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Model 990 dCLD II Component Leak Detector

OPERATIONS MANUAL

Manual No. 699909694
Revision E
March 2004

Model 990 dCLD II
Component Leak Detector

shown with Optional Front Control Panel

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Declaration of Conformity
Konformitätserklärung
Déclaration de Conformité
Declaración de Conformidad
Verklaring de Overeenstemming
Dichiarazione di Conformità

VARIAN

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Nous	Vacuum Technologies
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Noi	

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Model 990 dCLD II Component Leak Detector

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Electromagnetic Compatibility Directive
89/336/EEC
Measurement Control and Laboratory Equipment-EMC Requirements
EN61326:1998
Safety requirements for electrical equipment for control and laboratory use, incorporating amendments No. 1 and 2
EN61010-1:1993

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March 2001

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Preface

Hazard and Safety Information

This manual uses the following standard safety protocols:

WARNING *The warning messages are for attracting the attention of the operator to a particular procedure or practice which, if not followed correctly, could lead to serious injury.*

CAUTION *The caution messages are displayed before procedures, which if not followed, could cause damage to the equipment.*

NOTE *The notes contain important information.*

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Vacuum Technologies. All warning and cautions should be read carefully and strictly observed. Consult local, state, and national agencies regarding specific requirements and regulations. Address any safety, operation, and/or maintenance questions to your nearest Vacuum Technologies office.

Vacuum Equipment and Cleanliness

Cleanliness is vital when servicing any vacuum equipment.

CAUTION

- *Do not use silicone oil or silicone grease.*
- *Use powder-free butyl or polycarbonate gloves to prevent skin oils from getting on vacuum surfaces.*
- *Do not clean any aluminum parts with Alconox®. Alconox is not compatible with aluminum and will cause damage.*

NOTE

Normally, it is unnecessary to use vacuum grease. However, if it must be used, avoid silicone types, and use it sparingly. Apiezon® L grease is recommended (Vacuum Technologies Part Number 695400004).

O-ring Care

When removing, checking, or replacing O-rings, keep in mind the following:

NOTE

Vacuum Technologies recommends replacing all O-rings during routine maintenance or during any maintenance procedure requiring that O-rings be removed.

CAUTION

Remove O-rings carefully with your fingers. Do not use metal tools for this task. Follow these guidelines to prevent scratching of any sealing surfaces:

- *Wipe all O-rings clean with a lint-free cloth before installation to ensure that no foreign matter is present to impair the seal.*
- *Do not use grease or use other substances on O-rings that will come in contact with the spectrometer tube.*
- *Do not use alcohol, methanol, or other solvents on O-rings. To do so causes deterioration and reduces the O-ring's ability to hold a vacuum.*
- *In allowable situations, apply a small amount of Apiezon® L grease and wipe the O-rings "shiny" dry.*

NOTE

Included in the Vacuum Technologies' Component and Spectrometer Tube Cleaning Kit (p/n 670029096), is recommended for cleaning the spectrometer tube components.

VacuSolv® can also be used for fine cleaning of other parts in the leak detector's vacuum system, such as valves and fittings. No rinsing steps or high-temperature drying is required following cleaning with VacuSolv. Although appropriate precautions are advised, VacuSolv is compatible with most materials and does not contain toxic chemicals or CFCs (chlorofluorocarbons).

Contacting Vacuum Technologies

In the United States, you can contact Vacuum Technologies Customer Service at 1-800-8VARIAN.

Internet users:

- Send email to Customer Service & Technical Support at vpl.customer.support@varianinc.com
- Visit our web site at www.varianinc.com/vacuum
- Order on line at www.evarian.com

See the back cover of this manual for a listing of our sales and service offices.

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Section 1. Introduction to the Model 990 dCLD II

The Vacuum Technologies' Model 990 dCLD II is an industrial component Helium Mass Spectrometer Leak Detector designed to be integrated into dedicated leak testing systems. Its ease of use, remote communications capability, and integration flexibility make it the ideal leak detector for solving demanding leak-testing applications.

The 990 dCLD II is comprised of a 19-inch (48.26 cm), rack-mountable control unit and a Turbomolecular high vacuum pumped spectrometer tube assembly (turbo spec tube). An optional front control panel, which can be mounted either on the front of the control unit or remotely, provides easy set up of operating parameters, visual display of leak rate and pressure, and system status via a state-of-the-art industrial touch panel. The 990 dCLD II uses Varian Vacuum Technologies' Platform leak detector electronics architecture to operate the turbo spec tube assembly and provide leak rate and system status information to the operator interface.

1.1 Unpacking the 990 dCLD II

The 990 dCLD II is shipped to you in two or three boxes, depending on whether or not you ordered the optional front control panel. The contents of the boxes include:

- ❑ 990 dCLD II Control Unit, Cables, Mating Connector Kit, and Operations Manual
- ❑ Turbomolecular Pump Spectrometer Tube Assembly and Cal Leak Certification Envelope
- ❑ Optional Front Control Panel, Cable

Carefully unpack the boxes. Keep the original packaging in the event you have to return 3an item. If you have to return an item for replacement or repair, contact Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

Descriptions of the Control Unit, Turbo Spec Tube Assembly, and Cables follow. A brief description of the Optional Front Control Panel is included in this section. A more detailed description is in Section 4, "Setup and Monitor Operations via the Optional Front Control Panel".

1.2 Control Unit

The 990 dCLD II control unit operates and controls the turbo spec tube assembly and provides leak rate and system status information to a host computer or Programmable Logic Controller (PLC) through optically isolated discrete I/O connections and/or an RS-232 host serial port, or to the optional front control panel interface. Inside the control unit, the Vacuum Technologies' Platform performs the various functions of a helium mass spectrometer leak detector.

1.2.1 Front Panel Connections

Figure 1-1 shows the front panel hardware and connections of the 990 dCLD II control unit.

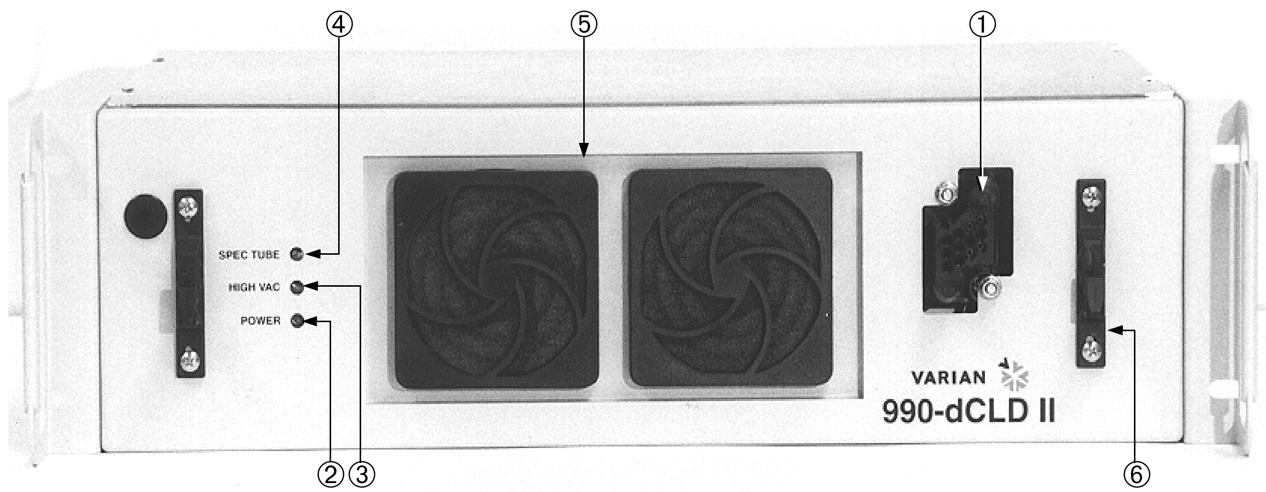

Figure 1-1 Control Unit Front Panel

① Connector for Optional Front Control Panel	The connector provides signals and power for the 990 dCLD II Optional Front Control Panel only.
② POWER LED	Steady ON verifies the presence of +5 VDC from the main power supply.
③ HIGH VAC LED	Steady ON verifies that the turbo pump is up to speed.
④ SPEC TUBE LED	Steady ON verifies that the ion source filament is operational, flashing indicates that the system is busy.
⑤ Fan filter guard	The dual air intakes have replaceable filters (see "Dual Air Intake Filter Replacement" on page -18).
⑥ Brackets for Optional Front Control Panel	The Brackets provide a quick connect/disconnect latch and connector arrangement for the optional front control panel.

1.2.2 Rear Panel Connections and Controls

The rear panel of the 990 dCLD II, Figure 1-2, provides power, cooling for the control unit, connection and control to various devices through the interfaces discussed below.

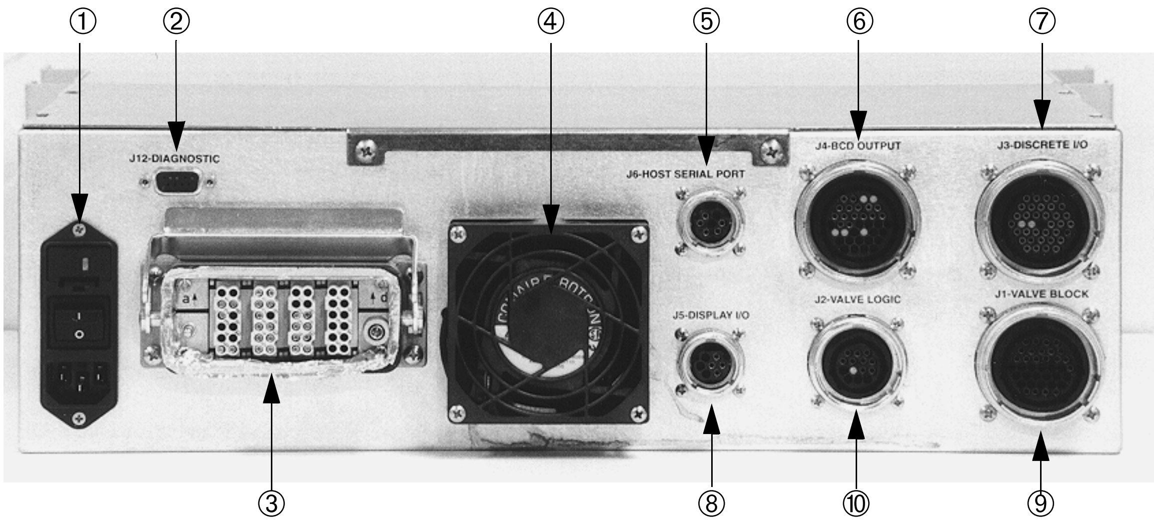

Figure 1-2 Control Unit Rear Panel

① Power Entry Module	A power module that consists of a fuse drawer with voltage selector, power on/off switch, and mains power input.
② J12 Diagnostic Port	A male, 9-pin, polled RS-232 D-sub diagnostic connector designated for service use only. A null modem cable is required.
③ J11 Turbo Spec Tube Connector	A keyed, locking connector for the turbo spec tube assembly cable.
④ Exhaust Fan	A fan for cooling the control unit and optional front control panel.
⑤ J6 Host Serial Port	A female 7-pin connector for a high-speed, interrupt-driven RS-232 interface for host computer control and monitoring.
⑥ J4 BCD Output	A female 37-pin connector for BCD (Binary Coded Decimal) output.
⑦ J3 Discrete I/O	A female 37-pin connector to provide discrete I/O for PLC control.
⑧ J5 Display I/O	A female 14-pin connector for display I/O to the optional front control panel. Connects to control unit front panel when the optional front control panel is remotely mounted.
⑨ J1 Valve Block	A female 37-pin connector to provide valve control signals to the cal leak valve block.
⑩ J2 Valve Logic	Not operational.

1.3 Turbomolecular Pump Spectrometer Tube Assembly

The Turbomolecular Pump Spectrometer tube (turbo spec tube) assembly is shown in Figure 1-3. It consists of the four subassemblies described below.

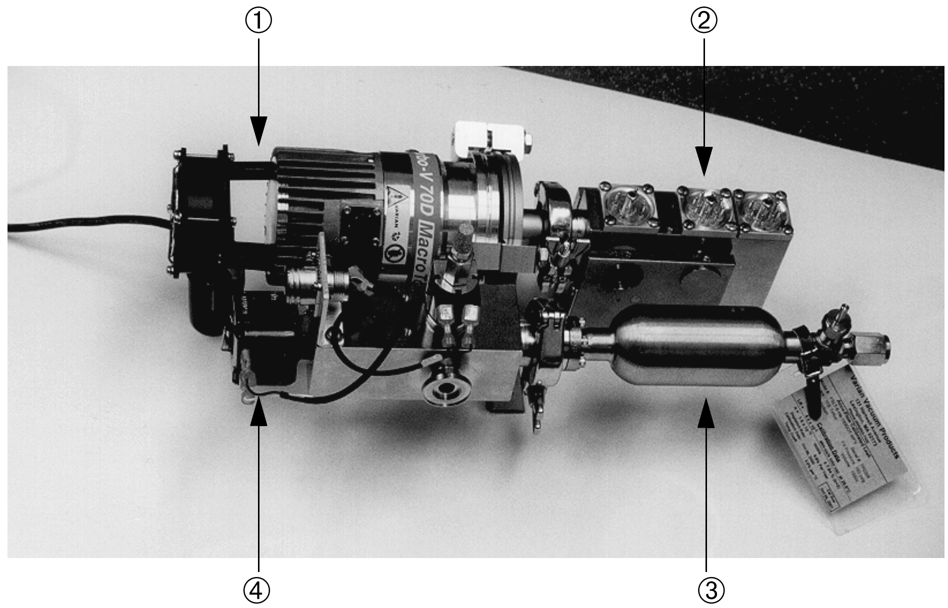

Figure 1-3 Turbomolecular Pump Spectrometer Tube Assembly

① Turbomolecular pump	Provides high vacuum for spectrometer tube operation.
② Spectrometer Assembly	Magnetic-sector spectrometer optimized for the detection of helium ions.
③ Internal calibrated leak	A helium leak standard that provides verification of 990 dCLD II operation.
④ Cal leak valve block	Provides valving for the internal calibrated leak.

1.4 Cables

All cables necessary to power the control unit and to connect the control unit to the turbo spec tube assembly have been provided. The cables have been customized to the length you specified at the time of your order. Section 3, “Setup and Operations via the Rear Panel” includes details about the connections. Part numbers are included in Section 5.7 “Spare Parts List” on page 5-23.

- Power Cable – Connects to main power.
- 37-pin Cal Leak Valve Block Cable – Connects to the cal leak valve block for calibrated leak operation.
- Turbo Spec Tube Cable – Connects to the turbo spec tube assembly. It ends with the spectrometer tube block connector (spec tube block connector), the turbo cooling fan, and the connector for the turbo pump power input.
- Turbo Pump Cable – Connects from the spec tube block connector to the turbo pump. It provides power to the turbo pump.
- 14-pin Display I/O Cable – Connects to the optional front control panel when it is remotely located. This cable is supplied with the optional front control panel.

1.5 Mating Connectors

A kit containing mating connectors and pins for building cables for connections J3, J4 and J6 is supplied with your 990 dCLD II. Build the cables according to the tables included in Appendix B “Customer Accessible Inputs and Outputs”.

1.6 Optional Front Control Panel

The Model 990 dCLD II Optional Front Control Panel provides indication of the leak rate measurement and spectrometer pressure through bar graph displays, and control of the leak detector via control buttons and a touch screen panel. The optional front control panel can be mounted remotely from the control unit or directly onto its front face.

Once the 990 dCLD II is set up, calibrated and put into production, control is turned over to the PLC or host computer when PARALLEL ENABLE is asserted. Control remains with the PLC or host computer until that control is specifically released by de-asserting PARALLEL ENABLE. However, during operation you can use the optional front control panel to monitor leak rate, pressure and operating parameters.

Section 4, “Setup and Monitor Operations via the Optional Front Control Panel”, of this manual provides a detailed description of the optional front control panel, a discussion of the bar graph and pressure displays, and details of the touch screen display and how to use the menus provided to set up and monitor the 990 dCLD II.

1.7 Specifications

The specifications for the 990 dCLD II are listed below.

Maximum Test Pressure	**V70 Configuration**	
	Fast Speed	≤ 500 mTorr
	Slow Speed	≤ 100 mTorr
	V70D Configuration	
	Fast Speed	≤ 3 Torr
	Slow Speed	≤ 1 Torr
	V70LP Configuration	
	Fast Speed	≤ 5 Torr
	Slow Speed	≤ 3 Torr
Helium Sensitivity	**V70 Turbo Configuration**	
	Slow Speed	Min. Detectable Leak: 2 x 10^{-10} atm cc/sec
		Display: 10^{-9} through 10^{-6} atm cc/sec
	Fast Speed	Min. Detectable Leak: 2 x 10^{-9} atm cc/sec
		Display: 10^{-8} through 10^{-5} atm cc/sec
	V70D Turbo Configuration	
	Slow Speed	Min. Detectable Leak: 2 x 10^{-9} atm cc/sec
		Display: 10^{-8} through 10^{-5} atm cc/sec
	Fast Speed	Min. Detectable Leak: 2 x 10^{-8} atm cc/sec
		Display: 10^{-7} through 10^{-4} atm cc/sec
	V70LP Turbo Configuration	
	Slow Speed	Min. Detectable Leak: 2 x 10^{-8} atm cc/sec
		Display: 10^{-7} through 10^{-4} atm cc/sec
	Fast Speed	Min. Detectable Leak: 2 x 10^{-7} atm cc/sec
		Display: 10^{-6} through 10^{-3} atm cc/sec
Response Time	< 0.5 seconds for helium	
Typical Recovery Time	< 2 seconds to recover below 20% of a 10^{-3} leak	
Noise Level	< 2% of the most sensitive scale, peak-to-peak, in accordance with AVS Std. 2.1	

Recommended Ambient Operating Conditions	**Operating Temperature**	**Control Unit:** 0 °C to 50 °C (32 °F to 122 °F) **Turbo Spec Tube Assy.:** 5 °C to 35 °C (41 °F to 95 °F) **Optional Front Control Panel:** 0 °C to 35 °C (32 °F to 95 °F)
	Maximum Relative Humidity	80% for temperatures up to 31 °C (88 °F), decreasing linearly to 50% HR at 40 °C (104 °F). No hoarfrost, dew, percolating water, rain, solar radiation, etc.
	Atmospheric Air Pressure	75 kPa to 106 kPa
	Pollution Degree	II
	Installation (Overvoltage)	Category II in accordance with UL3101-1 standard.
Heat Load	350 W	
Power Requirements	**Voltage Range**	115 / 230 VAC 47 Hz to 63 Hz
	Maximum Current	3 A/1.5 A, 350 Watts
	Fuse Rating	5 A, 250 VAC, slo-blo®
Conformance Standards	Meets applicable UL, CSA, and CE Standards	
Dimensions	**Control Unit**	19" rack, 5.25" high by 16.5" deep 48.26 cm rack, 13.33 cm by 41.91 cm (including mating connectors)
	Turbo Spec Tube Assembly	19" wide by 9" high by 8" deep 48.26 cm by 13.33 cm by 11.43 cm
	Optional Front Control Panel	17.2" wide by 5.25" high by 4.5" deep 43.69 cm by 22.86 cm by 20.32 cm (including mating connectors)
Weight	**Control Unit Assembly**	27 lbs. (12.25 kg)
	Turbo Spec Tube Assembly	17 lbs. (7.71 kg)
	Optional Front Control Panel	7 lbs. (3.18 kg)
	Cables (turbo and valves)	14 lbs. (6.35 kg)

System I/O Capability	J3 Inputs	Opto-isolated, 5 to 24 VDC 3600 Ohm resistive load.
	J3 Outputs	Emitter follower with 10 Ohm series resistor, 14 mA max drive current, 24 VDC max.
	J3 Momentary Inputs	Opto-isolated, 5 to 24 VDC 3600 Ohm resistive load, requires 200 ms per min pulse width.
	J3 Analog Leak Rate Output	0 to 10 V per decade linear; 1, 2 or 3 V per decade logarithmic. Note: 3 V per decade logarithmic has limited use on the highest decade.
	J4 BCD Leak Rate Output	Emitter follower with 10 Ohm series resistor, 14 mA max drive current, 24 VDC max. Note: This output is valid only when the leak rate output pulse is low. The leak rate is updated every 50 ms.
	J6 Host Serial Port	9600 Baud, No parity, 8 Bits, 1 Stop Bit, interrupt-driven RS-232 port for connection to a host computer.
	J12 Diagnostic Port	9600 Baud, No parity, 8 Bits, 1 Stop Bit, configured as DTE (Data Terminal Equipment). Use null modem cable when connecting to a host computer.

Section 2. Customer Integration

The information provided in this section assists you in making decisions to provide the optimum level of leak detection for your operation.

2.1 Physical Considerations

The control unit of the Model 990 dCLD II is intended to be mounted in a standard 19-inch rack enclosure. It can, however, be mounted in any orientation provided that air movement through the unit is not impeded. For efficiency sake, mount the Model 990 dCLD II so that the LEDs can be seen from a convenient location to determine the status of the system at a glance.

The Optional Front Control Panel can be mounted either directly onto the face of the control unit or remotely in a standard 19-inch rack enclosure. A 10-foot cable provides connection to the front of the control unit. As is the case with the control unit, it can be mounted in any orientation that provides unimpeded ventilation, and that allows easy viewing and access to the displays, touch screen panel, and control buttons. Also, keep in mind that the audio for the 990 dCLD II emanates from the rear of this panel.

The Turbo Spec Tube Assembly can be mounted in any orientation. The spectrometer tube must be isolated from strong magnetic fields such as motors, transformers, and magnets. Steel structures and steel objects should be should be kept at least 2 inches away from the closest edge of the spectrometer tube. Failure to do so will result in damage to the magnet in the spectrometer tube. During normal operation, the spectrometer tube feels quite warm. A continuously running fan at the end of the high vacuum pump directs cooling air toward the end of the pump.

To achieve maximum sensitivity, mount the turbo spec tube assembly as close as possible to the test chamber or part being tested. The length and number of bends in the plumbing between the turbo spec tube assembly and the test chamber should be less than the length and number of bends in the plumbing between the turbo spec tube assembly and the mechanical backing pump. Likewise, the diameter of the plumbing between the turbo spec tube assembly and the test chamber should be the same size or larger than the diameter of the plumbing between the mechanical backing pump and the turbo spec tube assembly. You must also consider the type and size of the mechanical pumps for your system. For accurate and repeatable leak testing, Vacuum Technologies recommends that customer-supplied roughing and forepumps be helium-stable mechanical pumps, such as Vacuum Technologies oil-sealed mechanical pumps. (See Section 2.3 “Size of Mechanical Pumps” on page 2-7.) The use of non-helium-stable pumps will result in erratic, unreliable leak rate readings and an inability to calibrate successfully.

2.2 Common Configurations

The 990 dCLD II is available with your choice of three pumps:

- ❑ V70 Turbomolecular Pump
- ❑ V70D MacroTorr® Turbomolecular Pump
- ❑ V70LP MacroTorr® Turbomolecular Pump

Table 2-1 lists operating information about the three pumps and compares advantages and limitations relating to sensitivity and clean up time.

Table 2-1 V70, V70D and V70LP Turbomolecular Pump Comparison

Speed	Helium Pumping Speed (L/sec)*	Range of Leak Rate (atm cc/sec)	Minimum Detectable Leak (atm cc/sec)	Maximum Foreline Pressure (Torr)	Advantages	Limitations
V70 Turbomolecular Pump						
Slow	60	10^{-9} to 10^{-6}	2×10^{-10}	0.1	Provides the highest sensitivity of the three pumps.	Has the slowest clean up time of the three pumps.
Fast	60	10^{-8} to 10^{-5}	2×10^{-9}	0.1	Provides faster clean up than V70 in Slow speed, with slight loss in sensitivity.	Requires low foreline pressure.
V70D MacroTorr Turbomolecular Pump						
Slow	30	10^{-8} to 10^{-5}	2×10^{-9}	1.0	Provides higher foreline pressure than V70 in Fast speed.	Provides less sensitivity than the V70.
Fast	30	10^{-7} to 10^{-4}	2×10^{-8}	5.0	Provides faster clean up than V70D in Slow speed and V70 in either speed.	Provides less sensitivity than the V70.
V70LP MacroTorr Turbomolecular Pump						
Slow	60	10^{-7} to 10^{-4}	2×10^{-8}	5.0	Provides the fastest clean up for the sensitivity.	Sensitivity is low, and is lower than the V70 or V70D.
Fast	60	10^{-6} to 10^{-3}	2×10^{-7}	10	Provides the highest foreline pressure and the fastest clean up time of all three pumps.	Sensitivity is the lowest in fast mode of all three pumps.

* Total helium pumping speed is affected by backing pump.

The 990 dCLD II component system has been modularly designed to fit your operations. Table 2-2 provides a comparison of the three most commonly used configurations:

- ❑ Single mechanical pump
  See Figure 2-1 and Table 2-3 on page 2-4.
- ❑ Dual mechanical pump
  See Figure 2-2 and Table 2-4 on page 2-5.
- ❑ Split flow dual mechanical pump
  See Figure 2-3 and Table 2-5 on page 2-6.

Table 2-2 Configuration Comparison

Configuration	Advantages	Limitations
Single Mechanical Pump	❑ Higher sensitivity ❑ Lower cost	❑ Longer cycle time ❑ Backing pump doubles as rough pump
Dual Mechanical Pump	❑ Higher sensitivity ❑ Faster pump-down. ❑ Shorter cycle time ❑ Separate pumps for rough and backing	❑ Higher cost.
Split Flow Dual Mechanical Pump	❑ Faster pump-down ❑ Faster clean-up ❑ Shorter cycle time ❑ Separate pumps for rough and backing	❑ Lower sensitivity ❑ Higher cost

2.2.1 Single Mechanical Pump Configuration

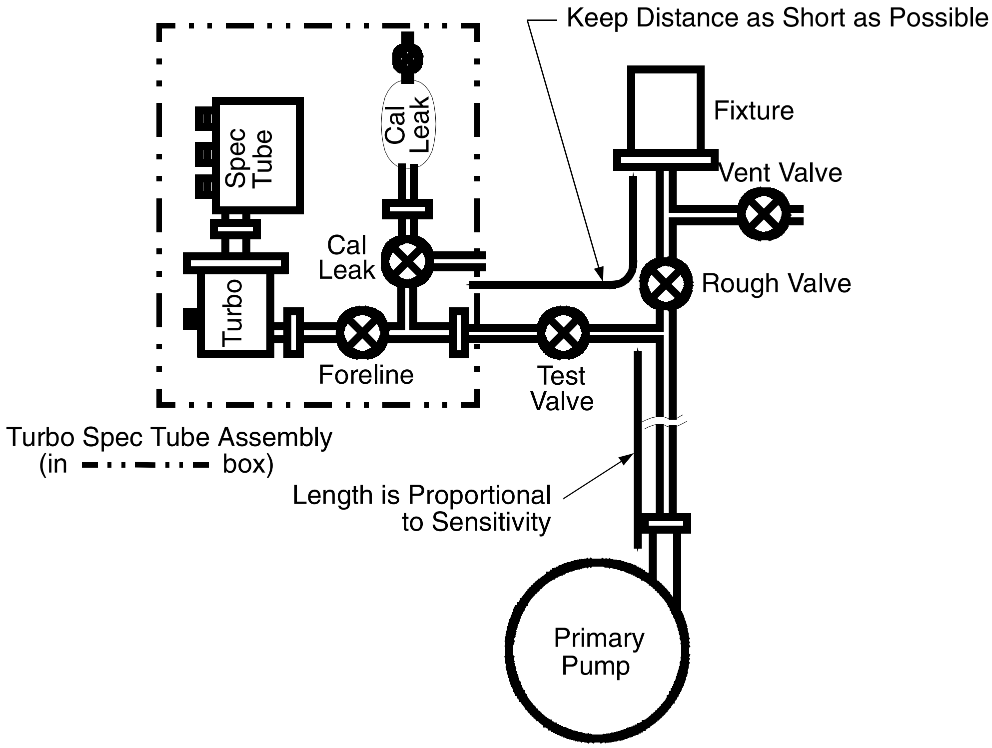

Figure 2-1 Single Pump Configuration

Table 2-3 Single Mechanical Pump System Valve Sequence

State	Vent Valve	Rough Valve	Test Valve	Remarks
Pre-Vented	Closed	Closed	Closed	The Pre-Vented state allows time to ensure that all valves are closed before any open. The time spent in the pre-vented state depends on valve actuation time.
Vented	Opened	Closed	Opened	The Vented state places the fixture at atmosphere. The Test Valve keeps the turbo backed.
Pre-Roughing	Closed	Closed	Closed	The Pre-Roughing state allows time to ensure that all valves are closed before any open. The time spent in the pre-roughing state depends on valve actuation time.
Roughing	Closed	Opened	Closed	The Roughing state brings the fixture to vacuum. The turbo is not being pumped. The maximum time here is approximately 3 minutes.
Test	Closed	Opened	Opened	The Test Valve re-opens at the appropriate foreline pressure, backing the turbo and exposing the fixture to the foreline.

Note: Foreline and Cal Leak valves are under the control of the 990 dCLD II.

2.2.2 Dual Mechanical Pump Configuration

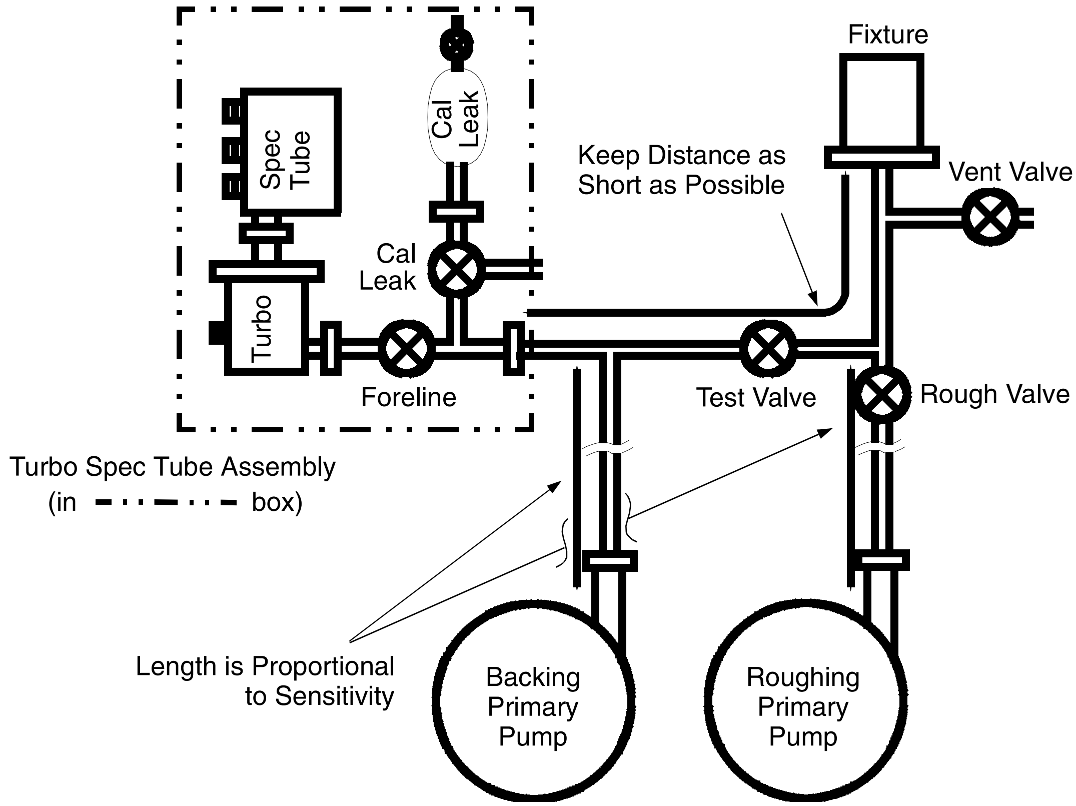

Figure 2-2 Dual Mechanical Pump Configuration

Table 2-4 Dual Mechanical Pump System Valve Sequence

State	Vent Valve	Rough Valve	Test Valve	Remarks
Pre-Vented	Closed	Closed	Closed	The Pre-Vented state allows time to ensure that all valves are closed before any open. The time spent in the pre-vented state depends on valve actuation time.
Vented	Opened	Closed	Closed	The Vented state places the fixture at atmosphere. The backing primary pump keeps the turbo backed.
Pre-Roughing	Closed	Closed	Closed	The Pre-Roughing state allows time to ensure that all valves are closed before any open. The time spent in the pre-roughing state depends on valve actuation time.
Roughing	Closed	Opened	Closed	The Roughing state brings the fixture to vacuum.
Test	Closed	Closed	Opened	The Test Valve re-opens at the appropriate foreline pressure, exposing the fixture to the foreline.

Note: Foreline and Cal Leak valves are under the control of the 990 dCLD II.

