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990 CLD Autoline™ Leak Detector

INSTRUCTION MANUAL

Manual N0. 6999-09-690
Revision L
February 2004

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990 CLD Autoline™ Leak Detector

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auquel se réfère cette déclaration est conforme à la (auz) norme(s) ou au(x) document(s) normatif(s).
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89/336/EEC. . . . . Electromagnetic Compatibility Directive
EN55011:1991 Class B . . . . . EMC/Limits for Radiated Emissions
EN55022:1995 Class A. . . . . EMC/Limits for Conducted Emissions

IEC 1000-4-2/IEC 1000-4-3. . . . . EMC/Limits for Electrostatic Emissions
IEC 1000-4-4/IEC 1000-4-6

IEC 801-2 Crit B . . . . . EMC/Immunity to Electromagnetic Fields
IEC 801-3 Crit A and Transient Burst
IEC 801-4 Crit B

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Operations Manager
Vacuum Technologies
Varian, Inc.
Lexington, Massachusetts, USA

March 2001

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Preface

Hazard and Safety Information

This manual uses the following standard safety protocols:

WARNING



Warnings are used when failure to observe instructions or precautions could result in injury or death.

CAUTION



Cautions are used when failure to observe instructions could result in damage to equipment, whether Vacuum Technologies supplied or other associated equipment.

NOTE



Notes contain information to aid the operator in obtaining the best performance from the equipment.

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990 CLD Leak Detector Hazards

This product must only be operated and maintained by trained personnel.

Before operating or servicing equipment, read and thoroughly understand all operation/ maintenance manuals provided by Vacuum Technologies. Be aware of the hazards associated with this equipment, know how to recognize potentially hazardous conditions, and how to avoid them. Read carefully and strictly observe all cautions and warnings. The consequences of unskilled, improper, or careless operation of the equipment can be serious.

In addition, 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.

WARNING



The mechanical components of leak detectors are typically cleaned with alcohol, methanol, or other solvents.

When heated, sprayed, or exposed to high-temperature equipment, these solvents become flammable and explosive, causing serious injury or death. Do not use these solvents near a high-temperature source. Ventilate the working area with a blower and use in a large, well-ventilated room.

Alcohol, methanol, or other solvents are irritants, narcotics, depressants and/or carcinogens. Their inhalation and/or ingestion may produce serious side effects. Prolonged or continued contact with the skin will result in absorption through the skin and moderate toxicity. Always ensure that cleaning operations are carried out in large, well-ventilated rooms, and wear eyeshields, gloves, and protective clothing.

CAUTION



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

NOTE



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

NOTE



During reassembly, always use Loctite® PST® (teflon-impregnated pipe thread compound) on pipe threads.

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NOTE



Where applicable, inspect for any damage to retaining rings and O-rings. Remove them carefully with your fingers. Do not use any metal tools for this task. This prevents scratching of any sealing surfaces.

NOTE



To clean O-rings, wipe them with a clean, lint-free cloth or paper.

If vacuum grease is required, apply Apiezon® L lightly; remove excess grease until only a shiny, thin film remains.

CAUTION



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

WARNING



Store the Ion Source in a cool, dry area in a tightly sealed container. Wash hands thoroughly after handling the Ion Source and especially before smoking or eating.

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990 CLD Leak Detector Factory Calibration Data

Model Number _____ Date _____

Serial Number _____ Initials _____

The Vacuum Technologies 990 CLD leak detector is thoroughly tested prior to shipment. It is shipped tuned to helium on Filament No. 1. Normally, once set, the tuning adjustments are left untouched and calibration is verified as required.

The data recorded below includes readings taken during the final test prior to shipment. They are convenient for reference purposes, if tuning adjustments are altered. Slight changes may occur when using Filament No. 2 or after an ion source is replaced. Dial and switch settings and voltage measurements made prior to shipment are also indicated.

Filament Selection	FILAMENT switch set to No. 1	
Ion Voltage (ION)	_____ VDC	(between TP1 and TP4)
Ion Dial Setting	_____	(Numbers at 12 o'clock position)
Emission Voltage	_____ VDC	(between TP12 and TP13 Located on Main Electronics Board)
Focus Voltage:	_____ VDC	(between TP3 and TP4)
Focus Setting:	_____o'clock	
Residual Background Switch	In RUN position	
RANGE SELECT	_____	
CAL	_____o'clock	
COARSE ZERO	_____o'clock	
ZERO	Centered at five turns (out of 10)	
SENSITIVITY	HIGH	

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Section 1. Introduction

This manual covers the description, installation, operation, theory, and maintenance of the Vacuum Technologies 990 CLD AutoLine™ leak detector (Figure 1-1 on page 1-1). The 990 CLD leak detector is a modular, mass spectrometer leak detector that uses helium as the trace gas. Helium spray probes, system coupling kits, and other accessories are available as optional equipment to suit individual requirements.

The 990 CLD leak detector uses a Vacuum Technologies fast start, turbo or MacroTorr turbo drag pump with ceramic bearings as its vacuum source. The high vacuum pump is ready for leak detector operation in less than two minutes. An external mechanical pump (purchasable from Vacuum Technologies) is required for use with the vacuum system.

Maintenance encompasses all of the mechanical assemblies and electronics troubleshooting to the board level.

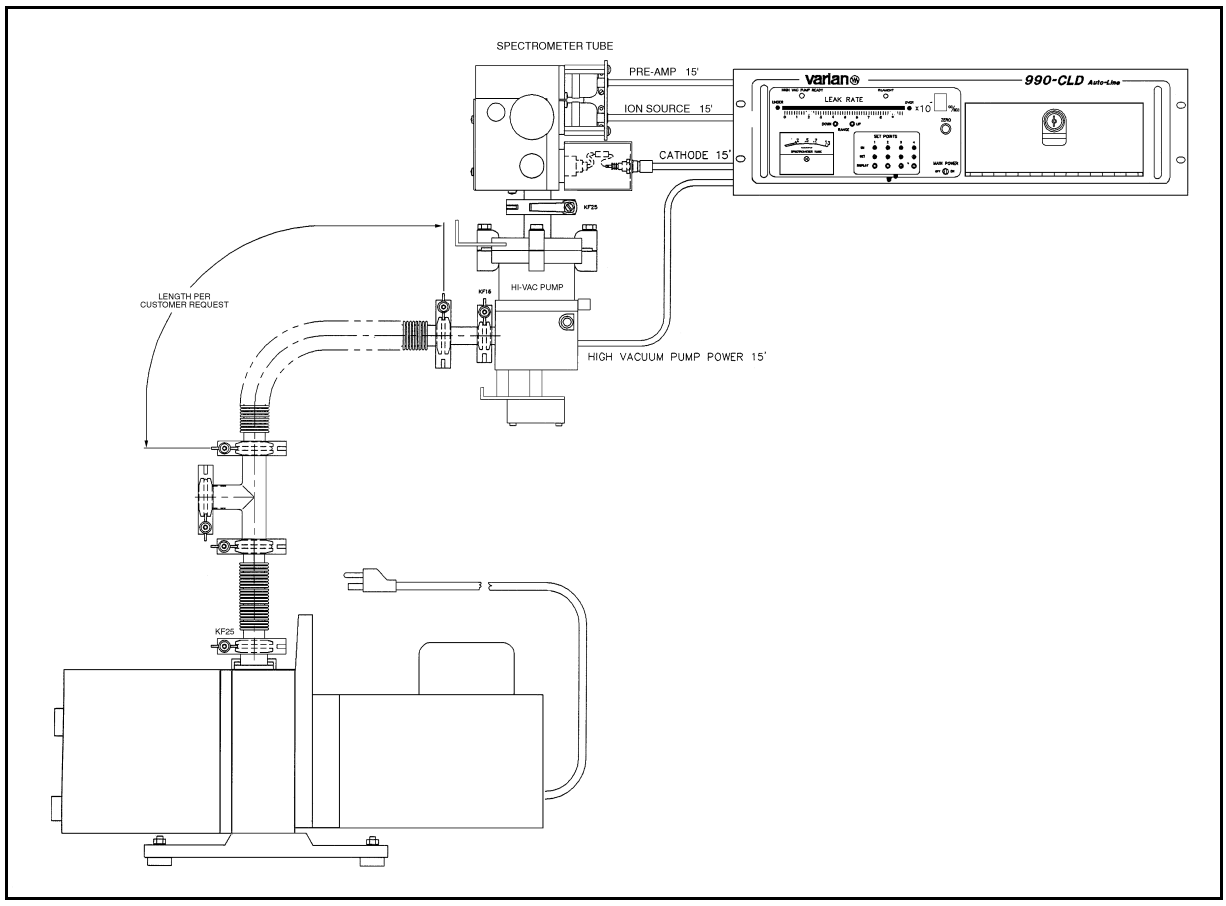


Figure 1-1 990 CLD Leak Detector

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Model Types

The basic 990 CLD leak detector (PN L990000000120) is equipped with the components listed in Table 1-1.

