Model 330 ELSD

Installation and Operation Guide

TELEDYNE ISCO
A Teledyne Technologies Company

Part #69-5233-515

Revision E, March 29, 2011.

Notice

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Intended Use

The ELS Detector manuals address their operation and performance without regard to the nature of the material being analyzed or processed. They do not presume to inform, instruct or advise users in the correct or safe execution of specific procedures. When you are using this instrument, follow generally acceptable procedures for quality control and methods development.

Changes or modifications to this instrument not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CAUTION

The user shall be made aware that if this instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Electrical Hazards

To avoid the possibility of electrical shock, do not open the detector cover. The detector does not contain user-serviceable components.

To avoid electrical shock, turn the power to the detector off and unplug the power cord from the rear of the detector before you replace a fuse. To protect against fire hazard, replace fuse with those of the same type and rating.

It is recommended that all components of the HPLC be connected to a common ground.

To avoid electrical shock, power off the detector before making any electrical connections.

Chemical Hazards

When you handle solvents, change tubing, or operate the detector observe safe laboratory practices when operating this detector to avoid chemical or electrical hazards.

Know the physical and chemical properties of the solvents and analytes you use. Refer to the Material Safety Data sheets for any chemical you come in contact with.

Do not use gases that support combustion with combustible solvents. Always use inert gases.

To avoid inhaling harmful organic solvents and other materials, the detector exhaust should not be allowed to enter the laboratory atmosphere.

Physical Hazards

To avoid burns, turn off the power at least 30 minutes before performing maintenance procedures.

Use caution when working with any polymer tubing under pressure:

- Always wear eye protection when near pressurized tubing.
- Extinguish all nearby flames
- Do not use tubing that has been severely stressed, kinked or weaken by chemical attack.

General Warnings

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood. While specific hazards may vary according to location and application, take heed of the following general warnings:

WARNING

Liquids associated with this instrument may be classified as carcinogenic, biohazard, flammable, or radioactive. Should these liquids be used, it is highly recommended that this application be accomplished in an isolated environment designed for these types of materials in accordance with federal, state, and local regulatory laws, and in compliance with your company's chemical/hygiene plan in the event of a spill.

AVERTISSEMENT

Eviter de répandre des liquides dangereux. Les liquides qui sont analysés dans cet instrument peuvent être cancérigènes, hasards biologiques, inflammables, ou radioactifs. Si vous devez utiliser tels liquides, il est très recommandé que vous le faites à l'intérieur d'un environnement isolé conçu pour tels liquides. Cet environnement isolé devrait être construit selon les règlements fédéraux, provinciaux, et locaux, aussi que le plan de votre compagnie qui concerne l'évènement d'un accident avec les matières hasardeuses.

WARNING

Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired.

AVERTISSEMENT

Éviter les usages périlleux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie de l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

WARNING

If this system uses flammable organic solvents, Teledyne Isco recommends that you place this system in a well-ventilated environment, designed for these types of materials. This environment should be constructed in accordance with federal, state, and local regulations. It should also comply with your organization's plan concerning chemical and hygiene mishaps. In all cases use good laboratory practices and standard safety procedures.

AVERTISSEMENT

Ce système peut utiliser des dissolvants organiques inflammables. Pour réduire le péril qui peut être causé par l'accumulation des vapeurs explosives, Teledyne Isco recommande que vous installez ce système dans un environnement bien-aéré qui est conçu pour les matières hasardeuses. Cet environnement devrait être construit selon les règlements fédéraux, provinciaux, et locaux. Aussi, il devrait se conformer au plan de votre organisation qui concerne les mésaventures de l'hygiène ou de chimique. En tout cas, utilisez toujours de pratiques bonnes de la laboratoire et des procédures standardes de la sûreté.

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts, These three levels are described in the sample alerts below.

CAUTION

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

WARNING

Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

DANGER

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
Advertencias y Precauciones	
	Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.
	Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

Model 330 ELSD

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Model 330 ELSD

Section 1 Quick Start Guide

Thank you for your purchase of the ELSD. It is extremely important that you review this quick start guide and reproduce the QC tests before you begin your analysis with the detector. If the QC tests are not successfully reproduced in your laboratory it will be very difficult for us to assist you in achieving the very best results.

1.1 Unpacking and Installation

In addition to the ELSD and its accompanying accessories you will need the following to reproduce the QC test.

Gas Supply – Clean, dry, inert gas regulated to 65 ± 5 psi is needed for nebulization. Either argon or nitrogen is acceptable. Do not use gases that support combustion.

Exhaust Device – The carrier gas containing volatilized mobile phase and sample components will exit the ELSD. You should provide a means of removing this from the laboratory. The ELSD should be located close to a fume hood or other ventilation device.

Mobile Phases – 50/50 Methanol /Water

Injection Standard – 1000ng Sodium Benzoate in water preferably injected as 500 ng/µL in 2uL.

HPLC Pump – Fitted with 0.007" ID tubing and pressure regulator to create enough pressure for smooth pump operation without a column for the QC test. Refer to your pump manual.

Accessories – Tubing, fittings and tools to connect your HPLC system to the ELSD.

1.2 Connections

Exhaust – The ELSD exhaust is a ½" O.D. stainless steel tube. Use ½" I.D. tubing to connect to a fume hood during operation.

Communication – An output jack can be found on the back of the ELSD for connection to a chart recorder, computing integrator or computerized data system. The maximum signal output is 5V or 10mV.

Gas Connections – Connect a supply of clean, dry, inert gas regulated between 60 and 80 psi to the gas inlet port on the back of the unit. The internal gas regulator maintains the gas pressure at the factory set value displayed on the front panel.

Power Connection – The ELSD operates at 120V or 234V, 50/60 Hz. Confirm that the ELSD is configured for the correct voltage before plugging it in to line voltage.

Fluid Connections – Connect the outlet from your HPLC injector to the Liquid Inlet on the front of the unit. The length and volume between the injector outlet and the detector inlet should be kept as short as possible to avoid unnecessary band broadening.

Thermo-Split Drain – Place the ¼" stainless steel drain adapter, provided in the accessory kit, on the drain port located on the front of the instrument. Direct the outlet of the tube to a collection vessel. Place the open end of the flexible ¼" Tygon tubing in a suitable waste container, trimming the length as necessary. Watch the liquid level in the container during operation and empty when full, especially when running the spray chamber at sub-ambient temperature.

1.3 Status Alarm

A series of 10 beeps will be heard when the detector moves from a not ready condition to ready and vice versa. These beeps will continue every 30 seconds until the autozero key is pushed.

This feature can be disabled on the Control Page menu.