2.2.3 Split Flow Dual Mechanical Pump Configuration

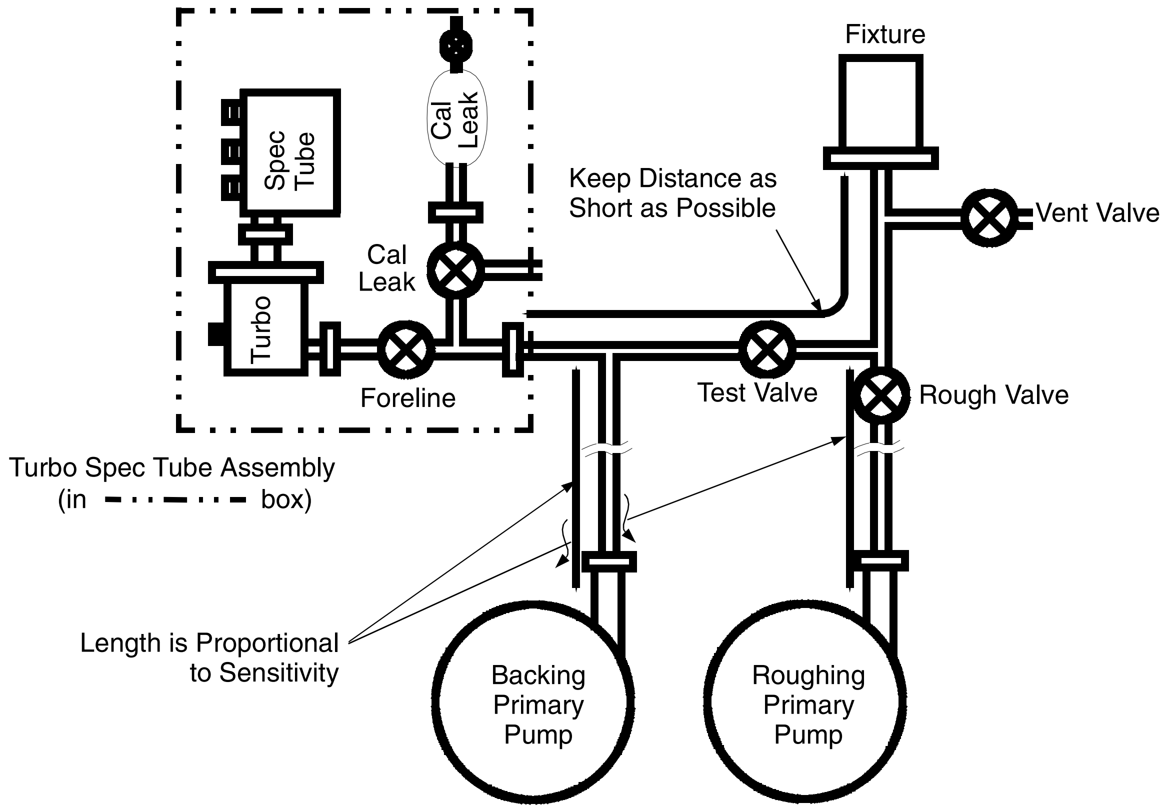

Figure 2-3 Split Flow Dual Mechanical Pump Configuration

Table 2-5 Split Flow Dual Mechanical Pump System Valve Sequence

State	Vent Valve	Rough Valve	Test Valve	Remarks
Pre-Vented	Closed	Closed	Closed	The Pre-Vented state allows time to ensure that all valves are closed before any open. The time spent in the pre-vented state depends on valve actuation time.
Vented	Opened	Closed	Closed	The Vented state places the fixture at atmosphere.
Pre-Roughing	Closed	Closed	Closed	The Pre-Roughing state allows time to ensure that all valves are closed before any open. The time spent in the pre-roughing state depends on valve actuation time.
Roughing	Closed	Opened	Closed	The Roughing state brings the fixture to vacuum.
Test	Closed	Opened	Opened	The Test Valve re-opens at the appropriate foreline pressure, exposing the fixture to the foreline.

Note: Foreline and Cal Leak valves are under the control of the 990 dCLD II.

2.3 Size of Mechanical Pumps

When selecting rough and forepumps for your system, the pumps listed in Table 2-6 are recommended. These pumps can be paired (within type) in any combination for forepump and rough pump except where noted. For more information, contact Vacuum Technologies Customer Service 1-800-8VARIAN.

Table 2-6 Recommended Mechanical Pumps

Type/Model Pump	Recommended for		Maximum Pumping Speed	Remarks	Varian Part Number
	Fore	Rough			
Rotary Vane					
DS-102	l		100 L/min (3.6 cfm)	Do not pair with a Rough Pump size ≤ DS-202	9499305
DS-202	l	l	200 L/min (7.0 cfm)		9499320
DS-302	l	l	300 L/min (10.6 cfm)		9499325
DS-402		l	400 L/min (14.1 cfm)		9499330
Dry Scroll					
PTS 300	l	l	300 L/min (10.6 cfm)		PTS03001UNIV
PTS 600	l	l	600 L/min (21.2 cfm)		PTS06101UNIV

2.4 Electronic Considerations

This section includes information necessary to interface the 990 dCLD II with a PLC or a host computer using either serial or parallel communications. This includes connection via J3 Discrete I/O, J4 BCD Outputs and J6 Host Serial Port.

2.4.1 Discrete I/O J3 Inputs

The discrete I/O is used to control operations via a PLC. Table 2-7 provides the input connections. For detailed information see Table B-1 on page B-1. For a cross reference of the function in other modes of operation, see Table 2-11 on page 2-15.

J3 Level inputs are opto-isolated, 5 to 24 VDC 3600 Ohm resistive load. J3 Momentary inputs are opto-isolated, 5 to 24 VDC 3600 Ohm resistive load, and require 200 ms minimum pulse width. Figure 2-4 shows the J3 input circuit sketch.

Table 2-7 J3 Inputs Summary Table

J3/ Pin	Input Name	Momentary or Level	Description
1	Input Common	N/A	Return for J3 inputs (with pin 25).
5	RUN / $\overline{\text{IDLE}}$	Level	Turns ON the spec tube and turbo (leave IDLE state).
6	PARALLEL ENABLE	Level	Disable changes to the parameters from discrete I/O, serial inputs or optional front control panel.
7	ZERO	Momentary	Performs a ZERO function.
8	STDLEAK	Momentary	Puts the Leak Detector in Read STD LEAK mode.
9	Full Internal Calibrate	Momentary	Performs a Full Calibration using the internal leak.
10	DECREMENT	Momentary	Decrements the Exponent in Manual Ranging.
11	INCREMENT	Momentary	Increments the Exponent in Manual Ranging.
12	AUTO / $\overline{\text{MANUAL}}$	Level	Puts the system in Auto Ranging if active.
23	Full External Cal	Momentary	Performs a Full Calibration with External Leak.
24	Quick Internal Cal	Momentary	Performs a Quick Calibration using the internal leak.
25	Input Common	N/A	Return for J3 inputs (with pin 1).
35	FIL OFF	Level	Turns the operating Filament OFF when active.
37	Quick External Cal	Momentary	Performs a Quick Calibration using the external leak.

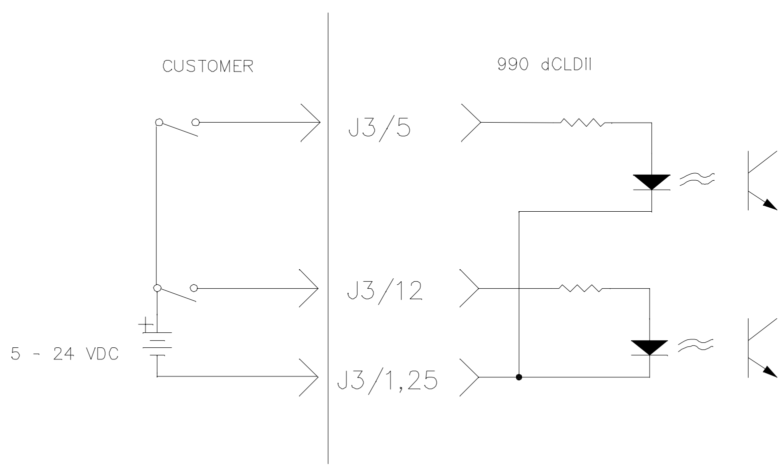

Figure 2-4 J3 Input Circuit Sketch

2.4.2 Discrete I/O J3 Outputs

Table 2-8 provides the J3 output connections. For detailed information see Table B-2 on page B-4. For a cross reference of the functions in other modes of operation, see Table 2-11 on page 2-15.

J3 Level outputs are opto-isolated emitter followers with 10 Ohm series resistor, 14 mA max drive current, 24 VDC max. Figure 2-5 shows the J3 output circuit sketch.

Table 2-8 J3 Outputs Summary Table

J3/ Pin	Output Name	Momentary or Level	Description
2	REJECT #1	Level	Active when Leak Rate is over set point #1.
14	Ready	Level	Active when Fil and Turbo ok, i.e., the system is ready to test.
15	Zeroing	Level	Active when performing a ZERO function.
16	Leak Rate Update		Valid data on BCD when low, becomes active during the time that the BCD leak rate output is updated.
17	Filament Fault	Level	Active when selected Ion Source Filament is non-functional.
18	CAL OK	Level	Active when last calibration ok. It is set inactive at the start of a CALIBRATE routine and at power on.
22	Calibrating	Level	Active when performing a CALIBRATE routine.
26	REJECT #2	Level	Active when Leak Rate is greater than set point #2.
27	+V Input	N/A	Customer-supplied +5 to +24 VDC for J3.
28	+V Input	N/A	Customer-supplied +5 to +24 VDC for J3.
29	REJECT #3	Level	Active when Leak Rate greater than set point #3.
30	REJECT #4	Level	Active when Leak Rate greater than set point #4.
33	HiVac OK	Level	Active when turbo is ok.
31	Analog Output	Analog	Analog Leak Rate output voltage.
32	Analog Return	Ground	Analog Leak Rate output voltage return.

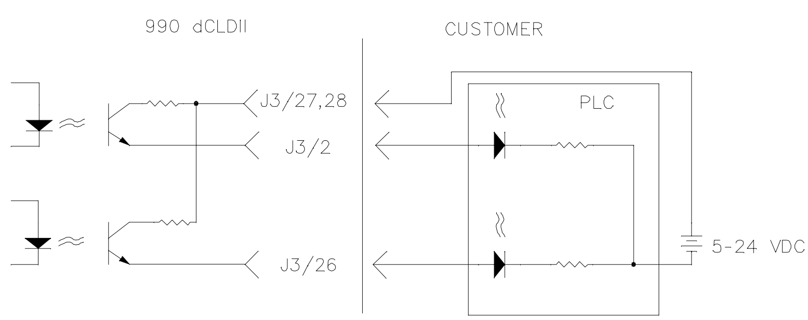

Figure 2-5 J3 Output Circuit Sketch

2.4.3 BCD J4 Outputs

Table 2-9 provides the J4 output connections. For detailed information see Table B-2 on page B-4.

J4 outputs are opto-isolated emitter followers with 10 Ohm series resistor, 14 mA max drive current, 24 VDC max. Note: This output is valid only when the leak rate output pulse is low. The leak rate is updated every 50 ms. Figure 2-6 shows the J4 output circuit sketch.

Table 2-9 J4 Outputs Summary Table

J4/ Pin	Output Name	Momentary or Level	Description
3	LSD A MAN	Level	Mantissa BCD Leak Rate, the ones place of the least significant digit.
4	LSD B MAN	Level	Mantissa BCD Leak Rate; the twos place of the least significant digit.
5	LSD C MAN	Level	Mantissa BCD Leak Rate; the fours place of the least significant digit.
6	LSD D MAN	Level	Mantissa BCD Leak Rate; the eights place of the least significant digit.
7	MSD A MAN	Level	Mantissa BCD Leak Rate; the ones place of the most significant digit.
8	MSD B MAN	Level	Mantissa BCD Leak Rate; the twos place of the most significant digit.
9	MSD C MAN	Level	Mantissa BCD Leak Rate; the fours place of the most significant digit.
10	MSD D MAN	Level	Mantissa BCD Leak Rate; the eights place of the most significant digit.
11	LSD A EXP	Level	Exponent BCD Leak Rate; the ones place of the least significant digit.
12	LSD B EXP	Level	Exponent BCD Leak Rate; the twos place of the least significant digit.
13	LSD C EXP	Level	Exponent BCD Leak Rate; the fours place of the least significant digit.
14	LSD D EXP	Level	Exponent BCD Leak Rate; the eights place of the least significant digit.
15	MSD A EXP	Level	Exponent BCD Leak Rate; the ones place of the most significant digit.
20	+V Input	N/A	Customer-supplied +5 to +24 VDC for J4.
21	+V Input	N/A	Customer-supplied +5 to +24 VDC for J4.

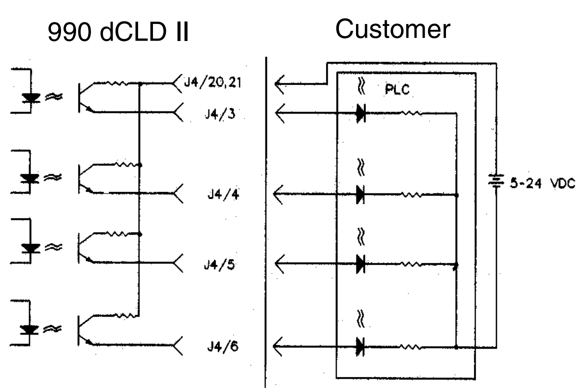

Figure 2-6 J4 Output Circuit Sketch

2.4.4 Host Serial Port J6

The Host Serial Port is used to interface the 990 dCLD II to a PLC or computer via an RS-232 connection. Table 2-10 and Figure 2-7 provide details of the connection.

J6 connections are referenced to the chassis ground and are not isolated. Electrical characteristics comply with EIA/TIA Standard EIA/TIA-232-E.

Table 2-10 J6 Summary Table

J6/ Pin	EIA Name	Description
2	Received Data	Data Into the 990 dCLD II
3	Transmitted Data	Data Out of the 990 dCLD II
5	Signal Common	Ground
6	Clear To Send	Handshaking Signal Out of the 990 dCLD II
7	Request To Send	Handshaking Signal Into the 990 dCLD II

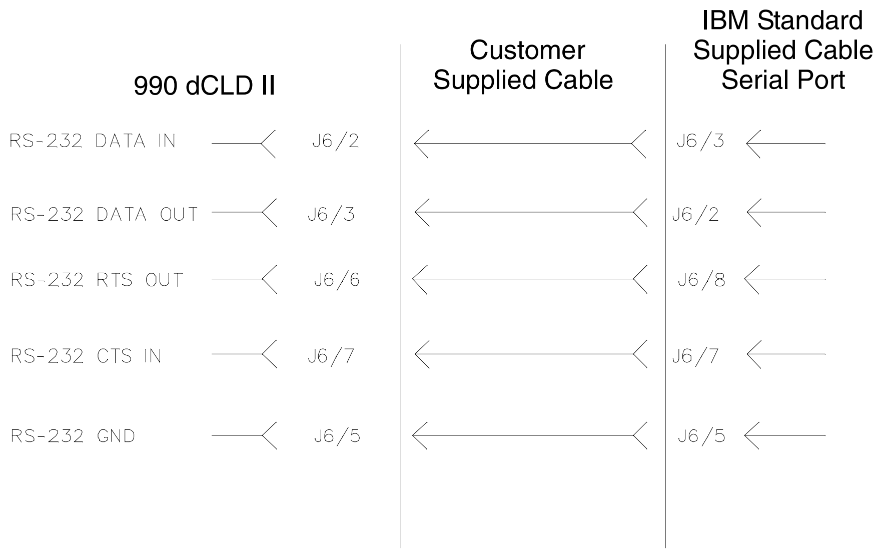

Figure 2-7 J6 Circuit Sketch

2.5 Operating Modes Commands Cross Reference

Most functions can be accomplished in at least two of the setup or operating modes of the 990 dCLD II. Table 2-11 lists functions and provides the commands to accomplish those functions in each operating mode:

- ❑ J6 Host Serial Port RS-232 Command (detailed information is provided in Appendix A "Communications Protocol")
- ❑ Discrete I/O J3 (detailed information is provided in Appendix B "Customer Accessible Inputs and Outputs")
- ❑ Optional Front Control Panel (detailed information is provided in Section 5, "Maintenance")

Except for the first entry in the table, PARALLEL ENABLE, the table is organized alphabetically by function, sub-function, and various tasks you might need to accomplish within that function. For instance, the commands available for AUTO-ZERO<0 are to be able to set it Active or Inactive, and to inquire about its status. Those two activities are grouped together, and listed alphabetically within the group. This table will prove useful as you learn to set up and run the 990 dCLD II.

Table 2-11 Commands for Operating Modes

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Turn control over to the PLC	PARALLEL ENABLE	J3/6	None	None
Set Auto-Zero<0 Active or Inactive	AUTO-ZERO<0 - 1 Active, 0 Inactive		1 INIT-AZ<0<CR> 0 INIT-AZ<0<CR>	ZEROING screen, Section 4.6.6 "Zeroing".
Is Auto-Zero<0 enabled?	AUTO-ZERO<0 - Status inquiry		?AZ<0<CR>	SYSTEM INFORMATION screen, Section 4.5 "System Information Screen"

Perform a full external calibration	Calibrate - Full - External	J3/23	EXTERNAL<CR>
			then
			?QUICK-CAL<CR>
			if returns 0, then
			CALIBRATE<CR>
			else
			0 INIT-QUICK-CAL<CR>
			then
			CALIBRATE<CR>
				Ensure USE NORM CAL and USE EXT LEAK are set in the SET UP CAL LEAK menu, Section 4.6.1 "Calibrated Leak Set-Up".
				Press the CALIBRATE button, Section 4.1 "Control Buttons".

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter

Perform a full internal calibration	Calibrate - Full - Internal	J3/9	INTERNAL<CR>
			then
			?QUICK-CAL<CR>
			if returns 0, then
			CALIBRATE<CR>
			else
			0 INIT-QUICK-CAL<CR>
			then
			CALIBRATE<CR>
				Ensure USE NORM CAL and USE INT LEAK are set in the SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”. Press the CALIBRATE button. Section 4.1 “Control Buttons”.

Set the Calibration mode to Normal or Fast	Calibrate - Mode - 0 Normal, 1 Fast		0 INIT-QUICK-CAL<CR> 1 INIT-QUICK-CAL<CR>	SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”, set FAST or NORM
Will a Normal or a Fast calibration be performed when asked.	Calibrate - Mode inquiry - 0 Normal, 1 Fast		?QUICK-CAL<CR>	SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”, USE NORM CAL / USE FAST CAL

Perform a fast external calibration	Calibrate - Quick - External	J3/37	EXTERNAL<CR>
			then
			?QUICK-CAL<CR>
			if returns 1, then
			CALIBRATE<CR>
			else
			1 INIT-QUICK-CAL<CR>
			then
			CALIBRATE<CR>
				Ensure USE FAST CAL and USE EXT LEAK are set in the SET UP CAL LEAK menu, Section 4.6.1 “Calibrated Leak Set-Up”
				Press the CALIBRATE button, Section 4.1 “Control Buttons”.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter

Perform a fast internal calibration	Calibrate - Quick - Internal	J3/24	INTERNAL<CR>
			then
			?QUICK-CAL<CR>
			if returns 1, then
			CALIBRATE<CR>
			else
			1 INIT-QUICK-CAL<CR> then CALIBRATE<CR>
				Ensure USE FAST CAL and USE INT LEAK are set in the SET UP CAL LEAK menu, Section 4.6.1 “Calibrated Leak Set-Up”.
				Press the CALIBRATE button, Section 4.1 “Control Buttons”.

Was the last Calibration successful?	Calibrate - Successful inquiry	J3/18	?CALOK<CR>	HOME screen, Section 4.4 “Touch Panel Home Screen”, or exponent display not flashing **C**.
Use an external calibrated leak	Calibrated Leak - EXTERNAL	N/A	EXTERNAL<CR>	Set USE EXT LEAK in the SET UP CAL LEAK menu, Section 4.6.1 “Calibrated Leak Set-Up”.
Set the External calibrated leak value	Calibrated Leak - External - Set Value	N/A	X.XE-XX INIT-EXTLEAK<CR>	SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”, set EXTERNAL LEAK VALUE
What is the value of the external calibrated leak?	Calibrated Leak - External - Value inquiry		?EXTLEAK<CR>	SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”, EXTERNAL LEAK VALUE
Set the Internal calibrated leak value	Calibrated Leak - Internal - Set Value	N/A	X.XE-XX INIT-STDLEAK<CR>	SET UP CAL LEAK screen, Section 4.6.1 “Calibrated Leak Set-Up”, set INTERNAL LEAK VALUE
What is the value of the internal calibrated leak?	Calibrated Leak - Internal - Value inquiry		?STDLEAK<CR>	HOME screen, Section 4.4 “Touch Panel Home Screen”. SET UP CAL LEAK Menu, Section 4.6.1 “Calibrated Leak Set-Up”, INTERNAL LEAK VALUE.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Use the internal calibrated leak	Calibrated Leak - Use INTERNAL	N/A	INTERNAL<CR>	Set USE INT LEAK in the SET UP CAL LEAK menu, Section 4.6.1 “Calibrated Leak Set-Up”.
Temporarily Set Emission Current	Emission I - Set Temp		XXXX PUT-EMISSION<CR>	MANUAL TUNING, set EMISSION I, Section 4.7.2 “Manual Tuning”
Store the Emission Current in Non-Volatile RAM	Emission I - Store		XXXX INIT-EMISSION<CR>	N/A
What is the Emission Current?	EMISSION I - Value inquiry		?EMISSIONCURRENT<CR>	MANUAL TUNING, Section 4.7.2 “Manual Tuning”, EMISSION I
Set the operating Filament	FIL - Set operating		1 INIT-FILAMENT<CR> 2 INIT-FILAMENT<CR>	MANUAL TUNING, Section 4.7.2 “Manual Tuning”, FIL1ACTV / FIL2ACTV
What is the Filament Bias Voltage?	FIL Bias Volt - Value inquiry		?FILAMENTBIAS<CR>	N/A
Turn the operating filament off.	FIL OFF - when active	J3/35	0 INIT0FILAMENT<CR>	N/A
What is the Fixed Focus Voltage?	FIXED FOCUS V - Value inquiry		?FIXEDFOCUS<CR>	N/A
Temporarily Set Gain	Gain - Set Temp		X.X PUT-GAIN<CR>	MANUAL CALIBRATION, Section 4.7.1 “Manual Calibration”
What is the system Gain?	Gain - Value inquiry		?GAIN<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”
Allow or disallow control unit to be put into RUN or IDLE mode	IDLE - allow or not		ENABLE-IDLE<CR> DISABLE-IDLE<CR>	N/A
Put the control unit into RUN or IDLE mode	IDLE - Mode RUN - Mode	J3/5	IDLE<CR> RUN<CR>	N/A

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Obtain a summary of all Ion Source Parameters.	ION Source - Values inquiry		*Note: Values are for example only.* ?ALL<CR> Reports: FILAMENTBIAS 122.1 IONCHAMBER 269.1 VARIABLEFOCUS 235.4 REPELLER 402.2 FIXEDFOCUS 212.7 SUPPRESSOR 145.0 EMISSIONCURRENT 1.040 OFFSET 59	MANUAL TUNING, ION V, Section 4.7.2 “Manual Tuning” MANUAL TUNING, VAR FOCUS MANUAL TUNING, REPELLER V MANUAL TUNING, EMISSION I
Temporarily Set Ion Voltage	ION V - Set Temp		XXX PUT-ION<CR>	MANUAL TUNING, set ION V, Section 4.5 “System Information Screen”
Store the Ion Voltage in Non-Volatile RAM	ION V - Store		XXX INIT-ION<CR>	N/A
What is the Ion Voltage?	ION V - Value inquiry		?IONCHAMBER<CR>	MANUAL TUNING, Section 4.5 “System Information Screen”, ION V
Obtain the present leak rate value	Leak Rate - Current - Value inquiry	J3 or J4 Outputs	?LEAK<CR>	HOME screen Section 4.4 “Touch Panel Home Screen” Bar graph display
Read the last Standard Leak value input.	Leak Rate - Standard - Value inquiry	J3/8	?STDLEAK<CR>	Press the READ STANDARD LEAK button, read bar graph display. Press again to turn off. Section 4.1 “Control Buttons”.
Temporarily Set Preamplifier Offset	OFFSET - Set Temp		XX PUT-OFFSET<CR>	N/A

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
What is the Preamp offset?	OFFSET - Value inquiry		?OFFSET<CR>	N/A
Set the Analog Output to Linear	Output - Analog - Linear		INIT-LINEAR<CR>	OUTPUT CONTROL SET-UP screen, Section 4.6.5 “Output Control Setup”.
Set the Analog Output to 1V Logarithmic	Output - Analog - Log 1V		INIT-1LOG<CR>	OUTPUT CONTROL SET-UP screen, Section 4.6.5 “Output Control Setup”.
Set the Analog Output to 2V Logarithmic	Output - Analog - Log 2V		INIT-2LOG<CR>	OUTPUT CONTROL SET-UP screen, Section 4.6.5 “Output Control Setup”.
Set the Analog Output to 3V Logarithmic	Output - Analog - Log 3V		INIT-3LOG<CR>	OUTPUT CONTROL SET-UP screen, Section 4.6.5 “Output Control Setup”.
Decrement the Manual Range exponent by 1 (more negative)	Range - Manual - DECREMENT	J3/10	DECREMENT<CR>	Set the MANUAL RANGE parameter and make sure it is ON in LEAK RATE RANGING SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”.
Select Manual Ranging or Auto-Ranging mode	Range - MANUAL - if inactive, AUTO if active (Note: Auto-Ranging is factory default.)	J3/ 12	MANUAL<CR> AUTO<CR>	Set MANUAL RANGE to ON in LEAK RATE RANGING SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”. Set MANUAL RANGE to OFF for Auto-Ranging.
Increment the Manual Range exponent by 1 (less negative)	Range - Manual - INCREMENT	J3/11	INCREMENT<CR> Make sure MANUAL is set by viewing ?SETUP<CR> if necessary, use MANUAL<CR>	Set the MANUAL RANGE parameter and make sure it is ON in LEAK RATE RANGING SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Set the exponent of the Manual Range	Range - Manual - Set	N/A	-XX INIT-EXPONENT<CR>	LEAK RATE RANGE SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”. Set the MANUAL RANGE
What decade is manual ranging in?	Range - Manual - Value inquiry		?EXPONENT<CR>	LEAK RATE RANGE SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”. Set the MANUAL RANGE
Set the value that Auto-range will range down to	Range - Range Stop - Set Value		-XX INIT-RANGESTOP<CR>	LEAK RATE RANGE SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”. Set the RANGE STOP.
Set the exponent of the least sensitive range of detectable leak	Range - Top - Set	N/A	-XX INIT-RANGE<CR>	LEAK RATE RANGE SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”. Set the TOP RANGE.
What is the least sensitive decade that can be measured in this configuration?	Range - Top - Value inquiry		?RANGE<CR>	LEAK RATE RANGE SET-UP Menu, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”, TOP RANGE
Temporarily Set Repeller Voltage	Repeller V - Set Temp		XXX PUT-REPELLER<CR>	MANUAL TUNING, set REPELLER V, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”
Store the Repeller Voltage in Non-Volatile RAM	Repeller V - Store		XXX INIT-REPELLER<CR>	N/A
What is the Repeller Voltage?	REPELLER Voltage - Value inquiry		?REPELLER<CR>	MANUAL TUNING, Section 4.7.2 “Manual Tuning”, REPELLER V

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Enable / Disable Audio Set Point	Set point - Audio - Enable		ENABLE-AREJECT<CR> DISABLE-AREJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
What is the value of the Audio Set Point?	Set point - Audio - Value inquiry		?AREJECT<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”, which reject set points are enabled. Values are on REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Set the Value of the Audio Set Point	Set point - Audio - Set	N/A	X.XE-XX INIT-AREJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Enable / Disable Reject #1	Set point - Reject 1 - Enable		ENABLE-1REJECT<CR> DISABLE-1REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Set the Value of Reject Set Point #1	Set point - Reject 1 - Set	N/A	X.XE-XX INIT-1REJECT<CR>	REJECT & AUDIO SET POINTS SET-UP screen, Section 4.6.2 “Reject and Audio Set Points”.
What is the value of Reject Set Point #1?	Set point - Reject 1 - Value inquiry		?1REJECT<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”, which reject set points are enabled. Values are on REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Enable / Disable Reject #2	Set point - Reject 2 - Enable		ENABLE-2REJECT<CR> DISABLE-2REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Set the Value of Reject Set Point #2	Set point - Reject 2 - Set	N/A	X.XE-XX INIT-2REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
What is the value of Reject Set Point #2?	Set point - Reject 2 - Value inquiry		?2REJECT<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”, which reject set points are enabled. Values are on REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Enable / Disable Reject #3	Set point - Reject 3 - Enable		ENABLE-3REJECT<CR> DISABLE-3REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Set the Value of Reject Set Point #3	Set point - Reject 3 - Set	N/A	X.XE-XX INIT-3REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
What is the value of Reject Set Point #3?	Set point - Reject 3 - Value inquiry		?3REJECT<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”, which reject set points are enabled. Values are on REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Enable / Disable Reject #4	Set point - Reject 4 - Enable		ENABLE-4REJECT<CR> DISABLE-4REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
Set the Value of Reject Set Point #4	Set point - Reject 4 - Set	N/A	X.XE-XX INIT-4REJECT<CR>	REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.
What is the value of Reject Set Point #4?	Set point - Reject 4 - Value inquiry		?4REJECT<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”, which reject set points are enabled. Values are on REJECT & AUDIO SET POINTS screen, Section 4.6.2 “Reject and Audio Set Points”.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Obtain a summary of set-up parameters.	Setup - Values inquiry		*Note: Values are for example only.* ?SETUP<CR> Reports: turbo speed Slow range -05 auto exponent -08 reject 1.0E-05 stdleak 4.0E-06 output linear filament Two Lit use idle no	 SYSTEM INFORMATION screen, Section 4.5 “System Information Screen” LEAK RATE RANGE SET UP menu Section 4.6.4 “Range Stop and Manual Range Set Up and Control” LEAK RATE RANGE SET UP, set RANGE STOP HOME screen, Section 4.4 “Touch Panel Home Screen” SYSTEM INFORMATION screen Bar Graph display, SYSTEM INFO. screen SYSTEM INFORMATION screen n/a
What is the Suppressor Voltage?	SUPPRESSOR V - Value inquiry		?SUPPRESSOR<CR>	N/A
What are the System and Test Port pressure values?	System Pressure - Value inquiry		?PRESSURES<CR>	SPEC-TUBE PRESSURE display GAUGE CAL screen, Section 4.7.3 “Gauge Calibration”
Obtain the status of the 990 dCLD II	System Status inquiry		?STATUS<CR> One line that reports, in an ASCII string, the status of the system as reported by the discrete I/O lines. If the function is inactive, the format is: REJ/ RDY/ HLD/ FLT/ ZRO/ CAL/ where a three-letter mnemonic is followed by a /.	HOME screen, Section 4.4 “Touch Panel Home Screen” SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”.

Table 2-11 Commands for Operating Modes (Continued)

What you want to do	Function	Conn / Pin	RS-232 Command	Optional Front Control Panel Menu and Parameter
Set the operating speed of the turbo pump	Turbo - Speed - Set 0 Slow, 1 Fast		0 INIT-SPEED<CR> 1 INIT-SPEED<CR>	LEAK RATE RANGE SET-UP screen, Section 4.6.4 “Range Stop and Manual Range Set Up and Control”
What is the status of the Turbo?	Turbo - Status inquiry		?TURBO<CR>	SYSTEM INFORMATION screen, Section 4.5 “System Information Screen”
Temporarily Set Variable Focus Voltage	VAR FOCUS - Set Temp		XXX PUT-FOCUS<CR>	MANUAL TUNING, set VAR FOCUS, Section 4.7.2 “Manual Tuning”
Store the Variable Focus Voltage in Non-Volatile RAM	VAR FOCUS - Store		XXX INIT-FOCUS<CR>	N/A
What is the Variable Focus Voltage?	VAR FOCUS - Value inquiry		?VARIABLEFOCUS<CR>	MANUAL TUNING, Section 4.7.2 “Manual Tuning”, VAR FOCUS
What is the installed software revision?	VERsion - Inquiry		VER<CR>	VERsion screen, Section 4.5.1 “System Software Version”
ZERO the leak rate	ZERO	J3/7	ZERO<CR>	Press the ZERO button. Section 4.1 “Control Buttons”.

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Section 3. Setup and Operations via the Rear Panel

3.1 Physical Setup

Figure 3-1 on page 3-3 shows the system block diagram for the 990 dCLD II. Information regarding the physical setup is discussed below.

