **[Standby]**, and **[Zero]** will be available.

Operation Screen in 'Run' Mode



NOTE: Press 'Enter' at any time from the Operation screen to list error messages. Refer to Section 5.1, Operation Error Messages, for error message descriptions and solutions.

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3.7 MENU SCREEN

The <<Menu>> screen is accessed through the Operation screen by pressing the **[Menu]** screen key. It offers the following options:

```
                    <<Menu>>

 1. Method
 2. Configuration
 3. Diagnostics


 [Exit]
```

1. **Method:** Brings you to the <<Method>> screen for method options.
2. **Configuration:** Brings you to the <<Configuration>> screen for configuration options.
3. **Diagnostics:** Brings you to the <<Diagnostics>> screen for diagnostic options.

Press 1, 2, or 3 to select one of the above options.
Press **[Exit]** to return to the Operation screen.

3.8 SETTING UP A RUN

To Set Up a Run You Will Need To:

1. Load the desired method.

Choose from the following method options:

- ***Select a previously saved method***
- ***Edit an existing method***
- ***Create a new method.***

Refer to Section 3.10, Method Options, for details.

2. Configure the instrument.

Set the following non-method dependent parameters:

- ***Audio Alarm***
- ***Full-Scale Voltage***
- ***Fault Relay Override.***

Refer to Section 3.12, Configuration Options, for details.

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3.9 METHOD SCREEN

Press 1 from the <<Menu>> screen to bring up the <<Method>> screen. It offers the following options:

```
<<Method>>

1. Select Method
2. Edit Method

[Menu]
```

1. **Select Method:** Select from a list of up to ten previously saved methods.
2. **Edit method:** Edit a previously existing method or create a new method.

Press 1 or 2 to select one of the above options.
Press **[Menu]** to return to the <<Menu>> screen.

3.10 METHOD OPTIONS

3.10.1 SELECT A PREVIOUSLY SAVED METHOD

Press 1 from the <<Method>> screen to choose the Method option. This will bring up the <<Method List>>screen:

```
<<Method List>>

0. METHOD A
1. METHOD B
2. METHOD C
3. METHOD D
4. METHOD E

[Menu]    [More]
```

From the <<Method List>> screen, you may select from up to ten previously saved methods. Method numbers 0 through 4 are displayed on the first screen. Press **[More]** to reach method numbers 5 through 9. Press **[More]** again to return to method numbers 0 through 4.

Press the number of the desired method, and a <<Confirmation>> screen will appear:

```
<< Confirmation>>

Number: 0
Name: METHOD A
Temperature: 70.0 °C
Gas Flow: 1.9 L/min
Gain: 1
Impactor: Off

[OK]    [Cancel]
```

Press **[Cancel]** to cancel loading this method, and you will return to the <<Method List>> screen with the original method loaded.
Press **[OK]** to accept this method, and you will return to the Operation screen with the new method loaded.

NOTE: After the new method is loaded, the instrument will enter the Operation screen in the same mode it was in prior to loading the method. If the unit was in 'Standby' when the new method was accepted, it will remain in 'Standby' until you press [Run]. If the unit was in 'Run' mode prior to loading the new method, the new method will run immediately after loading the new method.

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3.10.2 EDIT AN EXISTING METHOD

Methods are edited through the <<Edit Method>> screen. To access this screen:

1. Press 2 from the <<Method>> screen, OR
2. Press **[Edit]** from the Operation screen while in 'Run' mode.

The <<Edit Method>> screen will display the currently loaded method:

```
                <<Edit Method>>
1. Method Number:    0
2. Method Name:      METHOD A
3. Tube Temp:        70.0 °C
4. Gas Flow:         1.9  L/min
5. Gain:             1
6. Impactor:         Off
[Cancel]    [Menu]    [Save]    [Run]
```

Press the number corresponding to the parameter you want to change:

1. **Method Number:** Press 1 to change the method number, and the current value will flash. Select the new method number, using any number between 0 and 9. Press **'Enter'** to accept, and the new value will be listed in the method, or press ' * ' (asterisk) to cancel the change, and the original value will return in the method.
2. **Method Name:** Press 2 to change the method name. This will bring up the <<Edit Name>> screen:

```
                <<Edit Name>>
Press Enter when name is completed.
Name:
ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890
  [<=]        [=>]        [Accept]    [Back]
```

Use the arrow keys to move the cursor to the desired letter, number, or space (position between Z and 1). Press **[Accept]** to select a character. Press **[Back]** to remove the most recently selected character. Method names can contain up to 18 characters (numbers, letters, and spaces). Press **'Enter'** when you have completed the method name, and a <<Confirmation>> screen will appear:

```
              <<Confirmation>>
New Name:  METHOD A


[OK]          [Cancel]
```

Press **[OK]** to accept the new name, and the <<Edit Method>> screen will appear with the new method name listed.
Press **[Cancel]** to reject the new name, and the <<Edit Method>> screen will reappear with the original name intact.

3. **Tube Temperature:** Press 3 to change the drift tube temperature, and the current setpoint will flash. Enter the new temperature setting using the numeric keys. The allowable drift tube temperature range is 25° - 120°C. Press **'Enter'** to accept, and the new setpoint will be listed in the method; or press ' * ' (asterisk) to cancel the change, and the original setpoint will return in the method.
4. **Gas Flow:** Press 4 to change the gas flow rate, and the current setpoint will flash. Enter the new gas flow rate using the numeric keys. Gas flow rates from 0 to 4.0L/min are allowed and values outside of this range will not be accepted. Press **'Enter'** to accept the change, and the new value will be listed in the method, or press ' * ' (asterisk) to cancel the change, and the original value will return in the method.
5. **Gain:** Press 5 to change the gain setting, and the current setpoint will flash. Press 5 repeatedly until the desired value is displayed, from a choice of 1, 2, 4, 8, or 16. Press **'Enter'** to accept the change, and the new value will be listed in the method, or press ' * ' (asterisk) to cancel the change, and the original value will return in the method. Each increase in gain value will produce a twofold signal amplification over the previous value.
6. **Impactor:** Press 6 to change the impactor position, and the current setting will flash. Press 6 to toggle between the 'Off' and 'On' positions until you reach the desired setting. Press **'Enter'** to accept the change, and the new setpoint will be listed in the method; or press ' * ' (asterisk) to cancel the change, and the original setpoint will return in the method.

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CANCELING METHOD CHANGES

Press **[Cancel]** from the <<Edit Method>> screen to cancel ALL method changes made in the current editing session, and you will return to the <<Menu>> screen with the original method settings intact.

SAVING METHOD CHANGES

You may press **[Save]**, **[Run]**, or **[Menu]** from the <<Edit Method>> screen to activate the method change(s):

Press **[Save]** to **permanently** save these changes to the method. The Operation screen will then appear with the new settings.

Press **[Run]** to make **temporary** changes to the method. The Operation screen will then return with the new settings listed, and the method name will now have an asterisk in front of it to indicate that the changes are temporary. Temporary changes will not be saved if the method is reloaded or if the unit has been powered off and on.

Press **[Menu]** to **permanently** save these changes to the method and then go directly to the <<Menu>> screen. Refer to Section 3.7, Menu Screen, for details on using the <<Menu>> screen.

3.10.3 CREATE A NEW METHOD

Create a new method by saving the new method name, number, and parameter settings over a previously existing method. Follow the instructions in Section 3.10.2, Edit an Existing Method.

3.11 CONFIGURATION SCREEN

Press 2 from the <<Menu>> screen to access the <<Configuration>> screen:

```
<<Configuration>>

1. Audio Alarm:            Off/On
2. Full-Scale Voltage:     10mV/1000mV
3. Fault Relay Override:   Off/On


[Menu]
```

1. **Audio Alarm:** Set audio alarm. If activated, an audio alarm will sound whenever an operation error occurs on the instrument.
2. **Full-Scale Voltage:** Set full-scale voltage to either 10mV or 1000mV, depending on your data collection system.
3. **Fault Relay Override:** Set the fault relay override. In the 'On' position, the fault relay will be disabled and the pump flow will not shut down when operation errors occur. In the 'Off' position, the fault relay is active. This function is useful during equilibration and method optimization.

Press 1, 2, or 3 to select one of the above options.
Press **[Menu]** to return to the <<Menu>> screen.

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3.12 CONFIGURATION OPTIONS

3.12.1 SET AUDIO ALARM

Press 1 on the <<Configuration>> screen to toggle the audio alarm between the 'Off' and 'On' settings until you reach the desired setting.

In the 'On' position, the audio alarm will be triggered whenever operation errors occur on the detector while it is in the 'Run' mode. The error(s) must be remedied in order to deactivate the alarm. The total number of errors is displayed on the operation screen, and error details can be checked by pressing **'Enter.'**

In the 'Off' position, the audio alarm will not be triggered when operation errors occur.