1.4 Operation

1.4.1 Start-up

1. Make all connections; gas, liquid, power, communications, exhaust, and drain as described above. Do not turn on your gas supply yet.
2. Press the MENU|POWER key to begin self-diagnostic tests. When tests are complete, press MENU|POWER again to exit standby.
3. Cycle through the settings using the ▲ or ▼ keys to confirm the operating conditions are correct. If the settings are not correct, use the MENU|POWER key to enter the menu screens and correct the set points using the ▲ or ▼ keys. Accept the modified value by pressing the MENU|POWER key. The AUTOZERO functions as an escape key, abolishing any changes made.
4. Start your HPLC pump to deliver 1.0ml/min mobile phase to the detector. When you see liquid coming out of the drain port, which may take as long as 10 minutes, the internal "p" trap is filled with mobile phase. Stop the pump.
5. Before the conditions are met, a * blinks at the upper right corner on the display and the green light above ready is not lit. Press the MENU|POWER key to display the error condition. Allow up to 30 minutes for temperatures reach their set points and the electronics to stabilize, and then start the gas flow. When the gas flow is stable, start the mobile phase flow.
6. When the ready light illuminates, press the AUTOZERO button to reset the baseline. Cycle through the settings to BLN. Record this value. It is the voltage offset by the AUTOZERO function. It is important to note this value for each set of operating conditions. If the value is high, greater than 500mV, the mobile phase is not being evapo-

rated and the detector temperatures should be modified. Monitor your data system and ELSD signal for stability. The signal should be stable within 2mV. When stable, begin your analysis.

1.5 Reproduce the QC Test

1. Confirm that the correct conditions are entered. Modify if necessary. Please refer to the QC report shipped with your detector for the exact conditions used to test your ELSD. The general conditions are:
   1ml/min of 50/50 Water/Methanol,
   Spray Chamber 25°C, Drift Tube 55°C, Filter 5
2. When the signal is stable, inject the 100ng sodium benzoate sample. Wait for the resulting peak, and then repeat twice.
3. Stop the data collection and integrate the resulting peaks.
4. Compare the resulting peak heights and signal to noise ratio to the factory QC results shipped with the detector.
5. Complete the QC Test Report and send to SofTA.

1.6 Shut Down Procedure

Stop the pump, press the power key until the standby countdown is activated, the detector will enter standby mode when the time expires. In standby the gas flow is shut off and the laser and heaters are turned off.

1.7 Menu Structure

1.7.1 Home Screen

XX = SC, DT, OC, ET, RST, BLN, GAS, FLT, CL, GX, FS

SC = Spray Chamber (setpoint: 10°C to 70°C; readout range: -10.0°C to 120.0°C)

DT = Drift Tube (setpoint: 22°C to 120°C; readout range: -10.0°C to120.0°C)

OC = Optical Cell (setpoint: 22°C to 70°C; readout range: -10.0°C to 120.0°C)

ET = Exhaust Tube (setpoint: 22°C to 70°C; readout range: -10.0°C to 120.0°C)

RST= Reset baseline to about 20mV.

BLN = Baseline reading (5000.000 – 0.000mV)

GAS = Gas (0.0 to130.0psi)

FLT = Filter (OFF, weight 1 to 10,FLT, BFT)

CL = Calibration (20% to 200%)

GX = Gain (Normal or EDR)

FS = Full Scale (5V or 10mV)

1.7.2 Available Menus

[Spray Chamber Page] Sets Spray Chamber temperature.

[Drift Tube Page] Sets Drift Tube temperature.

[Control Page] Sets Run/Standby mode, on/off Laser, on/off alarm.

[Timer] ets duration of the count down time.

[Filter Page] Sets the weight of filter for noise filtration

[Load Method Page] Loads one of nine methods.

[Save Method Page] Saves a method

[Calibration Page] Attenuates or amplifies the detector output

[Detector Gain Page] Changes Gain

[Full Scale Page] Changes Full Scale

1.8 Choosing Operating Conditions

The drift tube temperature and the Thermo-Split spray chamber temperature are selected to provide the maximum detector response with minimum baseline noise. The temperatures are selected based on the solvent volatility and mobile phase flow rate. Some experimentation will be required to optimize the ELSD.

When setting the ELSD temperatures for a new method, select 25°C for spray chamber temperature and 55°C for drift tube temperature. These temperatures should then be adjusted for the best signal to noise ratio during method optimization. A mobile phase that is highly organic and volatile will require a moderately high drift tube temperature and an ambient or elevated spray chamber temperature. Highly aqueous or high boiling point organic mobile phases will perform best at moderate drift tube temperatures and sub-ambient spray chamber temperatures.

1.9 Intended Use

The ELS Detector guides and manuals address the operation and performance of the unit without regard to the nature of the material being analyzed or processed. They do not presume to inform, instruct or advise users in the correct or safe execution of specific procedures. When you are using this instrument, follow generally acceptable procedures for safety, quality control and methods development.

Changes or modifications to this instrument not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.10 Safety Notices

CAUTION

The user shall be made aware that if this instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1.10.1 Electrical Hazards

- To avoid the possibility of electrical shock, do not open the detector cover. The detector does not contain user-serviceable components.
- To avoid electrical shock, turn the power to the detector off and unplug the power cord from the rear of the detector before you replace a fuse. To protect against fire

hazard, replace fuse with those of the same type and rating.

- It is recommended that all components of the HPLC be connected to a common ground.
- To avoid electrical shock, power off the detector before making any electrical connections.

1.10.2 Chemical Hazards

- When you handle solvents, change tubing, or operate the detector observe safe laboratory practices to avoid chemical or electrical hazards.
- Know the physical and chemical properties of the solvents and analytes you use. Refer to the Material Safety Data sheets for any chemical you come in contact with.
- Always use inert gases. Do not use gases that support combustion with combustible solvents.
- To avoid inhaling harmful organic solvents and other materials, the detector exhaust should not be allowed to enter the laboratory atmosphere.

1.10.3 Physical Hazards

- To avoid burns, turn off the power at least 30 minutes before performing maintenance procedures.
- Use caution when working with any polymer tubing under pressure:
  - Always wear eye protection when near pressurized tubing.
  - Extinguish all nearby flames
  - Do not use tubing that has been severely stressed, kinked or weaken by chemical attack.

Model 330 ELSD

Section 2 Introduction

2.1 Overview

ELSDs are near universal detectors, primarily used in High Performance Liquid Chromatography (HPLC) though they have been used successfully in other types of chromatography as well. Their principal requirement is that the analyte be less volatile than the mobile phase. An ELSD cannot detect highly volatile analytes. However, most analytes of interest are less volatile than the eluting solvents.