Table 1-1 990 CLD Leak Detector Component Parts

Description	Part Number
Main Electronics Console L9022301, 302, or 303, 120 V Control Input	L9022301, 302, or 303
Spectrometer Tube Cable	L9023301
Spectrometer Tube Adapter with bracket and four clamps NW63	L9027301
Spectrometer Tube	K6356301

The leak detector can be ordered customized with different components, according to Table 1-2.

Table 1-2 900 CLD Customized Configuration

Order Number[1]			
L990XX	**XX**	**XX**	**XXX**
Mechanical Pump (Optional): ❑ 00 = No Pump ❑ 09 = SD-90 ❑ 20 = SD-200 ❑ 30 = SD-300	*OPTO Module:* ❑ 00 = No OPTO Modules ❑ 12 = 120 VAC ❑ 60 = 35-60 VDC ❑ 28 = 2.5-28 VDC	*High Vacuum Pump:* ❑ OO = No Turbo or Controller ❑ MT[2]= V70D MacroTorr with Controller ❑ OT[3] = V70 Turbo with Controller	*Voltage:* ❑ 115 Volts AC ❑ 220 Volts AC

[1]Order number syntax is comprised of two digits for Mechanical Pump, OPTO Module, High Vacuum Pump and three numbers for Voltage.

[2] V70D MacroTorr Turbo (PN 9699361), with controller, features high compression ratio for light gases, utilization of very small mechanical pumps while maintaining a high inlet pumping speed, and high throughput capacity at pressures greater than 10^{-3} mbar.

[3] V70 Turbo (PN 9699357), with controller, features high pumping speed for light gases, low vibration level, and superior reliability compared to conventional turbo pumps due to the use of ceramic ball bearings and a reduced number of components.

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OPTO-22 Modules

Spare OPTO-22 modules for 120 VAC units, or for input control voltages other than 120 VAC, can be ordered as listed in 1-3.

Table 1-3 OPTO–22 Module Part Numbers

Vacuum Technologies Part No.	Mfr. Part No.	Description
L9018301	G4 IAC5	120 AC input module, quantity: 5 required
L9018302	G4 IDC5G	35 to 60 VDC input module, quantity: 5 required
L9018303	G4 IDC5D	2.5 to 28 VDC input module, quantity: 5 required

Test Cycle Description

The Vacuum Technologies 990 CLD leak detector (Figure 1-1) can detect leaks in the range of 2 x 10^{-10} cc/sec to 10 cc/sec, depending on high vacuum pump and mechanical pump selection. Major assemblies which comprise the leak detector include a mass spectrometer tube, a high vacuum pump, a main electronics console, and interconnecting wiring.

The test cycle occurs as follows:

1. When the high vacuum pump gets up to speed the spectrometer tube pressure is low enough (≤ 2 x 10^{-4} Torr*) to permit energizing of the ion-source filament in the spectrometer tube. There are actually two filaments, but only one is energized at a time.

   *1 Torr = 1000 milliTorr = 1/760 standard atmospheric pressure; hence, 10^{-4} Torr is approximately 1/10,000,000 atmosphere. See 6“Fundamentals of Leak Detection” for other conversions.

2. Helium is applied sparingly to the test object, such as from a spray probe.

   If there is a leak in the test object, helium entering through the leak spreads to all parts of the evacuated system. Some of this helium is exhausted through the mechanical pump to atmosphere; the rest of the helium is diffused through the high vacuum pump (against or *contra* the normal flow) and reaches the spectrometer tube. The rate at which helium enters the spectrometer tube appears on the associated horizontal bar graph display and can be monitored on an internal or optional external loudspeaker, as desired.

   As long as helium from the spray probe enters a leak in the test object, the leak rate appears on the leak detector front panel. When the spray probe is removed, the leak rate drops rapidly as helium is quickly evacuated from the leak detector by the actions of the high vacuum and mechanical pumps. The end result is a rise and fall of the leak rate indication on the display, which is directly proportional to the leak rate in the test object.

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Signal Flow

The electrical signal that represents the concentration of helium in the vacuum system originates in the spectrometer tube preamplifier (Figure 1-2 on page 1-5). Also, refer to "High Vacuum System" on page 1-14.

The signal flow occurs as follows:

1. The helium ions create an electrical current on the input of an electrometer amplifier. The voltage at the output of the electrometer circuit travels through the cable connecting the spectrometer tube to the 990 Controller.
2. The signal flows through offset and calibration circuitry and is distributed to three main sections of the controller: the range selection and display circuitry, the set point circuitry, and the leak rate output circuitry.
3. The range select circuitry takes input from the front panel RANGE DOWN/UP pushbuttons, the RANGE SELECT switch, and the remote exponent control inputs, and determines which decade of signal to send to the bar graph display and to the audio circuitry.
4. The set point circuitry uses voltage comparators, hysteresis circuitry, and mechanical output relays to indicate when the signal has exceeded any one of four preset thresholds. The leak rate output circuitry produces a linear or logarithmic voltage proportional to the signal (see Appendix A "Understanding the 990 CLD Analog Leak Rate Output").
5. The leak rate output signal is buffered and clipped so as not to adversely affect equipment that is connected to the leak rate output.

The 990 CLD controller also contains circuitry to operate the ion source and cold cathode gauge in the spectrometer tube and to operate and protect the high vacuum pump. The ion source support circuitry includes a multi-voltage high voltage supply and ion emission regulator control loop. The cold cathode gauge control is a specialized 2000 V supply with a voltage output proportional to the spectrometer tube pressure. The high vacuum pump controller is a micro controller-based printed circuit board that monitors motor temperature and current for protection of the pump and is capable of running the pump at one of two selected speeds.

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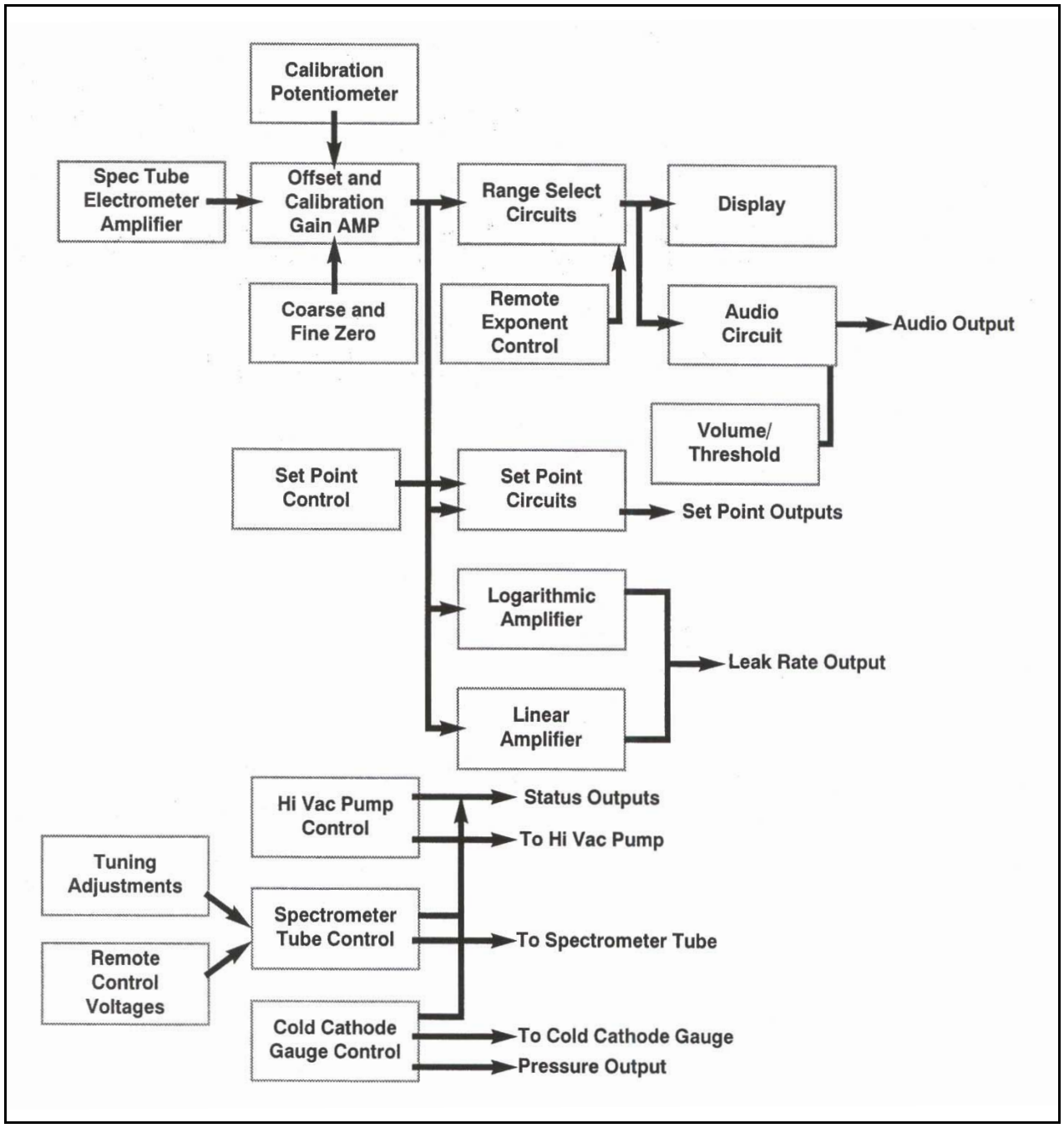


Figure 1-2 Signal Flow Diagram

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Physical Description

The physical components of the 990 CLD leak detector include:

- ❑ “Controls and Indicators”
- ❑ “Internal Components” on page 1-13

Controls and Indicators

The spectrometer tube and high vacuum pump are mounted together on a bracket with proper couplings to simplify customer mounting and are connected to the main electronics console by electrical cables. The spectrometer tube/high vacuum pump can then be connected via vacuum tubing to a mechanical pump of the customer's choice. For convenience, the primary and secondary operating controls and indicators are mounted on the console front panel. The secondary controls are part of the main electronics assembly and are located behind a lockable front panel door.