3.1.1 Control Unit

The Control Unit is designed to be mounted in a 19-inch rack cabinet. Air is required to flow through the control unit entering through the two filtered air intakes at the front of the unit and exiting at the rear of the unit through a fan. Locate the control unit in a way that allows easy viewing of the front LEDs and easy access to the rear panel connections.

3.1.2 Turbo Spec Tube Assembly

The Turbo Spec Tube assembly can be mounted in any orientation. The spectrometer tube must be isolated from strong magnetic fields such as motors, transformers, and magnets. Steel structures and steel objects should also be kept at least two inches away from the closest edge of the spectrometer tube. During normal operation, the spectrometer tube feels quite warm. A continuously running fan at the end of the high vacuum pump directs cooling air toward the end of the pump. The pump operates between 5 °C and 35 °C ambient temperature.

3.1.3 Connecting the Control Unit to the Turbo Spec Tube Assembly

Make the following connections from the rear panel of the 990 dCLD II to the turbo spec tube assembly. The rear panel connections are shown in Figure 1-2. This section discusses connection to turbo spec tube assembly only.

WARNING *All connections should be made with power OFF.*

1. Connect the Cal Leak Valve Block cable to J1 and the cal leak valve block.
2. Connect the keyed, locking end of the Turbo Spec Tube cable to J11.
3. Place the spec tube block connector firmly onto the spectrometer and tighten the hold-down screw.
4. Attach the turbo fan power connection from the turbo into the white plastic fitting on the spec tube block connector.
5. Attach the turbo pump cable to the pump and onto the spec tube block connector and tighten it firmly.
6. Verify that the proper mains voltage is set and connect the power cord to the power entry module.

   To change the input voltage, remove the fuse drawer and remove the gray fuse holder. Rotate the fuse holder 180° so that the correct voltage appears in the fuse drawer window.

   Replace the fuse drawer.
7. Plug the power cord into an appropriate power source.

3.1.4 Customer Controlled Connections

As previously discussed in Section 2, “Customer Integration”, setup of the parameters is most easily accomplished via the optional front control panel or host computer, but can also be accomplished using a combination of PLC and host computer. Once setup is complete, operation is from the PLC, host computer, or a combination of the two. Monitoring of operations can be from the optional front control panel, PLC, or host computer. Table 2-11 on page 2-15 cross references the different modes of operation and details the pin connections, commands, RS-232 commands and optional front control panel menus and buttons.

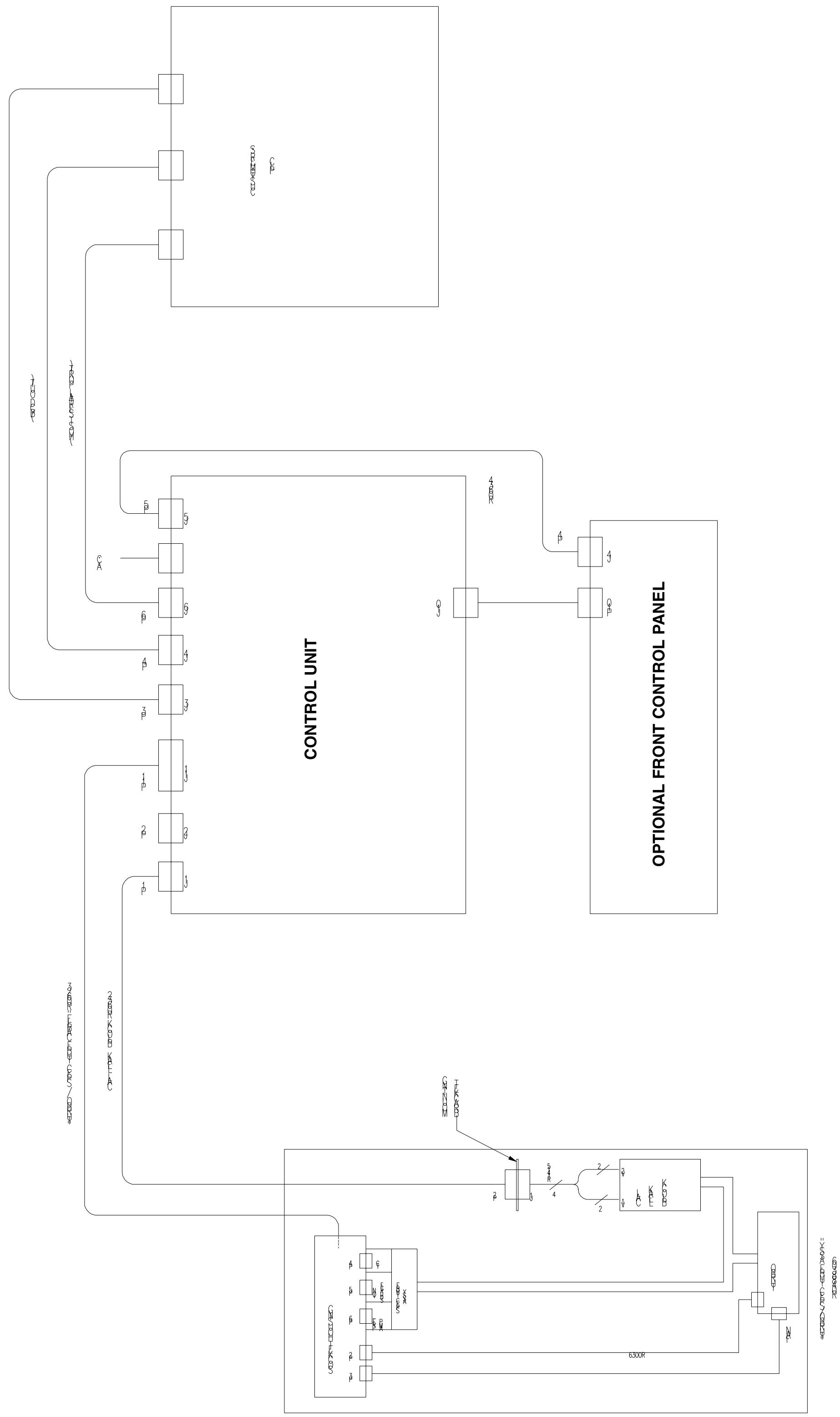


Figure 3-1   System Block Diagram

3.1.4.1 Optional Front Control Panel Connection

If you are using the optional front control panel for setup and monitoring of the 990 dCLD II, connect it to the front of the control unit by lining up the connection brackets and giving it a straight, firm push. The power and signal connection ¿ mates (Figure 3-2), and you hear the optional front control panel click into place via the quick connect/disconnect latch arrangement. To disconnect it, give it a solid tug and it easily disconnects.

The optional front control panel can also be mounted remotely from the control unit (see discussion in Section 2.1 “Physical Considerations” on page 2-1). Mount the optional front control unit in a rack and connect the Display I/O cable to connector J5 on the rear panel of the control unit to the connection J4 ¡ on the back of the optional front control panel (see Figure 3-2).

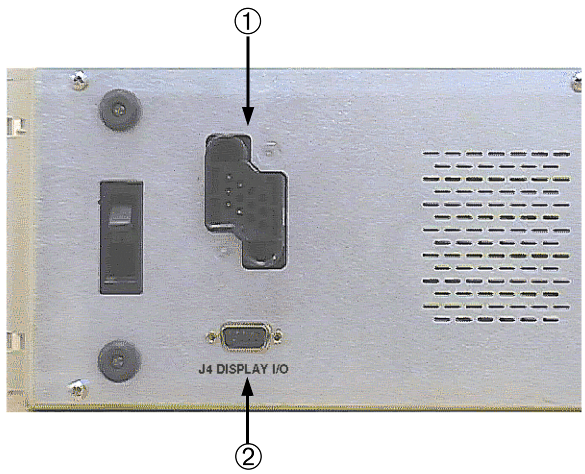


Figure 3-2 Optional Front Control Panel, Left Rear View

3.1.4.2 Discrete I/O Connection

To use the Discrete I/O J3 for operations, build the cable for PLC connection according to Table B-1 on page B-1 in Appendix B “Customer Accessible Inputs and Outputs”. Remember, the 990 dCLD II does not provide power to this I/O.

Setup of the parameters must be accomplished in one of three ways:

- ❑ Using a host computer via host serial port J6
- ❑ The combination of PLC and host computer (see Appendix A “Communications Protocol” and Table B-3 on page B-9
- ❑ Via the optional front control panel

Control is then turned over to the PLC for operation.

3.1.4.3 Host Computer Connection

To use a computer for operations, build the cable according to Table B-3 on page B-9 and connect to the host serial port J6. For greater security, you must also make connection to J3, pin 6 to make PARALLEL ENABLE available. Asserting PARALLEL ENABLE prevents operating parameters from being changed while it is active. See Appendix A “Communications Protocol” for detailed information regarding the commands used to set up, monitor and operate the 990 dCLD II. A cross reference of the different modes of operation is provided in Table 2-11 on page 2-15.

3.1.4.4 BCD Output Connection

To use BCD J4 for output, build the cable for PLC connection according to Table B-2 on page B-4. Remember, the 990 dCLD II does not provide power to this I/O.

3.2 System Sensitivity and Configuration

During the process of installing the 990 dCLD II and building the associated vacuum system, it is necessary to determine the sensitivity of the system. The 990 dCLD II is able to measure four decades of leak rate signal at once for a given configuration. For example, in a typical system with the V70D MacroTorr pump running at high speed, the four decades of leak rate are 10^{-7}, 10^{-6}, 10^{-5}, and 10^{-4}. Running the V70D MacroTorr pump at slow speed yields 10^{-8}, 10^{-7}, 10^{-6}, and 10^{-5} decades of leak rate. Table 3-1 shows the effects of pump type and speed on the four decades of detectable leak rate. Table 3-1 shows the four decades displayed for any given configuration and turbo speed setting.

Table 3-1 Leak Rate Range for High Vacuum Pump Type and Speed Combinations

	Turbo Speed Fast	Turbo Speed Slow	Maximum Test Pressure
V70 Turbo Pump	10^{-8}, 10^{-7}, 10^{-6}, $\underline{10^{-5}}$	10^{-9}, 10^{-8}, 10^{-7}, $\underline{10^{-6}}$	100 mTorr
V70D MacroTorr Pump	10^{-7}, 10^{-6}, 10^{-5}, $\underline{10^{-4}}$	10^{-8}, 10^{-7}, 10^{-6}, $\underline{10^{-5}}$	3 Torr
V70LP MacroTorr Pump	10^{-6}, 10^{-5}, 10^{-4}, $\underline{10^{-3}}$	10^{-7}, 10^{-6}, 10^{-5}, $\underline{10^{-4}}$	5 Torr

Note: The underlined decade represents the variable set in TOP RANGE parameter.

The pumping speed of the backing pump and the conductance of the vacuum system also play an important role in the determination of system sensitivity. A calibrated helium leak on the as configured system must be used to characterize the leak rate measurements. The 990 dCLD II must be set up to display the desired four (4) decades of leak rate measurement by setting the Range (Top Range) and selecting the Turbo speed and Ranging method. These and other parameters are discussed in the next section.

3.3 Initial System Parameter Setup

The 990 dCLD II performs functions and tests based upon parameter values. Some parameters are entered and set when the system is assembled and tested. Some parameters are calculated and change automatically during power up, Calibrate, or Zero functions. Other parameters should be changed when a change is made to the physical system, such as when the button thermocouple (TC), ion source or preamplifier is changed. What these parameters are set to are a function of the physical configuration and sensitivity needs as was discussed in the previous section and in more detail in Section 2.

Adding to the stability and reliability of the 990 dCLD II, several parameters relating to the operation and performance are stored in EPROM in the control unit. This means if you lose power, or when the control unit is shut off, you do not lose that information. Parameters can be viewed and changed through commands entered via the rear serial port or the optional front control panel, if it is installed (refer to Section 4, "Setup and Monitor Operations via the Optional Front Control Panel").

This section explains each of the parameters and what happens during the related function; related functions or parameters are grouped together. There is also reference to the area in the document where you can find information on how to set the parameter or perform the function. Remember, Table 2-11 on page 2-15 cross references functions and how to set parameters across all operating modes.

3.3.1 Parameters and Operating Modes

The parameters and operating modes work together to perform leak detection, and what you enter determines the type of test and sensitivity of testing performed. The discussion below includes an explanation of what the parameter or function means, so you know how to use it for your system and how to set it in varying operating modes. Some parameters are grouped together so you can see how they relate to one another or affect an operation.

NOTE *For more information on how to set a parameter or select a function, refer to the following:*

- ❑ *Appendix A "Communications Protocol"*
- ❑ *Appendix B "Customer Accessible Inputs and Outputs"*
- ❑ *Section 4, "Setup and Monitor Operations via the Optional Front Control Panel"*
- ❑ *Table 2-11 on page 2-15, Cross Reference of Commands for Operating Modes*

TURBO SPEED	Set the speed of the high vacuum pump to FAST or SLOW, depending on the sensitivity requirement of the system. (Refer to Table 2-1 on page 2-2.) Note that the highest tolerable testing pressure is achieved with the pump running in the high-speed (fast) mode. To set the turbo speed, issue the INIT-SPEED<CR> command or, if the optional front control panel is installed, set the turbo speed via the Leak Rate Ranging Set-Up screen (see Section 4.6.4 "Range Stop and Manual Range Set Up and Control" on page 4-15).
RANGE	Range must be set equal to the exponent of the least sensitive range of the leak detector (Section 3.2 "System Sensitivity and Configuration" on page 3-6), depending on the sensitivity of the vacuum system. (See "TOP RANGE".) To set the RANGE variable, issue the INIT-RANGE<CR> command.
TOP RANGE	TOP RANGE is the exponent value of the least sensitive range of leak detection for the configured system. The system detects four decades starting from the TOP RANGE. The TOP RANGE variable must be set appropriately for the given system configuration and is the largest exponent value. See Table 3-1 on page 3-6. To set the TOP RANGE, issue the INIT-RANGE<CR> command, or if the optional front control panel is installed, set the parameter via the Leak Rate Ranging Set-Up screen (see Section 4.6.4 "Range Stop and Manual Range Set Up and Control" on page 4-15).
AUTO-RANGE MANUAL RANGE	Auto-Ranging causes the leak detector to detect leaks within the four decades starting at the least sensitive value set in the RANGE variable (RS-232) or TOP RANGE (optional front control panel). The 990 dCLD II is shipped from the factory with Auto-Ranging enabled set as the default. Manual Range is used to force the 990 dCLD II to respond to a leak rate detected in only one decade (the exponent never changes). This feature is useful when the test operator is only concerned with monitoring the leak rate measurement within a single decade. You must set Manual Range ON and also set the EXPONENT variable (see "MANUAL EXPONENT" below) to the desired decade. Regardless of the ranging mode selected, the RANGE variable (above) must be set to the least sensitive decade. To set Manual Range ON, issue the MANUAL<CR> command or, if the optional front control panel is installed, turn Manual Range ON via the Leak Rate Ranging Set-Up screen (see Section 4.6.4 "Range Stop and Manual Range Set Up and Control" on page 4-15).

MANUAL EXPONENT

The MANUAL EXPONENT is the exponent value that you want Manual Range to display when Manual-Ranging is set to ON.

To set the exponent, use the INIT-EXPONENT<CR> command, or if the optional front control panel is installed, set the MANUAL RANGE parameter via the Leak Rate Ranging Set-Up screen (see Section 4.6.4 “Range Stop and Manual Range Set Up and Control” on page 4-15).

RANGE STOP

The RANGE STOP feature configures the 990 dCLD II so that it only auto-ranges down to the pre-selected decade entered in the range stop variable field, as opposed to all four decades beginning at the TOP RANGE. For example, if RANGE STOP is enabled and set to –07, then the most sensitive range that the leak detector displays is 10^{-07}.

This feature is useful when a product specification is more than one decade less stringent than the sensitivity of the leak detection system as it is configured. If the configured system is capable of detecting 10^{-09} atm cc/sec but the test specification is only in the 10^{-07} atm cc/sec range, then setting the RANGE STOP to –08 reduces the test cycle time by eliminating the need for the leak detector to reach its most sensitive decade (10^{-09}) during each test cycle.

To set the RANGE STOP exponent, issue the INIT-RANGESTOP<CR> command, or if the optional front control panel is installed, set the RANGE STOP parameter via the Leak Rate Ranging Set-Up screen (see Section 4.6.4 “Range Stop and Manual Range Set Up and Control” on page 4-15).

ENABLE-IDLE
DISABLE-IDLE

The ENABLE-IDLE command allows the control unit to be put into IDLE or RUN mode. The factory default setting is DISABLE-IDLE.

Issue the ENABLE-IDLE<CR> command to allow the control unit to be put into RUN or IDLE mode. If IDLE is DISABLEd, the 990 dCLD II will operate without asserting the IDLE/RUN input (J3/5) in the discrete I/O.

IDLE MODE
RUN MODE

IDLE mode allows the spectrometer tube and turbo pump to be shut down without turning off main power. Volatile operating parameters will not be lost in this mode. The factory default setting is the IDLE function is disabled. The Idle function must be ENABLED before it can be used.

To put the control unit in IDLE mode, de-assert the IDLE/RUN input (J3/5) in the discrete I/O.

RUN mode powers the spectrometer tube and turbo pump. The IDLE function must be ENABLED before RUN can be used.

To put the control unit in RUN mode, assert the IDLE/RUN input (J3/5) in the discrete I/O

NOTE

The ENABLE-IDLE command must be issued for the IDLE and RUN modes to be operational. The factory default setting is DISABLE-IDLE.

CALIBRATE

CALIBRATE is used to perform an automated calibration based upon the parameters set. Calibration is either to a known INTERNAL or EXTERNAL leak whose value has been entered into the appropriate parameter, and is either performed in NORMAL or FAST mode.

To perform an automated calibration, issue the CALIBRATE<CR> command or, if the optional front control panel is installed, press the CALIBRATE button.

CALIBRATED LEAK VALUE

The 990 dCLD II is shipped from the factory with a calibrated leak (Cal Leak) as part of the turbo spec tube assembly. Its value is noted on the tag attached to it and on the Cal Leak Certification. During setup, enter the value of the calibrated leak (Section 4.6.1 “Calibrated Leak Set-Up” on page 4-13). When a Calibration is performed, the system compares the leak rate signal with the stored value.

INTERNAL

To enter the value of the internal calibrated leak, issue the INIT-STDLEAK<CR> command or, if the optional front control panel is installed, enter the value via the Calibrated Leak Set-Up screen (Section 4.6.4 “Range Stop and Manual Range Set Up and Control” on page 4-15).

EXTERNAL

If you are using an external leak, you must enter its value so the system can use it for comparison when a Calibration is performed.

To enter the value of the external calibrated leak, issue the INIT-EXTLEAK<CR> command or, if the optional front control panel is installed, enter the value via the Calibrated Leak Set-Up screen (Section 4.6.1 “Calibrated Leak Set-Up” on page 4-13).

NORMAL CALIBRATION

The NORMAL calibration routine performs a thorough tuning process and a system gain adjustment (calibration). The full tuning process involves independently scanning the ion source chamber voltage and the variable focus voltage, and optimizing each value for a maximum helium signal. Once the tuning process is complete, the preamplifier gain is adjusted to bring the leak detector into calibration.

The SPEC TUBE LED on the front of the control unit flashes while calibration is taking place, the Discrete I/O J3/22 is active, and the response to the inquiry ?STATUS<CR> includes CAL. If the optional front control panel is installed, the calibrate indicator LED lights while calibration is taking place.

To set the mode to NORMAL, issue the 0 INIT-QUICK-CAL<CR> command or, if the optional front control panel is installed, select NORM from the CAL LEAK SET-UP screen (Section 4.6.1 "Calibrated Leak Set-Up" on page 4-13).

FAST CALIBRATION

During FAST calibration, the leak detector compares the leak rate signal with the calibrated leak value and, if the gain adjustment required to bring the system into calibration is within the allowable limits. The full tuning operation is omitted.

The SPEC TUBE LED on the front of the control unit flashes while calibration is taking place, the Discrete I/O J3/22 is active, and the response to the inquiry ?STATUS<CR> includes CAL. If the optional front control panel is installed, the calibrate indicator LED lights while calibration is taking place.

If the calibration parameters are set to INTERNAL, the system notes the leak rate, turns off the leak and ZEROs the system. Then the system performs a NORMAL or FAST calibration as described above.

The SPEC TUBE LED on the front of the control unit flashes while calibration is taking place, the Discrete I/O J3/22 is active, and the response to the inquiry ?STATUS<CR> includes CAL. If the optional front control panel is installed, the calibrate indicator LED lights while calibration is taking place.

If the calibration parameters are set to EXTERNAL, the system performs a NORMAL or FAST calibration as described above.

NOTE

No ZEROing takes place during an EXTERNAL calibration because the 990 dCLD II has no control over the external calibrated leak.

The SPEC TUBE LED on the front of the control unit flashes while calibration is taking place, the Discrete I/O J3/22 is active, and the response to the inquiry ?STATUS<CR> includes CAL. If the optional front control panel is installed, the calibrate indicator LED lights while calibration is taking place.

To set the mode to FAST, issue the 1 INIT-QUICK-CAL<CR> command or, if the optional front control panel is installed, select FAST from the CAL LEAK SET-UP screen (Section 4.6.1 "Calibrated Leak Set-Up" on page 4-13).

ZERO

The ZERO function reads the background leak rate signal, stores the reading in memory, and then resets the zero reference point. Subsequent actual test measurements include both helium from the real leak and helium from background conditions, however, the recorded background signal from the measurement is subtracted and the resultant real leak rate is displayed.

NOTE

Performing the ZERO function while introducing helium to the test object can result in the suppression of a real leak. Only use the ZERO function after the helium source has been removed.

To perform a ZERO function, assert J3/7 in the discrete I/O, issue the ZERO<CR> command or, if the optional front control panel is installed, press the ZERO button (Section 4.1 "Control Buttons" on page 4-2).

ENABLE or DISABLE REJECT SET POINTS

Each REJECT SET POINT must be enabled before the function is operational. Conversely, each must be disabled to stop its operation.

To ENABLE set points, issue the ENABLE-*n*REJECT<CR> command, where *n* is equal to 1 through 4. If the optional front control panel is installed, enable individual reject set points by setting the ON/OFF buttons located to the right of each set point field to ON in the Reject and Audio Set Points screen (Section 4.6.2 "Reject and Audio Set Points" on page 4-14).

To DISABLE set points, issue the DISABLE-*n*REJECT<CR> command, where *n* is equal to 1 through 4. If the optional front control panel is installed, disable individual reject set points by setting the ON/OFF buttons to OFF in the Reject and Audio Set Points screen (Section 4.6.2 "Reject and Audio Set Points" on page 4-14).

REJECT SET POINTS

The REJECT SET POINTS are used to alert the operator that a measured leak rate has exceeded the set value. There are four set points available. Each set point must be enabled before they are operational.

To set the value of the REJECT SET POINTS, issue the INIT-*n*REJECT<CR> command, where *n* is equal to 1 through 4. If the optional front control panel is installed, enter the value through the Reject and Audio Set Points screen (Section 4.6.2 “Reject and Audio Set Points” on page 4-14).

ENABLE AUDIO REJECT

AUDIO REJECT must be enabled before the function is operational and reacts based upon its set point value.

To ENABLE the AUDIO set point, issue the ENABLE-AREJECT<CR> command or, if the optional front control panel is installed, enable AUDIO by setting the ON/OFF button located to the right of the audio set point field to ON in the Reject and Audio Set Points screen (Section 4.6.2 “Reject and Audio Set Points” on page 4-14).

To DISABLE the AUDIO set point, issue the DISABLE-AREJECT<CR> command or, if the optional front control panel is installed, disable AUDIO by setting the ON/OFF button to OFF in the Reject and Audio Set Points screen (Section 4.6.2 “Reject and Audio Set Points” on page 4-14).

AUDIO SET POINT

The AUDIO SET POINT control is used to activate the audio tone from the optional front control panel when the measured leak rate value exceeds the threshold value (leak rate pass/fail specification) set by the operator. The audio tone frequency increases as the size of the measured leak increases beyond the set point. As stated above, you must enable AUDIO REJECT before the function is operational. If AUDIO REJECT is disabled, the audio tone frequency will increase from zero leak rate instead of from the audio reject set point.

The audio volume control is located on the optional front control panel (see Figure 4-1 on page 4-1). The sound emanates from the rear of the optional front control panel.

To set the Audio Reject set point, issue the INIT-AREJECT<CR> command or, if the optional front control panel is installed, set the audio reject set point value in the Reject and Audio Set Points screen (Section 4.6.2 “Reject and Audio Set Points” on page 4-14).

LOG BAR GRAPH DISPLAY
LINEAR BAR GRAPH DISPLAY

In LOG BAR GRAPH DISPLAY mode, the 50-segment bar graph display on the optional front control panel represents the entire leak rate range of the leak detector, spanning from 10^{-11} atm cc/sec to 10^{0} atm cc/sec. The scale is displayed above the bar graph and LOG is displayed to the upper right of the bar graph.

In LINEAR BAR GRAPH DISPLAY mode, the 50-segment bar graph display on the optional front control panel represents the mantissa value of the leak rate, spanning from 0 to 10. The scale shows below the bar graph and LIN is displayed to the lower right of the bar graph. The numerical display, located to the far right of the bar graph, displays the leak rate exponent value. This mode offers exceptional resolution within a decade.

Set the display to LOG or LINEAR on the Output Control Set-Up screen (Section 4.6.5 “Output Control Setup” on page 4-16).

LINEAR ANALOG OUTPUT
1 V/DEC LOG OUTPUT

ANALOG options allow you to configure the output voltage to the I/O port (J3) on the back of the control unit. The options for output are LINEAR and 1, 2, or 3 volts per decade LOGarithmic output.

To set the leak rate analog output to LOG, issue the INIT-*n*LOG command, where *n* is 1, 2, or 3 volts or, if the optional front control panel is installed, toggle to the desired LOG output value on the Output Control Set-Up screen (Section 4.6.5 “Output Control Setup” on page 4-16).

To set the leak rate analog output to LINEAR, issue the INIT-LINEAR<CR> command, if the optional front control panel is installed, toggle to the LINEAR ANALOG OUTPUT on the Output Control Set-Up screen (Section 4.6.5 “Output Control Setup” on page 4-16).

AUTO-ZERO<0 ACTIVE

When AUTO-ZERO<0 is activated, it automatically adjusts the zero reference point back up to zero when the helium level drops below the previously set zero reference point. This feature ensures that the leak detector maintains calibration after a previously zeroed background signal naturally cleans up. The factory default setting is active.

If the optional front control panel is installed, when the AUTO-ZERO<0 feature is in the process of re-adjusting the zero reference point, the UNDER light indicator located on the left end of the bar graph illuminates.

The duration of time that the UNDER light stays on during this process is a function of how much helium is cleaning up and how fast it is cleaning up. If the magnitude of helium clean up is great, the UNDER light remains lit until the clean up rate has slowed or stabilized. Although leaks can be located in this state, quantitative testing must not be performed until the UNDER light is off. Occasional flashing of the UNDER light indicates normal minor adjustments to small changes in background. This does not impact the leak detector's ability to accurately locate and measure leaks.

To set AUTO-ZERO<0 to active, issue the 1 INIT-AZ<0<CR> command or, if the optional front control panel is installed, set the mode via the Zeroing screen (Section 4.6.6 "Zeroing" on page 4-17).

AUTO-ZERO < 0 INACTIVE

When AUTO-ZERO<0 is inactive, the leak detector does not automatically adjust the zero reference point back up to zero when the helium level drops below the previously set zero reference point. When this occurs, issue the ZERO command to re-adjust the zero reference point manually.

If the optional front control panel is installed, the UNDER light remains lit, indicating that the background level is below the previously set zero reference point. Press the **ZERO** button on the front panel to re-adjust the zero reference point manually. This clears the UNDER light indication.

To set AUTO-ZERO<0 to inactive, issue the 0 INIT-AZ<0<CR> command or, if the optional front control panel is installed, set the mode via the Zeroing screen (Section 4.6.6 "Zeroing" on page 4-17).

3.4 Startup

Turn the power **ON** by placing the power switch in the **I** position.

When first powered, the control unit performs a front panel lamp test, lighting all LEDs, after which the SPEC TUBE and HIGH VAC LEDs should extinguish and the POWER LED should remain lit. The following short three-line identification is sent via the host serial port J6:

polyFORTHII <LF>
Varian 990II_dCLD <LF>
hi <LF>

The cursor is positioned on the next line and is blinking. After the messages are sent, the control unit is running and ready to accept commands. See Appendix A "Communications Protocol" for a listing of commands and Table 2-11 on page 2-15 for a cross reference of commands in the different modes of operation.

NOTE

Unless otherwise stated, all commands must be issued in capital letters.

The NOT READY line in the discrete I/O is active and the response to ?STATUS<CR> contains RDY/, indicating that the 990 dCLD II is not ready. If IDLE is enabled (see "IDLE MODE RUN MODE" on page 3-10), the control unit is waiting for the RUN command to be issued. If IDLE is disabled, the unit is waiting for the pressure (as read by the ConvecTorr™ gauge in the spectrometer) to be less than 1 Torr.

The forepump in the system should be able to pump the spectrometer tube through the high vacuum pump to a pressure of much less than 1 Torr. When the spectrometer tube pressure passes through 1 Torr and RUN is active (IDLE is disabled) the control unit starts the high vacuum pump and waits for it to achieve the set speed (see ?SETUP in Appendix A "Communications Protocol", Table A-1 on page A-2). When the high vacuum pump achieves operating speed, the HIGH VAC LED on the front panel illuminates. When the pressure is less than 10 mTorr, the control unit sets the preamplifier offset and attempts to light the ion source filament. Setting the preamplifier offset takes up to two minutes. During this time, the SPEC TUBE LED flashes and a ?STATUS<CR> inquiry response contains ZRO.

When the ion source filament is successfully lit, the SPEC TUBE LED illuminates steadily, the READY line in the discrete I/O is active and, after a short time for verification that the ion source filament remains lit, the FILAMENT FAULT line in the discrete I/O becomes inactive. If you repeatedly issue the ?STATUS<CR> inquiry during this process, you see the response change from containing RDY/ to RDY and FLT, and, after a short time, FLT/.

The system is ready when the 3 LEDs on the control unit front panel remain steadily lit.

If the vacuum system has been at atmosphere or the electronics have been off for longer than a few minutes but less than a few hours, a wait of approximately 30 minutes is recommended so that the vacuum system and spectrometer tube can stabilize. During the stabilization period, the ZERO signal drifts, making zeroing and calibrating difficult.

NOTE *Allow approximately 30 minutes for the system to stabilize before running any tests if it has been off or IDLE for more than a few minutes.*

3.4.1 Start up Indications on the Optional Front Control Panel

If the optional front control panel is installed, the leak detector is ready for operation when the SYSTEM READY indication appears on the Home Screen, the test mode is displayed in the line above SYSTEM READY and the LED lights above the TEST/HOLD button (which is inoperable on the 990 dCLD II). For more information see Section 4.4, “Touch Panel Home Screen”. If the 990 dCLD II is being started after a long period of being off (several hours), it can take up to 30 minutes to stabilize and provide reliable, quantitative leak rate readings.

3.4.2 Calibration

Calibration of the 990 dCLD II should be checked at least once every shift using a known helium leak at a known temperature, such as the internal calibrated leak supplied with the 990 dCLD II. A pressure burst in the spectrometer tube, a blown Ion Source filament, a large temperature change (over 10 °C), a power outage, contamination, or helium buildup in the vacuum system are all factors that could affect calibration. The value of the calibrated leak should be as close as possible to the decade most used during testing. This enhances the accuracy of the leak detector.

To perform a calibration, set the parameters previously described in Section 3.3.1 “Parameters and Operating Modes” on page 3-7 and then issue the CALIBRATE<CR> command. When calibration is complete, the systems should respond **yes**, to ?CALOK<CR>.

3.4.3 Tuning

The 990 dCLD II is tuned to the spectrometer assembly at the factory. In normal operation, the 990 dCLD II upon issue of the CALIBRATE<CR> command or upon request via the optional front control panel (press the CALIBRATE button) performs a calibration to the value of the calibrated leak in the system or to the value of an external leak. If you are calibrating to an external leak, it should be rough pumped before opening the isolation valve to avoid excessive pressure and helium signal burst. A leak calibrated to the middle two decades of the four decades of range based upon your system configuration is recommended for use during the calibration routine.

Manually tuning (see Section 5.6 “Manual Tuning” on page 5-20) the 990 dCLD II is more likely to be necessary if:

- ❑ The control unit is connected to a spectrometer assembly in the field other than the one with which it was tested
- ❑ It cannot successfully CALIBRATE (respond **yes** to ?CALOK<CR>)
- ❑ The gain (?GAIN<CR>) is greater than 5.0
- ❑ A board in the Platform is changed
- ❑ The ion source is changed

3.4.4 Running

The 990 dCLD II senses the level of helium in the foreline of the high vacuum pump and converts the signal into a leak rate based upon the latest calibration and zero parameters in memory.