Evaporative light scattering detectors are replacing ultraviolet (UV) detection because they can detect most analytes, even those that do not absorb UV radiation, are stable during gradient elutions, and respond to the relative mass of the analyte – an important feature that is useful when detecting unknown materials. The ELSD is superior to the refractive index detector (RID), it can be used with gradient chromatography, it is not susceptible to ambient temperature changes, and it does not produce negative peaks, which can be difficult to quantify. The ELSD does not respond to the mobile phase disruption seen as solvent front peaks in the void volume with UV and RI detectors, so early eluting analytes can be easily quantified. Mass spectrometry (MS) detection is also a universal detector, but its high cost and complexity have kept it from being widely used.In fact, the operation requirements of MS closely match that of the ELSD. This allows the less expensive and complicated ELSD to be used as a method development detector for methods to be used on the MS systems.

2.2 Servicing

A periodic maintenance kit is available from Teledyne Isco (part #60-5247-024). The kit contains instructions, parts, and equipment for servicing the ELSD. Contact the factory for more information.

The ELSD should be cleaned and calibrated once a year by a qualified technician. Use water with a mild detergent, or for tougher stains, use Isopropyl Alcohol (IPA).

2.3 Operating Principles

The ELSD employs a unique method of detection. The process involves the nebulization of the column eluent, transforming it into an aerosol cloud. As this cloud travels through a heated zone within the instrument, the more volatile mobile phase evaporates, leaving a smaller cloud of analyte particles. These particles pass through a beam of light, scattering some of the light, which is converted into an electronic signal.

2.3.1 Nebulization

Nebulization transforms the liquid phase leaving the column into an aerosol cloud of fine droplets. The size and uniformity of the droplets are extremely important in achieving sensitivity and reproducibility. The ELSD uses a special concentric flow nebulizer and a constant flow of an inert gas to ensure a narrow droplet size distribution. Our nebulizer is constructed entirely from PTFE, which accumulates deposits less than either glass or stainless steel.

To handle flow rates and mobile phases common in HPLC, all ELSDs need a way to divert part of the aerosol cloud to waste. The ELSD uses a patent pending **Thermo-Split technology.** Our **Thermo-Split** chamber combines a gentle bend with temperature controlled walls. When the aerosol exiting the nebulizer encounters a cool environment, it partially condenses into larger particles whose momentum carries them into the wall and down the drain.

With cooling, the particles condense and increase in size. They are carried into the walls of the bend and exit via the drain.

Figure 2-1 Thermo-Split chamber: Cooling

With heat, the particles decrease in size and all pass the bend in the Thermo-Split chamber.

Figure 2-2 Thermo-Split chamber: Heating

With the Temperature control option installed, the temperature of the Spray Chamber may be elevated. As the aerosol traverses the chamber, it partially evaporates, shifting the particle size distribution low enough for essentially all the particles to negotiate the bend. These operating conditions may be useful for special applications. Under these conditions a majority of the aerosol particles pass through the chamber and are carried into the evaporative zone.

2.3.2 Evaporation

After passing through the nebulization chamber, the aerosol cloud is propelled through the heated evaporation tube, assisted by the carrier gas. In the evaporation tube, the solvent is volatilized to produce particles or droplets of pure analyte.

The temperature of the drift tube is set at the temperature required to evaporate the solvent. The temperature is kept as low as possible to avoid particle shape distortion, evaporation of the analyte or when working with thermally sensitive compounds.

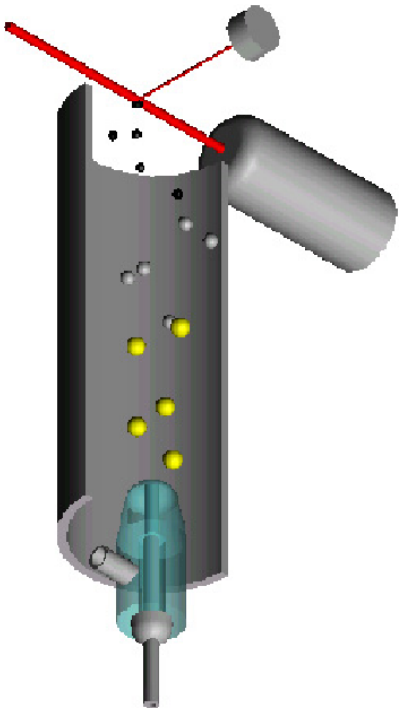


Figure 2-3 Evaporation and detection

2.3.3 Detection

The particles emerging from the evaporation tube enter the optical cell, where the sample particles pass through the light emitted by a low-power laser. The particles scatter the light, which is detected by a silicon photodiode located at a 90° angle from the laser. A light trap is located opposite the laser to collect the light not scattered by particles. The quantity of light detected is proportional to the solute concentration and solute particle size distribution. The photodiode produces a signal, which is sent to the outputs for collection.

2.4 Specifications

Table 2-1 Model 330CF ELSD Specifications	
Dimensions	9.8" W x 18" D x 11.5" H
Weight	25 lbs
Display	2 Line x 20 Character per line VFD
User Interface	Four multi-function keys
Evaporative Zone Temperature	Ambient to 120 °C
Thermo-Split™ Chamber Temperature	10 °C to 70 °C
Liquid Flow Rate	0.2 mL/min to 5 mL/min
Gas Requirements	65 psi ±5 psi Nitrogen or other inert gas
Gas Consumption	~ 2.5 SLPM
Operating Conditions	Intended for indoor use only, 60°F to 85°F and <90% R.H. non condensing
Electrical Requirements	Nominal 120 VAC, 50/60 Hz or Nominal 234 VAC, 50/60 Hz; 600 watts
Wetted Materials	Stainless steel, glass, anodized aluminum, Teflon®
Light Source	670 nm Laser Diode, <5mW
Detector	Hermetically sealed photo-diode/operational amplifier
Output Signal	0–5 VDC
Interface	RS232, Contact Closure

Model 330 ELSD

Section 3 Unpacking and Installation

3.1 Unpacking

The ELSD is shipped with the accessories listed in Appendix A. Unpack carefully and confirm that all the items are present. The ELSDs come in a high quality shipping container, engineered to avoid damage in transit. Save the shipping container and packaging for future shipments.

3.2 Connections

This section provides general connection information for the ELSD unit.

3.2.1 Power

The ELSD operates at 120V or 234V, 50/60 Hz. Confirm that the ELSD is configured for the correct voltage before plugging it into line voltage. If the power input module is set to the wrong voltage, unplug the power cord form the module. Open the fuse compartment by gently prying the cover from the module with a flat blade screwdriver. Remove the fuse block. Remove the voltage configuration card from the module by gently pulling with pliers or tweezers. Rotate the plastic voltage selector until the correct voltage appears on the side opposite the voltage selector. Replace the card and fuse block. Confirm that the correct voltage is indicated through the cover before securing the cover. Plug the modular power cord provided into the power input module on the back of the detector. The power cord is the disconnect device for the unit. Therefore, select a power outlet that is nearby and unobstructed, allowing easy access for disconnection in the event of an emergency.