3.12.2 SELECT FULL-SCALE VOLTAGE

Press 2 on the <<Configuration>> screen to toggle between the 10mV and 1000mV full-scale voltage settings until you reach the desired setting. The correct setting will depend on the data collection system that is used.

If output exceeds 999.9mV, signal output will read 'HI'. If output drops below -99.9mV, signal output will read 'LO'.

NOTE: The detector can output a maximum of 2500mV, as your data system permits.

3.12.3 SET FAULT RELAY OVERRIDE

Press 3 from the <<Configuration>> screen to toggle between the 'Off' and 'On' settings for the fault relay override until you reach the desired setting.

In the 'On' position, the fault relay function will be disabled, and operation errors will not turn off the pump flow. This feature is useful when you want to change operating conditions and do not want to trigger the fault relay while the instrument equilibrates.

In the 'Off' position, the fault relay will be active, and the pump flow will be stopped whenever an operation error occurs on the ELSD 2000ES.

NOTE: The proper wiring must be connected for fault relay to function. Refer to Section 2.4, Making Electrical and Fluid Connections, for details.

3.13 DIAGNOSTICS

Refer to Section 5, Diagnostics and Troubleshooting, for information on using diagnostic functions.

4. ROUTINE OPERATION

4.1 SAFETY

Please use the following guidelines to insure safe operation of the ELSD 2000ES:

1. KEEP LABORATORY WELL-VENTILATED to prevent buildup of vaporized solvent.
2. USE A FUME HOOD or other ventilation device to prevent the inhalation of any solvent fumes expelled through the exhaust tube.
3. AVOID OPEN FLAMES AND SPARKS when using flammable solvents.
4. USE AN INERT GAS, preferably nitrogen, to nebulize mobile phases containing organic solvents.
5. DO NOT REMOVE THE COVER of the instrument unless instructed to you by an Alltech representative.
6. ALWAYS POWER OFF before removing the cover.

CAUTION: Inside parts can be hot.

WARNING: LASER RADIATION - Avoid exposure to beam - Class IIIB laser product.

7. DANGER: Avoid direct eye exposure to laser light.
8. USE FAULT RELAY to prevent operation of the ELSD 2000ES under undesirable conditions.

CLASS 1 LASER PRODUCT

Contains a class 3B 30mW-650nm laser. Designed to comply with 21CFR 1040.10, 1040.11, and IEC60825 with amendments as of date of manufacture.

No user serviceable components inside. Refer servicing to qualified personnel.

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4.2 OPERATION NOTES

1. Monitor the liquid level in the 500mL drain waste container during Impactor 'On' mode and remove excess liquid when necessary. Or, submerge the drain tube in a large container at floor level so that you do not have to decant excess liquid as often. There is no need to check the waste container during Impactor 'Off' applications, since no liquid will be draining.

NOTE: Only the 500mL drain container provided can be positioned at bench level. Larger containers must be placed at floor level.

2. Mobile phase should not be flowing when the drift tube is not at proper vaporization temperature or when the nebulizer gas is turned off. Otherwise you may get liquid buildup in the drift tube.
3. IMPORTANT: Only volatile buffers are allowed in the mobile phase. Non-volatile buffer particles will be viewed as sample by the detector, causing unwanted baseline noise. Refer to Section 6.4, Volatile Mobile Phase Modifiers, for a list of suitable buffers.
4. Check the exhaust line and condensate trap daily. Dispose of condensate, if necessary. Do not allow the bottle to become full, as this will cause the exhaust gas to bubble through the condensate creating excess noise.

4.3 IMPORTANT OPERATING PARAMETERS

Ideal performance of the ELSD 2000ES is obtained by choosing the best settings for an application. Nebulizer gas flow rate, mobile phase flow rate, drift tube temperature, and impactor position are parameters that must be optimized for best results. The following paragraphs describe each parameter and provide suggestions on selecting the proper settings:

1. **IMPACTOR POSITION:** The correct impactor position for an application will depend on the mobile phase composition and flow rate, and on the volatility of the analyte. Achieving the proper balance between sensitivity and adequate mobile phase evaporation is the key.

   The **Impactor 'Off'** setting is best for the analysis of non-volatile compounds with low flow rate/highly aqueous mobile phases (1.0mL/min or less), or highly organic mobile phases. This setting provides maximum sensitivity by allowing the entire sample stream to reach the optical cell.

   The **Impactor 'On'** setting is best for analyzing compounds with high flow rate/highly aqueous mobile phases, and for the analysis of semi-volatile compounds. With the Impactor 'On', a portion of the sample stream is diverted to the drain tube. This results in adequate mobile phase evaporation at flow rates up to 5.0mL/min, including steep gradients. The Impactor 'On' setting is ideal for the analysis of semi-volatile compounds because it allows the use of significantly lower drift tube temperatures for greater sensitivity.

NOTE: The Impactor 'On' setting should be used with highly organic mobile phases only when the analyte is semi-volatile. Otherwise, sensitivity will be unnecessarily reduced.

   The impactor position that you choose will greatly affect the settings for all other parameters. See the following sections for details.

2. **NEBULIZER GAS FLOW RATE:** The nebulizer gas flow rate determines the size of the droplets formed during nebulization. Higher gas flow rates produce smaller droplets, which evaporate more easily than larger droplets. On the other hand, smaller droplets scatter less light and therefore will produce smaller signals than large droplets. You will need to experiment to determine the gas flow rate that will produce the best signal to noise ratio (S/N). Selection of the proper gas flow rate will be largely dependent on your impactor setting:

   Impactor 'Off': The lowest possible gas flow rate needed for effective nebulization will produce the largest signal. Refer to **Table 1** for the gas flow rate recommended for Impactor 'Off' applications.

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Impactor 'On': The gas flow rates used for Impactor 'On' mode will generally be lower than flow rates used for Impactor 'Off' mode. Gas flow rates will usually be about 2.2L/min or less for mobile phase flow rates of 1.0mL/min. Higher mobile phase flow rates may require higher gas flow rates. If the gas flow rate is set too high, more droplets will get past the impactor then can be evaporated in the drift tube at that temperature. This results in a noisy baseline. If the gas flow rate is set too low, the droplets created will be too large and there will be increased sample loss through impaction. This results in decreased sensitivity. Refer to Section 4.7, Optimization Procedure, for details on optimizing the gas flow rate for Impactor 'On' applications.

3. **MOBILE PHASE FLOW RATE:**
Impactor 'Off': The Impactor 'Off' setting is effective for highly organic mobile phases at flow rates up to 1.5mL/min, and for highly aqueous mobile phases up to 1.0mL/min. Higher mobile phase flow rates will require higher gas flow rates and higher drift tube temperatures. It is therefore advantageous to use the lowest possible mobile phase flow rate.

Substitution of a smaller bore column for your standard 4.6mm ID column will permit the use of lower solvent flow rates without affecting retention times. For example, a flow rate of 0.2mL/min with a 2.1mm ID column is equivalent to a 1.0mL/min flow rate with a 4.6mm ID column. Smaller bore columns will also provide an increase in sensitivity over standard size columns due to decreased sample dilution.

Impactor 'On': The Impactor 'On' mode can be used with mobile phase flow rates up to 5.0mL/min, including mobile phases that are highly aqueous and/or have steep gradients.

4. **DRIFT TUBE TEMPERATURE:** The proper drift tube temperature setting will be based on mobile phase volatility and flow rate, nebulizer gas flow rate, and analyte volatility. Drift tube temperatures can be selected from 25° - 120°C in 1° increments. The impactor setting you have selected for your application will reflect these parameters:

Impactor 'Off': Aqueous solvents and volatile buffers require higher drift tube temperatures than organic solvents for evaporation. Higher mobile phase flow rates also require higher drift tube temperatures than lower mobile phase flow rates. Lower gas flow rates produce larger droplets and therefore will require higher drift tube temperatures for mobile phase evaporation. Drift tube temperatures for Impactor 'Off' mode are generally higher and have a greater range than those used for Impactor 'On' mode. Refer to **Table 1** for recommended starting temperatures for Impactor 'Off' mode.

NOTE: If the drift tube temperature setting is too high, a noisy baseline will result. The solvent can boil in the nebulizer and cause poor nebulization.

NOTE: When running a gradient, optimize the parameters for the mobile phase portion which is the most difficult to vaporize.