The leak rate is always available:

- ❑ Through the host serial port (J6) by entering the ?LEAK<CR> command
- ❑ By measuring the voltage at the analog voltage output on J3
- ❑ By reading the BCD output on J4

If the optional front control panel is installed, observe the leak rate bar graph display or the leak rate displayed in the Home screen (Section 4.4 “Touch Panel Home Screen” on page 4-7).

The leak rate is valid if the READY line in the discrete I/O is active (?STATUS<CR> response contains RDY). In the event that the ready line is *inactive*, (?STATUS<CR> response contains RDY/) a leak rate might be able to be read, but it would not be a valid leak rate. For example, if the active ion source filament is burned out, READY would be inactive and FILAMENT FAULT would be active. This causes the host computer or PLC to halt testing and signal for help. Appendix B “Customer Accessible Inputs and Outputs”contains a description of the available discrete I/O lines in the 990 dCLD II.

3.5 Quick Start Checklist

- ❑ Make the vacuum connections between the 990 dCLD II spectrometer assembly and your vacuum system.
- ❑ Make electrical connections between the turbo spec tube assembly and the control unit (see Section 3.1.3 “Connecting the Control Unit to the Turbo Spec Tube Assembly” on page 3-2).
- ❑ Make mains power connection to the control unit.
- ❑ Power the 990 dCLD II by turning on the main power switch on the rear panel.
- ❑ Check that the POWER LED on the front panel of the control unit is lit after the power on lamp test is completed.
- ❑ Make sure that either IDLE mode is disabled and/or that the RUN input is active.
- ❑ Start the backing pump(s).
- ❑ Check that the HIGH VAC LED lights after the turbo pump achieves the set speed.
- ❑ Check that the SPEC TUBE LED lights after the spectrometer tube pressure goes below 10 mTorr.
- ❑ Allow the system to run for at least 30 minutes to stabilize.
- ❑ Calibrate the 990 dCLD II to a known helium leak.
- ❑ Zero the 990 dCLD II.

3.6 Operation via Rear Panel

Once setup is complete and the 990 dCLD II is warmed up, operation can be turned over to the PLC by asserting PARALLEL ENABLE. Monitoring operations can take place using the optional front control panel or PLC, or by issuing commands using a host computer connected to the host serial port.

3.6.1 PARALLEL ENABLE

PARALLEL ENABLE turns control of the 990 dCLD II over to the PLC. Operations can be monitored by issuing commands using a host computer connected to the host serial port but most parameter values cannot be changed. If a command is issued that is not allowed once PARALLEL ENABLE is asserted, the system responds **cant**. See Appendix A “Communications Protocol”.

If the optional front control panel is installed, you can monitor operations via the bar graph display, the SPEC-TUBE PRESSURE display, and view the HOME and SYSTEM INFORMATION screens on the touch panel, but, again, you cannot change parameter values. The CALIBRATE, READ STANDARD LEAK, and ZERO buttons are not functional. If you have set AUDIO to ON during setup, it remains operational, however you cannot change its set point value. If you attempt to initiate an action from the optional front control panel that is not allowed once PARALLEL ENABLE is asserted, you hear a double beep. See Appendix B “Customer Accessible Inputs and Outputs”.

To remove control from the PLC, you must de-assert PARALLEL ENABLE. Even if the system is shut down with PARALLEL ENABLE asserted, control remains with the PLC.

NOTE

If PARALLEL ENABLE is asserted, but the ?STATUS<CR> response contains RDY/, indicating that the 990 dCLD II is not able to measure a leak rate, check to see if IDLE is enabled. If IDLE is enabled (see Table 2-11 on page 2-15 or Appendix A “Communications Protocol”), the control unit is waiting for the RUN command.

3.7 Analog Leak Rate Output Voltage

To use the analog leak rate output voltage to measure leak rate, you must set the format of the output voltage. The 990 dCLD II offers a choice of four leak rate output voltage formats as shown in Table 3-2. The output voltage format is selected by entering the appropriate command listed in Table 3-2, through the host serial port or, if the optional front control panel is installed, through the Output Control Set-Up screen (see Section 4.6.5 “Output Control Setup” on page 4-16).

Table 3-2 also shows the conversion formulas for each output. The last column of the table references a graph to use for converting the output voltage to the leak rate for each output option. These graphs are in Section 3.7.1 “Analog Leak Rate Output Voltage Conversion Charts” on page 3-22.

Section 3.7.2 “Conversion of 2 V/Dec Log to Leak Rate if 10X Function Not Available” on page 3-24 contains an explanation of the recommended output and conversion formula if your PLC does not have a 10^{x} function.

Table 3-2 Analog Leak Rate Voltage Outputs

Output Option	Set-up Command	Formula		Output Response Curve
		Leak Rate	Vout	
Linear 0 - 10 V	INIT-LINEAR<CR>	Vout / $(10^{\lvert RANGE\ variable \rvert})$	(Leak Rate) X $(10^{\lvert RANGE\ variable \rvert})$	Figure 3-3 on page 3-22
1 V/decade	INIT-1LOG <CR>	Leak Rate = 10^{Vout} / $10^{\lvert RANGE\ variable \rvert +3}$	LOG (Leak Rate X $10^{\lvert RANGE\ variable \rvert +3}$)	Figure 3-4 on page 3-22
2 V/decade	INIT-2LOG<CR>	Leak Rate = $10^{Vout/2}$ / $10^{\lvert RANGE\ variable \rvert +3}$	2 X LOG (Leak Rate X $10^{\lvert RANGE\ variable \rvert +3}$)	Figure 3-5 on page 3-23
3 V/decade	INIT-3LOG<CR>	Leak Rate = $10^{Vout/3}$ / $10^{\lvert RANGE\ variable \rvert +3}$	3 X LOG (Leak Rate X $10^{\lvert RANGE\ variable \rvert +3}$)	Figure 3-6 on page 3-23

3.7.1 Analog Leak Rate Output Voltage Conversion Charts

Use the charts below (Figure 3-3 to 3-6) to convert the output voltage to the leak rate.

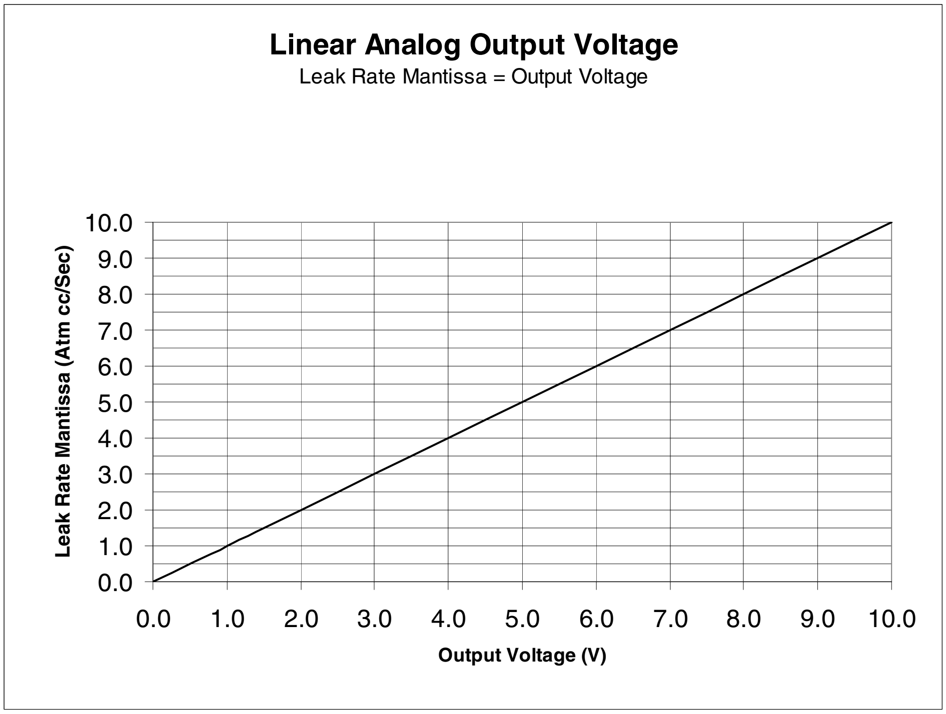


Figure 3-3 Linear Leak Rate Output Voltage Response

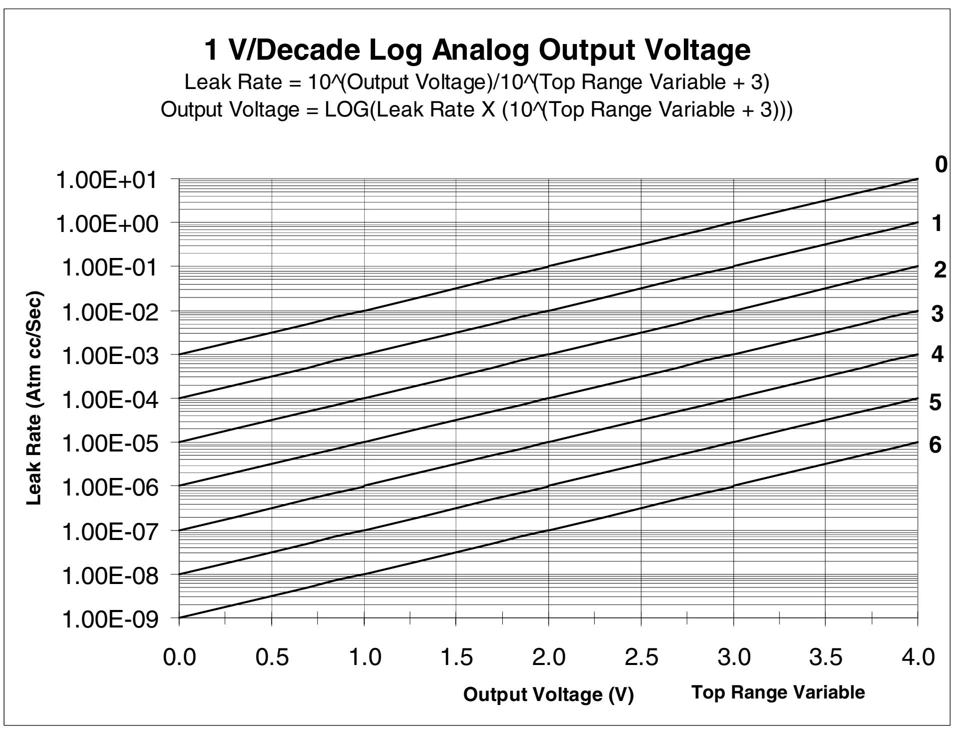


Figure 3-4 1 V/Decade Logarithmic Leak Rate Output Voltage Response

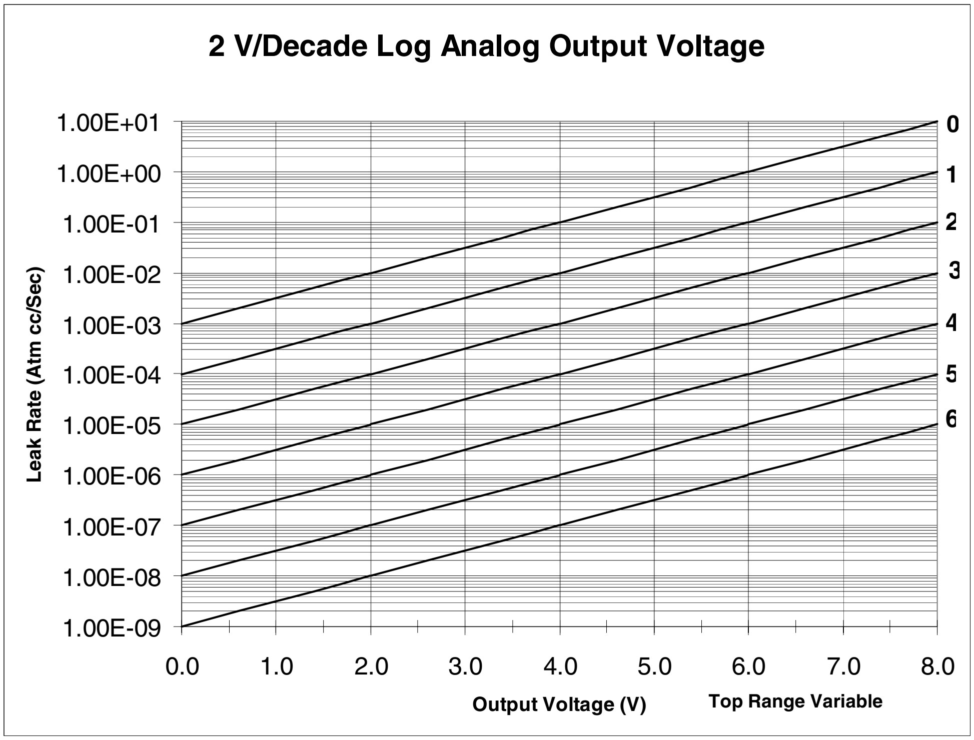


Figure 3-5 2 V/Decade Logarithmic Analog Output Voltage

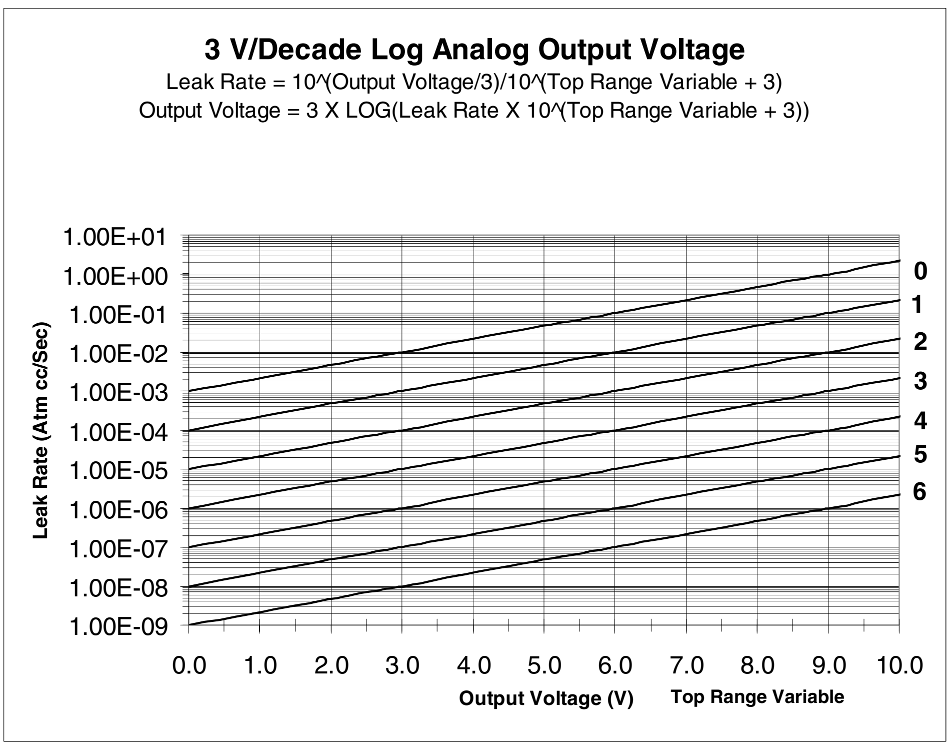


Figure 3-6 3 V/Decade Logarithmic Analog Output Voltage

3.7.2 Conversion of 2 V/Dec Log to Leak Rate if 10^X Function Not Available

To read leak rates in all four decades of the 990 dCLD II using the analog leak rate output voltage, it is recommended that the 2 V/Decade Log format be used. Use the following method to obtain the leak rate from the 2 V/Decade Log format if a 10^X function is not available in the host computer or PLC.

The leak rate is split into two integers; the first integer is the exponent of the leak rate, the second integer is the mantissa of the leak rate.

Exponent = INT (Vout /2) - |RANGE variable| + 3

Where: INT ( ) is the integer part of the expression
Vout is the analog leak rate output voltage
RANGE variable is the RANGE number from the ?SETUP<CR> command or viewed through the touch screen panel menu
| | is the absolute value of the expression inside the bars (change the sign to + if it is -)

Mantissa = 1 + Y·(1 + Y/2·(1 + Y/3·(1 + Y/4·(1 + Y/5·(1 + Y/6·(1 + Y/7))))))

Where:Y = 2.302259·(Vout / 2 - INT (Vout / 2))
INT ( ) is the integer part of the expression in parentheses

3.8 Shutdown

Shutting down the 990 dCLD II is as simple as turning the power off by moving the power switch on the rear panel to the **O** position. The system can be in any mode when it is shut down. When the system is shut down, all valves controlled by the system close. Also, if the PLC has asserted PARALLEL ENABLE when the system is shut down, it remains asserted and control remains with the PLC when it is turned back on.

Section 4. Setup and Monitor Operations via the Optional Front Control Panel

The Optional Front Control Panel of the 990 dCLD II is shown in Figure 4-1. It can be mounted remotely from the control unit or directly onto the front face of the unit. Operation controls include control buttons and a touch panel for the initial setup of the leak detector. A three-position access key switch is also provided to prevent unauthorized changes of the system setup commands.

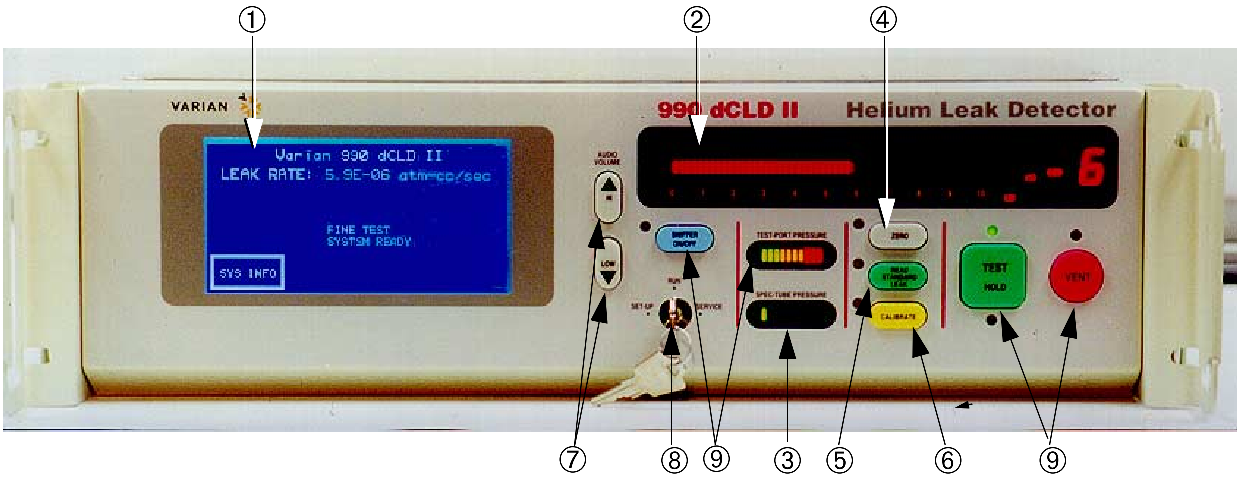


Figure 4-1 990 dCLD II Optional Front Control Panel

① Touch Screen Panel — The touch screen panel provides a convenient menu interface to set up the 990 dCLD II and displays information about the system while it is running.

② Leak Rate Display — The bar graph displays the leak rate in one of two forms:

- q A mantissa on the bar and a numerical exponent
- q Just the bar as a logarithmic bar graph display

The label at the right of the bar graph changes to indicate the current mode of operation: LOG or LIN. When in LOG, the values above the bar graph display the log scale 10^{-11} to 10^{-0}; when in LIN, values below the bar graph display the linear scale 0 to 10.

If the leak rate goes below the zero point that has been set, UNDER displays at the left of the bar graph. If the leak rate goes above the highest set point, OVER displays at the right of the bar graph.

③ Spec-Tube Pressure Display — The bar graph displays the pressure in the spectrometer tube. The graph changes color to indicate more or less favorable conditions.

④ Zero — The ZERO button is used to initiate a function that zeros the leak rate. The LED illuminates while Zeroing is taking place.

⑤ Read Standard Leak — The READ STANDARD LEAK button is used to verify calibration by exposing the internal calibrated leak to the system. The LED illuminates while the function is taking place.

⑥ Calibrate — The CALIBRATE button is used to initiate an automated calibrate function. The LED illuminates while calibration is taking place.

⑦ Audio Volume Control — The Audio Volume Control buttons are provided to change the volume level of the audio leak rate indication.

⑧ Key Switch — The three-position key switch, SET-UP/RUN/SERVICE, is used to access and control operational parameters, as well as service-related functions

NOTE

These panel items are not operational:

- *Test Port Pressure Bar Graph (displays as full)*
- *SNIFFER ON/OFF button*
- *VENT button*
- *TEST/HOLD button*
  The LED above the TEST/HOLD button lights when the System is ready, it does not refer to the function of the button.

4.1 Control Buttons

The ZERO button is functional only when the key switch is in the SET-UP or SERVICE positions, and when PARALLEL ENABLE is off.

Press the **ZERO** button to cause the 990 dCLD II to read the background leak rate signal, store the reading in memory, and then reset the zero reference point. While zeroing is taking place, ZEROING displays on the HOME screen operating state line and the ZERO button LED indicator lights.

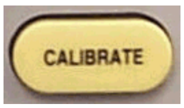
NOTE

Pressing the ZERO button while you are introducing helium tracer gas to the test object could result in the suppression of a real leak. Only use the ZERO button after the helium tracer gas source has been removed.

The READ STANDARD LEAK button is functional only when the key switch is in the SET-UP or SERVICE positions and when PARALLEL ENABLE is not asserted.

Press the **READ STANDARD LEAK** button to display the value on the bar graph, and on the System Information screen allowing verification of 990 dCLD II calibration. When the system is in READ STANDARD LEAK mode, its LED indicator lights and STD LEAK is displayed on the HOME screen operating state line.

After verifying the 990 dCLD II calibration, press the **READ STANDARD LEAK** button to turn it off.



The CALIBRATE button is functional only when the key switch is in the SET-UP or SERVICE positions, and when PARALLEL ENABLE is not asserted.

Press the **CALIBRATE** button to perform an automated calibration based upon the parameters set on the Calibrated Leak Set-Up screen (Section 4.6.1 “Calibrated Leak Set-Up” on page 4-13). The calibrate indicator LED lights while calibration is taking place and CALIBRATING is displayed on the HOME screen operating state line.

The Audio leak rate indication volume is controlled by the two buttons labeled HI and LOW and with up and down arrows. Press the **HI** arrow button to increase the volume of the tone. Press the **LOW** arrow button to decrease the volume of the tone.

When the leak rate bar graph display is set to LINEAR mode (see “Output Control Setup” on page -16), the audio signal increases from a low to high pitch as the leak rate increases within each decade. The pitch cycles low to high as it passes through each decade.

When the leak rate bar graph display is set to LOG mode (see “Output Control Setup” on page -16), the audio signal increases from a low to high pitch as the leak rate increases through the entire bar graph scale.

If it is set up before PARALLEL ENABLE is asserted, the audio signal is operable. The set point must be set before PARALLEL ENABLE is asserted.

4.1.1 Key Switch

The 990 dCLD II Key Switch allows three different levels of access to the touch panel system controls, RUN, SET-UP or SERVICE. Two different keys are provided with the leak detector:

- ❑ Key T008 operates the switch in either the RUN or SET-UP positions.
  The T008 key is intended for use by a line supervisor or engineer.

  In RUN mode (PARALLEL ENABLE is asserted), the control buttons are inoperable, and the touch panel MENUS box is not displayed on the HOME screen, allowing access to only SYSTEM and VERSION information. Leak rate can be observed on the bar graph display, and pressure can be observed on the SPEC-TUBE PRESSURE display. If it was enabled before PARALLEL ENABLE was asserted, the Audio signal is operational.
  In SET-UP mode, the control buttons for zeroing, calibrating and reading internal leak are functional, but the balance of the functions are the same as in RUN mode.

- ❑ Key T009 operates the switch in RUN, SET-UP or SERVICE positions.
  The T009 key is intended for service personnel and those who are very familiar with the operation of the unit, and those who are responsible for setting up and verifying changes of the operating parameters. All menus and control buttons are operational in SERVICE mode. RUN and SET-UP modes operate as discussed above.

4.2 Touch Screen Menus

The 990 dCLD II optional front control panel has a touch panel display for the initial setup and configuration of the leak detector parameters. Once the leak detector is set up, basic operation and control is taken over by the PLC when PARALLEL ENABLE is asserted. The instructions below apply to all menus of the touch panel.

4.2.1 Contrast Adjustment of the Touch Panel Display

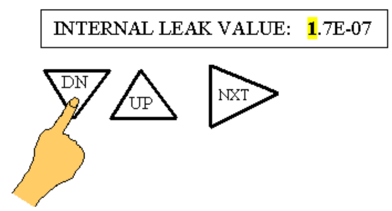
Press the upper left or right corner of the Touch Panel Home Screen to change the contrast.

4.2.2 Changing Variables in Touch Panel Screens

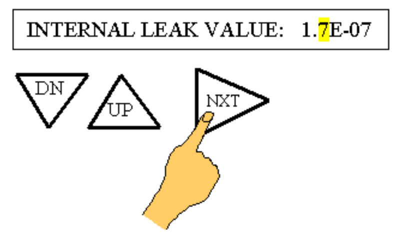
Touching the box that contains the variable to be changed causes the first digit of the variable to be highlighted.

1. Touch the box for the parameter you want to change to highlight the digit.

2. Touch the **UP** or **DN** arrow to change the value of the highlighted digit.



3. Touch the **NXT** arrow to select the next digit to be changed and set its value by repeating step 2.



4. Touch the **OK** box to accept changes and store the new value of the parameter into the memory of the leak detector. Touch **BACK** to exit the screen and return to the previous menu screen.

To change any digit, touch the box containing the parameter you want to change and then touch the **NXT** arrow to scroll to that digit and change it, as indicated in step 2.

NOTE

*Touching the **ESC** box before touching OK or BACK causes the selected parameter to revert to its previously stored value.*

4.2.3 Selecting Options in Touch Panel Screens

Many parameters are set via toggle boxes that you touch to switch between values or modes. For example, Manual Range can be set to ON or OFF by touching the toggle box to switch between displaying ON and OFF. In all cases, the information displayed in the box is the selected value. Most screen values do not change until you press **OK**, but some changes are immediate, for example, selecting the units from the UNITS SET-UP screen or selecting Linear or Logarithmic display from the OUTPUT CONTROL SET-UP screen.

4.3 Menu Hierarchy

Figure 4-2 and Figure 4-3 show the hierarchy of the 990 dCLD II touch screen menus and the parameters that can be changed from each menu. The numbers to the left of each menu refer to the section in this document that discusses that menu in detail.

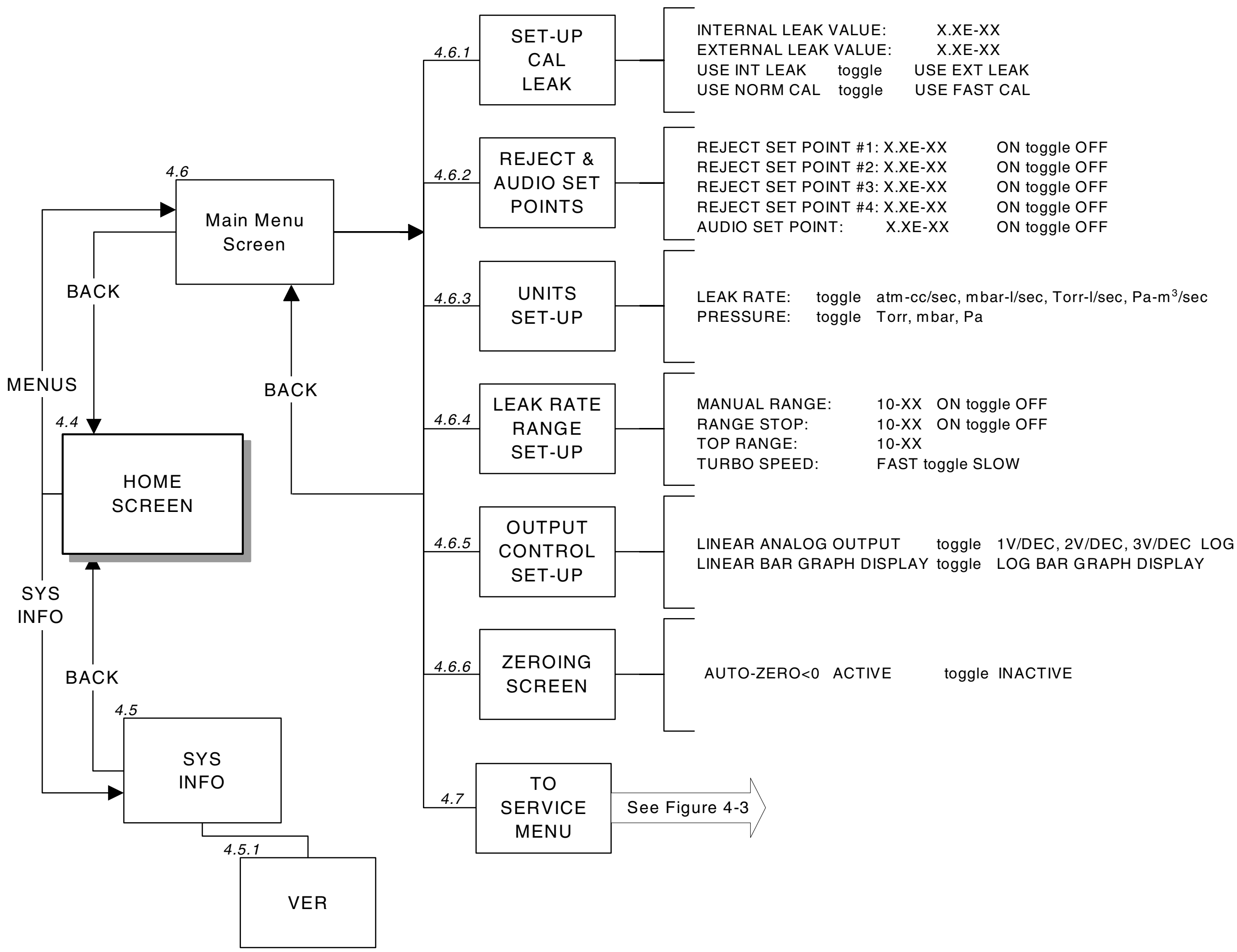


Figure 4-2 Menu Hierarchy (up to Service Menu)

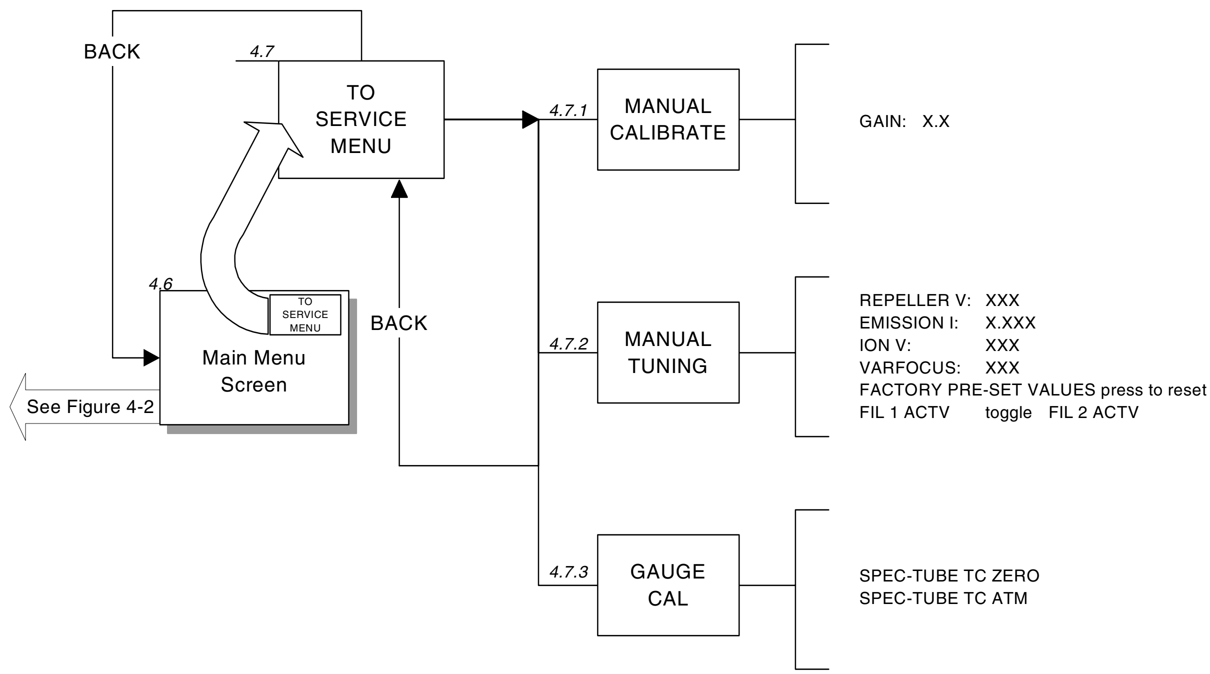


Figure 4-3 Service Menu Hierarchy

4.4 Touch Panel Home Screen

The 990 dCLD II Touch Panel Home Screen, Figure 4-4, displays a summary of the status and configuration that has been set, and has two touch screen boxes that either provide access to information or change the configuration. The Home Screen is displayed on power up and each time the RUN/SET-UP/SERVICE key is switched. The information provided on the Home Screen is:

- ❑ Digital Leak Rate Display
- ❑ Operating States
- ❑ Condition States
- ❑ SYS INFO touch screen box
- ❑ Reject Status Indicator
- ❑ Leak Detector Status
- ❑
- ❑ MENUS touch screen box

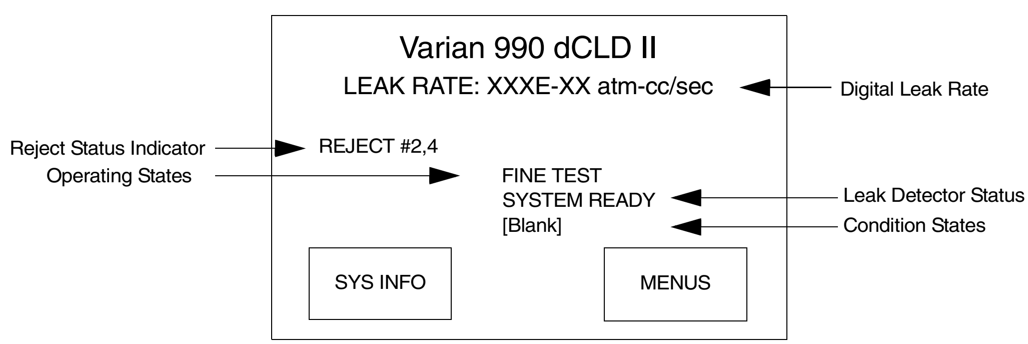


Figure 4-4 Touch Panel Home Screen

Digital Leak Rate

The Digital Leak Rate displayed on the touch panel Home screen correlates directly with the bar graph leak rate display when the mantissa value of the leak rate is greater than one. Leak rate readings with a mantissa value of less than one are shown on the touch panel Home screen with an exponent that is one decade below the bar graph display exponent. The units are user selectable from the Units Set-Up screen (see Section 4.6.3 “Units Set-Up” on page 4-15).