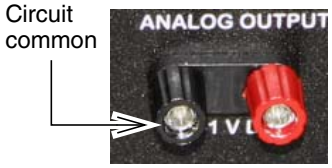
3.2.2 Exhaust

The ELSD exhaust is a ½" O.D. stainless steel tube.Use ½" I.D. tubing to connect to a fume hood during operation. Alternately, connect tubing and direct to a cooled collection vessel for later disposal.

3.2.3 Location

The ELSD rear panel has a fan for cooling. Position the instrument so that the rear panel is at least 5cm from any wall or object, to allow free movement of air.

3.2.4 Communication



Analog Voltage Output

An output jack can be found on the back of the ELSD for connection to a chart recorder, computing integrator or computerized data system. The maximum signal output is 5V.

Connect the terminated end of the output cable to the connector on the rear panel. The circuit common cable plug is indicated by a small tab on that side of the connector end (refer to Figure 3-1 on the following page).

CAUTION

Observe polarity when connecting to this output.

ELSD Connection

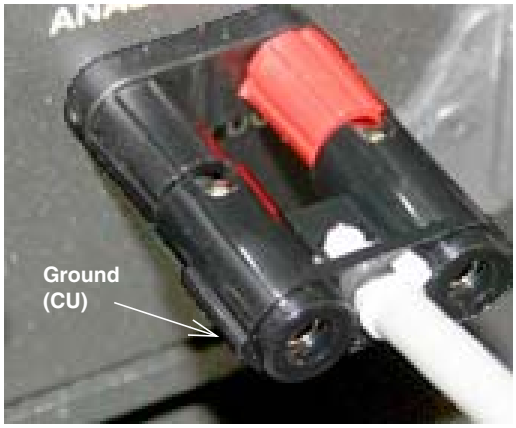


Figure 3-1 Observe polarity when connecting analog output cable

3.2.5 Digital I/O Connections

Rear Panel Connector for Digital I/O

Pin 1 and Pin 2: A contact closure output. Pins are open when an error conditions exists.

Pin 3 and pin 4: A contact closure input to turn on/off gas remotely. Gas control toggles with electrical continuity between these two pins. Maintain connectivity for a minimum of 500mS. A subsequent toggle command within 2 seconds may be ignored.

Pin 5 and 6: A TTL output for instrument status. A logical high indicates the detector is in standby.

Pin 7 and pin 8: A contact closure input to reset baseline remotely. Maintain connectivity for a minimum of 500mS. A subsequent toggle command within 2 seconds may be ignored.

3.2.6 Gas Connections

Connect a supply of clean, dry, inert gas regulated to 65psi ± 5 psi to the GAS INLET port on the back of the unit.

WARNING

Use only Nitrogen or Argon.

The internal gas regulator maintains the gas pressure at the factory set value displayed on the front panel.

3.2.7 Fluid Connections

Connect the outlet from your column to the LIQUID INLET on the front of the unit. The length and volume between the column outlet and the detector inlet should be kept as short as possible to avoid unnecessary band broadening.

3.2.8 Nebulization Chamber Drain

The instrument's internal "P" trap must be full during operation. Restricting the drain port with liquid is very important to ensure detection sensitivity. Introduce 10 mL of mobile phase into the drain using a squirt bottle or syringe.

Place the ¼" stainless steel drain adapter, provided in the accessory kit, on the drain port located on the front of the instrument. Direct the outlet of the tube to a collection vessel. Watch the liquid level in the vessel during operation and empty when full.

Attach the drain tube to the nebulization chamber drain port; ensure that the trap is full.

Figure 3-2 Attach drain adaptor; prime with mobile phase if desired

3.3 Installation Qualification Checklist

Table 3-1 may be completed to verify and document the installation procedures contained in this section of the manual.

Table 3-1 Installation Qualification Checklist

Step	Description	Installer Initials	Operator Initials
3.1	*Unpacking*		
3.1	*Unpacking*		
Connections			
3.2.1	*Power*		
3.2.2	*Exhaust*		
3.2.4	*Communication*		
3.2.5	*Digital I/O Connections*		
3.2.6	*Gas Connections*		
3.2.7	*Fluid Connections*		
3.2.8	*Nebulization Chamber Drain*		
Certification of Section 3 Completion			
	Installer Name (print):		
	Installer Signature:		
	Date:		
	Operator Name (print):		
	Operator Signature:		
	Date:		
Notes:			

Model 330 ELSD

Section 4 Operation

4.1 Instrument Controls

The ELSD is controlled via four multi-function keys on the front panel labeled MENU|POWER, ▲, ▼, and AUTOZERO. The ELSD features a 2 line vacuum florescent display and a row of status lights to aid in the operation of the detector.

4.1.1 Status Indicator Lights

The status lights below the display provide a visual indication of the conditions of the ELSD. From left to right the function of the status lights are:

1. Spray Chamber Heater: The yellow light is illuminated when the heater is active, blinks when the spray chamber is being controlled at the set temperature, and off when the spray chamber is cooling to a lower temperature.
2. Drift Tube heater: The yellow light is illuminated when the heater is active, blinks when the drift tube is being controlled at the set temperature, and off when the drift tube is cooling to a lower temperature.
3. Optic Cell Heater: The yellow light is illuminated when the heater is active, blinks when the optical cell is being controlled at the set temperature, and off when the optics cell is cooling to a lower temperature.
4. Laser power: The green light is illuminated when the laser is on and stable and off when the laser is off. The light blinks when laser power is low or unstable.
5. Gas Supply: The green light is on when the nebulizer gas pressure is within factory set limits, and the gas valve is open. The green light will blink if a pressure error exists. The green light will be off if the gas valve has been turned off.
6. Ready Condition: The green light is illuminated when all operating conditions are met and no error conditions exist.

4.1.2 Status Alarm

The status alarm sounds when the detector status changes from not ready to ready or from ready to not ready. The alarm is 10 short beeps repeated every 30 seconds. Pressing the AUTOZERO key resets the alarm. The alarm can be disabled via the Control Page menu screen.

4.1.3 MENU|POWER Key

The MENU|POWER key is a multi-function key. An audible beep is heard when the key is activated. When the instrument is off, press the MENU|POWER key to turn the ELSD on. Note that when the power cord is plugged in the MENU|POWER key is dimly illuminated from behind with a blue light. When the MENU|POWER key is used to turn on the ELSD, the backlighting expands to the

other keys. Once the ELSD is powered up the MENU|POWER key is used to view error conditions, cycle through the menu, accept changes to set points, enter standby mode, and turn the power off.

Error condition exist when the ready light is not illuminated and when the * appears in the upper right corner of the display. Press the MENU|POWER key and a description of the error is displayed in the window. The display will cycle through all error conditions.

Pressing the MENU|POWER key once, when no error conditions exist, or twice times, if an error condition exists, enters the menu screen.