Impactor 'On': Impactor 'On' applications will require lower drift tube temperatures than the Impactor 'Off' mode, generally about 50°C or lower. A temperature of 40°C is usually sufficient for evaporation of a highly aqueous mobile phase at 1.0mL/min. Higher mobile phase flow rates may require higher temperatures. Semi-volatile compounds can be analyzed at even lower drift tube temperatures for better sensitivity. If the drift tube temperature is set too high, semi-volatiles may evaporate too readily. If the drift tube temperature is too low, a noisy baseline will result from inadequate evaporation of the mobile phase. Ideally, you should use the lowest temperature that can produce an acceptable, low-noise baseline without compromising sensitivity. Refer to Section 4.4.2 for information on selecting the proper drift tube temperature for Impactor 'On' mode.

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4.4 SELECTING INITIAL OPERATING CONDITIONS

To select initial operating conditions you must:

1. Select the best impactor setting for your application based on the following guidelines:

   Select **Impactor 'Off'** for analyzing non-volatile analytes with highly organic mobile phases at flow rates up to 1.5mL/min or aqueous mobile phases at flow rates up to 1.0mL/min.

   Select **Impactor 'On'** for analyzing semi-volatile compounds or for analyzing non-volatile analytes with highly aqueous mobile phases at higher flow rates, up to 5.0mL/min, including steep gradients.

2. Follow the correct procedure for your impactor setting from the next sections.

4.4.1 SELECTING INITIAL CONDITIONS FOR IMPACTOR 'OFF' MODE

Use **Table 1** below as a guide for choosing initial ELSD operating conditions for Impactor 'Off' applications. This table provides recommendations for standard 4.6mm ID columns with mobile phase flow rates of 1.0mL/min. Some experimentation will be necessary to determine the optimum temperature and gas flow rates. Refer to Section 4.7, Optimization Procedure, for more information.

INITIAL ELSD OPERATING CONDITIONS: IMPACTOR 'OFF' MODE

Solvent 1mL/min	Drift Tube °C	Gas Flow L/min
Acetone	30	0.6
Acetonitrile	70	1.7
Chloroform	40	1.5
Heptane	50	1.5
Hexane	40	1.6
Isopropyl Alcohol	55	1.7
Methanol	60	1.6
Methylene Chloride	50	1.6
Tetrahydrofuran (stabilized)	60	1.7
Tetrahydrofuran (unstabilized)	40	1.6
Water	115	3.2
Methanol:Water (90:10)	75	2.0
Acetonitrile:Water (75:25)	80	2.0

Table 1

HIGHER OR LOWER MOBILE PHASE FLOW RATES

The recommended starting conditions in Table 1 are for mobile phase flow rates of 1.0mL/min with a standard 4.6mm ID column. Lower mobile phase flow rates and smaller bore columns may require much lower gas flow rates and drift tube temperatures. Higher mobile phase flow rates or highly buffered mobile phases may require higher gas flow rates and drift tube temperatures. Refer to Section 4.7, Optimization Procedure, for details.

MOBILE PHASES WITH MULTIPLE SOLVENTS

Calculate the starting temperature and starting gas flow rate using the values in **Table 1** in the same ratio as the mobile phase solvents. For example, when running a binary mobile phase of 60% methanol and 40% water, the drift tube temperature would be (0.60)(60) + (0.40)(115) = 82°C. The gas flow rate would be (0.60)(1.6) + (0.4)(3.2) = 2.2L/min.

GRADIENT SEPARATIONS

Choose operating conditions based on the least volatile portion of the mobile phase when performing gradient separations.

UNLISTED SOLVENTS

For any solvents not listed in Table 1 please refer to the solvent's boiling point and vapor pressure in a reference book such as the Merck Index or Handbook of Chemistry and Physics. Use the temperature and gas flow rate of the solvent listed in **Table 1** that most closely matches the boiling point and vapor pressure of the solvent of interest. If you are using a solvent with a boiling point higher than 100°C, the mobile phase flow rate must be reduced and/or the gas flow rate increased. The maximum operating temperature of the detector is 120°C. Solvents that boil above 120°C can only be used at very low flow rates, less than 0.5mL/min.

NOTE: Table 1 is only to be used in the selection of conditions for Impactor 'Off' mode.

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4.4.2 SELECTING INITIAL CONDITIONS FOR IMPACTOR 'ON' MODE

Impactor 'On' applications require a different approach. Use **Table 2** below as a guide for selecting initial conditions for this impactor setting:

INITIAL ELSD OPERATING CONDITIONS: IMPACTOR 'ON' MODE			
Analyte Composition	**Mobile Phase Composition**	**Drift Tube Temperature**	**Gas Flow Rate**
Non-volatile	Highly Aqueous and/or Steep Gradient	40°C	1.5L/min
Semi-volatile	Usually Organic	30°C	1.5L/min

Table 2

HIGHER MOBILE PHASE FLOW RATES

Use the starting conditions in **Table 2** for all mobile phase flow rates. Higher flow rates may require higher drift tube temperatures and higher gas flow rates. Refer to Section 4.7, Optimization Procedure, for details.

MULTIPLE SOLVENTS/GRADIENTS

Impactor 'On' applications do not require any special calculations for determining drift tube temperature and gas flow rate. The effects of individual solvent volatility are not as great for Impactor 'On' applications as they are for Impactor 'Off' applications. Use the recommendations in **Table 2** as a starting point regardless of the exact mobile phase composition. Refer to Section 4.7, Optimization Procedure, for details.

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4.5 START-UP SEQUENCE

1. Set up the unit as described in Section 2.4, Making Electrical and Fluid Connections. Remember to connect the fault relay, if desired.
2. Turn on the nebulizer gas supply. Set the regulator between 65 and 80psig.
3. Turn the ELSD 2000ES power switch on.
4. When the Operation screen appears, set up the desired method and configuration as indicated in Section 3.10, Method Options, and Section 3.12, Configuration Options.
5. Activate the method by pressing **[Run]**.
6. Allow the drift tube temperature to reach its setpoint.
7. Record a gas-only baseline for 10-15 minutes. Observe the signal output displayed on the front panel and on the chromatogram. You should get a stable, low-noise baseline. The noise should be in the millivolt range, ± 0.5mV.
8. If the baseline is unstable and/or drifting, the unit may have not reached its temperature setpoint. In the Impactor 'On' mode, only the drift tube temperature zone is heated. You can monitor the drift tube temperature directly through the front panel. In the Impactor 'Off' mode, there are two heated zones, the drift tube zone and the nebulizer zone. Both zones must reach the drift tube temperature setpoint. You can monitor both temperatures using the <<Manual Control>> screen.

NOTE: When switching from the Impactor 'Off' mode to the Impactor 'On' mode, it may take time for the nebulizer zone temperature to drop and reach equilibrium. Typically the nebulizer zone reaches equilibrium at 12-20°C. In this case, you can use the <<Manual Control>> screen to monitor the nebulizer zone temperature.

9. If the noise is higher than expected, you may want to perform the optics test to determine if there is a possible laser or electronics problem. Refer to Section 5.3.1, Optics Test, for details.
10. Flush the column with mobile phase before connecting it to the detector. The length of purging will depend on how long the column was in storage and what type of sample and mobile phase were used. It is very important that the column is free from silica "fines" or other contaminants before connecting to the ELSD. The ELSD 2000ES will detect the contaminants with great sensitivity.
11. After flushing the column, connect it to the LIQUID INLET on the left side panel of the detector. The tubing between the column and the nebulizer should be as short as possible. 0.005" ID inlet tubing is recommended.
12. Turn the pump on to the desired flow rate. Do not exceed the recommended maximum solvent flow rates.
13. Check connections for leaks and tighten the fittings, if necessary.
14. Observe the signal output on the display and the recorded baseline. After an initial rise when the pump is turned on, the signal level should drop close to the "gas only" level after several minutes. If it remains high after sufficient equilibration time, the mobile phase may be contaminated (column fines, buffers, etc.), or the temperature or gas flow settings may be too low for optimal evaporation of the mobile phase. Take corrective measures and allow the system to re-equilibrate for a few minutes.
15. You are now ready to inject your samples. The first time you use the ELSD 2000ES, you may want to reproduce the ELSD 2000ES QC procedure listed in the performance documents sent with the unit.

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4.6 SHUTDOWN SEQUENCE

1. Turn off the mobile phase flow.
2. Allow gas only to flow for approximately five minutes to clear any remaining droplets.
3. Press **[Standby]** from the Operation screen to put the unit into 'Standby' mode.
4. Turn off the gas supply at the source, if required.
5. Turn off the main ELSD power switch (bottom left on rear panel), if desired.