For example, the bar graph displays 0.8 x 10 –09 atm cc/sec (Figure 4-5), then the leak rate displayed on the touch panel Home screen is 8.0E-10 (8.0 x 10 –10) atm cc/sec (Figure 4-6). This feature provides exceptional leak rate resolution.

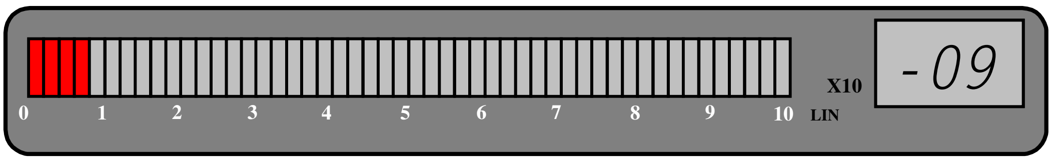


Figure 4-5 Bar Graph Display: 0.8 x 10 –09 atm cc/sec

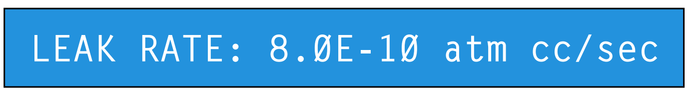


Figure 4-6 Touch Panel Digital Display: 8.0E –10 atm cc/sec

Reject Status Indicator

A REJECT status indicator displays below the Leak Detector Condition on the left-hand center of the Home screen when any of the four independent set points are enabled and have been activated (see Section 4.6.2, “Reject and Audio Set Points”). If all set points are disabled or are not active, then this indicator is not present.

Leak Detector Operating States

This line displays the current operating state. See Table 4-1 on page 4-9 for a listing and description of the messages that can appear here.

Leak Detector Status

This line displays the current operating state of the 990 dCLD II. Under normal operating conditions, this line reads SYSTEM READY. See Table 4-2 on page 4-9 for a listing and description of the messages that can appear here.

Leak Detector Condition States

Under normal operating conditions, this line is blank. If a problem occurs, it displays the condition that needs attention. See Table 4-3 on page 4-10 for a listing and description of the messages that can appear here.

SYS INFO and MENUS Touch Screen Boxes

Two touch screen boxes are displayed on the bottom of the Home screen. Touch the **SYS INFO** box to display the System Info screen, or touch the **MENUS** box to display the Main Menu screen.

NOTE

Flashing **C** *on the exponent display indicates that the leak detector requires calibration.*

Table 4-1 990 dCLD II Operating States

Display	Description
CALIBRATING	Indicates that the leak detector is currently performing a calibration routine.
CALIBRATION PREP	Indicates that the leak detector is preparing for a calibration routine.
FINE TEST	Indicates that the leak detector is in FINE TEST mode. When in FINE TEST mode the leak detector is ready for fine leak testing.
STD LEAK	Indicates that the internal calibrated leak standard valve is open and the leak detector is reading the leak value.
STD LEAK PREP	Indicates that the internal calibrated leak standard is being roughed before it is introduced to the system for calibration or verification.
ZEROING	Indicates that the leak detector is in the process of *Zeroing* out a background signal. The *Zero* routine is only initiated automatically during the start up and calibration routines, or manually when the operator presses the ZERO button on the optional front control panel.

Table 4-2 990 dCLD II Leak Detector Status

Display	Description
FILAMENT WAIT	Indicates that the system is lighting the filament.
OFFSET WAIT	Indicates that the system is setting the OFFSET value during the start-up routine.
SPEC TUBE PRESSURE WAIT	Indicates that the system (spectrometer tube) pressure is too high to light the filament.
STABILIZATION WAIT	Indicates that the system is waiting for the electronics to stabilize before completing the start-up routine.
SYSTEM READY	Indicates that the system is ready for testing. This message is only present during the initial start-up. Flashing **C** on the exponent display indicates that the leak detector requires calibration.
ZEROING WAIT	Indicates that the system is setting the initial zero values during the start-up routine.

Table 4-3 990 dCLD II Condition States

Display	Description
[BLANK]	This line is blank under normal operating conditions.
BOTH FILAMENTS BURNT OUT	Indicates that both filament 1 and filament 2 of the ion source have burnt out.
FILAMENT 1 BURNT OUT	Indicates that filament 1 of the ion source has burnt out. Filament 2 automatically illuminates, if it is still good, and the optional front control panel displays a flashing **C** in the leak rate exponent indicating that a calibration routine is required.
FILAMENT 2 BURNT OUT	Indicates that filament 2 of the ion source has burnt out. Filament 1 automatically illuminates, if it is still good, and the optional front control panel displays a flashing **C** in the leak rate exponent indicating that a calibration routine is required.
GAIN TOO HIGH	Indicates that the gain value required to calibrate the leak detector during the calibration routine is greater than the allowable value. This is generally the result of the system sensitivity being too low.
GAIN TOO LOW	Indicates that the gain value required to calibrate the leak detector during the calibration routine is less than the allowable value. This is generally the result of the system sensitivity being too high.
NO FOCUS PEAK	Indicates a tuning/calibration failure due to the system not detecting a focus peak during the tuning or calibration routine.
NO ION PEAK	Indicates a tuning/calibration failure due to the system not detecting an ion peak during the tuning or calibration routine.
SWITCHING FILAMENTS	Indicates that the system is momentarily in the process of switching from a burnt out filament to the next available filament.

4.5 System Information Screen

The System Information screen, Figure 4-7, displays details of the leak detector setup and operating conditions. Table 4-4 describes the displayed system information in detail.

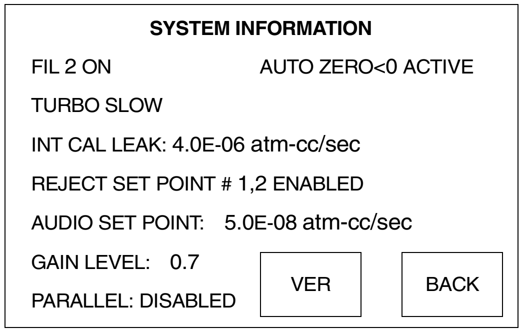


Figure 4-7 System Information Screen, Typical Display

Touch the box labeled **BACK** to return to the Home screen. Touch the box labeled **VER** to display the System Software Version screen.

Table 4-4 System Information Screen Conditions

Condition	Display	Description
AUDIO SET-POINT	AUDIO SET POINT: X.XE-XX	Audio Set Point is active, and is set at the value displayed.
	AUDIO SET POINT: INACTIVE	Audio Set Point is inactive.
CALIBRATED LEAK	INT CAL LEAK	System is set up to calibrate to the internal standard leak.
	EXT CAL LEAK	System is set up to calibrate to an external standard leak.
ION SOURCE FILAMENT	FIL 1 OFF	Filament 1 is selected and not lit.
	FIL 1 ON	Filament 1 is selected and lit.
	FIL 2 OFF	Filament 2 is selected and not lit.
	FIL 2 ON	Filament 2 is selected and lit.
REJECT SETPOINT	REJECT# 1,2,3,4 ENABLED	Reject set points displayed are active. If blank, all set points are disabled or inactive.
TURBO PUMP	TURBO FAST	System turbo pump is operating at high speed.
	TURBO SLOW	System turbo pump is operating at slow speed.

4.5.1 System Software Version

The System Software Version screen (Figure 4-8) provides system software revision information and the phone number for Vacuum Technologies.

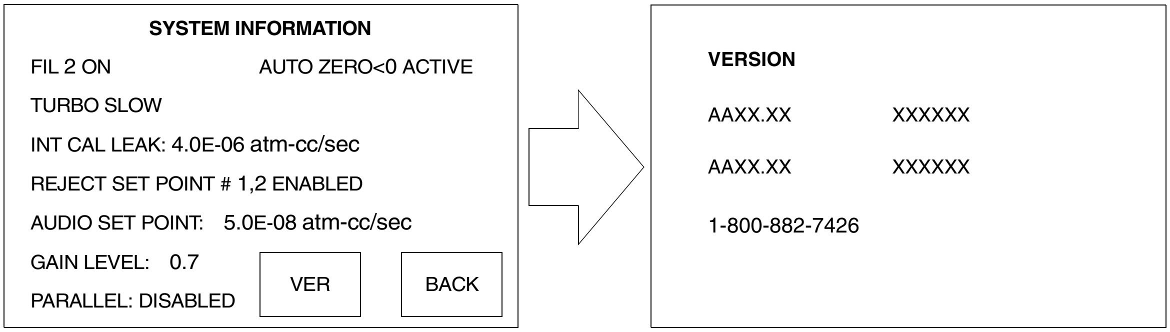


Figure 4-8 Software Version Screen

Touch the **VER** box. VERSION PLEASE WAIT is displayed while the inquiry takes place. The VERSION screen then displays the revision date and checksum of the main CPU and the optional front control panel CPU software. Inquiry of the checksum information takes several seconds.

This screen automatically reverts to the System Information screen approximately 15 seconds after the revision data is displayed in full.

4.6 Main Menu Selection Screen

Touch the **MENUS** box on the Home screen to display the Main Menu screen (Figure 4-9). The Main Menu screen displays the screens available for performing general setup of the 990 dCLD II. Touching the **BACK** box from this screen displays the Home screen. The screens available through the Main Menu screen are described in this section. Many menus contain toggle boxes that switch between selections each time you touch them. The value or selection that is displayed when you touch **OK**, is what is set. Other menus contain parameters. Change their values by following the procedure in Section 4.2.2 "Changing Variables in Touch Panel Screens" on page 4-5.

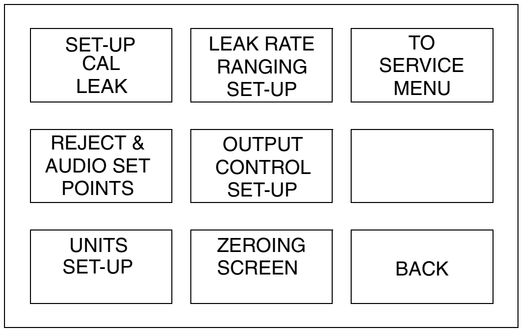


Figure 4-9 Main Menu Selection Screen

4.6.1 Calibrated Leak Set-Up

Touch the **SET-UP CAL LEAK** box to display the Calibrated Leak Set-Up screen, shown in Figure 4-10. It is used to set the values of the Internal and External Calibrated leaks, to select whether to use an INTERNAL or EXTERNAL calibrated leak standard for calibration, and to select NORMAL or FAST CALIBRATION mode.

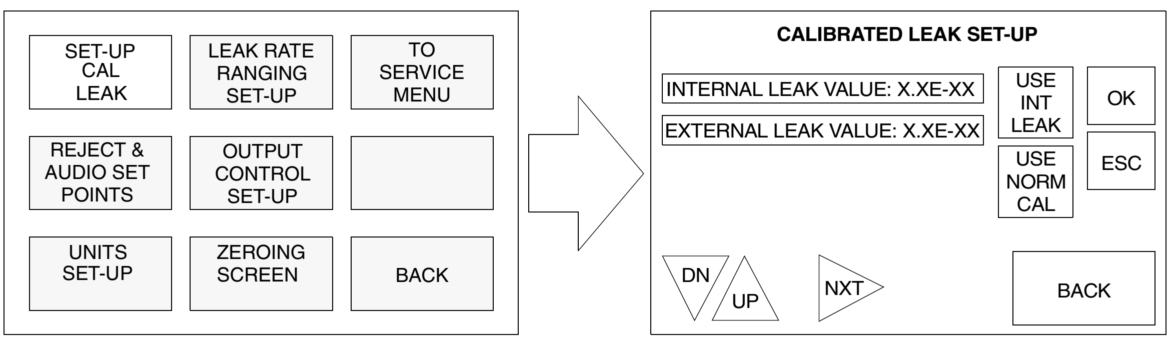


Figure 4-10 Calibrated Leak Set-Up Screen

4.6.1.1 Selecting Internal or External Calibrated Leak for Calibration

Touch the **USE INT/EXT LEAK** toggle box to switch between selecting whether the 990 dCLD II performs an automated calibration to the internal calibrated leak standard supplied with the leak detector, or to an external calibrated leak placed in the test port.

INTERNAL LEAK	Touch the **USE INT/EXT LEAK** toggle box to switch to USE INT LEAK. Check or change the values of the internal leak in the INTERNAL LEAK VALUE box. The values you enter must be in the units specified in the Units Set-Up screen (Section 4.6.3 "Units Set-Up" on page 4-15).
EXTERNAL LEAK	Touch the **USE INT/EXT LEAK** toggle box to switch to USE EXT LEAK. Check or change the values of the external leak in the EXTERNAL LEAK VALUE box. The values you enter must be in the units specified in the Units Set-Up screen (Section 4.6.3 "Units Set-Up" on page 4-15).

4.6.1.2 Selecting Normal or Fast Calibration Routine

Touch the **USE NORM/FAST CAL** toggle box to switch between NORMAL CALIBRATION and FAST CALIBRATION modes.

4.6.2 Reject and Audio Set Points

Touch the **REJECT & AUDIO SET POINTS** box to display the Reject and Audio Set Points screen (Figure 4-11). From this screen, set the parameters to enable/disable, display and/or change the value of the four reject set points and the audio set point using the procedure outlined in "Changing Variables in Touch Panel Screens" on page -5.

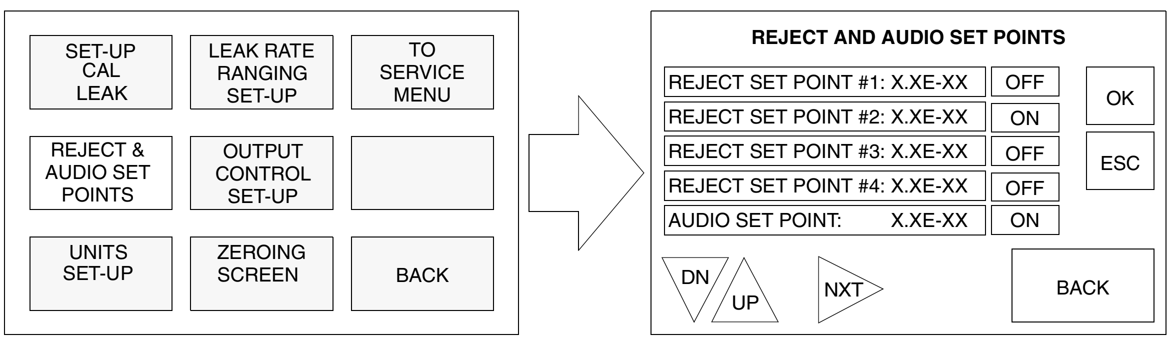


Figure 4-11 Reject and Audio Set Points Screen

REJECT SET POINTS	Touch the **REJECT SET POINT #1 (2**, **3** or **4)** box to change each reject's set point value. Touch the **ON/OFF** toggle box located to the right of each set point field to turn the Reject Point on or off.
AUDIO SET POINT	Touch the **AUDIO SET POINT** box to change the threshold leak rate value. Touch the **ON/OFF** toggle box located to the right of the audio setpoint box to turn the Audio Set Point on or off.

4.6.3 Units Set-Up

Touch the **UNITS SET-UP** box to display the Units Set-Up screen (Figure 4-12). This setup screen is used to select the leak rate and pressure units that are displayed on the leak rate bar graph, and in the Gauge Calibration screen, Section 4.7.3 “Gauge Calibration” on page 4-20. Note, this change is effective immediately upon selection.

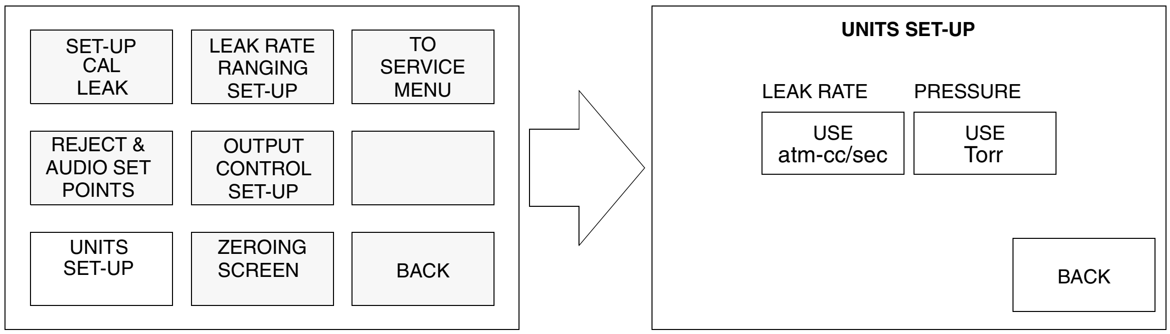


Figure 4-12 Units Set-up Screen

LEAK RATE UNITS — Touch the **LEAK RATE** units selection box to switch the leak rate units between atm-cc/sec, mbar-l/sec, Torr-l/sec, and Pa-m^3/sec.

PRESSURE UNITS — Touch the **PRESSURE** units selection box to switch units between Torr, mbar, and Pa.

4.6.4 Range Stop and Manual Range Set Up and Control

Touch the **LEAK RATE RANGE SET-UP** box to display the Leak Rate Ranging Set-Up screen (Figure 4-13). From this screen, set up and enable the RANGE STOP and MANUAL RANGE functions, set the TOP RANGE, and control the TURBO speed. For a discussion of how to determine these values, see Section 3.3.1 “Parameters and Operating Modes” on page 3-7.

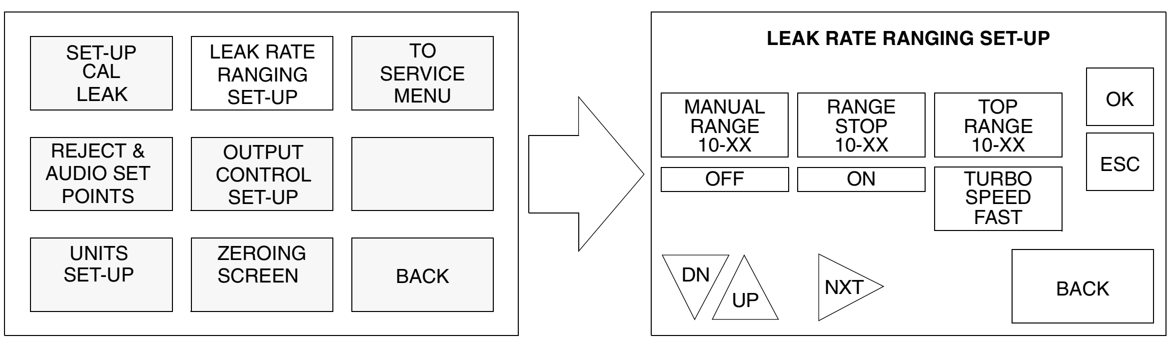


Figure 4-13 Leak Rate Ranging Set-Up Screen

MANUAL RANGE — To read out one fixed decade, touch the MANUAL RANGE ON/OFF toggle box to display **ON** and then set the value of the decade in the MANUAL RANGE box. This value must be set between the values of the TOP and STOP Range; other values are rejected.

Auto-Ranging ENABLED — When MANUAL RANGE is set to **OFF**, *Auto-Ranging* is enabled. The system reads out a maximum four decades starting from the value set for the TOP RANGE parameter. If RANGE STOP is ON, the system measures *from* the TOP RANGE decade *to* the RANGE STOP decade.

RANGE STOP — When Auto-Ranging is enabled (MANUAL RANGE is set to OFF), you can limit the range to less than four decades. Touch the RANGE STOP ON/OFF toggle box to display **ON** and then set the decade in the RANGE STOP box. The system then measures *from* the TOP RANGE decade *to* the RANGE STOP decade.

TOP RANGE — Set the TOP RANGE to the least sensitive value the configured system will evaluate. See Table 3-1 on page 3-6 and "TOP RANGE" on page 3-8 for a discussion of how to determine this value.

4.6.4.1 Leak Rate Range Selection through Turbo Speed Set-Up

The 990 dCLD II electronics allow for the display of only four full decades of sensitivity at one time. The four decades displayed depend on the pump model being used in conjunction with the TURBO SPEED and TOP RANGE selection set by the user.

Touch the **TURBO SPEED FAST/SLOW** toggle box to switch between SLOW and FAST. The mode displayed indicates the current speed of the turbo.

4.6.5 Output Control Setup

Touch the **OUTPUT CONTROL SET-UP** box to display the Output Control Set-Up screen (Figure 4-14). From here, select the desired leak rate output and type of bar graph display.

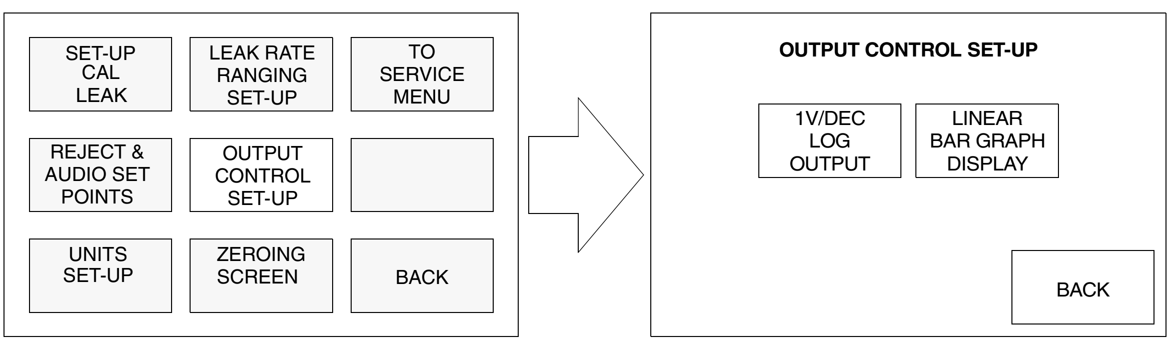


Figure 4-14 Output Control Set-Up Screen

4.6.5.1 Bar Graph Display Set-Up

Touch the **LINEAR BAR GRAPH DISPLAY** toggle box to switch the bar graph display between LOG BAR GRAPH DISPLAY mode and LINEAR BAR GRAPH DISPLAY mode. Note, this change is effective immediately upon selection.

4.6.5.2 Leak Rate Analog Output Voltage Selection

Touch the **LEAK RATE OUTPUT** selection box located at the left of Output Control Set-Up screen to switch the output voltage at the I/O port (J3 or J4) on the back of the control unit among the selections listed below.

LINEAR ANALOG OUTPUT	Touch the box to switch between LINEAR ANALOG OUTPUT or LOG output voltage selections, which are 1V/DEC LOG, 2V/DEC LOG and 3V/DEC LOG.

Convert the voltage to the leak rate using the appropriate chart in Section 3.7 “Analog Leak Rate Output Voltage” on page 3-21.

4.6.6 Zeroing

Touch the **ZEROING SCREEN** box to display up the Zeroing screen shown in Figure 4-15.

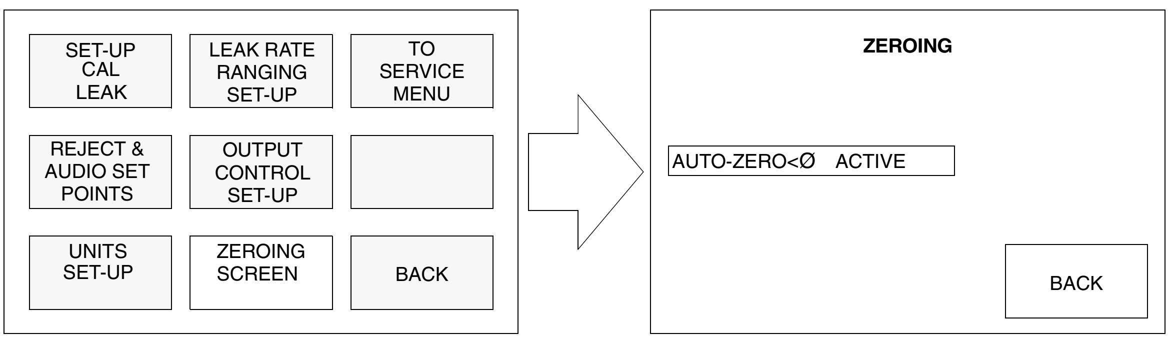


Figure 4-15 Zeroing Screen

Touch the **AUTO-ZERO<0** box to switch AUTO-ZERO<0 between ACTIVE and INACTIVE states. Touch **BACK** to return to the Main Menu. Note, this change is effective immediately upon selection.

4.7 Service Menus

The Service Menus are mainly used by service technicians to provide service to your system. There are times, however, that you may want to view the information that is accessed via these screens to troubleshoot a situation, or you may be asked to provide this information to a service technician.

Touch the **TO SERVICE MENU** box on the Main Menu to display the Service Menu Selection screen as shown in Figure 4-16, or **BACK** to return to the Home Screen.

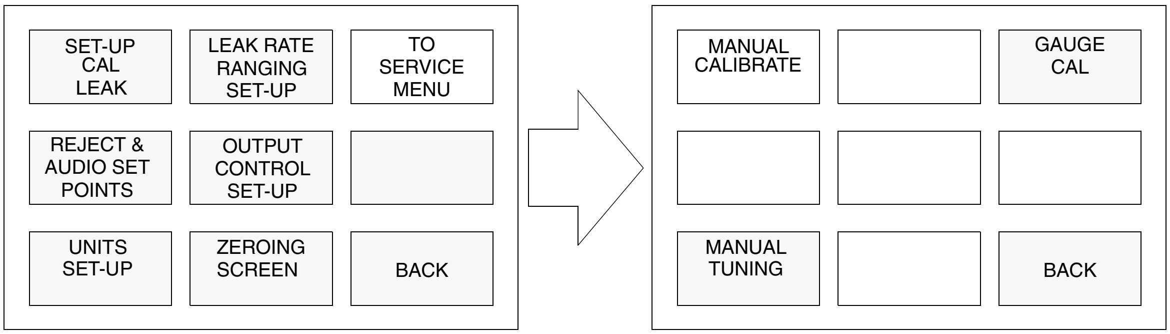


Figure 4-16 Service Menu Selection Screen

CAUTION *Many of the values for the parameters included in the Service Menus are calculated when the 990 dCLD II performs functions such as CALIBRATE and ZERO. Changing these values can cause unreliable test results.*

4.7.1 Manual Calibration

Touch the **MANUAL CALIBRATE** box to display the Manual Calibration screen shown in Figure 4-17.

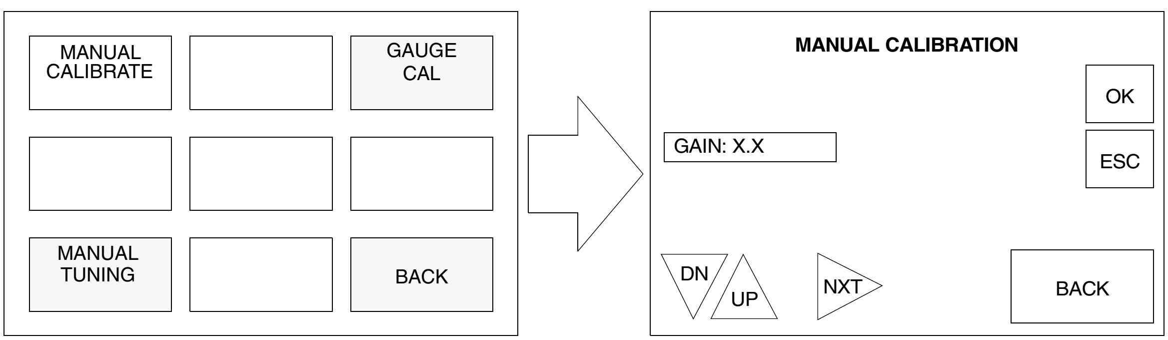


Figure 4-17 Manual Calibration Screen

You can use the Manual Calibration screen to view or change the calculated Gain. Setting the gain greater than 5.0 or less than 0.5 causes the system to report an unsuccessful calibration and revert to the values stored prior to calibration.

4.7.2 Manual Tuning

Touch the **MANUAL TUNING** box to view the Manual Tuning screen shown in Figure 4-18.

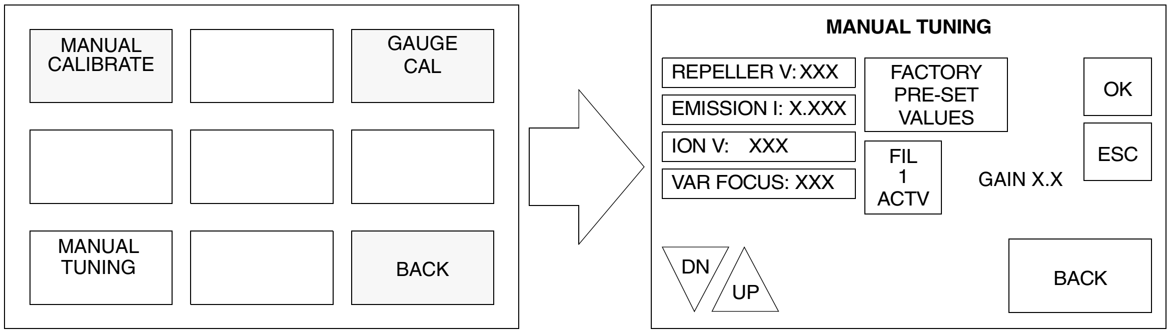


Figure 4-18 Manual Tuning Screen

You may need to manually tune the 990 dCLD II if:

- ❑ The control unit is connected to a spectrometer assembly in the field other than the one with which it was tested
- ❑ It cannot successfully CALIBRATE
- ❑ The gain is greater than 5.0
- ❑ A board in the Platform is changed
- ❑ The ion source is changed

Refer to Section 5.6 “Manual Tuning” on page 5-20 for detailed instructions on Manual Tuning.

Touch the FACTORY PRE-SET VALUES box to change the values to those set at the factory. Note, this change is effective immediately upon selection.

The Manual Tuning screen allows you to change the REPELLER V, EMISSION I, ION V, VAR FOCUS values.

4.7.3 Gauge Calibration

Touch the **GAUGE CAL** box to view the Gauge Calibration screen shown in Figure 4-19.