Pressing the MENU|POWER key twice, when no error conditions exist, or three times, if an error condition exists, enters the stand-by count down screen. Standby mode should be used when the system is being shutdown. When the detector enters stand-by count down mode a timer is started. After the time had expired the gas solenoid is closed, shutting off the flow of the nebulization gas, the laser is turned off, and the heaters are disabled.

To turn the power off, press and hold the MENU|POWER key for 5 seconds. Wait at least 10 seconds before turning the instrument on, after it has been turned off.

4.1.4 Autozero Key

When the AUTOZERO key is depressed the ELS Detection signal will reset to about 20mV. An audible beep is heard when the key is activated. When the detector is in the menu mode, the AUTOZERO functions as an escape key, abolishing any changes made. The AUTOZERO key is also used to reset the status alarm.

4.1.5 Display Screens

The ELSD uses one of four screens to aid in the operation of the detector:

Startup Screen

```
Program Loading
>>>>>>>>
```

The “>” moves from left to the right while the program is loaded. The process ends when “>” reaches the far right.

After loading the program, the system begins running diagnostics. Pressing the MENU|POWER key exits the start-up process without completing the diagnostics. If the MENU|POWER key is pressed before the completion of the diagnostics, the ELSD enters a special diagnostic mode.

```
Running Diagnostics
Checking Laser Power
```

When the ELSD finishes the start-up process it enters the stand-by mode. Press the MENU | POWER key to exit and enter the HOME Screen.

```
ELSD is in Standby Mode
Diagnostics Complete
```

```
Push PWR to exit
Laser Power OK
```

Home Screen

```
ELS DetectionXX
20.000mV 20.0°C
```

Pushing ▲ or ▼keys will circulate XX section to review operation condition. SC, DT, OC and ET sections display their set points to the degree for 5 seconds when selected. Then they display the actual temperatures to the tenth of a degree.

Pushing MENU | POWER key will bring up the Menu screen. If the key is pushed within 5 seconds after an arrow key was pushed, the selection at XX will be displayed. Otherwise, the timer page will always be the first menu page displayed.

If there is an asterisk (*) at the upper right corner, pushing MENU | POWER key will bring up a screen to explain what's wrong:

XX = SC, DT, OC, ET, RST, BLN, GAS, FLT or BFT, CL, GX, FS

SC = Spray Chamber (setpoint: 10°C to 70°C; readout range: -10.0°C to 120.0°C)

DT = Drift Tube (setpoint: 22°C to 120°C; readout range: -10.0°C to120.0°C)

OC = Optical Cell (setpoint: 22°C to 70°C; readout range: -10.0°C to 120.0°C)

ET = Exhaust Tube (setpoint: 22°C to 70°C; readout range: -10.0°C to 120.0°C)

RST= Reset baseline to about 20mV.

BLN = Baseline reading (5000.000 – 0.000mV)

GAS = Gas (0.0 to130.0psi)

FLT or BFT = Baseline Filter (OFF, weight 1 to 10, FLT or BFT)

CL = Calibration (20% to 200%)

GX = Gain (Normal or EDR)

FS = Full Scale (5V or 10mV)

RST/BLN Screen

When RST is selected from the menu screen, it will display "RST Baseline" for 5 seconds. Pushing MENU|POWER key during this period will reset the ELS Detection signal to about 20mV. [Using the AUTOZERO key can also reset the baseline.] After 5 seconds, the display changes to BLN and displays the voltage offset by the autozero function. This value is important to note for each set of operating conditions. If the value is high, greater than 500mV, the mobile phase is not being evaporated completely and the temperature set points should be modified. Other contaminates in the system can also affect this reading.

Menu Screen

Pressing the MENU|POWER key once, when no error conditions exist, or twice times, if an error condition exists, enters the menu screen.

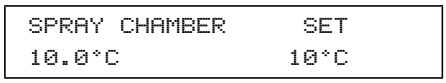
Push ▲ or ▼ keys to select the menus.

Push MENU|POWER twice to return to the Home screen.

Available Menus:

- [Spray Chamber Page] Sets Spray Chamber temperature.
- [Drift Tube Page] Sets Drift Tube, optical cell and exhaust tube temperatures.
- [Control Page] Sets Run/Standby mode, on/off Laser, on/off Alarm.
- [Timer] Sets duration of the shut down time.
- [Filter Page] Sets the type and weight of filter for noise filtration
- [Load Method Page] Loads one of nine methods.
- [Save Method Page] Saves a method
- [Calibration Page] Attenuates or amplifies the detector output
- [Detector Gain Page] Changes Gain
- [Full Scale Page] Changes Full Scale

Spray Chamber Page



The reading under SPRAY CHAMBER is the current temperature. The reading under SET is the setpoint.

Pushing ▲ or ▼ keys to change a setpoint at 1°C increment.

Pushing MENU|POWER key to accept the change and go back to Home screen.

Pushing AUTOZERO key to abolish the change and go back to Home screen.

Drift Tube Page

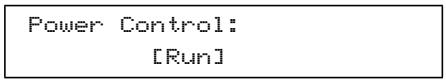
The reading under DRIFT TUBE is the current temperature. The reading under SET is the setpoint. The temperatures of the optical cell and the exhaust tube are controlled at the same temperature as that of DRIFT TUBE but their maximum temperature is limited.

Pushing ▲ or ▼ keys to change a set point at 1°C increment.

Pushing MENU|POWER key to accept the change and go back to Home screen.

Pushing AUTOZERO key to abolish the change and goes back to Home screen.

Control Page



[Run], [Standby], [Laser Off] or [Laser On], [Turn off Sound] or [Turn on Sound]

Use ▲ or ▼ keys to select an action.

Push MENU|POWER key to take an action and go back Home screen.

Push AUTOZERO key to keep the current state and go back Home screen.

If the display reads Laser Off or Laser On, pushing MENU|POWER key will turn the laser off or on. The laser may take up to 30 minutes to stabilize when it has been turned off, and on again.

If the display reads Turn off Sound or Turn on Sound, pushing MENU|POWER key will turn the status alarm off or on. The status alarm sounds when the detector status changes from not ready to

ready or from ready to not ready. The alarm is 10 short beeps repeated every 30 seconds. Pressing the AUTOZERO key resets the alarm.

Timer Page

1 min to 60 min

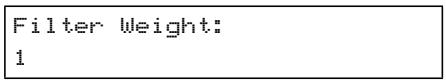
Use ▲ or ▼ keys to extend or reduce countdown interval.

Push MENU|POWER key to save the modified countdown interval but cancel countdown and return to home screen.

Push AUTOZERO key to cancel the countdown, keep the previous interval and go back Home screen.

The timer default value is 5 minutes and is the recommended time. The time can be increased up to 60 minutes or decreased down to 1 min.