There are two sections to the front panel and one on the back panel:

- ❑ “Primary Controls”
- ❑ “Secondary Controls” on page 1-8
- ❑ “Rear Panel Inputs and Outputs” on page 1-10

Primary Controls

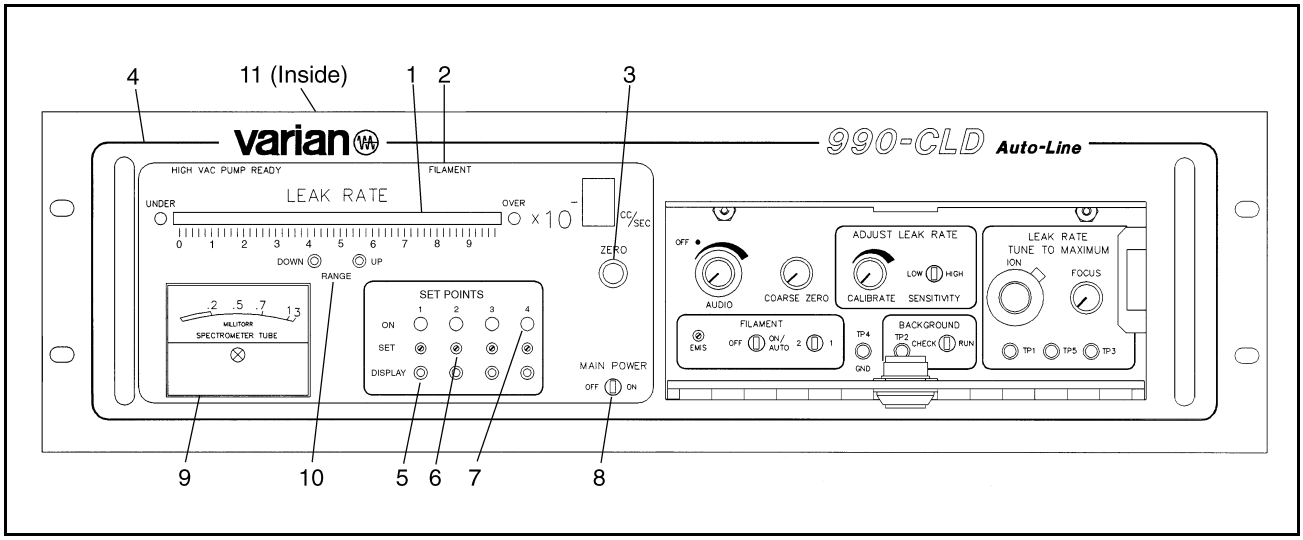


Figure 1-3 Primary Operating Controls and Indicators, 990 CLD Leak Detector

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Table 1-4 Primary Operating Controls and Indicators

Item	Control/Indicator	Function
1	LEAK RATE Display	Bar graph display. Indicates leak rate in std cc/sec. Over-scale and under-scale conditions are indicated by LEDs at the right and left of this display, respectively. The exponent in the window next to the *10-* mark reads 0 through 9, depending on the settings of the RANGE SELECT switch and RANGE pushbuttons.
2	FILAMENT LED	Green LED which lights when the filament in the spectrometer tube ion source is on and functional.
3	ZERO Adjustment	Potentiometer used to zero out the background trace gas detection.
4	HIGH VAC PUMP READY LED	Green LED which lights when the high vacuum pump is operational and running at its correct speed.
5	Set Point DISPLAY	Momentary pushbutton which causes the selected set point to be displayed on the LEAK RATE bar graph.
6	Set Point SET	Screwdriver potentiometer used to set the selected set point.
7	Set Point ON	Red LED which indicates that the leak rate has exceeded the set point.
8	MAIN POWER ON/OFF	Toggle switch which provides power to the entire leak detector.
9	SPECTROMETER TUBE	Meter which indicates pressure in the spectrometer tube as measured by the cold cathode gauge.
10	RANGE	Up and down pushbuttons that select the decade shown on the bar graph and exponent. Pushbuttons allow direct reading of a given leak. Used in conjunction with the RANGE SELECT switch.
11	RANGE SELECT switch	A rotary switch that selects the least sensitive range displayed. See Table 3-2.

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Secondary Controls

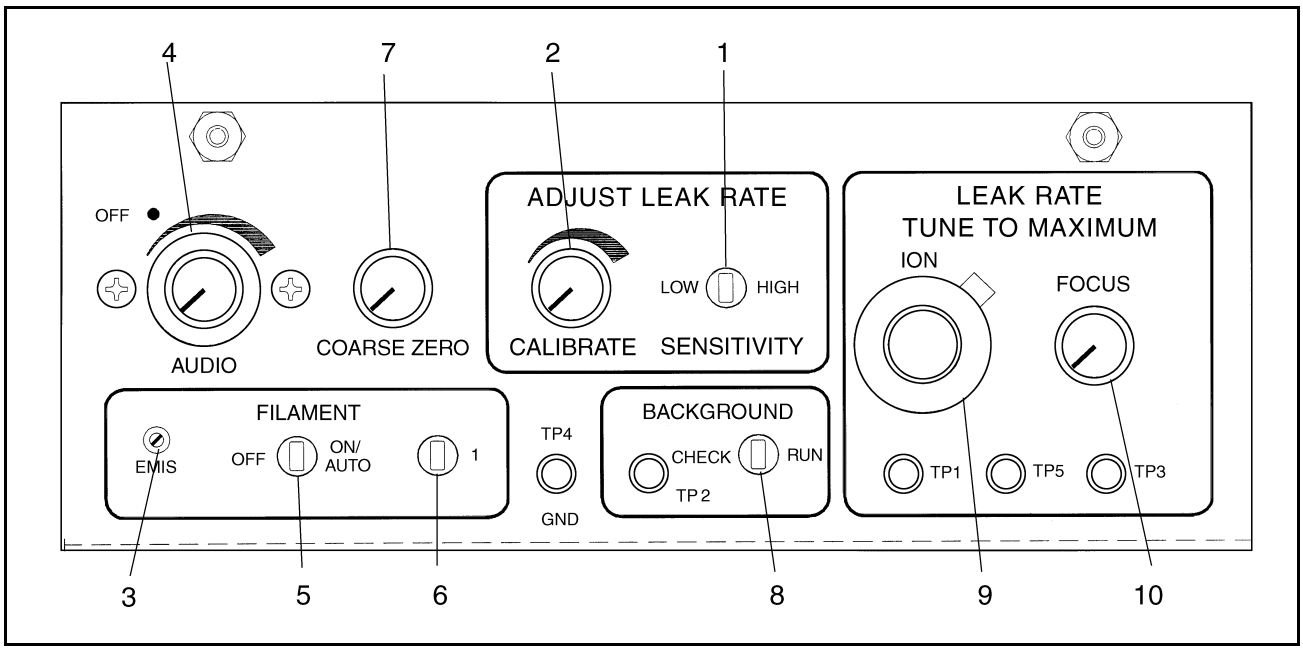


Figure 1-4 Secondary Operating Controls and Indicators, 990 CLD Leak Detector

Table 1-5 describes the Secondary Operating Controls and Indicators, which are used mainly for tuning and calibration purposes. Refer to Figure 1-4 and Figure 1-5 on page 1-10.