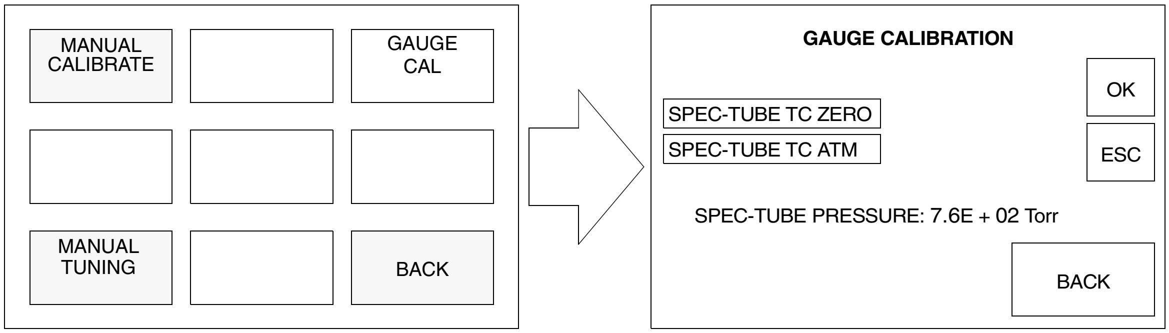


Figure 4-19 Gauge Calibration Screen

The Gauge Calibration screen displays the spectrometer tube pressure. Use this screen to calibrate the gauge following the procedure below:

1. With the system running, move to this screen and touch SPEC-TUBE TC ZERO. Verify that **Passed** appears to the right of TC ZERO.
2. Power off the 990 dCLD II.
3. Loosen the Turbo Vent screw and repower the system.
4. Power on the 990 dCLD II.
5. Move to this screen and touch SPEC-TUBE TC ATM. Verify that **Passed** appears to the right of TC ATM.

If **Failed** appears after either test, the ConvecTorr gauge must be replaced.

Section 5. Maintenance

Like other sensitive test equipment, a mass spectrometer leak detector requires periodic maintenance to ensure continued reliable operation. After prolonged use, the leak detector accumulates contaminants from even the cleanest of products tested. These contaminants eventually impair operation. A thorough disassembly and cleaning of the entire vacuum system, which includes the cal leak valve block and spectrometer tube, restores normal operation. For heavy production use, more frequent overhauls may be needed. Conversely, lighter use may permit a longer period between overhauls. In most cases, this work is done by user maintenance personnel, but it may also be done by Vacuum Technologies under the terms of a service contract.

This maintenance section does not cover overhaul of the entire vacuum system, nor does it cover customer-supplied parts except for the brief discussion regarding pumps below. It does cover maintenance that may have to be performed on a daily or as-required basis or, if the item has not required maintenance, on an annual preventive basis.

Customer-Supplied Pumps

Most pumps require regular maintenance. Oil gets contaminated over time and has to be replaced. In a system with dry pumps, tip seals have to be checked for wear. The customer-supplied roughing and forepumps of the system must be maintained at the intervals recommended by their manufacturer for this application in order to ensure reliable leak detection by the 990 dCLD II.

Important Reminders

Heed the following notes, cautions, and warnings when performing maintenance.

WARNING *Disconnect power from the 990 dCLD II before performing any maintenance procedure that requires physically disconnecting any part of the system.*

CAUTION *The preamplifier is a static sensitive device. Wear a grounding device while the preamplifier is being handled.*

WARNING *Store the Ion Source in a cool, dry area in a tightly sealed container. When handling the Ion Source, wear powder-free butyl or polycarbonate gloves. If you handle the Ion Source with bare hands, wash them thoroughly and especially before smoking or eating.*

Cleanliness is vital when servicing the leak detector or any vacuum equipment. There are some techniques more important in leak detector servicing than in general vacuum work:

CAUTION

Do not use silicone oil or silicone grease.

Use powder-free butyl or polycarbonate gloves to prevent skin oils from getting on vacuum surfaces.

Do not clean any aluminum parts with Alconox®. Alconox is not compatible with aluminum and will cause damage.

NOTE

Normally, it is unnecessary to use vacuum grease. However, if it must be used, avoid silicone types, and use it sparingly. Apiezon® L grease is recommended (Vacuum Technologies Part No. 695400004).

When removing, checking or replacing O-rings:

CAUTION

Remove O-rings carefully with your fingers. Do not use metal tools for this task. This prevents scratching of any sealing surfaces.

Do not use alcohol, methanol or other solvents on O-rings. To do so causes deterioration and reduces their ability to hold a vacuum.

Do not use grease or other substance on O-rings that will come in contact with the spectrometer tube.

Wipe all O-rings clean with a lint-free cloth before installation to ensure that no foreign matter is present to impair the seal. Apply a small amount of Apiezon® L grease and wipe the O-rings "shiny" dry.

NOTE

Due to the effective cleaning nature of VacuSolv solvent and its residue-free properties, Vacuum Technologies' Component and Spectrometer Tube Cleaning Kit (Part Number 670029096), used in accordance with the kit instructions, is recommended for cleaning the spectrometer tube components. The kit can also be used for fine cleaning of other parts in the leak detector's vacuum system such as valves and fittings. No rinsing steps or high-temperature drying is required following cleaning with VacuSolv. Although appropriate precautions are advised, VacuSolv is compatible with most materials and does not contain toxic chemicals or CFCs (chlorofluorocarbons).

For simplicity, the maintenance functions in this section are grouped by recommended frequency, as shown in Table 5-1, based on assumed everyday use.

Table 5-1 Scheduled Maintenance

Description	Daily	12 Months	Refer to
Calibration check	X		Section 5.1 “Daily Maintenance” on page 5-4
Recalibrate the internal calibrated leak		X	Section 5.2 “Recalibrate the Internal Calibrated Leak” on page 5-5
Spectrometer tube overhaul		X	Section 5.3 “Spectrometer Tube Overhaul” on page 5-5
Dual air intake filter replacement		X	Section 5.4 “Dual Air Intake Filter Replacement” on page 5-18

These functions can be carried out at routine intervals, as indicated. The 990 dDLD II must be calibrated to verify sensitivity at least once a day. However, other functions may be carried out either more or less often, depending on the frequency of use.

Maintenance functions that may be required on a demand basis, for example, changing an Ion Source after filament failure, are listed in Table 5-2.

Table 5-2 As-required Maintenance

Function	Most Common Symptom	Refer to
Spectrometer tube cleaning	Loss of sensitivity, increase in background, high ion voltage (> 300 VDC), required to tune the leak detector.	Section 5.3 “Spectrometer Tube Overhaul” on page 5-5
Ion source replacement	Filament failure (as soon as convenient after second filament is in use).	Section 5.5 “Ion Source Replacement Outside of Spectrometer Tube Overh aul” on page 5-19
Tuning adjustments	Use of a calibrated leak in the field other than the one tested at the factory, or if calibration is not successful.	Section 5.6 “Manual Tuning” on page 5-20

5.1 Daily Maintenance

5.1.1 Sensitivity Check using the Optional Front Control Panel

1. Press the READ STANDARD LEAK button.
2. Compare the value displayed on the HOME screen (Section 4.4, “Touch Panel Home Screen”) to the value of the known calibrated leak displayed on the SYSTEM INFORMATION screen (Section 4.5 “System Information Screen” on page 4-11) or listed on the tag of the calibrated leak. Adjust the value for temperature if necessary.
   - ❑ If the values do not match, press the CALIBRATE button to perform an automated calibration and then repeat step 1.
   - ❑ If specification is still not met, Manual Tuning may be required. See Section 5.6 “Manual Tuning” on page 5-20.

5.1.2 Sensitivity Check using the Diagnostic Serial Port J12

1. Send the inquiry ?STDLEAK<CR>.
2. Compare the value returned in the response to the value of the known internal calibrated leak.
   - ❑ If necessary, adjust the value for temperature.
3. If the values do not match, perform an automated calibration:
   - ❑ Issue the INTERNAL<CR> command to ensure performing an internal calibration.
   - ❑ Issue the 0 INIT-QUICK-CAL<CR> command to ensure pilfering a full calibration.
   - ❑ Issue the CALIBRATE<CR> command to perform the calibration.
   - ❑ The system should respond **ok**<CR><LF>.
4. Repeat step 1.

   If specification is still not met, Manual Tuning may be required. See Section 5.6 “Manual Tuning” on page 5-20.

5.2 Recalibrate the Internal Calibrated Leak

Helium calibrated leaks typically degrade at 3 percent per year. The calibrated leak supplied with your 990 dCLD II must be checked at least once a year to ensure it is at the value stated on its tag. Failure to check the leak could result in unreliable testing. You can arrange for testing and re-calibration at a lab of your choice.

Vacuum Technologies provides NIST-traceable calibrated leak testing and verification services. You can contact Customer Service at 1-800-8VARIAN (1-800-882-7426) to arrange for re-calibration.

5.3 Spectrometer Tube Overhaul

Spectrometer tube overhaul consists of removing, cleaning, and re-installing the 990 dCLD II Spectrometer Tube Assembly. There are four basic sub-assemblies in the spectrometer tube. Removal instructions follow in the order below.

- ❑ Thermocouple Button (TC)
- ❑ Ion Source
- ❑ Preamplifier
- ❑ Magnetic Poles

Table 5-3 lists the tools and parts required during spectrometer tube overhaul.

Table 5-3 Tools and Parts Required for Spectrometer Tube Overhaul

Tools	
Slotted screwdriver	
5/64" Hex wrench	
Part Number	**Description**
82850302	Ion Source
R1266301	Button Thermocouple (Button TC)
670029096	Vacuum Technologies Spectrometer Tube Cleaning Kit
	O-rings (Parker 2-025 V747-75 Black) Supplied with Ion Source, Button TC and Preamplifier

5.3.1 Removing the Spectrometer Tube Assembly

The spectrometer tube operates at a very high vacuum produced by the high vacuum pump. Service of the spectrometer tube requires that this vacuum be vented to the atmosphere.

NOTE *Rebuilt spectrometer tubes are available from Vacuum Technologies on an exchange basis. Contact Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426) for details.*

1. Loosen the hold-down screw ① to remove the spec tube block connector from the spectrometer assembly (Figure 5-1).

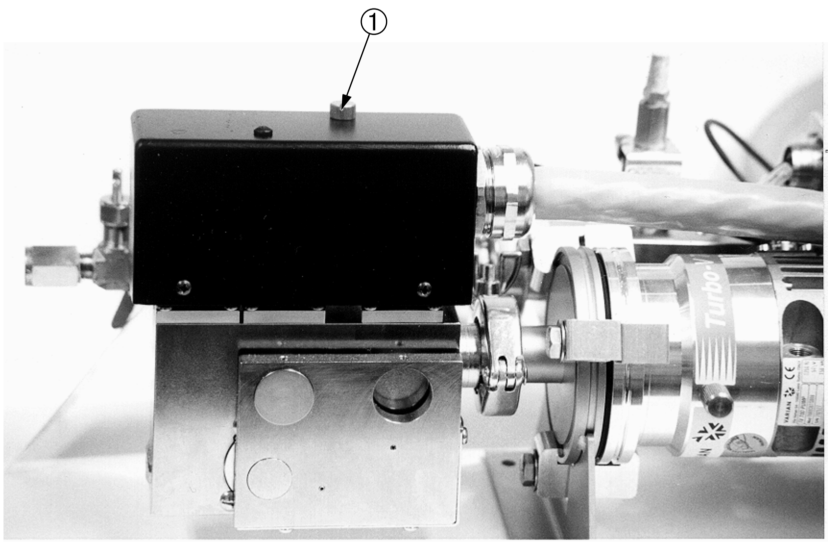


Figure 5-1 Removing the Spec Tube Block Connector

2. Remove the turbo fan power connection and the turbo pump power connection from the spec tube block connector.

3. Remove the KF-25 (ISO NW-25) quick clamp ① to disconnect the spectrometer tube from the Turbo Spec Tube Assembly (Figure 5-2).

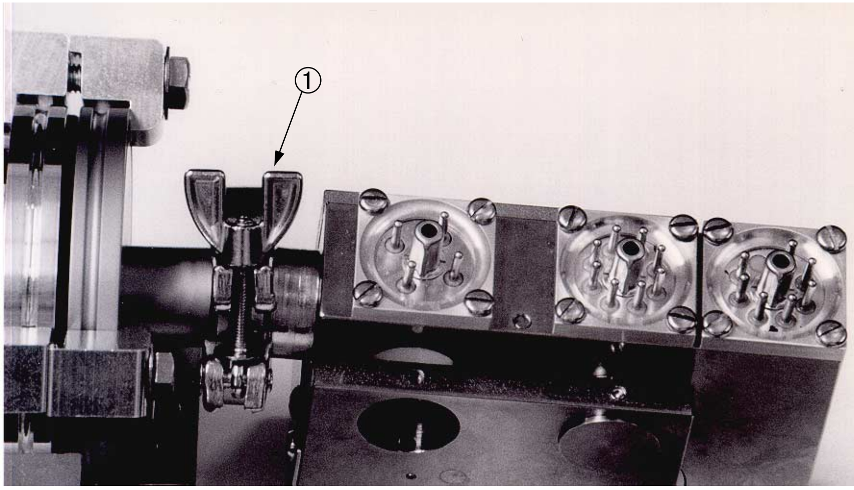


Figure 5-2 KF-25 Quick Clamp

4. Lay the spectrometer tube down on a clean non-magnetic surface.

CAUTION

If the spectrometer tube magnet comes in contact with a magnetic surface, the magnet may lose its gauss causing the spectrometer tube to lose sensitivity.

CAUTION

Do not remove the 6 magnet body bracket screws ① shown in Figure 5-3 while performing maintenance on the spectrometer tube.

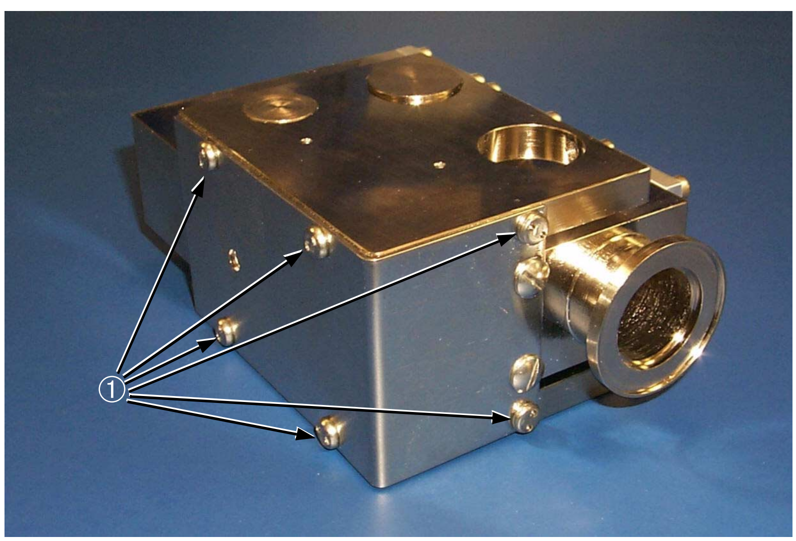


Figure 5-3 Magnet Body Bracket Screws

5. Remove the 2 slotted screws ① that mount the spectrometer tube magnet assembly to the spectrometer tube body (Figure 5-4).

Figure 5-4 Slotted Screws that Attach the Magnet Assembly to Spectrometer

6. Loosen the tuning magnets ① by using a hex wrench to back out the set screws ¡ (located on both sides of the assembly) Figure 5-5. Do not remove the set screws and tuning magnets completely.

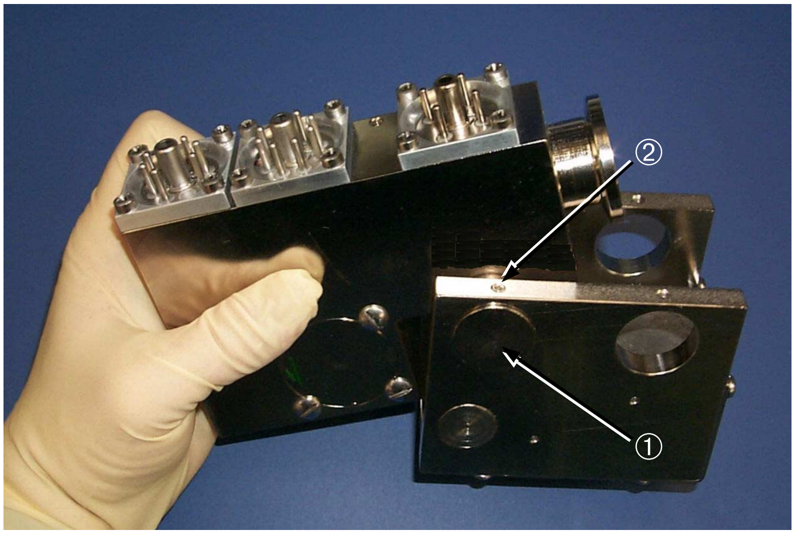


Figure 5-5 Set Screws that Secure the Tuning Magnets

7. Carefully slide the magnet assembly off of the spectrometer tube body.

5.3.2 Removing the Button TC

1. Remove the 4 slotted screws ① that hold the button TC header (Figure 5-6).

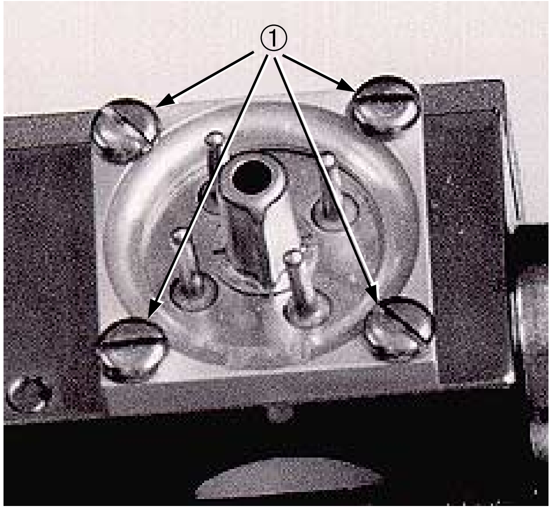


Figure 5-6 Button TC Assembly

2. Remove the button TC header ② (Figure 5-7) by pressing down on the button TC center post ① and lifting the header ② up and off of the button TC ③.

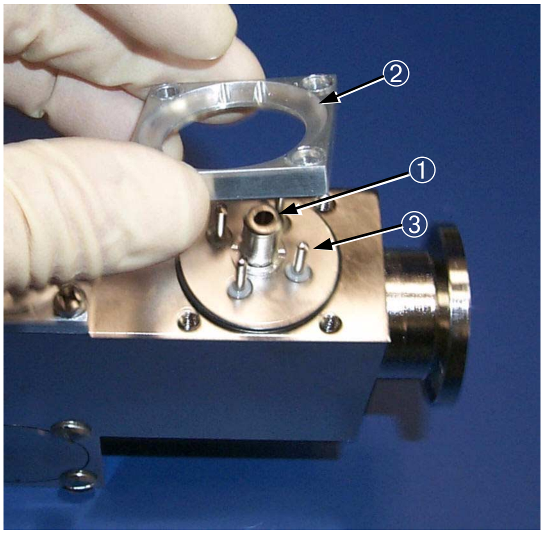


Figure 5-7 Removing the Button TC Header

3. Remove the button TC carefully and place it sensing wire ① side up as shown in Figure 5-8, (contact pin side down) on a clean surface.

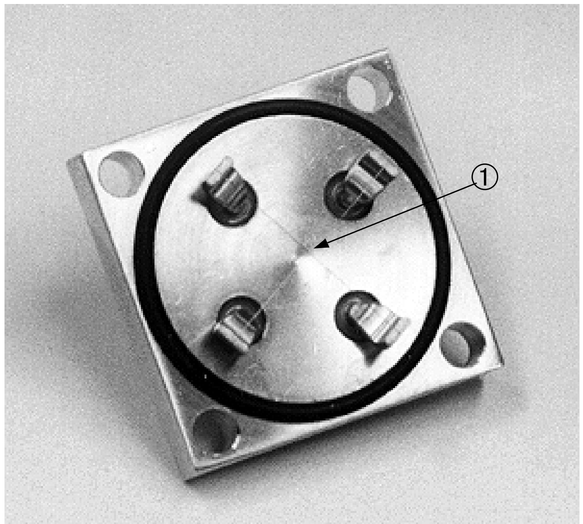


Figure 5-8 Button TC

CAUTION *The sensing wire on the bottom side of the TC is approximately 3 mils thick. Care must be taken not to damage this wire.*

5.3.3 Removing the Ion Source

NOTE *The ion source is typically replaced during the normal maintenance procedure. A new and clean ion source provides optimum sensitivity and system performance.*

See "Ion Source Replacement Outside of Spectrometer Tube Overhaul" on page -19 when replacing the ion source outside of annual maintenance.

WARNING *When handling the Ion Source, wear powder-free butyl or polycarbonate gloves. If you handle the Ion Source with bare hands, wash them thoroughly and especially before smoking or eating.*

1. Remove the 4 slotted screws that hold the ion source header piece.

2. Remove the ion source ① from the spectrometer tube body (Figure 5-9).

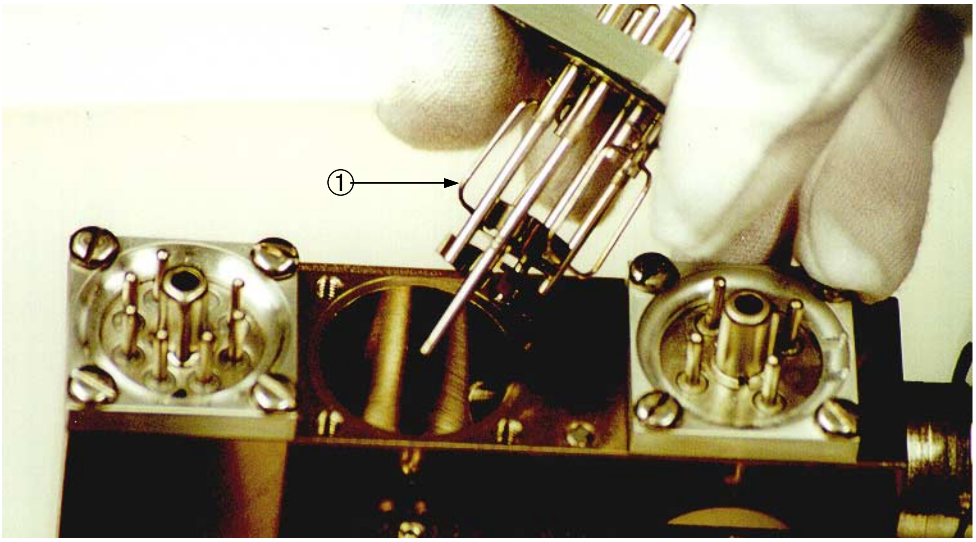


Figure 5-9 Removing the Ion Source

NOTE *Dark carbon-like deposits around the ion source filament and/ or a rainbow-like discoloration on the inside walls of the ion source cavity indicate that the spectrometer tube has been operated at too high a pressure. This can occur from a system pressure leak or transferring into test at too high a pressure.*

3. To remove the header from the ion source, push down on the center post.
4. Examine the ion source (Figure 5-10) and cavity (Figure 5-11) for deposits and discoloration. When examination is completed, dispose of it properly or return it to Vacuum Technologies for exchange.

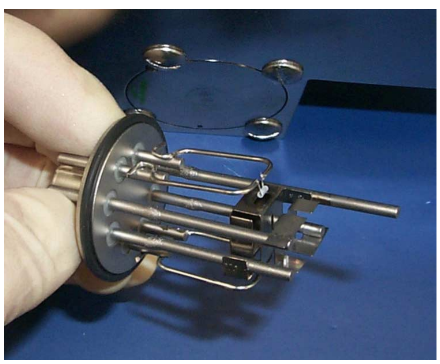


Figure 5-10 The Ion Source

The ion source cavity (Figure 5-11) contains the ground slit plate ①.

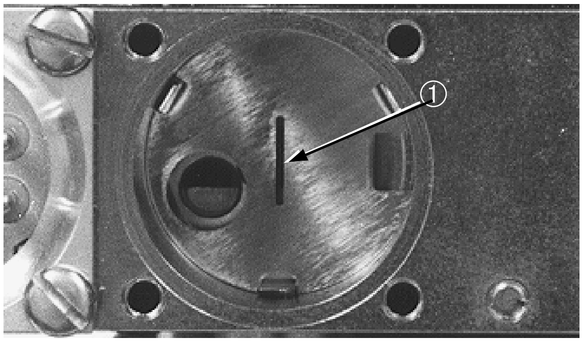


Figure 5-11 Ion Source Cavity

5. Remove the ground slit plate (Figure 5-12) by placing a thin, slotted screwdriver snug into the slot and carefully twisting and prying with the screwdriver.

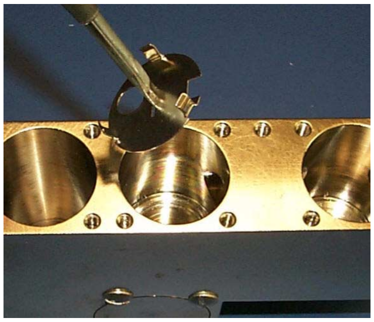


Figure 5-12 Ground Slit Plate

NOTE

A locking screwdriver designed to grab onto the slot of a screw works well for this procedure.

5.3.4 Removing the Preamplifier

CAUTION *The preamplifier is a static sensitive device. Wear a grounding device while the preamplifier is being handled.*

1. Remove the 4 slotted screws that hold the preamplifier header piece, repeating steps 1 and 2 in “Removing the Ion Source” .
2. Carefully remove the preamplifier ① from the spectrometer tube body (Figure 5-13) and place it carefully on a clean, safe, non-magnetic surface.

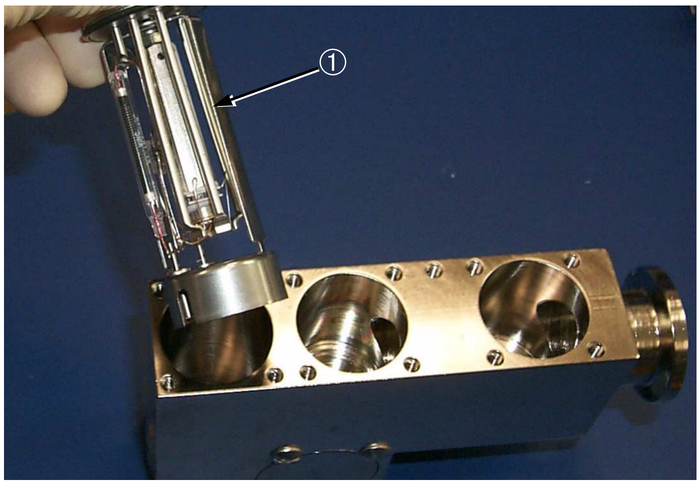


Figure 5-13 Removing the Preamplifier

5.3.5 Removing the Magnetic Poles

1. Remove the 4 slotted screws ① to free the magnet pole piece ② (Figure 5-14).

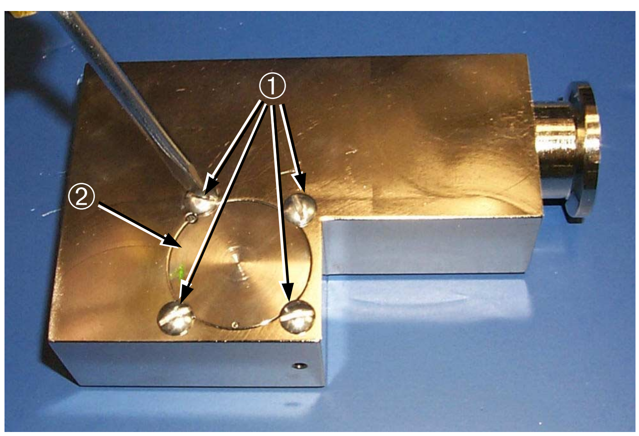


Figure 5-14 Magnetic Pole Piece

2. Pick up the spectrometer tube body and tilt the side over to remove the magnetic pole piece.

3. Remove the O-ring from the magnetic pole piece and place both the O-ring and the magnetic pole piece on a clean surface (Figure 5-15).

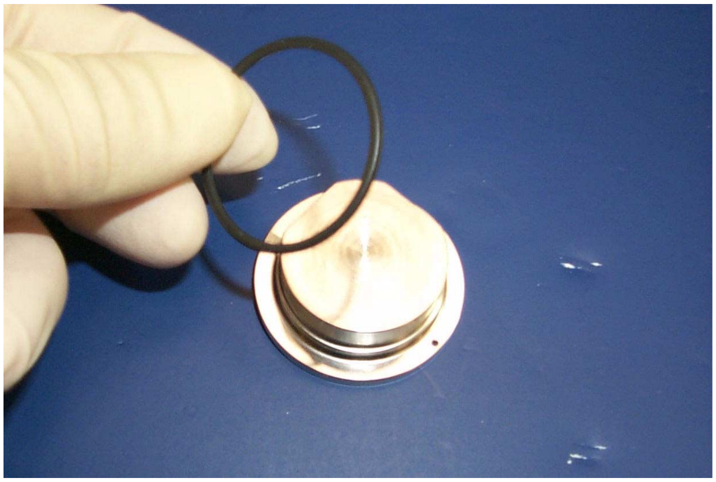


Figure 5-15 Removing the O-ring from Magnetic Pole Piece

4. Repeat steps 1 through 3 to remove the second magnetic pole piece (Figure 5-16) from the other side of the spectrometer tube body.

Figure 5-16 Removing the Second Magnetic Pole Piece

5. Remove the O-ring from the magnetic pole piece as in step 3.

5.3.6 Examining and Cleaning the Spectrometer Parts

1. Using the Scotch-Brite™ pad included with the spectrometer tube cleaning kit, polish away any discolored areas inside the spectrometer tube cavity.
2. Using the Scotch-Brite pad, polish away any discolored areas of the ground slit plate (Figure 5-17).

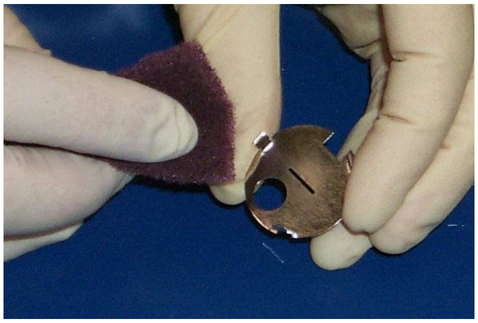


Figure 5-17 Discolored Ground Slit Plate

CAUTION *The ground slit plate is very thin. Take care not to bend or disfigure it during cleaning.*

3. Using the Scotch-Brite pad, polish away any discolored areas of the magnetic pole pieces (Figure 5-18).

Figure 5-18 Discolored Ground Magnet Pole Piece

4. Using the VacuSolv presaturated cleaning wipes and swabs (Figure 5-19), thoroughly wipe down all surfaces of the spectrometer tube body, magnetic pole pieces, and ground slit plate.

Figure 5-19 VacuSolv Cleaning Wipe

NOTE *If the button TC does not appear to be contaminated it may be reused after it is properly cleaned. To clean the button TC properly, soak it in liquid VacuSolv (or Acetone) followed by an isopropyl alcohol rinse. Dry the button TC thoroughly before re-assembling into spectrometer tube.*

NOTE *If you were seeing false system pressure readings prior to overhaul, it may be best to replace the Button TC whether or not you detect any physical signs of damage.*

5. Carefully wipe down and inspect all O-rings before reusing. Replace all damaged O-rings (Figure 5-20).

Figure 5-20 Inspecting the O-ring

NOTE *Vacuum Technologies recommends replacing all O-rings during routine maintenance or during any maintenance procedure requiring that the O-rings be removed.*

5.3.7 Reassembly

1. Carefully reassemble the spectrometer tube (Figure 5-21) in the reverse order of these instructions.

NOTE

Refer to Figure 5-21.

The preamplifier assembly has a slot ① that must be aligned with the alignment pin ② in the preamplifier cavity of the spectrometer tube body.

CAUTION

The ground slit plate has a hole in it that must be aligned with the hole on the bottom of the spectrometer tube body ion source cavity ③.

The ion source must be aligned so that its alignment pin ④ falls in the center of this hole.

A short could result at power up if the alignment pin touches the sides of the alignment hole.

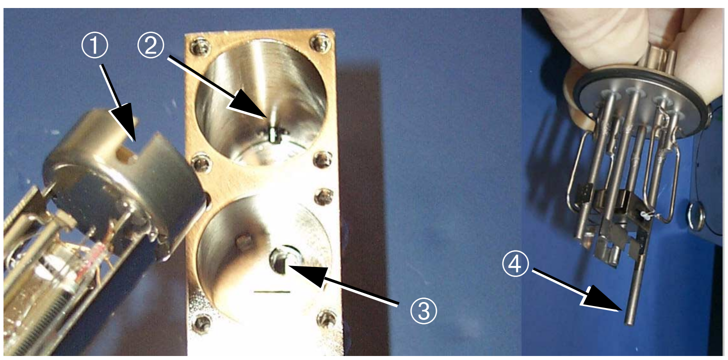


Figure 5-21 Spectrometer Tube Reassembly

5.4 Dual Air Intake Filter Replacement

The air intake filters should be checked at least every 12 months to ensure proper airflow through the control unit.