Filter Page



OFF, 1 to 10, FLT or BFT

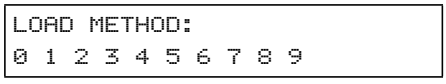
Use ▲ or ▼ keys to select an action.

Push MENU|POWER key to take an action and go back Home screen.

Push AUTOZERO key to keep the current state and go back Home screen.

There are two filter types to choose from FLT and BFT. The filter type is selected at the top of the menu after weight 10. Select FLT or BFT and push the MENU|POWER KEY to enter. Then enter the filter menu again and selected the appropriate filter weight. Filter weight is the level of baseline noise filtration. OFF indicates no filtration. 10 is maximum filtration. In most cases, select BFT for baseline filtering. The FLT setting applies a RC filter to the entire signal. For high-speed chromatography, less than a 5 sec peak width, select BFT and turn the weight OFF. If the peak widths are 5 to 30 seconds use the BFT filter with a weight of 1 to 10. For peak widths greater than 30 seconds, select the FLT setting with a weight of 1 to 10. When the baseline filter is on, a dramatic operation condition change (e.g. turning on/off the HPLC pump), may upset the filter and cause baseline drifting. The baseline will stabilize again in a few minutes.

Load Method Page



Method 0 is the current setup of the unit. It will be loaded upon power up. Use the ▲ or ▼ keys to select a method number, pushing MENU|POWER key will apply the method and update the Method 0.

If the number selected has no method saved with, "Method not available" will be displayed. If the non-volatile memory IC chip is damaged, the same message will be displayed.

Save Method Page

```
SAVE METHOD:
0 1 2 3 4 5 6 7 8 9
```

Up to 9 methods can be saved. Use the ▲ or ▼ keys to select a method number and the MENU|POWER key to save the current conditions to the selected method number. A method includes Spray Chamber Temperature Setpoint, Drift Tube Temperature Setpoint, Filter Weight, Calibration Factor, and Detector Gain.

Calibration Page

```
Calibration:
100%
```

20% to 200% in 1% increments

Use ▲ or ▼ keys to select an action.

Push MENU|POWER key to take an action and go back Home screen.

Push AUTOZERO key to keep the current state and go back Home screen.

This feature scales the detector output. This feature is useful to match individual detectors to each other for standardization within a lab, or set the full scale output to a value other than 5V or 10mV. At 100%, the signal is neither amplified nor attenuated.

Detector Gain Page

```
AMPLIFIER GAIN:
Normal
```

Normal, EDR

Use ▲ or ▼ keys to select an action.

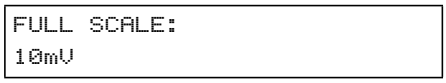
Push MENU|POWER key to take an action and go back Home screen.

Push AUTOZERO key to keep the current state and go back Home screen.

There are two gain settings: Norm and EDR. Use Normal setting for all analytical scale analysis. Analyte quantities from 10ng to 10,000ng can be quantified on Normal. "EDR" or Extended

Dynamic Range provides a greater dynamic range than the Normal setting. Analyte quantities from 20ng to 200,000ng can be quantified in this gain level.

Full Scale Page

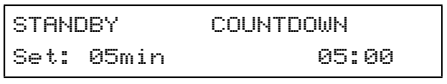


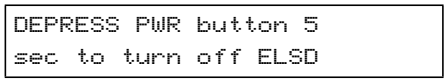
Another selection is 5V. Use whichever setting is appropriate for your data collection system. Using the Calibration parameter can also modify the full scale. See Calibration page section for details.

Error Condition Screen

If any of the detector parameters are not met, the Ready status indicator will not illuminate and the * will appear in the upper right corner of the home screen. Press the MENU|POWER key for more information about the affected parameter.

Standby Countdown Screen





Pressing the MENU|POWER key twice, when no error conditions exist, or three times, if an error condition exists, enters the standby countdown screen. Press MENU|POWER and hold for 5 seconds if you wish to turn off the detector immediately. It is recommended that the standby mode be activated when shutting down the detector. The timer allows enough time for the vapor to be expelled from the detector before the gas is turned off eliminating the possibility of condensation in the optics cell. After the time had expired the gas solenoid is closed, shutting off the flow of the nebulization gas, the laser is turned off, and the heaters are disabled. If there are no leaks between the gas source and the detector, the user will not need to return to the system after the standby sequence has started. The system runs the diagnostic tests, then enters standby mode. Press MENU|POWER to exit standby and begin running the detector.

4.2 Operation

If this is the first time you have operated the detector, please refer to the Quick Start Guide.

4.2.1 Start Up Procedure

It is very important that you reproduce the QC tests found in the Quick Start Guide before beginning your analysis.

1. Make all connections; gas, liquid, power, communications, exhaust, and drain as described in Section 2.
2. Turn on the power to the ELSD. Allow the system to run through the start-up sequence and then push the MENU|POWER key to exit standby and enter the Home screen.
3. Allow the Drift Tube and Spray Chamber temperatures to reach thermal equilibrium as indicated by the blinking of the corresponding status lights. Set the spray chamber and drift tube temperatures if needed.
4. When temperatures reach setpoints, turn on the regulated gas flow and gradually increase the gas pressure to 65psi ± 5 psi. If you use an on-off valve to turn on the gas, make sure the upstream gas pressure is below 70psi before you turn on the valve. Gas pressure higher than 70psi may permanently damage the detector.
5. When the temperatures reach the setpoints and the system is pressurized, the pump will automatically start to deliver the mobile phase to the detector. Monitor the Thermo-Split drain on the front of the unit. It may take up to 10 minutes (flowrate=0.75ml/min) to see liquid coming out of the drain tube if running reverse phase solvent. If running normal phase solvents, there may not be any flow from the drain tube.
6. An asterisk (*) may be blinking at the upper right corner indicating the detector is not ready yet. The pump will not run if the detector is not ready. You can depress MENU|POWER key to check what is not ready.
7. When the detector is ready, begin data collection system and monitor the baseline.
8. Press the AUTOZERO key to rest the baseline to approx. 20mV. Repeated autozeros may be necessary until the baseline stabilizes.
9. When the baseline is stable (variation is less than 1.0mV when FS is set as 5V) and the "*" has disappeared the Ready status light will be illuminated.
10. Run the sample and begin purification.

4.2.2 Shut Down Procedure

1. Depress the MENU|POWER key to enter the standby count-down screen. Stop the flow of mobile phase to the system.
2. Allow the detector to count down with the 5-minute timer.
3. If there are no leaks between your gas source and the ELSD, you do not have to turn the gas off at the source.

4.2.3 Choosing Operating Conditions

The drift tube temperature and the Thermo-Split spray chamber temperature are selected to provide the maximum detector response with minimum baseline noise. The temperatures are selected based on the solvent volatility and mobile phase flowrate. Some experimentation will be required to optimize the ELSD.