NOTE:

- **The last method in use before shutdown will reappear when the unit is powered up. Any temporary method changes will be lost, and only the original settings for the method will be listed.**
- **If the ELSD will not be used for several days, disconnect the column from the nebulizer inlet. Flush the column before reconnection.**
- **Instrument power may be left on without problem when the instrument is not in use. The laser may be turned off by putting the detector into 'Standby' mode.**

4.7 OPTIMIZATION PROCEDURE

Follow the optimization procedure based on the impactor setting used for your application:

4.7.1 OPTIMIZATION FOR IMPACTOR 'OFF' MODE

Drift Tube Temperature

1. Set the gas flow rate and drift tube temperature for your application as recommended in **Table 1**.

NOTE: If you are working with a flow rate below 1mL/min, the optimal drift tube temperature may be lower than the recommended temperature. If you are using a flow rate above 1mL/min the optimal temperature may be above the recommended temperature.

2. Monitor the baseline noise of the detector with gas and mobile phase flowing through your column.
3. If the baseline remains noisy after sufficient equilibration time, increase the drift tube temperature in 5°C increments from the recommended temperature and observe the change in baseline noise.
4. Once you achieve an acceptable baseline, decrease the temperature in 1°C increments until the baseline noise increases.
5. The optimal drift tube temperature will be the lowest temperature that will produce an acceptable, low-noise baseline.

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Gas Flow Rate

1. Set the drift tube to the optimal temperature determined from the procedure above.
2. Set the gas flow rate to the value recommended in **Table 1**.

NOTE: If you are using mobile phase flow rates below 1mL/min, the optimal gas flow rate may be lower than the recommended flow rate. If you are using mobile phase flow rates above 1 mL/min, the optimal gas flow rate may be above the recommended flow rate.

3. Start mobile phase flow and allow system to equilibrate.
4. Inject your sample and obtain peak areas for each of the components. Choose a sample concentration that allows you to see a peak that is on-scale with baseline noise.
5. Increase and decrease the gas flow rate by 0.2 L/min increments from the recommended setpoint and observe the change in peak area with each change.
6. Continue to reduce the gas flow rate and measure the resulting peak area until the baseline becomes unacceptably noisy.
7. The optimal gas flow rate will be the lowest flow that will produce the largest peaks with an acceptable, low-noise baseline. This can be determined by calculating the signal-to-noise ratio after each gas flow rate change. Plot the signal-to-noise ratio vs. peak area to help in identifying the optimal gas flow rate.

NOTE: Optimal conditions will need to be determined any time changes in mobile phase composition or flow rate are made.

4.7.2 OPTIMIZATION FOR IMPACTOR 'ON' MODE

Impactor 'On' applications require a different approach for optimization than Impactor 'Off'.

Drift Tube Temperature/Gas Flow Rate

1. Set the drift tube temperature to 40°C for non-volatile analytes and 30°C for semi-volatile analytes, and start with the gas flow rate set to 1.5L/min as a starting point.
2. Start mobile phase flow and allow system to equilibrate.
3. Increase the drift tube temperature by 1°C increments if necessary until adequate evaporation of the mobile phase is achieved (indicated by a stable baseline).
4. Inject your sample and obtain peak areas for each of the components. Choose a sample concentration that allows you to see a peak that is on-scale with baseline noise.
5. Change the gas flow rate in 0.2L/min increments from the recommended setpoint and observe the change in peak area with each change.
6. The optimal gas flow rate will produce the largest peaks with the lowest amount of baseline noise. Plot the signal-to-noise ratio vs. peak area to help in identifying the optimal gas flow rate.

NOTE: Settings will need to be re-optimized when any changes in mobile phase composition or flow rate are made.

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5. DIAGNOSTICS AND TROUBLESHOOTING

5.1 OPERATION ERROR MESSAGES

The 'Operation' screen will list the total number of operation errors currently occurring on the instrument. Press 'Enter' from the 'Operation' screen at any time to display error messages. The following table lists possible error messages with their causes and solutions:

OPERATION ERRORS

ERROR	WHEN OCCURS	POSSIBLE CAUSES	SOLUTIONS
Drift tube temperature error.	Drift tube temperature reading is more than 10°C (+/-) off its setpoint.	Drift tube temperature has not reached its setpoint.	Wait for drift tube temperature to reach its setpoint.
Nebulizer temperature error.	Nebulizer zone temperature is more than 10°C (+/-) off its setpoint. **NOTE:** This error can only occur during Impactor 'Off' mode, when this zone is programmed to reach the same temperature as the drift tube. The nebulizer zone is not heated during Impactor 'On' mode.	Nebulizer zone temperature has not reached its setpoint (Impactor 'Off' mode only). Possible heater or electronics error.	Wait for nebulizer zone temperature to reach its setpoint. Monitor nebulizer zone temperature through the <<Manual Control>> screen. Contact Alltech.
Gas flow error.	Gas flow reading is more than 0.3L/min (+/-) off its setpoint.	Gas source may be low or empty. Regulator pressure setting is too low. Nebulizer may be blocked. Possible gas flow sensor error or electronics error.	Check gas source and replace if necessary. Adjust regulator pressure to 65-80psig. Clean nebulizer. Refer to Section 6.5 for details. Contact Alltech if error persists.
Inlet gas pressure is low.	Inlet gas pressure is lower than 40 psig.	Regulator pressure setting is too low. Gas source may be low or empty. Possible gas pressure sensor error.	Adjust regulator pressure to 65-80psig. Replace gas source if necessary. Contact Alltech.
Optical sensor or pre-amp error.	Signal from the photodiode is too negative for proper analog-to-digital conversion inside the detector.	Optical sensor error or pre-amp electronics error.	Contact Alltech.

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5.2 DIAGNOSTICS OPTIONS

Several diagnostic functions are available for troubleshooting purposes. Press 3 on the <<Menu>> screen to bring up the <<Diagnostics>> menu:

```
<<Diagnostics>>

1. Diagnostic Tests
2. Manual Control
3. Error Log

[Menu]
```

It offers the following options:

1. **Diagnostic Tests:** Used to access the <<Diagnostic Tests>> menu.
2. **Manual Control:** Used to monitor the temperature of the drift tube and nebulizer zones during equilibration and also used during troubleshooting.
3. **Error Log:** Used to track operation errors that occur during a run.

Press 1, 2, or 3 to select one of the above options. Press **[Menu]** to return to the <<Menu>> screen.

5.3 PERFORMING DIAGNOSTIC TESTS

Several diagnostic tests are available to assist you in troubleshooting. Press 1 from the <<Diagnostics>> menu to bring up the <<Diagnostic Tests>> screen:

```
<<Diagnostic Tests>>

1. Optics Test
2. Nebulizer Gas Pressure Test
3. Flow Meter Test
4. Communication Test

[Menu]
```

1. **Optics Test:** Used to check laser functioning.
2. **Nebulizer Gas Pressure Test:** Used to check flow of gas through the nebulizer.
3. **Flow Meter Test:** Used to check functioning of the gas flow meter.
4. **Communication Test:** Used to check the functioning of the RS-232 wiring within the detector.

Press 1, 2, 3, or 4 to select a specific test from the above choices. Refer to Sections 5.3.1-5.3.4 for details on performing specific tests.

Press **[Menu]** to return to the <<Menu>> screen after all necessary diagnostic tests have been completed.

5.3.1 OPTICS TEST

1. Turn off mobile phase flow. Wait several minutes for system to equilibrate with only gas flowing.
2. Press 1 from the <<Diagnostic Tests>> menu to start the Optics Test, and the testing screen will appear:

```
System is checking optics. Please wait.

                    00:00:40
            Current     Max.      Min.
Laser off:
```

3. The test takes 40 seconds to complete and progress can be monitored on the screen timer. The following steps occur during the Optics Test:

   - *Laser is turned 'Off' and detector is allowed to stabilize.*
   - *Maximum signal, minimum signal, and average signal data are collected for laser 'Off'. During data collection, the current signal reading is listed under 'Current'. After data collection, the average signal value is displayed under 'Current'.*
   - *Laser is turned 'On' and detector is allowed to stabilize.*
   - *Maximum signal and average signal are recorded for laser 'On'.*
   - *The offset between laser 'On' and laser 'Off', and the amount of variation in laser signal are determined.*
   - *Results are then displayed.*

4. Passing requirements for the Optics Test are: laser on/off offset must be greater than 0.5mV and less than 30 mV, laser off stability must be within 1.5mV, and laser on stability must be within 1.5mV.

Example screen with pass results:

```
Test passed. Press any key to continue.

            Current    Max.     Min.
Laser off:    10.1      10.2     10.0 mV (sample values)
Laser on:     15.2      15.7          mV
Offset         5.1 mV
```

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OPTICS TEST RESULTS

RESULT	CAUSE	SOLUTION
Noise level at laser off is high.	Electronics error.	Contact Alltech.
Laser on offset is too large.	Optics and/or light trap may need cleaning. Electronics error.	Contact Alltech for cleaning details. Contact Alltech.
Offset between laser on/off is low.	Laser or other electronics error.	Contact Alltech.
Noise level at laser on is high.	Optics and/or light trap may need cleaning. Electronics error.	Contact Alltech for cleaning details. Contact Alltech.