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Table 1-5 Secondary Operating Controls and Indicators

Item	Control/Indicator	Function
1	SENSITIVITY HI/LOW	Toggle switch that changes the speed of the high vacuum pump. It is used to change the sensitivity of the leak detector by a factor of ten.
2	CALIBRATE	Potentiometer used to adjust the gain of the leak detector's amplifiers. Used to calibrate the leak detector.
3	EMIS	Screwdriver-adjustable potentiometer adjusts the level of electron emission current in the spectrometer tube ion source.
4	AUDIO VOL/THRESH	Concentric potentiometers. The outer knob varies the tone's volume heard at the speaker. The inner knob varies the audible threshold of a given leak rate.
5	FILAMENT OFF - ON/AUTO	Toggle switch to either manually turn off the filament or place it in the ON/AUTO mode.
6	FILAMENT,1, FILAMENT 2	Toggle switch which selects the active filament in the spectrometer tube ion source.
7	COARSE ZERO	Potentiometer used to zero any background signal.
8	CHECK/RUN	When the toggle switch is in the CHECK position, the leak detector is rendered insensitive to helium. When in the RUN position, the leak detector is sensitive to helium.
9	ION	Ten-turn ion voltage adjustment potentiometer used for tuning the leak detector to helium.
10	FOCUS	Potentiometer used to adjust the focus voltage of the ion beam.

NOTE



Pin connections read from left to right as viewed from the rear of the console.

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Rear Panel Inputs and Outputs

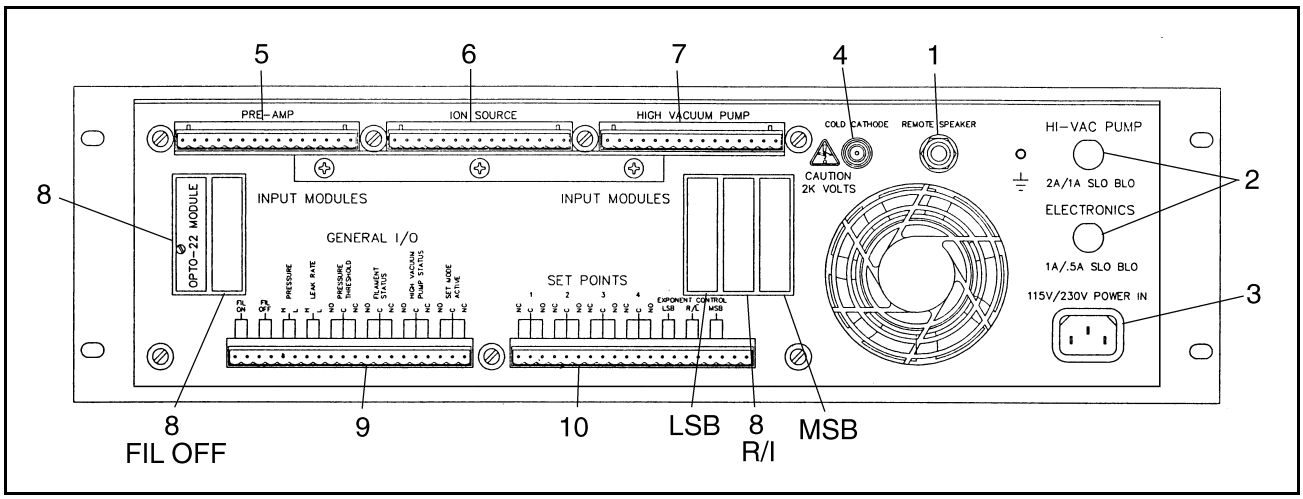


Figure 1-5 Rear Panel, 990 CLD Leak Detector

Table 1-6 Rear Panel Inputs and Outputs

Item	Description	Input/ Output	Function
1	REMOTE SPEAKER Jack	O	Jack for external speaker. The loudspeaker should have an internal impedance between 4 and 8 Ohms, and a 5 W minimum power capability. The mating plug (supplied) is a Switchcraft 260 or equivalent. When the remote loudspeaker plug is connected to the jack on the back panel, it automatically disconnects the internal loudspeaker.
2	HIGH VAC pump fuse Electronics fuse	N/A	Main power protection devices
3	POWER Input Connector	I	IEC-320
4	COLD CATHODE Connector	O	High-Voltage SHV connector for connection to the cold cathode gauge in the spectrometer tube. See “Wire Run Lists” on page 2-4.
5	PRE-AMP Connector	I/O	Pluggable terminal block for connections to the detector in the spectrometer tube. See “Wire Run Lists” on page 2-4.
6	ION SOURCE Connector	O	Pluggable terminal block for connections to the ion source in the spectrometer tube. See “Wire Run Lists” on page 2-4.

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Table 1-6 Rear Panel Inputs and Outputs (Continued)

Item	Description	Input/ Output	Function
7	HIGH VACUUM PUMP	O	Pluggable terminal block for connections to the Connector high vacuum pump. See “Wire Run Lists” on page 2-4.
8	OPTO-22 Modules	N/A	Input voltage selection modules for filament and remote exponent control signals.
Note *The input voltages applied to the General I/O connector depend on the optional OPTO-22 input module purchased. These modules are available in 2.5 to 28 VDC., 35 to 60 VDC, and 120 VAC (5“Parts List” on page 5-1).*			
9	General I/O Connector	I/O	Pluggable terminal block for connections to the equipment as described below.
9-1 (+), 9-2 (–)	FILAMENT ON	I	Voltage applied for at least two seconds causes the active filament in the spectrometer tube to light if the unit is in the Remote Filament Control mode.
9-3 (+), 9-4 (–)	FILAMENT OFF	I	Voltage applied for at least two seconds causes the active filament in the spectrometer tube to shut off if the unit is in the Remote Filament Control mode. See.
9-5 (+), 9-6 (-)	PRESSURE	O	Spectrometer tube pressure monitor output, 0 to + 10 V. 4 V = filament protection threshold.
9-7 (+), 9-8 (-)	LEAK RATE	O	Leak rate monitor output, 2 or 3 V/decade logarithmic, or 0 to 10 V linear.
9-9, 9-10, 9-11	PRESSURE THRESHOLD	O	Relay energizes when spectrometer tube pressure is too high for operation.
9-13,9-14	FILAMENT STATUS	O	Relay contact closes when the active filament in the spectrometer tube is on.
9-16, 9-17	HIGH VACUUM PUMP	O	Relay contact closes when high vacuum pump is STATUS functional and operating at its correct speed.

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Table 1-6 Rear Panel Inputs and Outputs (Continued)

Item	Description	Input/ Output	Function
9-18, 9-19, 9-20	SET MODE ACTIVE	O	Relay contact closes when any of the four SET POINT SET buttons are pressed.
10	SET POINTS Connector	O	Pluggable terminal block for connections to set point relays.
10-1, 10-2, 10-3	Set Point 1	O	Relay contact switches state when the leak rate meets or exceeds the first set point.
10-4, 10-5, 10-6	Set Point 2	O	Relay contact switches state when the leak rate meets or exceeds the second set point.
10-7, 10-8, 10-9	Set Point 3	O	Relay contact switches state when the leak rate, meets or exceeds the third set point.
10-10, 10-11, 10-12	Set Point 4	O	Relay contact switches state when the leak rate meets or exceeds the fourth set point.
10-15 (+), 10-16 (-)	R/L exponent control	I	Voltage applied to pin 15 with respect to pin 16 enables remote control of the leak rate display's exponent
10-13 (+), 10-14 (-)	LSB exponent	I	When the leak rate exponent is set to remote 7 (+),10-18 (-) MSB exponent I control (see above), voltage applied to LSB and/or MSB results in a binary representation of the desired leak rate exponent level.

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Internal Components

Internal components consist of:

- ❑ “Sub–assembly Level Items”
- ❑ “High Vacuum System”

Sub–assembly Level Items

Internally, the 990 CLD leak detector (Figure 1-6) is comprised of electronic subassemblies, power and control transformers, and interconnecting cabling. All subassemblies are user replaceable. The subassemblies include:

- ❑ The display board, which contains the bar graph display), set point display and adjustment, and associated drivers.
- ❑ The power supply board, which contains circuits for the audio leak rate indicator and for spectrometer tube control.
- ❑ A cold cathode gauge control assembly.
- ❑ A rear panel I/O PCB.
- ❑ A controller for the turbo or MacroTorr turbo drag pump.