When setting the ELSD temperatures for a new method, select 25°C for spray chamber temperature and 55°C for drift tube temperature. These temperatures should then be adjusted for the best signal to noise ratio during method optimization. For the best performance, a mobile phase that is highly organic and volatile requires an ambient or elevated spray chamber temperature and moderately high drift tube temperature. When highly aqueous or high boiling point organic mobile phases with the detector, the best performance will at sub-ambient spray chamber temperatures and moderate drift tube temperatures.

Thermo-Split Spray Chamber Temperature

The Thermo-Split Spray Chamber can operate from 10°C to 70°C. The Spray Chamber temperature controls the vapor phase split ratio. For an easily evaporated mobile phase, the split ratio can be set low. To achieve this, the Thermo-Split chamber is heated. As the aerosol traverses the chamber, it partially evaporates, shifting the particle size distribution low enough for essentially all the particles to negotiate the bend. So, when highly organic mobile phases are used, the Thermo-Split chamber is used at ambient or elevated temperatures. Under these conditions a majority of the aerosol particles pass through the chamber and are carried into the evaporative zone.

For difficult to evaporate mobile phases, or high flow rates the split ratio needs be high so the Thermo-Split chamber is cooled. When the aerosol exiting the nebulizer encounters a cooled environment, it partially condenses into larger particles whose momentum carries them into the wall and down the drain. By making the walls suitably cold, 99+% of an aqueous stream can be diverted away from the evaporative zone.

As an example, the following data was collected with 90% water and 10% methanol at 1ml/min, a more difficult to evaporate mobile phase. The recommended conditions for this mobile phase are 15°C Spray Chamber and 45°C Drift Tube. Figure 4-1 shows the effect of Spray Chamber temperature on the resulting peaks when the drift tube temperature is held constant.

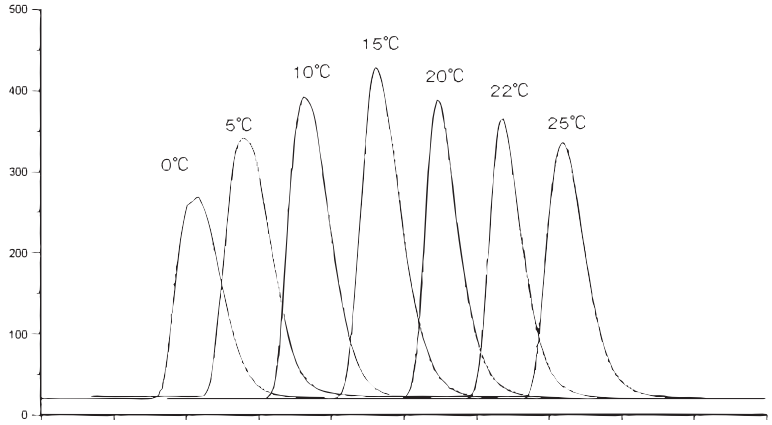


Figure 4-1 Spray Chamber Temperature Effects – Sub-ambient

As the Spray Chamber temperature increases from 0° to 15°C, more of the vapor phase goes to Drift Tube and not to the drain and the signal becomes larger. When the Spray Chamber is heated from 15°C to 25°C the signal decreases because the vapor is partially evaporated in the spray chamber. When the SC temperature is higher than 30°C, more of the vapor is sent to the Drift Tube. A Drift Tube temperature of 45°C is not sufficient to evaporate the larger volume of vapor and results in more baseline noise.

When the mobile phase is changed to 90% Methanol and 10% water at 1 mL/min the recommended conditions are Spray Chamber 50°C and Drift Tube 70°C. In Figure 4-2, the drift tube was held content at 70°C and the spray chamber was lowered. The signal height decreased as the spray chamber temperature decreased because more of the vapor was diverted from the Drift Tube and sent to the drain.

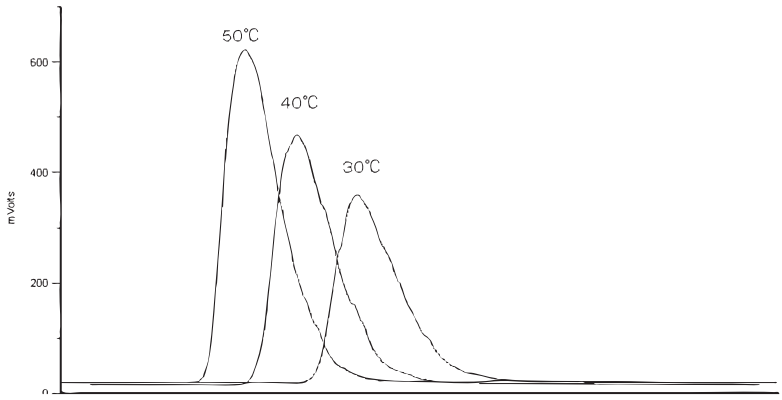


Figure 4-2 Spray Chamber Temperature Effects – Elevated

Drift Tube Temperature

The drift tube temperature can be set from ambient to 120°C. The drift tube temperature is set at a temperature high enough to evaporate the mobile phase and not vaporize the analyte. A higher drift tube temperature may give result in a quieter baseline but smaller peak. The drift tube temperature should always be higher than the spray chamber temperature but only as high as needed to achieve a quite baseline.

In this example the mobile phase was 90% water and 10% methanol at 1ml/min and the spray chamber was held constant at 10°C. Figure 4-3 shows the effect of drift tube temperature on the signal.

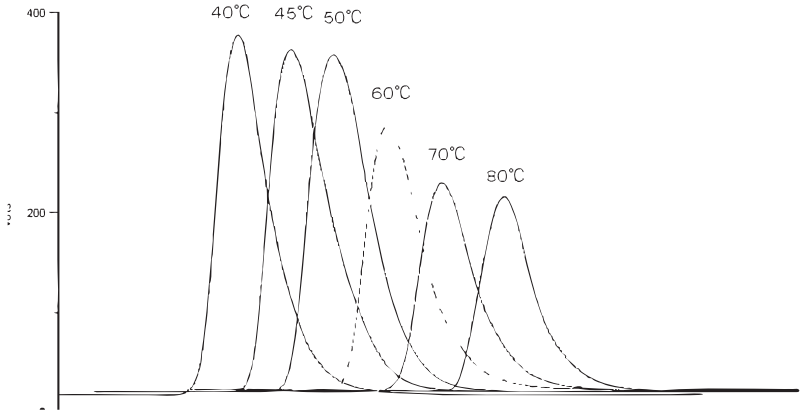


Figure 4-3 Drift Tube Temperature Effects

The effect of temperature on signal between 45°C and 50°C is small, but as the drift tube temperature increased above 60°C the signal height decreased.