6. Press any key to return to the <<Diagnostic Tests>> screen.

5.3.2 NEBULIZER GAS PRESSURE TEST

1. Check that the inlet gas pressure is set between 65 and 80psig before starting the test.
2. Turn off mobile phase flow. Wait several minutes for the unit to stabilize.
3. Press 2 from the <<Diagnostic Tests>> screen to start the Nebulizer Gas Pressure Test, and the testing screen will appear:

```
System is checking gas pressure at the nebulizer.  Please wait.

                    00:01:30
          Current     Max.      Min.
```

4. The test takes 90 seconds to complete and progress can be monitored on the screen timer. The following steps occur during the Nebulizer Gas Pressure Test:

- Gas flow is automatically turned on to 2.0L/min and the detector is allowed to stabilize.
- Maximum and minimum nebulizer gas pressure readings are taken. During data collection, the current gas pressure reading is listed under 'Current'. After data collection, the average nebulizer gas pressure for the entire testing period is displayed under 'Current'.
- The gas flow is returned to its pre-testing setpoint and the test results will then be displayed.

5. Passing requirements for the Nebulizer Gas Pressure test are: gas pressure minimum of 3 psig and a maximum of 30 psig, and pressure variation less than 0.3 psig during the testing period.

Example screen with pass results:

```
Test passed. Press any key to continue.

                 Current   Max.     Min.
Gas Pressure:    21.2      21.1     21.0 psig
```

6. If test does not pass, results screen will read "Test failed.", and then provide a more detailed error message. Refer to the following table, Nebulizer Gas Test Results, for possible fail messages and their solutions.

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NEBULIZER GAS PRESSURE TEST RESULTS

RESULT	CAUSE	SOLUTION
Gas pressure at nebulizer is too high.	Nebulizer may be blocked.	Clean nebulizer. Refer to Section 6.5 for cleaning details.
	Possible nebulizer gas pressure sensor error and/or other electronics error.	Contact Alltech.
Gas pressure at nebulizer is too low.	There may be gas leaks present before the nebulizer.	Check gas connections for leaks and tighten fittings if necessary.
	Gas source may be low or empty.	Check gas source and replace if necessary.
	Regulator pressure may be too low.	Adjust regulator pressure to 65-80psig.
	Possible nebulizer gas pressure sensor error and/or other electronics error.	Contact Alltech.
Gas pressure at nebulizer is unstable.	Nebulizer may be blocked.	Clean nebulizer. Refer to Section 6.5 for cleaning procedure.
	Inlet gas pressure is unstable.	Check stability of gas source and remedy if necessary.
	Gas flow meter error.	Contact Alltech.
	Nebulizer may need replacement.	Contact Alltech.

7. Press any key to return to the <<Diagnostic Tests>> screen.

5.3.3 FLOW METER TEST

1. Make sure the inlet gas pressure is set between 65 and 80psig before starting the test.
2. Turn on gas flow. Any flow rate up to 4.0L/min can be used. Wait several minutes for the unit to equilibrate.

NOTE: It is okay to leave mobile phase running, as long as current detector settings provide adequate evaporation.

3. Press 3 from the <<Diagnostic Tests>> screen to start the Flow Meter Test. The testing screen will then appear:

```
System is testing gas flow.  Please wait.

00:01:30
```

4. The test takes 90 seconds to complete and progress can be monitored on the screen timer. The following steps occur during the Flow Meter Test:
   - *Gas flow is turned 'On' and detector is allowed to stabilize.*
   - *Maximum and minimum gas flow rate values are collected over the testing period. During data collection, the current gas flow rate reading is listed under the 'Current' heading. After data collection, the average gas flow rate is displayed under the 'Current' heading.*
   - *The test results will then be displayed.*
5. Passing requirements for the Flow Meter Test are: gas flow must be at least 0.1L/min and should not fluctuate more than 0.2L/min during the testing period.

   Example screen with pass results:

```
Test passed. Press any key to continue.

                 Current   Max.    Min.
Gas flow rate:     2.0     2.0   2.0L/min
```

6. If the test fails, results screen will read "Test failed.", and then provide a more detailed error message. Refer to the following table, Flow Meter Test Results, for possible fail messages and their solutions.

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FLOW METER TEST RESULTS

RESULT	CAUSE	SOLUTION
There is no gas flow at nebulizer.	Gas inlet on the nebulizer is blocked.	Contact Alltech.
	Gas supply is empty or valve is closed.	Check gas supply and remedy if necessary.
	Gas leaks present before the gas flow sensor.	Contact Alltech.
Gas flow at nebulizer is unstable.	Unstable inlet gas pressure.	Check stability of gas source and remedy if necessary.
	Gas flow meter error.	Contact Alltech.
	Nebulizer may need replacement.	Contact Alltech.
Gas flow does not match the setpoint.	Gas supply is low or empty.	Check gas supply and replace if necessary.
	Blockage in gas line before the detector.	Check gas line for blockage remedy/replace as necessary.

7. Press any key to return to the <<Diagnostic Tests>> screen.

5.3.4 COMMUNICATION TEST

NOTE: The Communication Test only checks the RS-232 wiring inside the detector and nowhere beyond it.

1. Short out pins 2 and 3 on the RS-232 port on the rear panel of the unit. Contact Alltech if you need assistance.
2. Press 4 on the <<Diagnostic Tests>> screen to perform a Communication Test.
3. The <<Communications>> screen will then appear with the test results.

Example Screen with pass results:

```
<<Communications>>

Sent:
Test OK

Received:
Test OK

[Exit]
```

4. Sent/Received results messages will read "Test OK" if RS-232 communications are working fine. Any other message indicates a problem and Alltech should be contacted.
5. Press **[Exit]** to return to the <<Diagnostic Tests>> menu.

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5.4 MANUAL CONTROL SCREEN

The <<Manual Control>> screen is helpful during equilibration and troubleshooting. Press 2 from the <<Diagnostics>> screen to bring up the <<Manual Control>> screen:

```
<<Manual Control>>

1. Laser: On                          5.5 mV
2. Gas Flow: On          17.9 psi     2.0 L/min
3. Drift Tube Heater: On              52.0 °C
4. Nebulizer Zone Heater: On          52.0 °C
5. Optics Block Heater:               46.8 °C
6. Exhaust Tube Heater:               46.8 °C
     [Menu]
```

1. **Laser:** Off/On
   Press 1 to toggle between laser 'Off' and 'On'. The offset between laser 'On' and laser 'Off' should be within 30mV. Perform an Optics Test (see Section 5.3.1 for details) if you suspect a problem.
2. **Gas Flow:** Off/On
   Press 2 to toggle between gas flow 'On' and 'Off'. Also displays nebulizer gas pressure reading.
3. **Drift Tube Heater:** Off/On
   Press 3 to toggle between drift tube heater 'On' and 'Off'. Also displays current drift tube temperature.
4. **Nebulizer Zone Heater:** Off/On
   Press 4 to toggle nebulizer zone heater 'On' and 'Off'. Also displays current nebulizer zone temperature. The <<Manual Control>> screen is the only place to access the nebulizer zone temperature reading. This zone can not be set manually.
5. **Optics Block Heater:**
   Displays the current temperature reading of the optics block, which heats to 90% of the drift tube temperature set point. This heater cannot be toggled 'On' or 'Off'.
6. **Exhaust Tube Heater:**
   Displays the current temperature reading of the exhaust tube, which heats to 90% of the drift tube set point. This heater cannot be toggled 'On' or 'Off'.

Press **[Menu]** to return to the <<Menu>> screen when you are done using <<Manual Control>> screen.

NOTE: The <<Manual Control>> screen is not to be used for running the unit independently of a method. Method settings cannot be changed through the Manual Control screen. The instrument should be run from the Operation screen.

5.5 ERROR LOG

The Error Log is useful for tracking errors that occur during operation of the instrument. Press 3 from the <<Diagnostics>> screen to access the <<Error Logs>> screen:

```
<<Error Logs>>

No:    1  (Old record)
Type:  Gas flow error.
Level: 1
Time:  1:09:36

[Exit]      [Next]      [Previous]      [Delete]
```

Press **[Next]** to scroll to the next error log.
Press **[Previous]** to scroll to the previous error log.
Press **[Delete]** to clear the error details from a log.
Press **[Exit]** to return to the <<Diagnostics>> screen.

Each time an operation error occurs on the detector, an error log is created. There is room for ten logs. Each log lists the type of error (refer to Section 5.1, Operation Error Messages, for a list of possible errors), the error level (always 1), and the amount of time elapsed since powering up the detector. Error logs will not register until the unit has remained error-free for at least 5 minutes after running a method. Once an error is logged, no additional errors will be logged until the original error has been remedied and the detector has been allowed to operate for an additional five minutes without an error.