To replace the dual air intake filters:

1. Grasp the fan filter guard at the clips ① on the sides or top and bottom, and pinch together lightly.

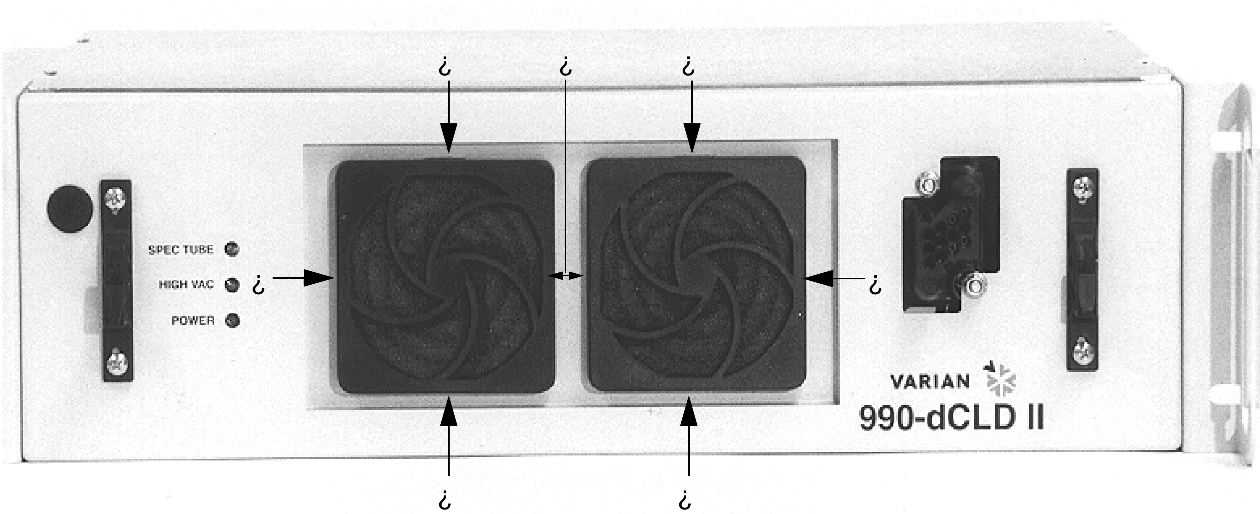


Figure 5-22 Control Unit Front Panel

2. Pull the fan filter guard off toward you.
3. Remove the filter element and discard it.
4. Place a new filter element into the housing.
5. Snap the fan filter guard back into place on the front of the control unit.
6. Repeat the procedure for the other filter.

5.5 Ion Source Replacement Outside of Spectrometer Tube Overhaul

The ion source has 2 filaments. The spare is automatically turned on when Filament 1 burns out, or by entering the *n* INIT-FILAMENT<CR> command (where *n* is the number of the filament you want to turn on) or, if the optional front control panel is installed, by manually touching the filament selector box located on the Manual Tuning screen (Section 4.7.2 “Manual Tuning” on page 4-19). Calibration may be necessary to obtain maximum sensitivity after changing filaments. It is recommended that the ion source be replaced as soon as convenient after the spare filament has been put into use. Replacement takes about 3 minutes.

Tools: Slotted screwdriver

Parts: Ion Source

1. Turn off the main power switch located on the back of the 990 dCLD II leak detector.
2. Loosen the holding screw to remove the spec tube block connector from the spectrometer assembly.
3. Remove the cal leak valve block connection and the turbo power connection from the spec tube block connector.
4. Vent the spectrometer tube by loosening the KF-25 (ISO NW-25) quick clamp and tipping the spectrometer tube away from the high vacuum system manifold.
5. Remove the 4 slotted screws that secure the ion source header (Figure 5-6 on page 5-9).
6. Remove the ion source header by pressing down on the center post and lifting the header up and off of the ion source.
7. Gently slide the ion source out of the spectrometer tube body (Figure 5-9 on page 5-11).

NOTE *Dark carbon-like deposits around the ion source filament and/ or a rainbow-like discoloration on the inside walls of the ion source cavity indicate that the spectrometer tube has been operated at too high a pressure. This can occur from a system pressure leak or transferring into test at too high a pressure.*

8. Remove the ground slit plate (Figure 5-12 on page 5-12) by placing a thin, straight screwdriver snug into the slot and carefully twisting and prying with the screwdriver.
9. Examine the ion source (Figure 5-10 on page 5-11) and cavity for deposits and discoloration. When examination is completed, discard the ion source or return it to Vacuum Technologies for exchange.
10. Inspect the ground slit plate (Figure 5-17 on page 5-15) and ion source cavity (Figure 5-11 on page 5-12) to verify that they are clean. If not, follow applicable instructions in Section 5.3.6 “Examining and Cleaning the Spectrometer Parts” on page 5-15 to clean the spectrometer body and ground slit plate.

5.5.1 Reassembly

1. Replace the ground slit plate (see Figure 5-21 on page 5-17).
2. Replace the ion source (see Figure 5-21 on page 5-17).

CAUTION

Refer to Figure 5-21 on page 5-17.

The ground slit plate has a hole in it that must be aligned with the hole on the bottom of the spectrometer tube body ion source cavity ③. The ion source must be aligned so that its alignment pin ④ falls in the center of this hole.

A short could result at power up if the alignment pin touches the sides of the alignment hole.

3. Carefully reassemble the spectrometer tube assembly in the reverse order of these instructions.

5.6 Manual Tuning

To manually tune the 990 dCLD II, the system must be attached to a vacuum system and be running with the setup parameters as described in Section 3.3 "Initial System Parameter Setup" on page 3-7. Note that the actual value of the calibrated leak is not important for the first part of this exercise, only that a maximum value is achieved.

NOTE

*Attempting to change calibration requirements when PARALLEL ENABLE is active will either result in the change being rejected and a response of **cant** being received through the serial port, or if the optional front control panel is installed, the menus not being accessible.*

5.6.1 Manual Tuning via the Serial Port

1. Operate the valves in the vacuum (external leak) system to rough pump, then expose (turn on) the calibrated leak to the foreline of the spectrometer assembly high vacuum pump.
2. Wait approximately 20 seconds for the leak to stabilize.
3. Set the Ion Voltage to its nominal value by entering the command, 250 PUT-ION<CR>, and the Variable Focus to its nominal value by entering the command, 190 PUT-FOCUS<CR>.
4. Change the value of the REPELLER parameter in 10 V steps starting at 320 V using the PUT-REPELLER<CR> command.
5. Check the leak rate at each step by using the ?LEAK<CR> command.

6. When the maximum leak rate is found, enter the same value for the REPELLER but use the INIT-REPELLER<CR> command instead of the PUT-REPELLER <CR> command. See the example in Table 5-4.

Table 5-4 Example: Setting REPELLER Parameter Value using J12 Diagnostic Port

Observed Leak Rate	Type
1.0E-6	?LEAK<CR> 320 PUT-REPELLER<CR>
1.2E-6	?LEAK<CR> 330 PUT-REPELLER<CR>
1.3E-6	?LEAK<CR> 340 PUT-REPELLER<CR>
9.6E-7	?LEAK<CR> 330 PUT-REPELLER<CR>
1.3E-6	?LEAK<CR> 330 INIT-REPELLER<CR>
1.3E-6	?LEAK<CR> (Done)

7. Repeat the procedure in steps 3, 4, and 5 changing EMISSION current in 100 μA steps using the PUT-EMISSION<CR> command starting at 300 μA to find the peak. Refer to the example in Table 5-5.

Table 5-5 Example: Setting EMISSION Parameter Value using J12 Diagnostic Port

Observed Leak Rate	Type
1.0E-6	?LEAK<CR> 300 PUT-EMISSION<CR>
1.2E-6	?LEAK<CR> 400 PUT-EMISSION<CR>
1.3E-6	?LEAK<CR> 500 PUT-EMISSION<CR>
9.67E-7	?LEAK<CR> 400 PUT-EMISSION<CR>
1.3E-6	?LEAK<CR> 400 INIT-EMISSION<CR>
1.3E-6	?LEAK<CR> (Done)

8. Turn the leak off to isolate the calibrated leak in the system.
9. Wait for the system leak rate to decrease to a stable value. Type ZERO<CR> and check that the SPEC TUBE LED on the front of the control unit flashes while zeroing is in process. The zeroing process runs for only a few seconds (less than five).
10. When zeroing is complete, turn the leak on to expose the calibrated leak to the foreline of the turbo pump again. Wait for the system to stabilize.
11. Type CALIBRATE<CR> and check that the SPEC TUBE LED flashes on the front of the control unit while calibration is in process.
12. When calibration is complete, verify that the leak rate matches the value listed on the tag of the calibrated leak in the vacuum system using the ?LEAK<CR> command.
13. Isolate the calibrated leak and, using ?LEAK<CR>, observe that the leak rate decreases to near zero.
14. If the time for the leak rate decay is more than a few seconds, there could be a vacuum leak or the vacuum system might not be fully stabilized. It might be necessary to invoke the ZERO function (step 9) again to re-zero the 990 dCLD II.

5.6.2 Manual Tuning via the Optional Front Control Panel

1. Operate the valves in the vacuum system to rough pump, then expose the calibrated leak to the foreline of the spectrometer assembly high vacuum pump.
2. Wait approximately 20 seconds for the leak to stabilize.
3. Move to the Manual Tuning Screen (Section 4.7.2 "Manual Tuning" on page 4-19).
4. Change the ION V parameter value up or down to find the peak signal and press **OK**.
5. Change the VAR FOCUS parameter value up or down to find the peak signal and press **OK**.
6. Change the REPELLER parameter value up or down to find the peak signal and press **OK**.

5.7 Spare Parts List

Table 5-6 lists some parts available for the 990 dCLD II. To order, contact Vacuum Technologies Customer Service at 1-800-882-7426 or order online at www.evarian.com.

Table 5-6 Spare Parts List

Assembly	Part Number
5 Range Calibrated Leak	659500008
6 Range Calibrated Leak	659500009
7 Range Calibrated Leak	R1676301
8 Channel Valve Driver PCB	L7230301
Button TC	R1266301
Fan	661300030
Front Panel Fan Filter	Comair Rotron #554140
Front Panel Fan Filter Guard	642970942
Fuse	5.0 A 645300044
Fuse Drawer	642971010
Ion Source	82850302
Main Power Supply	659077039
PCB – 979 I/O	R1431301
PCB – CPU	R2361302
PCB – Digital Interface	L9536301
PCB – Gauges	R0395301
PCB – Ion Source Controller	R2400301
PCB – Power Indicator	L9605301
PCB – Power Supply	L9255301
PCB – Preamplifier Driver	L9524301
Power Entry Module	642971009
Preamplifier	L9030301 (Std Sensitivity)
Rack Mount Kit	R1674301
Spectrometer Tube Assembly Exchange Program	EXL9713301
Spectrometer Tube Cleaning Kit	670029096
Spectrometer Tube Magnet Assembly	K3023301

Table 5-6 Spare Parts List (Continued)

Assembly	Part Number
Front Control Panel Cable, 5 ft.	R0634305
Front Control Panel Cable, 10 ft.	R0634310
Touch Screen Assembly	R1437301
Turbo Controller PCB and Transformer	9699840LL
Turbo / Spectube Cable Assembly, 5 ft.	R0623305
Turbo / Spectube Cable Assembly, 10 ft.	R0623310
V70 Turbo Pump Exchange Program	Call Vacuum Technologies
V70D Turbo Pump Exchange Program	Call Vacuum Technologies
V70LP Turbo Pump Exchange Program	Call Vacuum Technologies
Wiring Harness Turbo Spectube	R1127301

Section 6. Troubleshooting

This section provides general guidelines to help diagnose and correct common problems that may be encountered on 990 dCLD II systems. For additional assistance on specific 990 dCLD II product issues, please contact Vacuum Technologies.

6.1 General

Start by recording all symptoms encountered, including any quantitative data.

NOTE *Be sure to keep a calibration and maintenance log, and keep it current.*

Verify the following before checking for the other symptoms listed in this section.

- ❑ The power cord is connected.
- ❑ All cables between the 990 dCLD II control unit, the cal leak valve block, the turbo pump, and the spectrometer tube are properly installed.
- ❑ All connections between the 990 dCLD II control unit and the testing station are properly installed.
- ❑ The POWER LED is on, or if the optional front control panel is installed, the LED above the HOLD/VENT button is lit.
- ❑ All controls for calibration and set points are set to the proper values.
- ❑ Consult your maintenance log and setup processes for this information.
  For procedures to check these values, see Table 2-11 on page 2-15, and then Section 4 “Setup and Monitor Operations via the Optional Front Control Panel” on page 4-1 or Appendix A “Communications Protocol” and Appendix B “Customer Accessible Inputs and Outputs” as necessary.
- ❑ If applicable, that the oil level and color in all oil-sealed mechanical pumps has been checked or that the oil was recently changed and, that maintenance to customer-supplied mechanical pumps has been performed.

6.2 Symptoms Discussed in this Section

This section describes troubleshooting procedures for events that can occur during startup and calibration, and events that can occur during normal operation. The first three events described can take place during startup and calibration:

- ❑ POWER LED (Section 6.2.1 "POWER LED does not Light") does not come on.
- ❑ HIGH VAC LED (Section 6.2.2 "HIGH VAC LED does not Light") does not come on.
- ❑ SPEC TUBE LED does not turn on (Section 6.2.3 "SPEC TUBE LED does not Light or Stay Lit" on page 6-4).
- ❑ No helium response (Section 6.2.4 "No Helium Response" on page 6-5).

The following events can take place during normal operation:

- ❑ Station fails to pump down displaying gross vacuum failures.
- ❑ High number of rejects suspected of being false alarms.

6.2.1 POWER LED does not Light

To check the POWER LED:

1. Verify that the power cord is connected.
2. Verify that power is available at the receptacle into which the 990 dCLD II is plugged.
3. Verify that the proper voltage is selected on the rear panel of the 990 dCLD II.
4. Open the fuse drawer and verify that the fuses are functioning properly and have the correct rating for the power source.
5. Make sure the power switch is in the ON position.

If the POWER LED still won't light, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.2 HIGH VAC LED does not Light

To check the HIGH VAC LED:

1. Verify that the backing pump is powered, running, and producing a forepressure less than 1 Torr.

NOTE

The 990 dCLD II will not start any turbo pump until the forepressure is less than 1 Torr.

If the forepressure is less than 1 Torr and the turbo pump has not started:

a. Determine and correct the cause of high forepressure.

b. Turn the control unit off for a period of at least 10 seconds.

c. Turn the control unit back on.

If the turbo still does not start:

2. Check for a disconnected or damaged turbo pump cable.
3. Check for a disconnected or damaged main spec tube block connector cable.
4. Was a new pump installed? Allow up to 45 minutes for a newly-installed pump to reach full speed (the HIGH VAC LED is lit).
5. If the LED fails to light, replace the 990 dCLD II control unit to determine if it is at fault.
6. Replace the pump if a new control unit doesn't solve the problem.

If HIGH VAC LED still won't light, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.3 SPEC TUBE LED does not Light or Stay Lit

6.2.3.1 Check the Control Unit SPEC TUBE LED Using Diagnostic Port Interface J12

To check the SPEC TUBE LED:

1. Verify that the HIGH VAC LED on the front panel of the control unit is lit steadily. Verify that the system thermocouple (TC) pressure is less than 10 mTorr by issuing the ?PRESSURES<CR> command.
2. Switch to the other Ion source filament by entering the 2 INIT-FILAMENT<CR> or 1 INIT-FILAMENT<CR> command.
   - ❑ If both filaments are burnt out, replace the ion source, see Section 5.5 "Ion Source Replacement Outside of Spectrometer Tube Overhaul" on page 5-19.
   - ❑ If the SPEC TUBE LED is still not lit, replace the entire spectrometer tube.
3. Perform a full normal calibration. See Table 2-11 on page 2-15 or Table A-4 on page A-8.

If the SPEC TUBE LED still won't light or stay lit, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.3.2 Check the Control Unit SPEC TUBE LED Using Optional Front Control Panel Interface

To check the SPEC TUBE LED:

1. Verify that the system thermocouple pressure is less than 10 mTorr by viewing the system pressure parameter in the GAUGE CAL screen (see Section 4.7.3 "Gauge Calibration" on page 4-20).
2. Switch to the other Ion source filament using the MANUAL TUNING screen, Section 4.7.2 "Manual Tuning" on page 4-19.
   - ❑ If both filaments are burnt out, replace the ion source, see Section 5.5 "Ion Source Replacement Outside of Spectrometer Tube Overhaul" on page 5-19.
   - ❑ If the SPEC TUBE LED is still not lit, replace the entire spectrometer tube.
3. Check that the parameters in the CALIBRATED LEAK SET-UP screen, Section 4.6.1 "Calibrated Leak Set-Up" on page 4-13, are set to USE INT LEAK and USE NORM CAL and then perform a full calibration by pressing the CALIBRATE button.

If the SPEC TUBE LED won't light or stay lit, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.4 No Helium Response

6.2.4.1 Check the Helium Response Using Diagnostic Port Interface J12

To check the helium response:

1. Use ?SETUP<CR> to verify auto ranging is active. If necessary, issue the AUTO command.
2. Check that the leak to be read is installed in the system with the valve open.
3. Is the calibrated leak broken? Has it been dropped? If it rattles when shaken, it is broken and must be replaced.
4. Is the SPEC TUBE LED on? See Section 6.2.3 “SPEC TUBE LED does not Light or Stay Lit” on page 6-4.
5. Is the HIGH VAC LED on? See Section 6.2.2 “HIGH VAC LED does not Light” on page 6-3.
6. Are the valves in the system operating correctly? Check that the valves are properly oriented and actuating when commanded.
7. With the leak valved off, issue the ZERO command to ZERO the 990 dCLD II.
8. Enter 250 PUT-ION<CR>, 380 PUT-REPELLER, 200 PUT-FOCUS, 400 PUT EMISSION, then ?ALL<CR>. The typical voltage readings should be as follows:

Parameter	Voltage	Parameter	Voltage
FILAMENTBIAS	099.0	FIXEDFOCUS	190.0
IONCHAMBER	242.9	SUPPRESSOR	147.0
VARIABLEFOCUS	202.4	EMISSIONCURRENT	1.110
REPELLER	388.1	OFFSET	64
GAIN	1.0		

9. If all voltages are more than 20 percent lower than the values above, or if any two voltages are equal, disconnect the spec tube block connector and check the ion source for shorts using an ohm meter. If the Ion Source is not shorted:
   a. Replace the 990 dCLD II control unit to determine if the control unit is defective.
   b. Finally, replace the turbo spec tube cable to determine if it failed.
10. If the OFFSET number is 10 or 100, the preamplifier in the spectrometer tube could be defective. See Section 5.3.1 “Removing the Spectrometer Tube Assembly” on page 5-6, and then Section 5.3.4 “Removing the Preamplifier” on page 5-13.

11. If EMISSIONCURRENT is zero, the selected filament in the Ion Source is broken or the Ion Source is defective. Issue the INIT-FILAMENT<CR> command to change to the other filament, or replace the Ion source (Section 5.5 “Ion Source Replacement Outside of Spectrometer Tube Overhaul” on page 5-19).
12. Has the spectrometer tube been serviced lately? If so, refer to Section 5.3 “Spectrometer Tube Overhaul” to verify that:
    - ❑ The ground slit plate has been properly positioned (Figure 5-21 on page 5-17).
    - ❑ The ion source is correctly aligned (Figure 5-21 on page 5-17).
    - ❑ That the magnet pole piece inserts are fully inserted and secured in place with set screws).

If there is still no helium response, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.4.2 Check the Helium Response Using the Optional Front Control Panel Interface

To check the helium response:

1. Use the LEAK RATE RANGE SET-UP screen, Section 4.6.4 “Range Stop and Manual Range Set Up and Control” on page 4-15, to ensure that MANUAL RANGE is not ON. If necessary, turn it OFF.
2. Check that the leak to be read is installed in the system with the valve open.
3. Is the calibrated leak broken? Has the calibrated leak been dropped? If it rattles when shaken, it is broken and must be replaced.
4. Is the spec tube pressure shown on the Spec-Tube Pressure display minimum and stable? (See Figure 4-1 on page 4-1.) Does the Home Screen display SYSTEM READY? (See Section 4.4 “Touch Panel Home Screen” on page 4-7.)
5. Is the leak rate shown on the bar graph display stable? (See Figure 4-1 on page 4-1).
6. Are the valves in the system operating correctly? Check that the valves are properly oriented and actuating when commanded.
7. With the leak valved off, press the **ZERO** button to ZERO the 990 dCLD II.
8. Move to the MANUAL TUNING screen, Section 5.6 “Manual Tuning” on page 5-20, and change the ION V value to 250, REPELLER V to 380, VAR FOCUS to 200, EMISSION I to 400 and touch **OK**.

The typical values for these parameters' voltage readings should change as follows:

Parameter	Voltage	Parameter	Voltage
ION	242.9	GAIN	1.0
VAR FOCUS	202.4	EMISSION I	1.110
REPELLER	388.1		

9. If all values are more than 20 percent lower than the values above, or if any two values are equal, disconnect the spec tube block connector and check the ion source for shorts using an ohm meter. If the Ion Source is not shorted:
   a. Replace the 990 dCLD II control unit to determine if the control unit is defective.
   b. Finally, replace the turbo spec tube cable to determine if it has failed.
10. If EMISSION I is zero, the selected filament in the Ion Source is broken or the Ion Source is defective. Change to the other filament using the MANUAL TUNING screen, refer to Section 4.7.2 “Manual Tuning” on page 4-19, or replace the ion source, see Section 5.5 “Ion Source Replacement Outside of Spectrometer Tube Overhaul” on page 5-19.
11. Has the spectrometer tube been serviced lately? If so, refer to Section 5.3, “Spectrometer Tube Overhaul” to verify that:
    a. The ground slit plate has been properly positioned (Figure 5-21 on page 5-17).
    b. The ion source is correctly aligned (Figure 5-21 on page 5-17).
    c. That the magnet pole piece inserts are fully inserted and secured in place with set screws.

If there is still no helium response, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.5 Station Fails to Pump Down

Check the following items:

- ❑ Is the fixture completely closed?
- ❑ Is the O-ring on the fixture damaged?
- ❑ Is the fixture vacuum gauge working?
- ❑ Is the fixture manifold plugged with a product or component?
- ❑ Are any filters in the vacuum system plugged?
- ❑ Does it only pump partially down? This probably indicates a large leak in the system.
- ❑ Does the roughing pump continually gurgle? This may be difficult to detect with the pump's oil mist filter in place. Continued gurgling indicates a very large leak in the system, such as a partially-open fixture or a disconnected or broken valve.

If all of the above check out ok, remove the test fixture and check your vacuum system.

If station will fails to pump down, call Vacuum Technologies Customer Service at 1-800-8VARIAN (1-800-882-7426).

6.2.6 A High Number of Rejects, Suspected of being False Rejects

This type of problem is the most typical found in any helium leak detection system. While high levels of rejects can be traced to problems in the test equipment, they are also often real leaks in the product. Before tearing down the test station, take steps to ensure that the problem is not a production problem. The first step in this process is to use a *challenge leak*. This is a standard leak shaped like the production part that can be inserted into the production line to function like a *bad* part. If the station reads the leak within its stated tolerances and within the actual production cycle, then the problem is not in the station but probably is in the parts. If the standard leak is substantially out of tolerance, then the problem is most likely in the station.

Control of helium is one of the most vexing problems in any production environment where parts are filled with helium then tested in the same room (or building). In normal earth atmosphere, only 5 parts per million (PPM) of air is helium. This is one of the reasons helium is used as a leak-test trace gas. For example, in a room containing a closed helium cylinder, the helium background can rise to 10 to 50 PPM as a result of a leak from the closed cylinder. In production environments where parts are being filled with helium by various means and the testing areas are closed due to heating or cooling requirements, background readings as high as 2000 PPM are possible.

For a reference point, if your test process is performed at 100 mTorr, with 500 PPM helium in the air, the indicated leak rate would probably appear as a 3×10^{-5} atm cc/sec signal.

If your reject set point is at 3E-5, this high background would lead to false rejection of parts if the process was not designed to tolerate the background. If you are experiencing false helium rejections, look to the helium background as a possible cause. While there are methods for tolerating such high levels of helium (such as prolonged pump-down cycles), it is probably more economical to ventilate the area to reduce the background.

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Appendix A. Communications Protocol

This appendix defines the technical specifications for the RS-232 protocol to be used with the 990 dCLD II Component Leak Detection System.

A.1 Protocol (RS-232)

The RS-232 ports operate at 9600 baud, 8 bits, no parity, and one stop bit.

All characters transmitted to the leak detector are echoed by the leak detector. Commands, inquiries, and strings of commands and inquiries must be terminated by a carriage return <CR>; the carriage return is echoed as a space character.

The maximum length of the input is 80 characters; if no carriage return has been received before the 80th character, execution of the command string begins anyway. Do not explore this feature.

Words that begin with the **?** character are inquiries for the controlling device to determine the current state or value of a leak detector parameter. Words that begin with **PUT** are commands for the controlling device to set the current state or value of a volatile leak detector parameter. Words that begin with **INIT-** are commands for the controlling device to set non-volatile leak detector parameters. Other commands do not require a parameter, do not begin with any special character(s), and simply do what they say they do.

Successful inquiries respond with data as specified in the following tables followed by a space, then: **ok**<CR><LF>. Unsuccessful inquiries respond with the offending inquiry followed by a space, then: **#?**<CR><LF> (line feed, <LF>). Certain commands are restricted from use while PARALLEL ENABLE is active; these commands respond **cant**<CR><LF>.

Inquiries, parameters, and commands can be concatenated. Each word or numeric parameter is followed by one or more spaces. The string is terminated by a <CR>, which causes execution to begin. Successful strings respond with the specified data for the input inquiries in the order the inquiries were issued, followed by: **ok**<CR><LF>. Unsuccessful strings respond with the *first* offending command followed by a space then: **#?**<CR><LF>. All commands and inquiries following the failed word are ignored; all parameters are discarded.

Table A-1 through Table A-4 outline the available control and query commands.

- Table A-1 lists inquiries that are used to determine internal operating parameters. All inquiries, except VER, begin with **?** and end with <CR>.
- Table A-2 lists commands used to set NON-VOLATILE operating parameters.
- Table A-3 lists commands that are used to cause an immediate change in the spectrometer operating parameters. These commands do not change the non-volatile operating parameters.
- Table A-4 lists commands that are used to cause certain leak detection actions.

The inquiries listed in Table A-1 are used to determine internal operating parameters. All inquiries, except ver, begin with **?** and end with <CR>.

Table A-1 Internal Operating Parameters

Inquiry	Response
?ALL	Nine lines that report a summary of all ion source parameters. Each begins with a <CR><LF>. The format is as follows: FILAMENTBIAS 122.1 IONCHAMBER 269.1 VARIABLEFOCUS 235.4 REPELLER 402.2 FIXEDFOCUS 212.7 SUPPRESSOR 145.0 EMISSIONCURRENT 1.040 OFFSET 59 GAIN 1.5
?AZ<0	The response is **yes** or **no** indicating that AUTO-ZERO<0 is enabled or disabled.
?CALOK	Reports status of the last calibration. The response is **yes** or **no**.
?EMISSIONCURRENT	Reports the emission current. The format is: EMISSIONCURRENT 1.040
?EXPONENT	A three-character (minus followed by two digits) number indicating the current manual-mode exponent. The exponent is within the least sensitive range (as reported by ?RANGE<CR>) and the three lower (more negative exponent) ranges. Also see INIT-EXPONENT.

Table A-1 Internal Operating Parameters (Continued)

Inquiry	Response
?EXTLEAK	A seven-character number consisting of a two-digit calibration standard leak rate mantissa with a decimal point after the first digit followed by **E–** then a two-digit calibration standard leak rate range exponent (e.g., 1.3E-07). This inquiry is used for reporting the external calibration standard leak rate most recently input using INIT-EXTLEAK.
?FILAMENTBIAS	Reports the filament bias voltage. The format is: FILAMENTBIAS 122.1
?FIXEDFOCUS	Reports the fixed focus voltage. The format is: FIXEDFOCUS 212.7
?GAIN	A three-character number consisting of a two-digit gain factor with a decimal point after the first digit. This inquiry reports the value of the system gain.
?IONCHAMBER	Reports the ion chamber voltage. The format is: IONCHAMBER 269.1
?LEAK	A seven-character number consisting of a three-digit leak rate mantissa with decimal point after the first digit followed by **E-**, followed by a two-digit leak rate range exponent (e.g., 1.35E-04).
?*n*REJECT	A six-character number consisting of a two-digit reject leak rate mantissa with a decimal point after the first digit followed by **E-**, followed by a two-digit leak rate range exponent (e.g., 7.0E-05). This inquiry reports the value of the requested set point, where *n* is the reject set point 1 through 4.
?OFFSET	A number representing the position of the variable offset as a percent of full scale. 50 represents mid-scale.
?PRESSURES	The response begins with a <CR><LF>. The first line consists of the words: **test port TC** followed by a number of mTorr between 0 and 760000. The second line consists of the words: **system TC** followed by a number of mTorr between 0 and 760000.
?QUICK-CAL	A response of 0 indicates NORMAL Calibration by the 990 dCLD II. A response of 1 indicates FAST Calibration by the 990 dCLD II.
?RANGE	A three-character (minus followed by two digit) number indicating the exponent of the least sensitive range of detectable leak. The reported leak rates are in this range and three lower (more negative exponent) ranges. Also see INIT-RANGE.
?REJECT	A six-character number consisting of a two-digit reject leak rate mantissa with a decimal point after the first digit followed by **E-**, followed by a two-digit leak rate range exponent (e.g., 7.0E-05). This inquiry used for reporting the reject leak rate most recently input using INIT-REJECT.
?REPELLER	Reports the repeller voltage. The format is: REPELLER 402.2

Table A-1 Internal Operating Parameters (Continued)

Inquiry	Response
?SETUP	Eight lines that report a summary of setup parameters. Each begins with a <CR><LF>. The format is as follows: turbo speed Slow range -05 auto exponent -08 reject 1.0E-05 stdleak 4.0E-06 output linear filament Two Lit use idle no
?STATUS	One line which reports, in an ASCII string, the status of the system as reported by the discrete I/O lines. If the function is inactive, the format is: **REJ/ RDY/ HLD/ FLT/ ZRO/ CAL/** where a three-letter mnemonic is followed by a /. For example, if a **RDY/** is reported in the string, then the system is not ready. If a RDY is reported in the string, then the system is ready. **REJ** refers to the reject set point **RDY** refers to system ready **HLD** refers to the system being in the hold mode (used primarily in other leak detectors) **FLT** refers to ion source filament fault **ZRO** refers to the zeroing function **CAL** refers to the calibration function.
?STDLEAK	A seven-character number consisting of a two-digit calibration standard leak rate mantissa with a decimal point after the first digit followed by E– then a two-digit calibration standard leak rate range exponent (e.g., 1.3E-07). This inquiry is used for reporting the internal calibration standard leak rate most recently input using INIT-STDLEAK.
?SUPPRESSOR	Reports the suppressor voltage. The format is: SUPPRESSOR 145.0
?TURBO	Three lines that report the turbo status. Each line begins with a <CR><LF>. The first line consists of the word turbo followed by **Ready** or **Not Ready**. The second line consists of the word turbo followed by **Fault** or **No Fault**. The third line consists of the word turbo speed followed by **Off**, **Fast**, or **Slow**.
?VARIABLEFOCUS	Reports the variable focus voltage. The format is: VARIABLEFOCUS 235.4
VER	One line, which reports a date in the form **30 AUG 1995** followed by a six digit hexadecimal checksum.

The commands listed in Table A-2 are used to set NON-VOLATILE operating parameters. The current value of the operating parameter is changed to the new value. If PARALLEL ENABLE is active, the response is **cant**<CR><LF>.

Table A-2 Non-Volatile Operating Parameters

Command	Parameter
DISABLE-AREJECT	Sets the control unit to ignore the INIT-AREJECT command.
DISABLE-IDLE	Sets the control unit to ignore the RUN and IDLE commands.
DISABLE-*n*REJECT	Sets the control unit to ignore the INIT-*n*REJECT command, where *n* is the reject set point 1 through 4.
ENABLE-AREJECT	Sets the control unit to use the INIT-AREJECT command.
ENABLE-IDLE	Sets the control unit to use the RUN and IDLE commands.
ENABLE-*n*REJECT	Sets the control unit to use the INIT-*n*REJECT command, where *n* is the reject set point 1 through 4.
INIT-1LOG	None. The leak rate analog output voltage becomes logarithmic at 1 V per decade. See Section 4.6.5 “Output Control Setup”, or Section 3.7 “Analog Leak Rate Output Voltage”, or Table 2-11 on page 2-15.
INIT-2LOG	None. The leak rate analog output voltage becomes logarithmic at 2 V per decade. See Section 4.6.5 “Output Control Setup”, or Section 3.7 “Analog Leak Rate Output Voltage”, or Table 2-11 on page 2-15.
INIT-3LOG	None. The leak rate analog output voltage becomes logarithmic at 3 V per decade. See Section 4.6.5 “Output Control Setup”, or Section 3.7 “Analog Leak Rate Output Voltage”, or Table 2-11 on page 2-15.
INIT-AREJECT	A two-digit leak rate mantissa with a decimal point after the first digit followed by **E–**, followed by a two-digit leak rate range exponent: the helium leak rate number in atm cc/sec. Values outside the working range of the leak detector are not stored. Use to set the value of the audio reject set point.
INIT-AZ<0	Preceded by a 1 or a 0 followed by a space, to set the AUTO-ZERO<0 function Active or Inactive respectively.
INIT-DAC	A number in the range 0 to 255 followed by a space, to set a positive offset voltage in millivolts to electrically null the analog output voltage.
INIT-EMISSION	Preceded by a four-digit number of microamps followed by a space, in the range 0300 to 2000, which sets the emission current of the ion source.
INIT-EXPONENT	A three-character (minus followed by two digits) number indicating the exponent of the least sensitive range of detectable leak. Acceptable values are within the least sensitive range (as reported by ?RANGE<CR><LF>) and the three lower (more negative exponent) ranges. Unacceptable values not stored. It is best to use INIT-RANGE before using INIT-EXPONENT.
INIT-EXTLEAK	A two-digit leak rate mantissa with a decimal point after the first digit followed by **E–**, followed by a two-digit leak rate range exponent: the helium leak rate number in atm cc/sec of the external calibration standard leak. Values outside the working range of the leak detector are not stored.