A drift tube temperature setting that is too high could vaporize the analyte and cause a loss of sensitivity. If the analyte is thermally labile, use a lower temperature to improve sensitivity. However, there will be a point where the temperature is not high enough to evaporate the mobile phase and the increase in noise will negate the increase in signal. Optimize for the best signal to noise ratio.

Mobile Phase Flow rate

Mobile phase flowrate will also affect the optimum temperature set point. The higher the flowrate of an aqueous mobile phase, the lower the spray chamber temperature will need to be. High flowrates of volatile mobile phases may require a higher drift tube temperature. The ELSD may perform best at sub-ambient spray chamber temperatures if the flowrate is extremely high, even for volatile mobile phases.

Gradient Separations:
Suggested Operating Temperatures

For gradient separations, select the system temperatures required for the least volatile segment of the gradient program.

Table 4-1 Suggested Operating Temperatures for Gradient Separations

Solvent @ 1.0mL/min.	Drift Tube Temperature, °C	Spray Chamber Temperature, °C
90/10 Water/METHANOL	45	15
90/10 Methanol/WATER	65	50
50/50 Methanol/Water	60	30
Acetonitrile	60	50
Methanol	60	50
Water	45	10

4.2.4 Mobile Phase Considerations

Selecting a Solvent

High purity mobile phase solvents with low boiling points are recommended for use with the ELSD. Solvents should be spectral or HPLC grade. Dirty or contaminated solvents will cause baseline noise and drift, blocked fluid paths, and a build up in the detector. All solvents used should have less than 1ppm of residue after evaporation and filtered to less than 0.45µm. Solvents can be evaluated by pumping them directly into the detector, and comparing the noise to other known solvents. We have found that not all HPLC grade solvents are acceptable for use with an ELSD. Preservatives commonly used in Tetrahydrofuran (THF), will increase the noise level. If unstabilized THF is used, ensure that it is fresh. THF can contain peroxides that can increase noise and are potentially explosive if taken to dryness.

Mobile Phase Flowrate and Composition

The recommended flowrate for the ELSD is 0.25mL/min to 3mL/min. The mobile phase flowrate will affect baseline noise. In general, more baseline noise will be generated by higher flowrate of a mobile phase.

The ELSD will operate with common HPLC solvents that are volatile enough to form a vapor under the operating conditions. This includes common HPLC solvents such as water, methanol, acetonitrile, acetone, isopropyl alcohol, and THF. Normal phase solvents such as dichloromethane and hexane may also be used. Note that solvents with higher boiling points will generally result in more baseline noise. These should be used in limited percentages or at a lower flowrates.

Buffer Compatibility

The ELSD is not compatible with mobile phase modifiers that are not volatile, such as salts. Some modifiers are volatile and can be used. These include but are not limited to acetic acid, tri-

fluoroacetic aid (TFA), formic acid, triethylamine, and ammonia. The concentration of buffer in the mobile phase should be as low as possible.

Column Pre-Treatment

Chromatographic columns may introduce particles into the mobile phase, which may lead to increased noise and blocked fluid paths. It is recommended that the chromatographic column be flushed with at least 10 column volumes before it is connected to the ELSD.

4.2.5 QC Test Conditions

Please refer to the QC report shipped with your ELSD for the exact conditions used to test your ELSD. The general conditions are:

1.0 ml/min of 50/50 Water/Methanol

Spray Chamber 30°C

Drift Tube 60°C

Filter 5

Injected Standard: 1000ng Sodium Benzoate in water

DECLARATION OF CONFORMITY

ISM1-A

Application of Council Directive:	2004/108/EC -The EMC Directive 2002/96/EC – The WEEE Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	330 ELSD or 340CF ELSD
Year of Issue:	2010
Standards to which Conformity is Declared:	EN 61010-1 2nd edition Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61326-1:2006 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	A
EN61000-4-3	Radiated RF Immunity	80 MHz to 2.7Ghz 80% AM at 1kHz Level 2 - 3V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 1kV on AC lines	A
EN61000-4-5	Surge on AC Lines	Level 2 - 1kV common mode, Level 2 - 0.5KV differential mode	A
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, Level 1 - 1V rms, 80% modulated	A
EN61000-4-11	Voltage Dips/Interruptions	0% during half cycle	A
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	N/A
EN61000-3-2, 3-3	Harmonic, Flicker	N/A	N/A

The undersigned, hereby declares that the design of the equipment specified above conforms to the above Directive(s) and Standards as of November 1, 2010.

USA Representative

William Foster

William Foster
Vice President of Engineering

TELEDYNE ISCO
A Teledyne Technologies Company

60-5242-065

Teledyne Isco One Year Limited Warranty*

Factory Service for Teledyne Isco Flow Meters, Waste Water Samplers, and Syringe Pumps

This warranty exclusively covers Teledyne Isco instruments, providing a one-year limited warranty covering parts and labor.

Any instrument that fails during the warranty period due to faulty parts or workmanship will be repaired at the factory at no charge to the customer. Teledyne Isco's exclusive liability is limited to repair or replacement of defective instruments. Teledyne Isco is not liable for consequential damages.

Teledyne Isco will pay surface transportation charges both ways within the 48 contiguous United States if the instrument proves to be defective within 30 days of shipment. Throughout the remainder of the warranty period, the customer will pay to return the instrument to Teledyne Isco, and Teledyne isco will pay surface transportation to return the repaired instrument to the customer. Teledyne Isco will not pay air freight or customer's packing and crating charges. This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

The warranty for any instrument is the one in effect on date of shipment. The warranty period begins on the shipping date, unless Teledyne Isco agrees in writing to a different date.

Excluded from this warranty are normal wear; expendable items such as charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; and damage due to corrosion, misuse, accident, or lack of proper maintenance. This warranty does not cover products not sold under the Teledyne Isco trademark or for which any other warranty is specifically stated.

No item may be returned for warranty service without a return authorization number issued by Teledyne Isco.

This warranty is expressly in lieu of all other warranties and obligations and Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

The warrantor is Teledyne Isco, Inc. 4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco Inc. does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

Before returning any instrument for repair, please call, fax, or e-mail the Teledyne Isco Service Department for instructions. Many problems can often be diagnosed and corrected over the phone, or by e-mail, without returning the instrument to the factory.

Instruments needing factory repair should be packed carefully, and shipped to the attention of the service department. Small, non-fragile items can be sent by insured parcel post. **PLEASE BE SURE TO ENCLOSE A NOTE EXPLAINING THE PROBLEM.**

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln, NE 68504 USA

Mailing Address: Teledyne Isco, Inc.
PO Box 82531
Lincoln, NE 68501 USA

Phone: Repair service: (800) 775-2965 (lab instruments)
(866) 298-6174 (samplers & flow meters)
Sales & General Information: (800) 228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: IscoService@teledyne.com

March 8, 2011 P/N 60-1002-040 Rev E

TELEDYNE ISCO
A Teledyne Technologies Company