When all ten logs have been used, any additional error logs will begin saving over the old error logs. Each new overlapping record will be designated a 'New record' while each remaining log will be designated as an 'Old record'.

NOTE: Error logs will NOT be saved if the unit is powered off.

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5.6 DIAGNOSING BASELINE NOISE

There are many causes for baseline noise. Use the table below, Diagnosing Baseline Noise, to help identify the source.

Start diagnosing the noise at 'A' and work down the table until you determine the source of the baseline noise.

DIAGNOSING BASELINE NOISE

SYMPTOM	SOLUTION
A. Noise from Column • Column in-line • Mobile phase on • Nebulizing gas on • Laser on **Result:** • Noise disappears when column is removed.	**1.** The column may be leaking silica or packing material. Replace the column.
B. Noise from Mobile Phase • Column removed • Mobile phase on • Nebulizing gas on • Laser on **Result:** • Noise disappears when pump is stopped.	**1.** Current drift tube temperature and gas flow rate settings may not be providing adequate evaporation of the mobile phase. Re-optimize gas flow and/or drift tube temperature following the optimization procedure in Section 4.7. **2.** The nebulizer and/or drift tube may be dirty. Refer to Section 6.5 for cleaning procedures. **3.** The mobile phase may be contaminated with particulate matter. Filter current mobile phase or replace it with freshly prepared and filtered mobile phase. **4.** The mobile phase may contain excess air bubbles. Degas mobile phase. **5.** The pump may be the source. Check pump for pulsations. Make sure pump has been sufficiently purged to remove air. Incorporate pulse dampener into system if necessary. Examine pump check valve and seals and replace as necessary.
C. Noise from Gas • Column removed • Mobile phase off • Nebulizing gas on • Laser on **Result:** • Noise disappears when gas is turned off.	**1.** The gas supply may be contaminated with particulates. Replace with better quality/higher purity gas. **2.** The nebulizer, drift tube, and/or optics may need cleaning. Refer to Sections 6.5 for cleaning procedures. Contact Alltech for details on cleaning optics.
D. Noise from Flow Cell • Column removed • Mobile phase off • Nebulizing gas off • Laser on **Result:** • Noise disappears when laser is turned off.	**1.** The detector flow cell and/or laser optics may need cleaning. Contact Alltech for details. **2.** Check data cable for noise. **3.** Check light trap for condensation. Contact Alltech for details.
E. Noise from Electronics • Column removed • Mobile phase off • Nebulizing gas off • Laser off **Result:** • Baseline noise persists under the above conditions.	**1.** Possible electrical problem. Contact Alltech.

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5.7 TROUBLESHOOTING CHARTS

Consult the following charts to assist in troubleshooting your system:

TROUBLESHOOTING

PROBLEM	CAUSE	SOLUTION
Baseline drift	Detector has not fully equilibrated.	Wait for detector to fully equilibrate. Refer to Section 4.5, Start-Up Sequence, for equilibration procedure.
	Drift tube temperature not properly optimized.	Re-optimize drift tube temperature. Refer to Section 4.7, Optimization for details.
	Mobile phase mixing problem causing improper evaporation.	Correct mobile phase composition.
Baseline noise	Follow the procedure in Section 5.6, Diagnosing Baseline Noise, to determine the source of the problem and possible solutions.	
Spiking	Drift tube temperature and/or gas flow rate set too low.	Re-optimize drift tube temperature and gas flow rate following the optimization procedure in Section 4.7.
	Gas source contaminated or of low purity.	Use clean, dry, inert gas, usually 99.9% pure nitrogen.
	Mobile phase contaminated or made of low quality material.	Replace with fresh, filtered, higher-quality mobile phase.
	Drift tube and/or optical cell dirty.	Refer to Section 6.5 for drift tube cleaning procedure. Contact Alltech for details on cleaning optics.
	Improper nebulization.	Nebulizer may be partially obstructed. Refer to Section 6.5 for nebulizer cleaning procedure.
Drift tube and/or nebulizer zone(s) not reaching setpoint	Instrument is in 'Standby' mode.	Press **[Run]** on Operation screen to activate method conditions.
	Thermal fuse(s) may be blown.	Thermal fuse(s) must be replaced. Contact Alltech.
	Drift tube and/or nebulizer zone temperature sensor error(s) and/or other electronics error.	Drift tube and/or nebulizer temperature sensor(s) may need replacement. Contact Alltech.

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TROUBLESHOOTING

PROBLEM	CAUSE	SOLUTION
No mobile phase flow	Operation error(s) have occurred on the detector, triggering the fault relay to turn off pump flow.	Determine and fix the detector error, then restart pump flow.
	Mobile phase reservoir(s) are empty.	Refill reservoirs and purge pump.
	Leak(s) present.	Check system for loose fittings and tighten if necessary. Check pump seals and change if necessary. Check flow throughout system.
	Flow obstructed.	Replace tubing as necessary. Make sure mobile phase inlet filter is clean. Purge pump to remove any air present.
No gas flow	Gas source valve closed.	Open gas valve.
	Detector is in 'Standby' mode.	Press **[Run]** to activate method and start gas flow.
	Blocked nebulizer.	Clean nebulizer. Refer to Section 6.5 for nebulizer cleaning details.
	Source gas pressure too low.	Adjust source pressure to 65-80psig.
	Clogged inlet gas filter.	Replace filter. Contact Alltech.
	Gas source may be low or empty.	Check gas source. Replace if needed.
No power	Line unplugged.	Plug in power line.
	Wrong voltage selected.	Select correct voltage and change fuse. Refer to Section 6.6, Power Module Adjustments, for details.
	Blown Fuse.	Replace fuse. Refer to Section 6.6.2, Fuse Replacement, for details.
No LCD display	Electrical problem.	Contact Alltech.
No peak(s) detected	Sample is volatile at current detector conditions.	Use the Impactor 'On' setting with a lower drift tube temperature for semi-volatile compounds. Refer to Section 4.7, Optimization Procedure, for details.
	Compound is below the detection limit.	Increase sample concentration or injection volume and re-inject.
	Sample is being retained on column.	Try a different column for your separation.
	Detector has not been zeroed properly.	Re-zero the detector: Stop mobile phase flow and allow the baseline to settle. Press **[ZERO]** and then restart pump flow.

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TROUBLESHOOTING

PROBLEM	CAUSE	SOLUTION
No peak(s) detected (continued)	Impactor may not be set correctly.	Make sure you have chosen the correct impactor position for your application. Refer to Section 4.7, Optimization Procedure, for details.
	Impactor not turning properly.	Verify that current impactor position matches its setpoint: Stop mobile phase flow and remove the exhaust tube from the back of the detector. Examine the interior of the drift tube with a flashlight to check impactor position. Contact Alltech if position does not match setpoint.
	Gain set too low.	Increase gain value.
	Autosampler needle not pulling up sample properly, or sample loop blockage.	Repair or replace equipment as needed.
Change in peak height or loss in sensitivity	Dirty nebulizer and/or drift tube.	Clean nebulizer and/or drift tube. Refer to Section 6.5 for cleaning procedures.
	Detector settings changed.	Check drift tube temperature, gas flow, and impactor settings.
	Autosampler needle not pulling up sample properly, or sample loop blockage.	Repair or replace equipment as needed.
Broad peaks	Leak(s) (especially between the column and detector) present.	Check for loose fittings and tighten if necessary.
	Tubing between column and detector is too long or too large of an ID.	Use a shorter piece of 0.005 - 0.010" ID tubing.
Cut-off peaks	Sample concentration too high.	Decrease sample concentration until peaks are on-scale.
	Detector not zeroed properly.	Re-zero the detector: Turn off mobile phase flow and allow the baseline to settle. Press **[ZERO]**, then restart pump flow.
	Detector zeroed under improper nebulization settings.	Make sure drift tube, gas flow rate, and impactor settings are appropriate for your application. Re-optimize conditions if necessary. Refer to Section 4.7, Optimization Procedure, for details.
	Gain set too high.	Reduce gain value until peaks are on-scale.