Table A-2 Non-Volatile Operating Parameters (Continued)

Command	Parameter
INIT-FILAMENT	Precede the command by a single digit, either 1 or 2, then a space, to set the operating filament in the ion source. (e.g., 1 INIT-FILAMENT) Precede the command by 0 to turn OFF the currently operating filament.
INIT-FOCUS	Preceded by a three-digit number of volts followed by a space, in the range 100 to 250, which sets the variable focus voltage of the ion source.
INIT-ION	Preceded by a three-digit number of volts followed by a space, in the range 150 to 350, which sets the ion voltage of the ion source.
INIT-LINEAR	None. The leak rate analog output voltage becomes linear. See Section 4.6.5 “Output Control Setup”, or Section 3.7 “Analog Leak Rate Output Voltage”, or Table 2-11 on page 2-15.
INIT-*n*REJECT	A two-digit leak rate mantissa with a decimal point after the first digit followed by **E–**, followed by a two-digit leak rate range exponent: the helium leak rate number in atm cc/sec. Values outside the working range of the leak detector are not stored. Use to set the value of reject set point, where *n* is the set point 1 through 4.
INIT-QUICK-CAL	Preceded by a 1 or a 0 followed by a space, to set the calibration mode to FAST or NORMAL, respectively.
INIT-RANGE	A three-character (minus followed by two digits) number indicating the exponent of the least sensitive range of detectable leak. Acceptable values are -00 through -09. Unacceptable values are not stored.
INIT-RANGESTOP	A three-character (minus followed by two digits) number indicating the exponent the 990 dCLD II will auto-range down to. Acceptable values are between the TOP range and exponent range values.
INIT-REPELLER	Preceded by a three-digit number of volts followed by a space, in the range 200 to 450, which sets the repeller voltage of the ion source.
INIT-SPEED	Precede the command by a single digit, either 0 (for **Slow**) or 1 (for **Fast**), then a space, to set the operating speed of the high vacuum pump. (e.g., 0 INIT-SPEED<CR> commands the high vacuum pump to run at slow speed.)
INIT-STDLEAK	A two-digit leak rate mantissa with a decimal point after the first digit followed by **E–**, followed by a two-digit leak rate range exponent: the helium leak rate number in atm cc/sec of the internal calibration standard leak. Values outside the working range of the leak detector are not stored.

The commands listed in Table A-3 are used to cause an immediate change in the spectrometer operating parameters. These commands *do not* change the non-volatile operating parameters.

Table A-3 Spectrometer Operating Parameters

Command	Parameter
PUT-EMISSION	Preceded by a four-digit number of microamps followed by a space, in the range 0300 to 2000, which sets the emission current of the ion source.
PUT-FOCUS	Preceded by a three-digit number of volts followed by a space, in the range 100 to 250, which sets the variable focus voltage of the ion source.
PUT-GAIN	Preceded by a two-digit number followed by a space, with a decimal point after the first digit, in the range 1.0 to 9.0, used for adjusting the helium signal to match a calibration standard leak.
PUT-ION	Preceded by a three-digit number of volts followed by a space, in the range 150 to 350, which sets the ion voltage of the ion source.
PUT-OFFSET	Preceded by a two-digit number followed by a space, in the range 00 to 99, which sets the preamplifier offset index, used for nulling the preamplifier in the spectrometer tube.
PUT-REPELLER	Preceded by a three-digit number of volts followed by a space, in the range 200 to 450, which sets the repeller voltage of the ion source.

The commands listed in Table A-4 are used to cause certain leak detection actions.

Table A-4 Leak Detection Actions

Command	Action
AUTO	Initiates Auto-Ranging mode. Success is indicated by the **ok**<CR><LF> response. With PARALLEL ENABLE, the response is **cant**. AUTO is the factory default setting.
CALIBRATE	Performs an automatic calibration as specified by the parameters previously set. Success is indicated by a **yes**<CR><LF> response to ?CALOK<CR>. With PARALLEL ENABLE, the response is **cant**.
DECREMENT	Subtract 1 from the displayed leak rate exponent (making it more negative). Success is indicated by the **ok**<CR><LF> response. Has no effect in auto-ranging mode. Has no effect upon reaching the most sensitive range. With PARALLEL ENABLE, the response is **cant**.
EXTERNAL	Causes the control unit to use the external calibrated leak
FPEAK	Adjusts the variable focus ion source voltage to cause a maximum response to helium. With PARALLEL ENABLE, the response is **cant**.
IDLE	Causes the control unit to power off the turbo pump and spectrometer tube and retain operating parameters. ENABLE-IDLE must be set first.
INCREMENT	Add 1 to the displayed leak rate exponent (making it less negative). Success is indicated by the **ok**<CR><LF> response. Has no effect if in auto-ranging mode. Has no effect upon reaching the least sensitive range. With PARALLEL ENABLE, the response is **cant**.
INTERNAL	Causes the control unit to use the internal calibrated leak.
MANUAL	Terminates the Auto-Ranging mode. Success is indicated by the **ok**<CR><LF> response. With PARALLEL ENABLE, the response is **cant**.
RUN	Causes the control unit to start up the turbo pump and spectrometer tube from IDLE mode. ENABLE-IDLE must be set first.
SYTCATM	Sets the current system thermocouple reading to represent atmospheric pressure. Success is indicated by the **ok**<CR><LF> response. If the response is **failed**<CR><LF>, replace the gauge.
SYTCZERO	Sets the current system thermocouple reading to represent a pressure that is too low for a thermocouple to read. Success is indicated by the **ok**<CR><LF> response. If the response is **failed**<CR><LF>, replace the gauge.
TUNE	Adjust ion source voltage to cause a maximum response to helium. With PARALLEL ENABLE, the response is **cant**.
ZERO	Set the current leak rate measurement to be 0.0 atm cc/sec. Success is indicated by the **ok**<CR><LF> response. With PARALLEL ENABLE, the response is **cant**.

Appendix B. Customer Accessible Inputs and Outputs

B.1 Customer Accessible Inputs

Table B-1 is a listing of inputs by which the customer's controller, usually a PLC, can cause action in the 990 dCLD II. All inputs are opto-isolator LEDs with series resistors. The LED cathodes are all commoned and are connected to J3 pins 1 and 25 labeled +VRET. The customer must connect the (-) of a power supply to these pins as the 990 dCLD II does not provide power to the customer side of the opto-isolators. Apply 5 to 24 VDC in all cases unless otherwise noted in the first line of the behavior discussion.

Table B-1 Customer Accessible Inputs

Conn/Pin	Input Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/1	Input Common	N/A	Return for J3 inputs (with J25)	
J3/5	RUN / IDLE	Level	Turns ON Spec Tube and Turbo	Activation causes the 990 dCLD II to change from idle to run mode. RUN mode is normal operation. IDLE mode is a state in which the 990 dCLD II is powered, but the turbo and spec tube are off. This input has no effect on the 990 dCLD II and the 990 dCLD II assumes a running state when the PARALLEL ENABLE input J3/6 is not powered or if the RUN / IDLE function is disabled (by the DISABLE-IDLE command).
J3/6	Parallel Enable	Level	Disable Discrete inputs	Activation causes the 990 dCLD II to take inputs only from the rear panel I/O. Optional front control panel entries that change modes or parameters in the 990 dCLD II are ignored. Queries from the optional front control panel are allowed.
J3/7	Zero	Momentary (min. 0.2 s)	Perform a ZERO function	Activation causes the 990 dCLD II to perform a zeroing function identical to that invoked by pressing the optional front control panel ZERO button.

Table B-1 Customer Accessible Inputs (Continued)

Conn/Pin	Input Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/8	STDLEAK	Momentary (min. 0.2 s)	Put Leak Detector in Read STD LK mode	Activation causes the 990 dCLD II to move the valve state to the STDLEAK state, which is identical to pressing the front panel READ STD LEAK button.
J3/9	Full Internal Calibrate	Momentary (min. 0.2 s)	Perform Full Calibration with Internal Leak	Activation causes the 990 dCLD II to perform a normal calibration using the internal calibrated leak. The calibration includes zeroing.
J3/10	Decrement	Momentary (min. 0.2 s)	Decrement Exponent in Manual Ranging	Activation causes the 990 dCLD II to decrement the MANUAL RANGE variable.
J3/11	Increment	Momentary (min. 0.2 s)	Increment Exponent in Manual Ranging	Activation causes the 990 dCLD II to increment the MANUAL RANGE variable.
J3/12	Auto / Manual	Level	Auto Ranging if active	Activation causes the 990 dCLD II to change from MANUAL ranging to Auto-Ranging. This input has no effect on the 990 dCLD II and the 990 dCLD II assumes a manual or auto ranging state based on the last selection made from the front panel when the PARALLEL ENABLE input J3/6 is not powered.
J3/23	Full External Cal	Momentary (min. 0.2 s)	Perform a Full Calibration with External Leak	Activation causes the 990 dCLD II to perform a full calibration using the external calibrated leak. The calibration does not include zeroing.
J3/24	Quick Internal Cal	Momentary (min. 0.2 s)	Perform a Quick Calibration with Internal Leak	Activation causes the 990 dCLD II to perform a fast calibration using the internal calibrated leak. This assumes the cal-leak block or the valve block is installed. The calibration includes zeroing.
J3/25	Input Common	N/A	Return for J3 inputs (with J1)	

Table B-1 Customer Accessible Inputs (Continued)

Conn/Pin	Input Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/35	FIL OFF	Level	Filament is OFF when active	Activation causes the 990 dCLD II to turn off the operating filament in the spec tube. When the PARALLEL ENABLE input, J3/6, is not powered, this input has no effect on the 990 dCLD II and the 990 dCLD II keeps the filament on, assuming favorable conditions in the spec tube.
J3/37	Quick External Cal	Momentary (min. 0.2 s)	Perform a Quick Calibration with External Leak	Activation causes the 990 dCLD II to perform a fast calibration using the external calibrated leak. The calibration does not include zeroing.

B.2 Customer Accessible Outputs

Table B-2 is a listing of outputs by which the customer's controller, usually a PLC, can read information from the 990 dCLD II. All outputs are opto-isolated emitter-follower circuits with a 10-Ohm resistor in the collector. The resistors are all commoned and are connected to J3 pins 27 and 28 (or J2 pin 9 for the valve logic outputs) labeled +5, –24 VDC Input. The customer must connect the (+) of a power supply to these pins as the 990 dCLD II does not provide power to the customer side of the opto-isolators. Apply 5 to 24 VDC in all cases unless otherwise noted in the first line of the behavior discussion.

Table B-2 Customer Accessible Outputs

Conn/Pin	Output Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/2	REJECT #1	Level	Active when Leak Rate is over set point #1	Active when the value of the leak rate exceeds the value set in the 1REJECT variable. Inactive when the leak rate falls below the value set in the 1REJECT variable.
J3/14	Ready	Level	Active When Fil and Turbo ok	Active when the 990 dCLD II has successfully completed starting. This includes the turbo pump achieving speed, the spec tube pressure being low enough to support the ion source filament and the ion source emission loop running. It becomes *inactive* if, during normal operation, the turbo pump faults, the ion source filament burns out, the spec tube receives a pressure burst, the 990 dCLD II has received an IDLE or FIL OFF command, or the power is interrupted.
J3/15	Zeroing	Level	Active when performing Zero	Active when the 990 dCLD II is in the process of zeroing the leak rate. This happens when the ZERO command is invoked and at the end of an INTERNAL, NORMAL calibration.
J3/16	Leak Rate Update		Valid data on BCD when low	Active during the time that the BCD leak rate output is changing. It is an indication that the customer should not read the BCD data until this output becomes *inactive*.

Table B-2 Customer Accessible Outputs (Continued)

Conn/Pin	Output Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/17	Filament Fault	Level	Active when selected Ion Source Filament non-functional	Active if the selected filament in the ion source burns out or is shut off for some reason. Inactive when either of the filaments is lit and emission has been established.
J3/18	CAL OK	Level	Active when last calibration ok	Active at the completion of a successful CALIBRATION routine. It is set inactive at the start of a CALIBRATION routine and at power on.
J3/22	Calibrating	Level	Active when performing Cal	Active when the 990 dCLD II is in CALIBRATION mode. Inactive when the CALIBRATION routine is complete.
J3/26	REJECT #2	Level	Active when Leak Rate is over set point #2	Active when the value of the leak rate exceeds the value set in the 2REJECT variable. Inactive when the leak rate falls below the value set in the 2REJECT variable.
J3/27	+V Input	N/A	Customer-supplied +5 to +24 VDC for J3	
J3/28	+V Input	N/A	Customer-supplied +5 to +24 VDC for J3	
J3/29	REJECT #3	Level	Active when Leak Rate is over set point #3	Active when the value of the leak rate exceeds the value set in the 3REJECT variable. Inactive when the leak rate falls below the value set in the 3REJECT variable.
J3/30	REJECT #4	Level	Active when Leak Rate is over set point #4	Active when the value of the leak rate exceeds the value set in the 4REJECT variable. Inactive when the leak rate falls below the value set in the 4REJECT variable.

Table B-2 Customer Accessible Outputs (Continued)

Conn/Pin	Output Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J3/31	Analog Output	Analog	Analog Leak Rate Output Voltage	This analog voltage with respect to the Analog Return, represents the magnitude of the leak rate scaled by the selection of either LINEAR, 1LOG, 2LOG or 3LOG commands. The range of the voltage is 0 to 10 V. It is intended to drive a high impedance input of a PLC analog input module. The value of the voltage is updated every 50 mS.
J3/32	Analog Return	Ground	Analog Leak Rate Output Voltage Return	See Analog Output above.
J3/33	HiVac OK	Level	Active when turbo is ok	Active when the turbo pump has achieved the selected speed. Inactive if the turbo is stopped or is in the process of starting or stopping.
J4/3	LSD A MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the ones place in the least significant digit of the mantissa.
J4/4	LSD B MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the twos place in the least significant digit of the mantissa.
J4/5	LSD C MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the fours place in the least significant digit of the mantissa.
J4/6	LSD D MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the eights place in the least significant digit of the mantissa.
J4/7	MSD A MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the ones place in the most significant digit of the mantissa.

Table B-2 Customer Accessible Outputs (Continued)

Conn/Pin	Output Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J4/8	MSD B MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the twos place in the most significant digit of the mantissa.
J4/9	MSD C MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the fours place in the most significant digit of the mantissa.
J4/10	MSD D MAN	Level	Mantissa BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the eight's place in the most significant digit of the mantissa.
J4/11	LSD A EXP	Level	Exponent BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the ones place in the least significant digit of the exponent.
J4/12	LSD B EXP	Level	Exponent BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the twos place in the least significant digit of the exponent.
J4/13	LSD C EXP	Level	Exponent BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the fours place in the least significant digit of the exponent.
J4/14	LSD D EXP	Level	Exponent BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the eight's place in the least significant digit of the exponent.
J4/15	MSD A EXP	Level	Exponent BCD Leak Rate	Active when the BCD representation of the leak rate has a 1 in the ones place in the most significant digit of the exponent.

Table B-2 Customer Accessible Outputs (Continued)

Conn/Pin	Output Name	Momentary or Level Contact 5 to 24 VDC	Description	Behavior
J4/20	+V Input	N/A	Customer-supplied +5 to +2 VDC for J4	
J4/21	+V Input	N/A	Customer-supplied +5 to +2 VDC for J4	

B.3 Customer Accessible Inputs and Outputs

The Host Serial Port is used to interface the 990 dCLD II to a PLC or computer via an RS-232 connection. Table B-3 provides details of the connection.

J6 connections are referenced to the chassis ground and are not isolated. Electrical characteristics comply with EIA/TIA Standard EIA/TIA-232-E.

Table B-3 J6 Summary Table

J6/ Pin	EIA Name	Description
2	Received Data	Data Into the 990 dCLD II
3	Transmitted Data	Data Out of the 990 dCLD II
5	Signal Common	Ground
6	Clear To Send	Handshaking Signal Out of the 990 dCLD II
7	Request To Send	Handshaking Signal Into the 990 dCLD II

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Appendix C. Introduction to Leak Detection

C.1 Leak Testing—Why is it Needed?

Even with today's complex technology it is, for all practical purposes, impossible to manufacture a sealed enclosure or system that can be guaranteed leak proof without first being tested. Through the use of modern mass spectrometer leak testing techniques, as implemented by the 990 dCLD II Helium Leak Detector, leak rates in the 10^{-9} std cc/sec range can be reliably detected. The discussion that follows provides a brief summary of specific information pertinent to the overall subject of leak detection.

C.2 Classes of Leak Detection

There are four general classes of leak detection:

Hermetic Enclosures (or parts thereof) — These are tested to prevent entrance of contaminants or loss of fluid that would affect performance of the enclosed unit. Examples: electronic devices, integrated circuits, sealed relays, motors, ring pull tab can ends, and multipin feedthroughs.

Hermetic Systems — These are tested to prevent loss of fluid or gas within. Examples: hydraulic systems and refrigeration systems.

Evacuated Enclosures (or parts thereof) — These are tested to prevent too-rapid deterioration of vacuum with age. Examples: TV picture tubes, bellows sensing elements, full-panel opening can ends, etc.

Vacuum Systems — These are tested to minimize inleakage and allow attainment of better vacuum or higher gas removal ability at any given vacuum (absolute pressure).

C.3 Terminology

The following terminology has application throughout this manual:

Flow

std cc/sec	One cubic centimeter of gas per second at a pressure differential of one standard atmosphere (760 torr at 0° C).
atm cc/sec	One cubic centimeter of gas per second at ambient atmospheric pressure and temperature (used interchangeably with *std cc/sec* because the difference is insignificant for leak testing purposes).

Rate-of-Rise In vacuum systems this is defined as the rate of increase of absolute pressure per unit time, with the vacuum pump isolated from the system, and is the sum of actual inleakage and internal outgassing. Rate of rise is usually expressed in torr or microns (millitorr) per hour. The flow rate should be expressed in torr-liters/second.

Conversions

1 std cc/sec*	0.76 torr-liter/sec
1 torr-liter sec*	1.3 std cc/sec
1 std cc/sec	9.7×10^4 micron cubic feet per hour or practically 10^5 micron CFH (µCFH)
1 µCFH	practically 10^{-5} std cc/sec

**for practical purposes, equal*

Numerical Notation-Exponential System Most leak rates of commercial significance are very small fractions of a std cc/sec. Therefore minus powers of ten are used as a convenient system of numerical shorthand.

Table C-1 below shows the relationship of exponents and multipliers (to the base 10) to the arithmetic form, and the equivalent result.

Table C-1 Decimal Notation

Multiplier x 10^n		Arithmetic Form		Result
1×10^2	=	1 x 10 x 10	=	100
1×10^1	=	1 x 10	=	10
1×10^0	=	1	=	1
1×10^{-1}	=	1 x 1/10	=	.1
1×10^{-2}	=	1 x 1/10 x 1/10	=	.01
5×10^{-3}	=	5 x 1/10 x 1/10 x 1/10	=	.005
5×10^{-7}	=	5 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	=	.0000005
5×10^{-9}	=	5 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	=	.000000005

C.4 Various Methods of Testing for Leaks

There are many methods of testing for leaks in enclosures—either systems or containers. The more commonly used methods along with the range of accuracy provided are listed below:

Water Immersion (Air Bubble Observation) — This method is good to approximately 10^{-3} std cc/sec, and can be more sensitive if internal pressure is increased or vacuum is created above water pressure. This method is limited because of difficulty in differentiating between leakage bubbles and surface desorption bubbles. It is used to test industrial items such as valves, hydraulic components, castings, automotive and air conditioning components.

Dye Penetrant — A special dye, applied to one side of a surface suspected to contain a leak, seeps through the leak and appears on the other side. This method can take an hour or more for a 10^{-4} std cc/sec leak to show up. This test is inexpensive but destructive in some applications, as well as slow and messy.

Ultrasonic — This method is good to approximately 10^{-3} std cc/sec. This method tests for ultrasonic sounds coming from a gas leak and is used for testing of high pressure lines.

Halogen (sensitive to halogen elements or compounds, especially refrigerant gases) — This method is good to approximately 10^{-5} std cc/sec in most current applications, but extendable to 10^{-9} std cc/sec under some limited situations. It is critically dependent on operator judgement if leaks are below 10^{-5} std cc/sec and requires constant flow of fresh air in the test area because of the tendency of trace gas to *hang* in the area. The detector used in this method is sensitive to a variety of gases from external sources such as cigarette smoke and solvent fumes.

Radioisotope — This method is useful only for testing hermetically sealed cavities. It has approximately the same range as the helium method but it involves an expensive installation (from four to ten times the cost of a helium installation depending on the degree of isolation of radiation required). It also requires a radiation safety officer.

Helium — This method is good to 10^{-11} std cc/sec, and is capable of finding leaks of any size larger. It is useful for testing hermetic seals, vacuum enclosures, and vacuum systems, and is the most versatile of industrial and laboratory leak detection testing methods.

C.5 Helium Mass Spectrometer Leak Detection (MSLD)

Helium is an excellent trace gas because it is the lightest of the inert gases and as a consequence readily penetrates small leaks. In addition, its presence in the atmosphere is minute (5 PPM or 4 millitorr absolute). Helium is easily detected by a simple mass spectrometer (helium has a mass of 4 so that adjacent *peaks* of 3 and 6 are easily separated by this technique). Also, helium is readily available at reasonable cost, and is completely non-toxic and non-reactive. The basic principles of the helium MSLD technique are discussed below.

C.5.1 Principles of Mass Spectrometry

A mass spectrometer sorts gases by their molecular weights (mass number) to determine the quantity of each gas present. With the helium MSLD, the point of interest is primarily in helium and the mass spectrometer tube is relatively simple. The principle is to ionize the gases in vacuum, accelerate the various ions through a fixed voltage, and then separate the ions by passing them through a magnetic field. A slit, properly placed, allows only helium ions to pass through and be collected. The resulting current is amplified and a leak rate bar graph indicates the presence and amount of helium.

C.5.2 Application as a Leak Detector

A mass spectrometer leak detector consists of a spectrometer tube, the electronics to operate and interpret it, and a high vacuum system to maintain proper vacuum. In addition, means are provided for connecting a test object, and a *rough vacuum* pump and a system of *roughing* and *test* valves is provided to evacuate the test object for connection to the spectrometer tube; or, if it is a sealed object containing helium, to evacuate a chamber containing the test object.

C.5.3 The Nature of Flow in a Vacuum

It should be noted that the purpose of the vacuum system is to support operation of the analyzing spectrometer tube. Helium molecules entering through a leak individually reach the spectrometer tube in a few milliseconds. Helium molecules as well as molecules of other gases are continuously removed by the vacuum system turbo pump. If helium is continuously applied to a leak, the concentration in the spectrometer tube rises sharply at first, then reaches equilibrium when it is being pumped out at the same rate as it is entering. When helium is completely removed from the leak, the input drops to zero while the residual helium is pumped out of the system. Thus, a leak is indicated by a rise in output signal of the spectrometer tube.

C.5.4 Facts About Leak Rates

Visualizing Leaks in Everyday Terms	10^{-5} std cc/sec: approximately 1 cc/day 10^{-7} std cc/sec: approximately 3 cc/year

Audible or Visual Detection by Observer

a. Bubbles rising in water	10^{-4} std cc/sec or larger
b. Audible Leaks	10^{-1} std cc/sec or larger
Sizes of Leaks in Man-Made Joints	Studies indicate that almost all leaks at joints are about 5×10^{-7} std cc/sec (about 1 cc/month) or larger. This is true of ceramic-to-metal, plastic-to-metal seals, welded, soldered and brazed joints. Some long-path leaks are slightly smaller. Diffusion of helium through glass can be as high as 10^{-8} std cc/sec per square centimeter of surface area.
Variation in Leak Sizes	Leaks unintentionally *built-in* at joints during manufacture can vary from hour to hour and day to day. Breathing on a 10^{-6} std cc/sec leak provides enough moisture to close it temporarily; perhaps for several days. Atmospheric particles can close a leak of this size. Never depend on an *accidentally made* leak to remain constant. Manufacturing standard leaks for calibration purposes requires special techniques.

C.6 Leak Detection Methods

Most leak detection methods depend on the use of a tracer gas passing through the leak and being detected on the other side (for example, visual detection of air bubbles in water).

The mass spectrometer leak detector operates with helium as a tracer and is widely used because it combines high sensitivity with production testing capability. There are three basic methods in common use.

C.6.1 Test Piece Evacuated (Figure C-1a and Figure C-1b)

The object to be tested is evacuated by the leak detector roughing pump, then valved into the spectrometer vacuum system. The surface of the test object is then probed with a small jet of helium to locate individual leaks, or surrounded by helium (hooded) for an overall leak check.

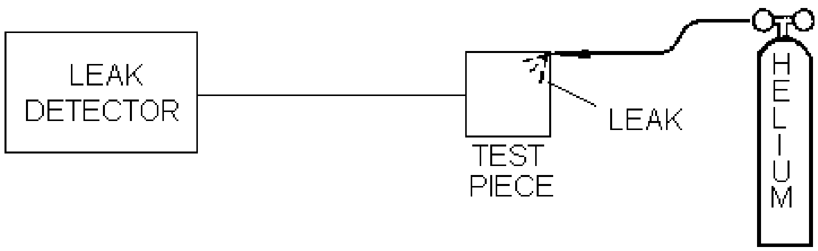

Figure C-1a Test Piece Evacuated: Tracer Probe Used to Locate Leak

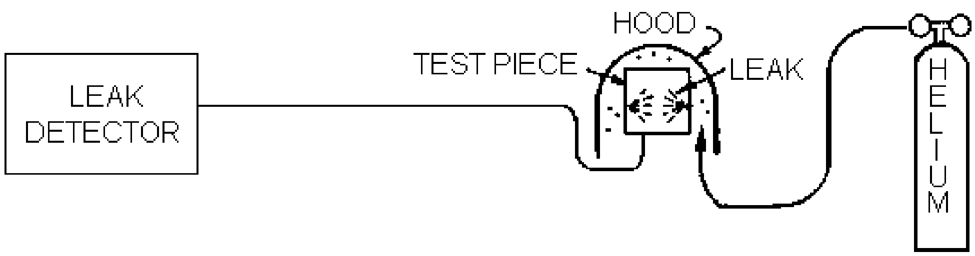

Figure C-1b Test Piece Evacuated and Hooded with Helium Atmosphere to Determine Overall Leak Rate

C.6.2 Test Piece Pressurized (Figure C-2)

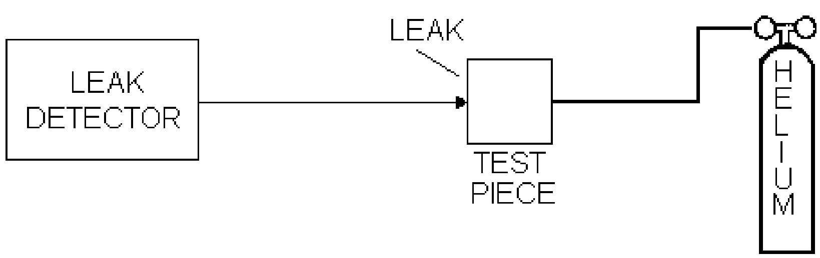

Figure C-2 Test Piece Pressurized: Detector Probe Used to Locate Leak

A sampling probe is connected to the leak detector. The object to be tested is filled with helium at the desired test pressure and the probe is moved over its surface. Some of the helium escaping from a leak is captured through the probe and enters the leak detector, thus locating the leak.

Sensitivity of this type of testing is limited to about 10^{-7} std cc/sec, since most of the escaping helium diffuses into the surrounding atmosphere. The sensitivity is also limited by operator technique and variation in ambient helium concentration in the vicinity of the testing.

An alternative to probing is to enclose the object and probe the enclosure for a change in helium content.

C.6.3 Test Piece Already Sealed (Figure C-3)

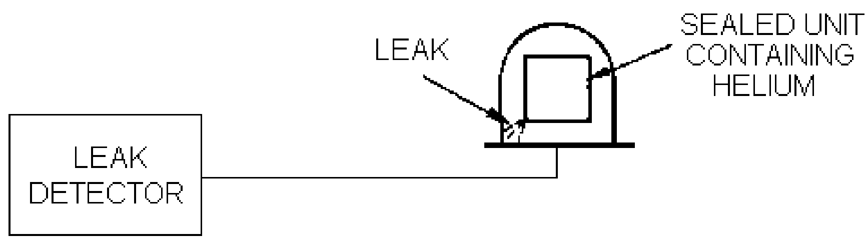

Figure C-3 Test Piece Sealed with Helium or Mixture of Helium and Other Gases: Bell Jar Used to Determine Overall Leak Rate

Sometimes it is necessary to leak check a completely sealed object. This is done by placing helium inside the object before sealing (either 100% or mixed with other gas used for backfilling). The object is then placed in a vacuum chamber connected to the leak detector. Helium escaping from the object into the vacuum chamber is detected by the spectrometer tube. Sensitivity depends on the partial pressure of helium in the object.

If the presence of helium in the finished object is undesirable, units already sealed can first be placed in a container that is then pressurized with helium for a specific time at a known pressure. Helium enters the object through leaks that are later detected, as described in the previous paragraph. Gross leaks are sometimes not detected, since all the helium entering through a large leak can be lost prior to testing. Also, spurious signals can be given by helium not entering the object, but entering surface fissures and remaining long enough to be detected.

C.7 Mass Spectrometer Leak Detector—Simplified Description

Each Model 990 dCLD II consists basically of an analytical sensing tube called a *spectrometer tube*, electronics to operate the tube, and a vacuum system to maintain a very high vacuum within this tube (usually less than 0.1 millitorr or about one ten-millionth of ordinary atmospheric pressure).

In the spectrometer tube, gas molecules are ionized (given a positive electrical charge) by bombarding them with electrons from a hot thoriated iridium filament. The ions, thus formed, are accelerated into a magnetic field where the mass 4 (helium) ions are deflected 90 degrees (see Figure C-4). Only helium ions reach the collector.

An extremely stable electrometer provides an electron current to the collector, which neutralizes the current produced by the collection of helium ions. The *feedback* current is presented on the leak rate bar graph. Since this current is directly proportional to the number of helium ions striking the collector per unit time, the panel leak rate bar graph directly reflects the concentration of helium in the vacuum system at any time. Any helium entering the system causes an increased concentration of helium within the spectrometer tube, which is reflected as an increase on the leak rate bar graph. In addition to the electrometer, the electronics also provide suitable voltages to operate the spectrometer tube and controls and instrumentation for the vacuum system.

Test pieces are generally *rough* pumped (or, if pressurized, the chamber in which they are to be tested is *rough* pumped) by a mechanical vacuum pump before they are connected to the spectrometer tube. This prevents overloading the vacuum pumping system.

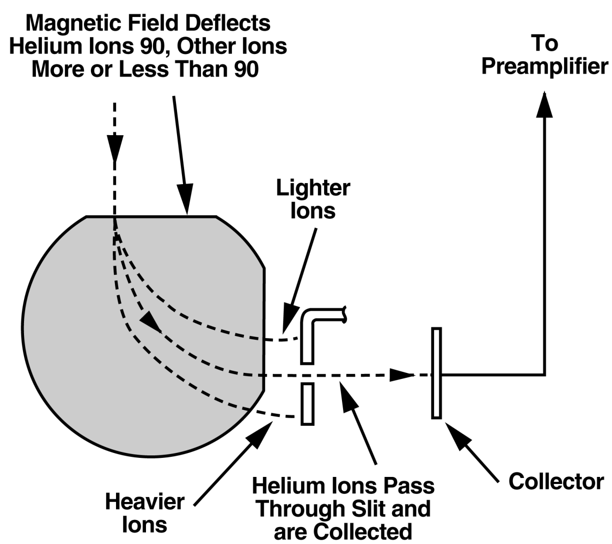

Figure C-4 Magnetic Separation Principle

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