NOTE *The mechanical pump is customer-supplied.*

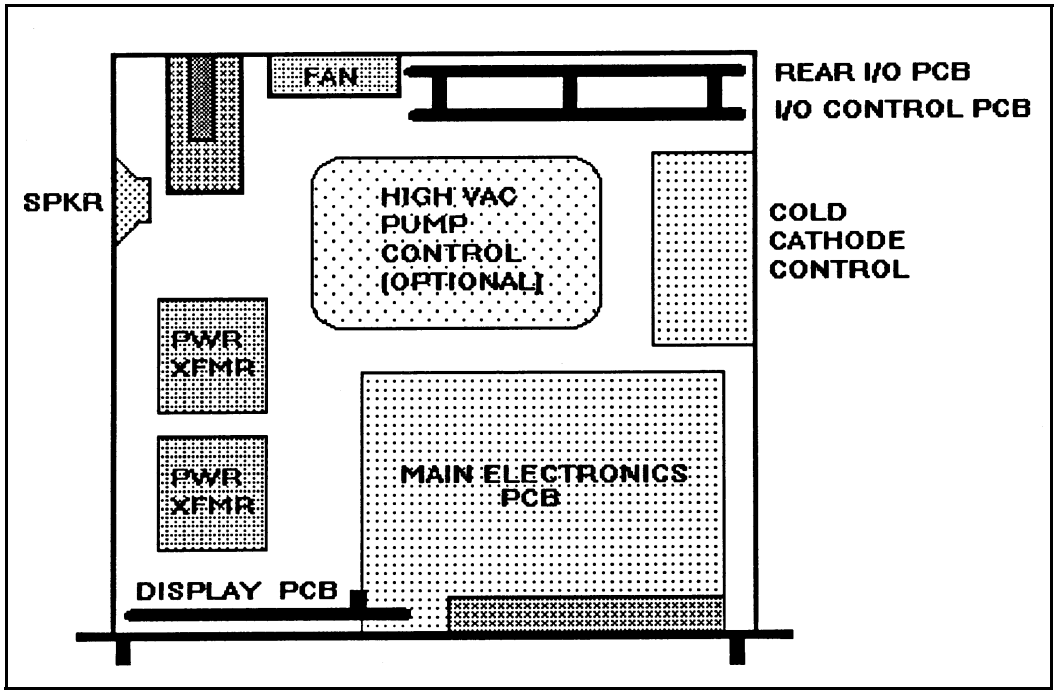


Figure 1-6 Main Electronics Console - Top View

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High Vacuum System

The high vacuum system serves three functions, it:

- ❑ Maintains the required vacuum in the spectrometer tube,
- ❑ Connects the customer's part or system to the spectrometer tube.
- ❑ Removes helium after a test.

Additionally, Contraflow™, an innovation of Vacuum Technologies, is utilized. The Contraflow technique takes advantage of the differences in compression ratios (outlet pressure divided by inlet pressure) produced by the high vacuum pump for gases of different molecular weights. For example, the maximum compression ratio of helium may be 100, while for oxygen, nitrogen, and other gases contained in air, the ratios are normally far in excess of one million. This principle is implemented in the leak detector by introducing helium into the high vacuum pump outlet (foreline) rather than into the *normal* pump inlet, as in conventional leak detectors. Helium, having a much lower maximum compression ratio than other gases contained in air, diffuses backwards through the high vacuum pump to reach the spectrometer tube where it is detected in the normal manner. Although the optional mechanical forepump is also attached to the high vacuum pump foreline and removes all inlet gases, including some helium, there is no appreciable loss of sensitivity in the Contra-Flow™ leak detector. In fact, at higher test pressures, it is more sensitive than the conventional method.

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Spectrometer Tube

The spectrometer tube is the heart of the leak detector. The spectrometer tube and the leak rate indicator shown in Figure 1-7 provide a visual representation of the helium concentration in the vacuum system.

The spectrometer tube consists of the following components:

- ❑ Ion Source
- ❑ Preamplifier Assembly
- ❑ Analyzing Magnet Assembly
- ❑ Enhancement Magnets
- ❑ Cold Cathode Gauge

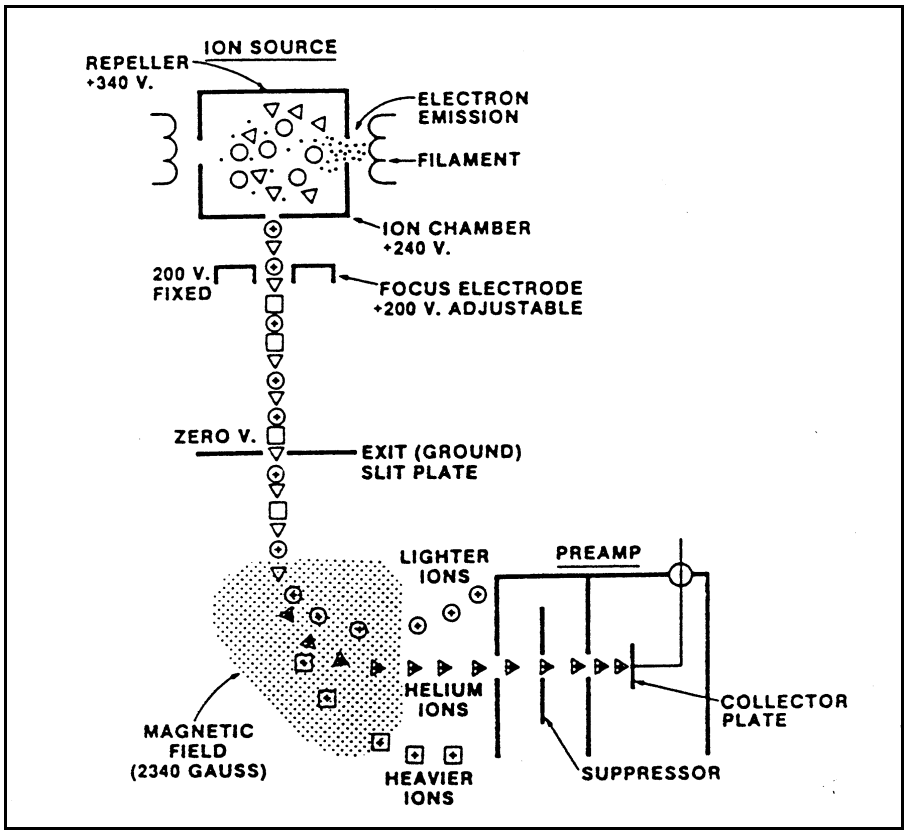


Figure 1-7 Spectrometer Tube Ion Flow

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Ion Source	The ion source consists of two filaments, two halves of an ion chamber, a pair of focus plates, and a grounded exit slit (the exit slit is a reZmovable part of the spectrometer tube). The top half of the ion chamber (the repeller plate) is held at a positive potential (repeller voltage) with respect to the bottom half of the ion chamber. The bottom half of the ion chamber is held at a positive potential (ion voltage) with respect to the grounded exit slit. Two focus plates are also held positive (variable focus and fixed focus) with respect to the bottom half of the ion chamber. When a filament is electrically heated, electrons are directed into the ion chamber with the help of the enhancement magnets. Electrons colliding with molecules produce positive ions. These ions are forced through the bottom of the ion chamber, the grounded potential exit slit, and enter the analyzing magnetic field. This magnetic field separates and allows only the helium ions to reach the preamplifier. The variable focus and ion chamber voltages require adjustment when ion sources are changed. This fine-tuning procedure produces an efficient, helium-sensing spectrometer tube.
Preamplifier Assembly	The preamplifier assembly consists of an ion collector assembly and a sensitive electrometer amplifier. The ion collector assembly includes: ❑ Ground potential electrodes to guide the beam of helium ions. ❑ A suppressor electrode to exclude any other ions. ❑ An ion collector electrode mounted on a low-leakage feed-through.
Analyzing Magnet	The magnetic field is generated by two blocks of Alnico V magnet material which are bonded to a mild steel yoke. The yoke connects the two pole pieces that define the magnetic field which separates the helium ions from the other ions.
Enhancement Magnets	External magnetic pole pieces on each side of the ion source enclosure direct the electron beam for maximum ionization and sensitivity.

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Section 2. Customer Integration

This section contains instructions for unpacking, inspecting, and installing the Vacuum Technologies 990 CLD leak detector. Also included are instructions for setting up the leak detector prior to actual operation.

The rack-mounted 990 CLD leak detector is intended for applications in which the leak detector components are permanently mounted. Once the instrument is installed and connected by manifold to a mechanical pump, it is expected that it will remain fixed at that location for an extended period.

Unpacking

The leak detector is shipped in a heavy duty carton with fitted styrofoam cushions for maximum shock protection. One carton contains the spectrometer tube already mounted to the high vacuum pump, the second contains the console assembly and cables, instruction manual, and accessories. Separate the cushions and save them with the carton if it is likely that the leak detector will be transported. Various articles of the vacuum system are shipped with protective covers of various types that must be removed prior to installation.

Inspection

Factory packing provides maximum protection during shipment. However, the leak detector and related items should be inspected immediatey after being removed from the packing carton(s). Any damage should be reported to the carrier without delay.

Be sure that you have received every item ordered.

Storing the Leak Detector

If the leak detector is not used immediately, store it as received without special precautions. A non-condensing, dust-free area is preferred.

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Leak Detector Location and Required Services

Vacuum Technologies recommends the use of either its SD-90, SD-200, SD-300, or SD-450 helium stable mechanical pumps. Do not use a pump that exhibits helium retention characteristics which cause high background.

The best arrangement for joining the leak detector and the mechanical pump is to use a stainless steel or aluminum vacuum-tight manifold whose ends match and abut the NW 16 connection at the high vacuum pump.