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6. APPENDICES

6.1 SPECIFICATIONS

ELSD 2000ES SPECIFICATIONS	
Light Source:	Laser diode with collimating optics, 650nm, max output less than 30mW, Class IIIB
Product Class:	Class 1 laser product
Detector Element:	Silicon photodiode
Temperature Range:	Ambient to 120°C in 1°C increments
Nebulizer Gas:	Up to 4L/min, nitrogen preferred, 65psig min. pressure, 80psig max pressure
Mobile Phase Flow Rate:	0-5.0mL/min
Analog Outputs:	Selectable for either 0-1V or 0-10mV full scale
Communications:	**Remote Inputs:** TTL/ Contact closure-zero, gas on, gas off **Outputs:** Contact closure-fault relay; Serial (RS-232) I/O Windows™ based PC control
Operating Parameter Selection & Display:	Graphical LCD with alphanumeric keypad or Windows™ based PC control
Power Requirements:	120/240V, 50/60Hz 6/3A
Dimensions:	23.0" H x 12.5" W x 21.6" D (58.4cm H x 31.8cm W x 54.8cm D)
Weight:	35lbs (16kgs)
Environmental Operating Temperature:	18 to 35°C

6.2 REPLACEMENT PARTS

REPLACEMENT PARTS		
Part No.	**Qty.**	**Description**
600410A	1	Signal Cable
457025	1	Line Cord
50117	1	Open-End Wrench, 3/8"x 7/16"
1998	1	Open-End Wrench, 1/4" x 5/16"
50182	1	Ball Driver, 3/32" (long)
16459	1	Ball Driver, 3/32" (short)
600141A	1	Drift Tube Cleaning Brush
35852	1	Flex Connect Tubing, 6" x 0.005" ID
50186	1	Nebulizer Gas Supply Line
121947	1	Tygon® Tubing, 3/8" OD, 4'
FC302251	1	Fuse, 3A
FC602251	1	Fuse, 6A
600125	1	Waste Collection Bottle w/ Lid, 500mL
600517	1	SS Drain Tube
61002	1	3/8" SS Nut
61008	1	3/8" SS Ferrule
600100ESM	1	Operating Manual
600400A	1	Exhaust Trap Kit
600826	1	Laser
600509	1	O-Ring for Nebulizer
600514	1	Nebulizer
600140A	1	Lead Ring
600805A	1	ELSD 2000 Control CD-ROM
272106	1	RS-232 Cable for ELSD 2000
600101M	1	ELSD 2000 PC Control Operating Manual
600804	1	Light Trap Assembly

6.3 CONTACT INFORMATION

Alltech Associates, Inc.
2051 Waukegan Road
Deerfield, IL 60015 USA
Phone: (847) 948-8600
Fax: (847) 948-1078
Web Address: www.alltechWEB.com
Email: alltech@alltechemail.com
Technical Support:
1-800-33-SOLVE
techsupport@alltechemail.com
Ordering Information: 1-800-ALLTECH

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6.4 VOLATILE MOBILE PHASE MODIFIERS

VOLATILE BUFFERS AND MOBILE PHASE MODIFIERS					
	pKa	**pKb**	**pH Range**	**BP**	**MP**
Acids					
Trifluoroacetic Acid	0.3	13.70		72.4°C	
Formic Acid	3.75	10.25		100.7°C	
Acetic Acid	4.75	9.25		116.0°C	
Carbonic Acid	6.37	7.63		-	
Bases					
Ammonia	9.25	4.75		-33.35°C	
Methylamine	10.81	3.19		16.6°C	
Ethylamine	10.66	3.34		-6.3°C	
Triethylamine	11.01	2.99		89.3°C	
Buffers					
Ammonium Formate			3.0-5.0		120°C
Pyridinium Formate			3.0-5.0		
Ammonium Acetate			3.8-5.8		111°C
Pyridinium Acetate			4.0-6.0		
Ammonium Carbonate (used for reverse phase)			8.0 (adjusted)		
Ammonium Carbonate			5.5-7.5 and 9.3-11.3		
Ion-Pair Reagents					
Pentafluoropropionic Acid	~0.6			96-97°C	
Heptafluorobutyric Acid	~0.6			120°C	
Nonafluoropentanoic Acid	~0.6			140°C	
Pentadecafluorooctanoic Acid	~0.6			189°C	
Tridecafluoroheptanoic Acid	~0.6			175°C	

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6.5 ELSD 2000ES CLEANING PROCEDURE

6.5.1 OPTICS BLOCK, DRIFT TUBE, AND NEBULIZER CLEANING PROCEDURE

CAUTION: Use of controls, adjustments, or performance of procedures other than those specified herein may result in hazardous exposure to laser light.

Procedure Time: Approximately 1 Hour

Occasionally, the optics block, drift tube and nebulizer may require cleaning to remove any particulate buildup that has accumulated during use of the detector. Dirty components can cause excess noise and reduced sensitivity during your analyses. A dirty drift tube can sometimes be verified by looking straight down the drift tube with a flashlight (with mobile phase flow turned off).

The following materials will be needed to complete the cleaning procedures:

- *Long wire brush included in the accessory kit*
- *Hex ball driver, 3/32" (long), supplied in the accessory kit*
- *Phillips head screwdriver*
- *Two 1/4" x 5/16" open-end wrenches*
- *Sonicator bath*
- *HPLC-grade water*
- *HPLC-grade 50:50 methanol:water solution*

CAUTION: Class 3B laser radiation when open and interlocks defeated. Avoid exposure to beam.

1. Switch the instrument off and remove the power cord.
2. Disconnect any remaining electrical connections from the back of the ELSD, including the signal cable and any contact closure connections on the terminal strip.
3. Remove the exhaust elbow from the back of the instrument.
4. Remove the liquid line from the right side of the instrument.
5. After allowing the unit at least 30 minutes for internal cooling, remove the cover screws (4 on each side and 4 on the back).
6. Remove the ELSD cover by carefully sliding it toward the back of the instrument.

CAUTION: The optics block and exhaust tube may still be hot.

7. Cover the electrical boards with paper towels or other protective material to prevent damage from liquids.
8. To easily access the nebulizer it is necessary to remove the front panel. There are 4 inside screws on each side that hold the front panel to the instrument chassis. Remove the ribbon cable attached to the front panel and then remove the screws.
9. Carefully remove the front panel from the chassis and set aside.
10. In the lower front portion of the instrument, the nebulizer is held in place by a circular plate. There are 2 lines connected to the nebulizer; one for solvent, one for gas. Carefully remove the two lines using the ¼" wrench.
11. Use the hex ball driver to remove the two screws that hold the plate.
12. Remove the nebulizer from the drift tube using a twisting motion.
13. Remove the o-ring from the nebulizer and inspect for wear. If cracked, you will need to replace the o-ring (part no. 600509) after sonicating the nebulizer.
14. Place the nebulizer in a beaker filled with 50:50 methanol: water solution. Note: Do not sonicate the o-ring!
15. Sonicate the nebulizer in an ultrasonic bath for 10min.
16. If the nebulizer is blocked completely, connect a high-pressure air line to the nebulizer inlet to help remove the blockage.
17. If the nebulizer is permanently blocked or cannot be cleaned, a new nebulizer should be ordered (part no. 600514).
18. Place paper towels or other absorbent material under the drift tube where the nebulizer was removed and also under the liquid drain. Liquid will drip down the drift tube when cleaning and this will prevent it from leaking onto the counter.
19. With water, wet the wire brush provided in the accessory kit and carefully insert the brush into the drift tube from the exhaust outlet.

CAUTION: Be careful not to insert the brush too far, which could cause irreversible damage to the impactor.

20. Carefully clean the sides of the drift tube with the wire brush, loosening any particles that adhere to the drift tube. Suitable solvents can also be used if particles are not removed with water.
21. After cleaning, remove the wire brush and rinse the drift tube with water/solvent to remove any loose particles.

CAUTION: Be careful not to drip solvent on the internal components of the ELSD.

22. Next the light trap and optics block should be cleaned. Using two 5/16" wrenches, very carefully disconnect the sweep gas tubing from the light trap at the union. Refer to Figure 6.1 for details. Avoid contacting the sweep gas tubing's direct attachment to the light trap.
23. Using the hex ball driver, remove the 4 hex head screws connecting the light trap to the optics block and remove the light trap. Refer to Figure 6.1 for details. To clean, inspect the inside of the light trap for residue. Swab the inside of the light trap as necessary with a suitable solvent to clean any residue. The inside of the light trap should be black.

Warning: Do not swab with acetone, as this will remove the black coating from the inside of the light trap and optics block.

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24. With the light trap removed, the optics block can be accessed for cleaning. Inspect the inside of the optics block for residue. Swab the inside of the optics block with a suitable solvent to clean any residue. The inside of the optics block should be black.

25. Reattach the light trap and replace the 4 hex head screws. Make sure the light trap has the proper orientation so the magnetic interlock makes the proper connection. Refer to Figure 6.1 for details. Carefully reconnect the light trap sweep gas fitting.

26. Replace the nebulizer o-ring and insert the nebulizer back into the drift tube. Make sure the nebulizer is firmly in place.

27. Reattach the nebulizer plate using the hex head screws.

28. Replace the liquid and gas inlet lines to the nebulizer.

29. Replace the front panel. Secure the front panel and ground wire in place using the 4 screws on each side.

30. Reattach the ribbon cable to the front panel.

31. Replace the instrument cover and tighten the cover screws.

32. Attach the exhaust elbow and reconnect any electrical connections (signal cable, contact closure wires) to the back of the instrument.

33. Reconnect the power cable.

34. It is recommended to run nitrogen gas for approximately 15 minutes to dry out any residual cleaning solvent or water from the unit. For a high temperature flush, set the ELSD to run in Impactor Off mode with a temperature of 100°C and nitrogen flow of 2.0L/min. When the temperature reaches its set point, run HPLC-grade water at 1.0mL/min through the ELSD for 30 minutes. This will help remove any particles loosened from cleaning.

35. Resume normal operation of the unit. If the problem persists, continue troubleshooting with the manual or contact Alltech Technical Support at 1-800-33-SOLVE.

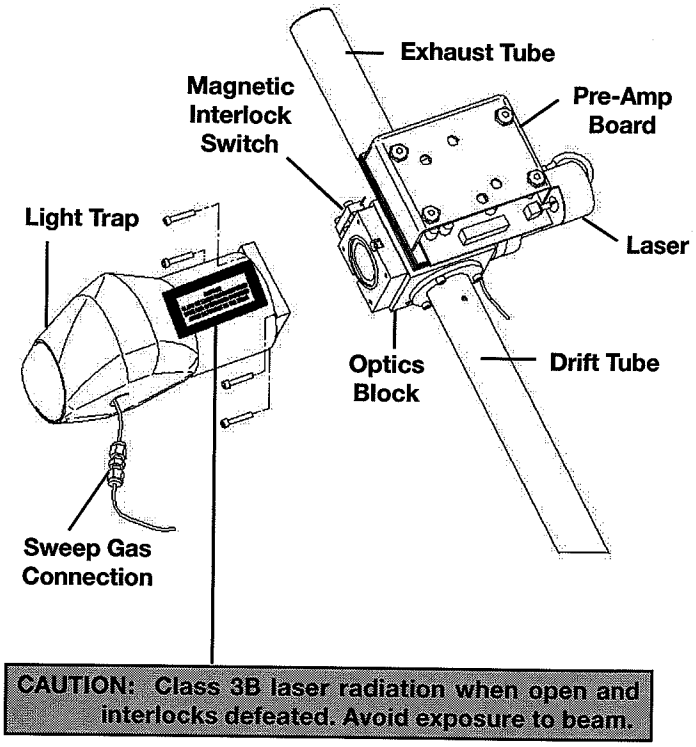


Figure 6.1

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6.6 POWER MODULE ADJUSTMENTS

CAUTION: Only suitably qualified personnel should carry out these adjustments.

6.6.1 CHANGING THE INPUT VOLTAGE

1. Power off the detector and unplug the power cord from the rear panel of the detector.
2. Insert the blade of a small screwdriver into the slot next to the power connector and gently pry open the fuse block.
3. Pull the fuse block straight out. See Figure 6.2.
4. Use tweezers or a pair of needle-nose pliers to pull the voltage selector card straight out.
5. Position the plastic voltage selector for the appropriate voltage as indicated in Figure 6.3.
6. Press the voltage selector back into place.
7. Press the fuse block back into place.

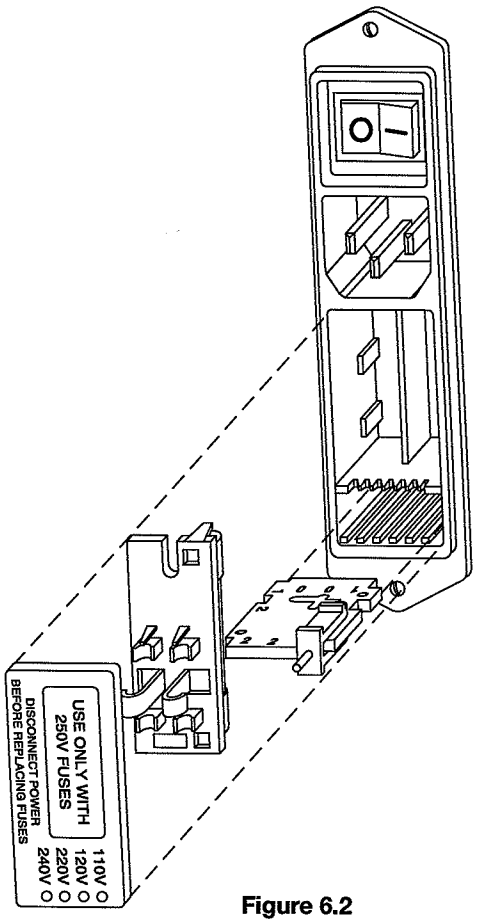


Figure 6.2

6.6.2 FUSE REPLACEMENT

1. Turn the detector power off and unplug the power cord.
2. Slide the fuse drawer out. See Figure 6.2.
3. Remove the blown fuse and replace with the new fuse. Be sure to use the appropriate fuse for your input voltage: 6A 250V for 120V, 3A 250V for 240V.
4. Replace the fuse block.

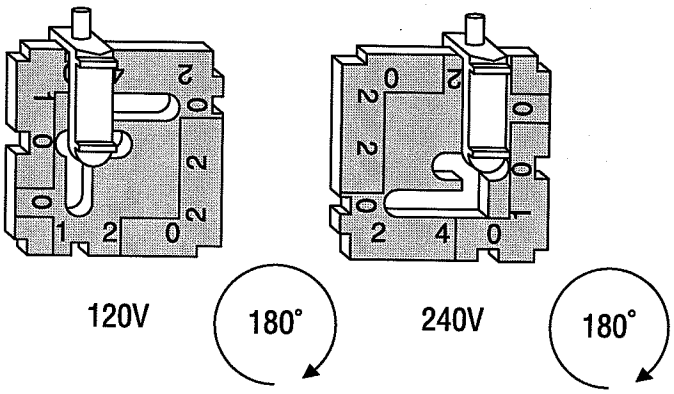


Figure 6.3

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6.7 WARRANTY, RETURNS, AND REPAIRS

WARRANTY

Alltech warrants its products against defects in workmanship or material under normal use or service for one year. All obligations or liabilities under this warranty are limited to repair or replacement, at Alltech's option, F.O.B. Deerfield, IL, of parts that are returned, freight prepaid and which are accepted as being defective upon inspection by Alltech Associates, Inc.

Components that are subject to normal wear and/or are scheduled for routine replacement within the warranty period, and/or parts, which are subjected to effects of corrosion or deterioration by chemical or other action are excluded from the above warranty for malfunction because of inadequate facilities, operating conditions, or utilities.

Equipment and components may only be returned with Alltech's prior approval and must bear an Alltech Return Authorization Number. Call the Alltech Customer Service Department to obtain a Return Authorization Number.

Guarantee/Warranties on accessories and equipment included by Alltech from other manufacturers are limited to the guarantees given on such equipment by the respective manufacturers.

Any modifications made to equipment covered by this warranty, without written permission from Alltech Associates, Inc. will void the warranty. Alltech reserves the right not to honor this warranty if the products are obviously mishandled by the user.

Alltech Associates, Inc. assumes no responsibility for consequential, economic or incidental damages of any nature or on-site reinstallation costs arising out of future alleged failure of any of its products or their accessories.

This warranty supersedes any and all previous warranties unless otherwise agreed upon at the time of sale, such as for customized equipment.

SHIPMENTS

All shipments are made F.O.B. Deerfield, IL.

DAMAGED SHIPMENTS

The Interstate Commerce Commission has held that carriers are responsible for both concealed and visible damage occurring during transit. Unpack the shipment upon receipt and check for concealed damage even if no visible damage is apparent. If concealed damage is discovered, stop unpacking the unit, request an immediate inspection by the local carrier agent, and obtain a written report of the findings to support a claim. This request must be made within 15 days of receipt, otherwise, the claim will not be honored by the carrier. Do not return damaged goods to Alltech without first obtaining an inspection report and calling Alltech for a Return Authorization Number.

FILING OF CLAIMS

After a damage inspection report has been obtained, Alltech will cooperate in replacing damaged goods and in handling of claims, which have been initiated by either party.

RETURNS

If it is necessary to return any material to Alltech, please call Alltech's Customer Service Department for a Return Authorization Number and forwarding instructions. No returns may be made without a Return Authorization Number.

REPAIRS

Alltech Associates, Inc. is the only organization authorized to service or repair the ELSD 2000ES. Any repairs performed without notifying Alltech Associates, Inc. will void the warranty. To obtain repair service, call Alltech's Customer Service Department for instructions and a Return for Repair Number.

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