Services required for operation include:

- ❑ Power 115 VAC, 50/60 Hertz, 15 A service. (Option: 230 VAC, 50/60 Hertz)
- ❑ Helium, welding grade, standard cylinder with pressure regulating. valve and hose.

Care should be exercised in the selection of the size of a mechanical pump because its pumping speed is inversely proportional to the minimum detectable leak of the subsystem.

The discharge port (foreline) of the high vacuum pump requires a 16 mm KF-type fitting to connect it to the mechanical pump.

Installation

The spectrometer tube/high vacuum pump assembly can be mounted horizontally, or vertically with the spectrometer tube on the top of the assembly. Support rails must be added on the sides of the main electronics console when the console is mounted in a standard 19″ rack and when rack slides are not used.

When rack slides are used, Vacuum Technologies recommends the Model CTN-1-20 non-tilt, quick-disconnect slide manufactured by ZERO Corporation, Monson, MA.

Installation of the system consists of:

1. Performing “Electrical Connections” on page 2-3.
2. “Leak Rate Output Voltage Selection” on page 2-5, if required.
3. Setting the “Leak Rate Output Voltage Selection” on page 2-5.

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Electrical Connections

For this procedure, refer to Figure 1-1 on page 1-1, Figure 1-3 on page 1-6 through Figure 1-5 on page 1-10. Electrical connections include spectrometer tube, high vacuum pump, spectrometer tube integral ground, and ancillary connections.

To complete electrical connections:

1. Ensure that the MAIN POWER switch on the leak detector is in the off position.
2. Refer to "Wire Run Lists" on page 2-4 and terminate the high vacuum pump and spectrometer tube cables at the console using pluggable terminal blocks, with the exception of the cold cathode gauge cable and main power cable. This enables these cables to be cut to length to fit the application. Care must be taken to make the correct connections to the pluggable terminal blocks, if the cable length is adjusted. The cold cathode gauge connector (a high voltage SHV-type) must be cut and replaced if it is necessary to adjust its length. Ion source and preamplifier connections on the spectrometer tube are keyed to prevent accidental interchanging. Custom spectrometer tube cable lengths (20' maximum) are available upon request.
3. Connect the power cable to the appropriate power source.
4. Refer to "Wire Run Lists" on page 2-4 and perfom auxiliary connections as required for the application:
   - ❑ Four, 6 A, 250 VAC, form C, dry contacts are provided on a pluggable terminal block (labeled SET POINTS) on the rear panel of the console. These contacts either *make* or *break* an externally-connected circuit once the leak rate equals or surpasses the pre-programmed set points.
   - ❑ A pluggable terminal block provides the main control and I/O functions of the controller.
   - ❑ Five pairs of isolated connections are provided, one to turn on the filament in the ion source, one to turn it off, and three to control the display range. The level of voltage required to operate these functions is selected via the installation of five *OPTO-22* modules accessible at the rear panel of the console. Voltage ranges of 2.5 to 28 VDC, 35 to 60 VDC, or 120 VAC/DC are available.
   - ❑ A pair of connections provides an analog voltage output proportional to the leak rate as read by the spectrometer tube. The output is configured by four Internal jumpers. The output can be selected to be linear or logarithmic (Appendix A "Understanding the 990 CLD Analog Leak Rate Output" on page A-1). Changing the jumpers requires re-calibrating the output. Refer to 4"Maintenance" on page 4-1 for details. The factory default setting is linear output.
   - ❑ A pair of connections provides an analog voltage output proportional to the spectrometer tube pressure as read by the cold cathode gauge in the spectrometer tube. The output voltage ranges from 0 to 10 V indicating a minimum to maximum meter scale. The high pressure trip point for filament protection is approximately 4 V.

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- ❑ A 6 A, 250 VAC, form C, dry contact provides an indication that the spectrometer tube pressure is low enough for proper operation.
- ❑ A 6 A, 250 VAC, form C, dry contact provides an indication that the filament is operating.
- ❑ A 6 A, 250 VAC form C, dry contact provides an indication that the high vacuum pump is operational and that it is running at the selected speed. This relay changes state after the SENSITIVITY switch is changed while the pump shifts to its new operating speed.

Wire Run Lists

Table 2-1 Ion Source Cable Wire Run List

Octal Receptacle Pin No.	15-pin Connector (rear panel of Console)		Function
	Pin No.	Color	
1 and 4	1	WHT and BLK (two wires)	FILAMENT 1/FILAMENT2
2	3	RED	Variable Focus
3	5	ORG	Ion Chamber
N/C	7	Shield	Ground
5	9	VEL	FILAMENT 2
6	11	RN	Fixed Focus
7	13	BLU	Repeller
8	15	BRN and VIO (two wires)	FILAMENT 1

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Leak Rate Output Voltage Selection

The leak rate output voltage, on the 990 CLD leak detector rear panel, can be configured to vary linearly or logarithmically with the measured leak rate. For a logarithmic output format, either a 2 V/decade or 3 V/decade sensitivity is available (Figure 2-1).

NOTE

For logarithmic output, the shorting plugs shown in Figure 3-1 on page 3-14 must be in position A-1. Both shorting plugs shown in Figure 2-1 and Figure 3-1 must be in these positions at all times.

Refer to Appendix A "Understanding the 990 CLD Analog Leak Rate Output" for a discussion on choosing the best leak rate output format for a specific application. The accompanying graphs may aid in the conversion from output voltage to leak rate and vice versa.

The factory-set linear output voltage ranges from 0 V for a zero leak rate on the most sensitive scale to 10 V at full scale on the least sensitive scale. When the UNDER LED is lit on the Least Sensitive scale, the output voltage maximum is +10.7 V.

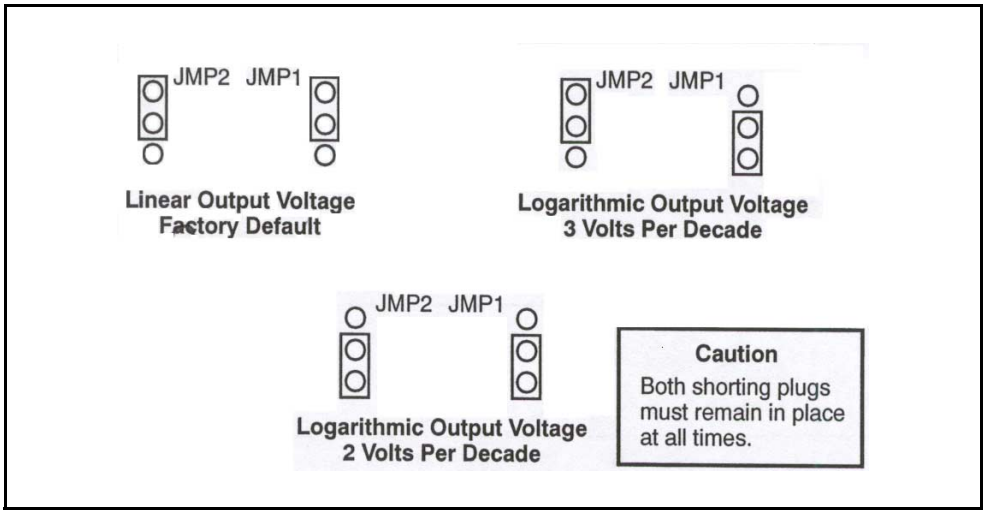


Figure 2-1 Leak Rate Output Voltage Selection

The logarithmic output voltage for the 2 V/decade choice ranges from near zero for a zero leak rate on the most sensitive scale to 8 V at full scale on the least sensitive scale. If the:

- ❑ UNDER LED is lit, the output voltage minimum is – 0.2 V.
- ❑ OVER LED is lit when on the Least Sensitive scale, the output voltage maximum is 10.7 V.

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Sensitivity

During the process of installing the 990 CLD leak detector and building the associated vacuum system, determining the sensitivity of the system is necessary. The detector is able to measure four decades of leak rate signal. For example, in a typical system with the V70D MacroTorr pump running at high speed, the four decades of leak rate might be 10^{-7}, 10^{-6}' 10^{-5}, and 10^{-4}. Running the MacroTorr pump at slow speed or using a V70 Turbomolecular pump in place of the MacroTorr pump would yield 10^{-8}, 10^{-7}, 10^{-6}, and 10^{-5} decades of leak rate. Table 2-2 indicates the effects of pump type and speed on the four decades of leak rate.

Table 2-2 Leak Rate Range for Pump Type and Speed

	Fast Speed	Slow Speed
Turbo Pump	10^{-8}, 10^{-7}, 10^{-6}, 10^{-5}	10^{-9}, 10^{-8}, 10^{-7}, 10^{-6}
MacroTorr Pump	10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}	10^{-8}, 10^{-7}, 10^{-6}, 10^{-5}

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.

Set the leak detector to display the desired for decades of leak rate measurement using the following parameters:

SENSITIVITY — Using the SENSITIVITY-SWITCH, set the speed of the high vacuum pump to high or low, depending on the sensitivity requirement of the system. The highest tolerable testing pressure is achieved with the switch in low sensitivity position.

RANGE SWITCH — Using the RANGE switch, set the exponent of the least sensitive range of the leak detector depending on the sensitivity of the vacuum system.

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Table 2-3 Preamplifier Cable Wire Run List

Octal Receptacle Pin No.	15-pin Connector (rear panel of Console)		Function
	Pin No.	Color	
1	2	RG-58 Center	Suppressor Voltage
2	4	RED	+15V
4	8	RG-58 Shield (multi-conductor shield)	Ground
5	10	BLK	–15V
6	12	GRN	Offset 2
7	14	RG-174 Center	Signal
8	15	RG-174 Shield	Signal Return

NOTE



A jumper is required in the 15-pin connector between pins 8 and 15.

Table 2-4 Turbo Cable Wire Run List

Pin No.	15-pin Connector (rear panel of Console)		Function
	Pin No.	Color	
Bayonet Connector			
A	1	RED	Pump Temperature Sensor
B	2	BLU	
C	3	GRN	3-Phase Power, 54 V
D	4	BLK	
E	5	Shield	Ground
F	6	VEL	Pump Temperature Sensor
Molex Mini-Fit Connector			
1	14	BLK or RED	Cooling Fan, +24 V
4	15	WHT or BLK	Cooling Fan, 24 V return

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Dismounting the Leak Detector

To disassemble the 990 CLD leak detector from the rack:

1. Shut down the leak detector.
2. Label and disconnect controller electrical connections.
3. Remove the leak detector carefully from the rack on the slides.

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Section 3. Operations

This section contains instructions for operating the 990 CLD leak detector. Due to the universality of the instrument, specific procedures for operating the leak detector vary according application. This section describes the features of the leak detector in detail and provides general operating guidelines to optimize the performance of the instrument.

NOTE



Shut off the power, vent the high vacuum pump, and allow it to stop before moving it

WARNING



Switch off the cold cathode high voltage lead before making a connection. The cold cathode high voltage lead has a potential of 2000 V when the MAIN POWER switch is on.

There are two types of procedures:

- ❑ “Required Daily Procedures” on page 3-2, which are done each time the leak detector is used.
- ❑ “As-Required Procedures” on page 3-8, which are done when warranted.

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Required Daily Procedures

Required daily procedures include:

- ❑ “Installation and Initial Setup Procedure” on page 3-2
- ❑ “Tuning Adjustments and Calibration Check” on page 3-4

Installation and Initial Setup Procedure

Complete this procedure at each startup:

1. Make all mechanical and electrical connections to the component parts of the leak detector.
2. Start the mechanical pump that is connected to the discharge line of the high vacuum pump.
3. Verify the control settings on the secondary panel of the console as shown on the Factory Calibration Data Sheet “990 CLD Leak Detector Factory Calibration Data” on page 2-xvii.
4. Move the MAIN POWER switch to the ON position.

   The spectrometer tube pressure gauge must measure upscale. If the meter does not measure upscale:

   a. Turn off the MAIN POWER switch.

   b. Check the connections to the COLD CATHODE high voltage SHV connector on the rear panel.

   c. Check the connections on the cold cathode gauge itself.
5. Verify that the fan on the high vacuum pump starts and that the HIGH VAC PUMP READY LED is lit.

   If neither of these actions occur within two minutes:

   a. Turn off the MAIN POWER switch.

   b. Check the connections to the HIGH VACUUM PUMP connector on the rear panel.

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6. When the spectrometer tube pressure meter indicates two-thirds of the way down in the green band (from right to left), move the FILAMENT switch on the secondary control panel to the ON/AUTO position.

   When the FILAMENT switch is in the ON/AUTO position, and the needle of the spectrometer tube pressure gauge reaches two-thirds of the way down the green band, the filament lights automatically.

   If the FILAMENT lamp fails to light, change the position of the FILAMENT 1, FILAMENT 2 switch.

   - ❑ If changing the FILAMENT 1, FILAMENT 2 switch position has no effect, turn off the MAIN POWER switch and check the connections to the ION SOURCE connector on the rear panel of the controller.
   - ❑ If changing to FILAMENT 2 results in the FILAMENT lamp lighting, then it is possible that Filament number 1 is burned out. Replace the ion source during the next scheduled maintenance period.

7. Ensure that the LEAK RATE display reads upscale.

   It the display does not read upscale:

   - ❑ Use the RANGE pushbuttons to select an appropriate scale.

   or

   - ❑ Use the ZERO potentiometers on the front panel and on the secondary control panel might require adjustment to obtain a reading.

   If an upscale LEAK RATE reading cannot be obtained:

   a. Turn off the MAIN POWER switch.

   b. Check the connections to the PRE-AMP connector on the rear panel.

8. Check the tuning and calibration of the leak detector as described in “Tuning Adjustments and Calibration Check” on page 3-4.

9. Check the functioning of equipment wired to the General I/O and SET POINT connectors.

   If it is desired to use the SET POINT function of the leak detector, refer to “As-Required Procedures” on page 3-8.

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Tuning Adjustments and Calibration Check

Each day, and as otherwise scheduled, properly tune the spectrometer tube helium sensitivity. This is generally done by using a standard reference leak of known value, called a calibrated leak. Two types of calibrated leaks are available: those with a helium reservoir* and those that operate on the capillary principle and require a helium source from the user.

* The calibrated leak contains a reservoir of helium which permeates through an internal glass barrier at a very low constant rate, whether the built-in valve is open or closed. Leave the valve open to prevent helium build-up and a sudden burst of helium on valve opening. This valve permit a zero check when using the calibrated leak and verifies the helium peak (but not adjacent peaks).

Vacuum Technologies:

- ❑ Calibrated leaks with a helium reservoir have constant leak rates in the ranges of 10^{-7} and 10^{-8} std cc/sec.
- ❑ Calibrated leaks operating on the capillary principle have constant leak rates of 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} std cc/sec.
- ❑ Tuning leaks are generally have an approximate leak rate signal of 10-6 std cc/sec at 100 milliTorr test port pressure.

Sensitivity

The range of the exponent display is preset at the factory to agree with the sensitivity of the system when the SENSITIVITY switch, located on the secondary front panel, is set to HIGH. When this SENSITIVITY switch is set from HIGH to LOW, the system's sensitivity is lowered by a factor of ten. However, the exponent range does not automatically reflect this sensitivity change and must be manually set.

Example

The system is operating at high sensitivity, and the exponent range is 10^{-8}, 10^{-7}, 10^{-6}, and 10^{-5}. If the controller is switched to low sensitivity, set the display's exponent range by decreasing the number on the RANGE SELECT switch from 5 to 4. The range of the exponent display is now 10^{-7}, 10^{-6}, 10^{-5}, and 10^{-4} (Table 3-3 on page 3-12).

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If the bar graph ZERO control is set such that none of the segments on the bar graph illuminate, the corresponding UNDER scale LED illuminates. Adjust the ZERO control so that one segment is lit (with no helium or leak present). If the OVER scale LED illuminates (along the 50 bar graph segments), select a larger leak range.

Initial positioning of the SENSITIVITY switch, when tuning and calibrating, depends on the test object leak size specification and the operating range of the device being used for tuning. Table 3-1 on page 3-5 indicates the suggested positions of the SENS1TIVITY switch under these conditions.

Example

If the anticipated test object leak rate specification is in the:

- ❑ 10^{-4} cc/sec range, then a calibrated leak in the 10^{-4}, 10^{-5}, or 10^{-6} range, or a tuning leak is appropriate.
- ❑ 10^{-8} range then a calibrated leak with a range of 10^{-8} or 10^{-9} is appropriate.

NOTE



If a direct-reading measured leak value is required, changing the position of the SENSITIVITY switch requires re-calibration. Normally, adjusting the CALIBRATE control accomplishes this.

Table 3-1 Suggested Setting of SENSITIVITY Switch for Tuning

Range of Test Object Leak Specification (cc/sec)[7]	Calibrated Leak Selection					Position of SENSITIVITY Switch
	Helium Reservoir Leak		Capillary Leak		Tuning Leak	
	10^{-8}	10^{-7}	10^{-5}	10^{-4}		
0^{-4}	x	x	x	x	LOW	
0^{-5}	x	x	x	x	x	LOW
0^{-6}	x	x	x	x	x	HIGH
0^{-7}	x	x	x	x	x	HIGH
0^{-8}	x	x			HIGH	
0^{-9}	x	x			HIGH	

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Tuning the Spectrometer Tube Using a Helium Reservoir Leak

The calibrated leak can be used for two functions:

- ❑ Tuning the spectrometer tube
- ❑ Calibrating the leak detector

These functions are normally performed at the same time, in the sequence indicated.

To tune the spectrometer tube:

1. Place the calibrated leak in the vacuum system as close as possible to the test chamber.
2. Open the valve on the calibrated leak and operate the vacuum system.
3. Start and run the leak detector.
4. Observe the leak rate indication on the LEAK RATE bar graph.

   It is probably less than that of the calibrated leak. If necessary, use the RANGE pushbuttons to set the largest reading without lighting the OVER SCALE LED.
5. Close the valve on the calibrated leak and check for a decrease in the displayed leak rate.
6. If required:
   - ❑ Carefully rotate the FINE ZERO adjustment to obtain a zero reading on the LEAK RATE display.
   - ❑ Move the COARSE ZERO adjustment on the secondary controls panel to obtain a zero reading on the LEAK RATE display.
7. Re-open the valve on the calibrated leak and observe the LEAK RATE display.
8. Use the RANGE pushbuttons to position the reading between 1 and 9 on the display.
9. Gently adjust the FOCUS control for a maximum reading on the LEAK RATE display, then adjust the ION control for a maximum peak on the LEAK RATE display.

   NOTE

   The ION control is a 10-turn potentiometer that normally only requires a slight adjustment for a maximum reading on the display. The detector is tuned to helium at the factory. When tuned to helium, the number on the outer dial at the 12 o'clock position should be between 2 and 8.

   If enhancement magnets have been disturbed or if extensive repair work was performed on the spectrometer tube, it might be necessary to adjust the enhancement magnets or reset the ion source emission current on the spectrometer tube. Refer to 6“Fundamentals of Leak Detection” on page 6-1 for enhancement magnet and emission current readjustment.
10. Repeat steps 5 through 9, as a change in one adjustment may affect others.

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Calibrating the Leak Detector

Calibration the detector is normally performed after tuning the leak detector to helium. If calibration is attempted before verifying tuning, the calibration procedure may not be successful. The Minimum Detectable Leak (MDL) is a function of pumping speed, vacuum system architecture, and electrical noise level. MDL, therefore, varies for each application. The following calibration procedure assumes that a calibrated leak of appropriate size is used.

Because of the variability of detector installations, it is difficult to provide an exact calibration of the gain (and possibly the emission current). In some cases, the normal peaking and calibration procedure below is all that is needed to achieve calibration. In approximately one-third of installations. however, the helium signal is too strong even for minimum gain. In those cases, move to the procedure that follows.

To calibrate the detector:

1. Verify that the detector has been tuned to helium as described in "Tuning the Spectrometer Tube Using a Helium Reservoir Leak" on page 3-6.
2. Place the calibrated leak in the vacuum system as close as possible to the test chamber.
3. Open the valve on the calibrated leak.
4. Start and run the leak detector.
5. Set the front panel RANGE pushbutton so that the exponent in the LEAK RATE display matches the exponent of the calibrated leak.
6. Close the valve on the calibrated leak and look for a decrease in the displayed leak rate.
7. If required:
   - ❑ Carefully rotate the ZERO adjustment to obtain a zero reading on the LEAK RATE display.
   - ❑ Move the COARSE ZERO adjustment on the secondary controls panel to obtain a zero reading on the LEAK RATE display.
8. Re-open the valve on the calibrated leak and observe the LEAK RATE display.
9. Adjust the CALIBRATE potentiometer so that the LEAK RATE display bar graph reading matches the value of the calibrated leak.

   If the display cannot be made to match the leak rate, then change the position of the SENSITIVITY switch and the RANGE SELECT switch and go to step 5. Refer to "Sensitivity" on page 3-4.
10. Repeat steps 6 through 8.

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To peak and calibrate the leak detector for a strong helium signal:

NOTE *Only use this procedure if the standard procedure above fails.*



1. Follow the normal peaking procedure.
2. Set the CALIBRATE potentiometer at minimum (fully counterclockwise).
3. Adjust the EMIS potentiometer (with the alignment tool provided with the leak detector) to bring the unit into calibration.
4. Check the emission current with a voltmeter between TP12 and TP13 on the leak detector main electronics PCB. The voltage reading should be between 0.2 V and 1.5 V. If calibration cannot be achieved with emission current in this range, then the scaling of the leak detector must be changed by the:
    a. Position of the SENSITIVITY switch located behind the door of the leak detector.
    b. Setting of the red RANGE SELECT switch which is accessible through the top cover of the leak detector.
    The calibration procedure (but not necessarily the peaking procedure) must be performed after changing either of these parameters.

This completes detector calibration.

As-Required Procedures

These include:

- ❑ “Set Point Operation” on page 3-9
- ❑ “Leak Rate Display RANGE SELECT Pushbutton Operation” on page 3-9
- ❑ “RANGE SELECT Switch” on page 3-10
- ❑ “Auto Filament Toggle Switch” on page 3-10
- ❑ “Remote Filament Control” on page 3-10
- ❑ “Remote Exponent Control Operation” on page 3-11
- ❑ “Gain-Selective Amplifier” on page 3-14

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Set Point Operation

There are four leak rate set points available on the leak detector. The set points are programmed on the front panel. Outputs relating to the set points are located in the SET POINT connector on the rear panel of the controller. Each set point output is a form C dry contact. If the instantaneous leak rate measured by the spectrometer tube is:

- ❑ Below the threshold of the set point, the NC and C connections of that set point are closed.
- ❑ Greater than or equal to the threshold of the set point, the ON LED in the SET POINT section on the front panel is lit and the NO and C connections of that set point are closed. The ON LED turns off when the leak rate falls back below the threshold.

To program any of the set points:

1. Use the RANGE pushbuttons to select the exponent of the desired set point threshold leak rate.
2. Press and hold the front panel DISPLAY pushbutton.
3. Turn the SET potentiometer using an alignment tool or a small-bladed screwdriver until the LEAK RATE displays the desired threshold point.
4. Release the DISPLAY pushbutton.

NOTE



The LEAK RATE display shows the set point threshold while the corresponding DISPLAY pushbutton is pressed and the measured leak rate reappears when all DISPLAY pushbuttons are released.

Leak Rate Display RANGE SELECT Pushbutton Operation

The range selection *wraps around*, for example, if the UP button is repeatedly pressed and released, the exponent number counts down through four decades of available leak rate, then jumps back to the highest exponent number, and then count down again. The reverse occurs when pressing the DOWN pushbutton.

Pressing and releasing the:

- ❑ UP button causes the bar graph to display a larger leak rate (a lower exponent number).
- ❑ DOWN pushbutton causes the bar graph to display a smaller leak rate (a higher exponent number).

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RANGE SELECT Switch

The RANGE SELECT switch determines the lowest exponent digit that appears. The switch setting does not affect the electrical sensitivity of the leak detector. This setting is used to match the displayed exponent to the exponent on a calibrated leak at the end of the Calibration Procedure. See Table 3-3 on page 3-12 for information on switch setting.

Auto Filament Toggle Switch

The 990 Controller includes circuitry that allows the filament to be lighted automatically once the spectrometer tube reaches an acceptable pressure. If the FILAMENT toggle switch is in the:

- ❑ OFF position prior to reaching the critical spectrometer tube pressure, light the manually by moving the switch to the ON/AUTO position.
- ❑ ON/AUTO position prior to reaching the critical spectrometer tube pressure, the filament lights automatically.

The filament can be turned off at any time by switching the FILAMENT toggle switch to the OFF position.

Some hysteresis is included in the filament control circuit. The filament control circuit lights the filament when the needle of the cold cathode gauge meter is two-thirds of the way down the green band (from right to left). The filament extinguishes when the needle rises to the upper edge of the green band. This hysteretic pressure margin eliminates oscillations in spectrometer tube pressure due to the transient outgassing of the filament as it lights.

Remote Filament Control

The 990 CLD leak detector includes a remote filament control feature. The OPTO-22 modules must be inserted into the back panel connectors of the 990 Controller (refer to Table 2-2 on page 2-6). When jumper *J11* on the main electronics board is in the:

- ❑ LOCAL position, it activates the front panel FILAMENT toggle switch.
- ❑ REMOTE position, the momentary actuation of the FILAMENT ON line turns the filament on if or once the spectrometer tube critical pressure is reached. A momentary actuation of FILAMENT OFF turns off the filament

The FILAMENT ON and FILAMENT OFF lines are accessed viaJ10 on the 990 Controller back panel.

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Remote Exponent Control Operation

Three isolated pairs of inputs are provided for remotely controlling the range that appears on the bar graph. The EXPONENT R/L pair, pins 15 (+) and 16 (-) of item 10 in Figure 1-5 on page 1-10, determine remote or local operation of display ranging.

- ❑ Apply a voltage of 5 V to this pair and the console reads ranging information from the rear panel inputs as opposed to reading the *Range UP*, and *DOWN* switches on the front panel.

The LSB and MSB pairs, positions 13 (+) and 14 (-) of item 10 (Figure 1-5 on page 1-10) and pins 17 (+} and 18 (-) of item 10, respectively, determine which of the four ranges are selected. MSB and LSB, taken together, represent a two-digit binary number:

- ❑ Voltage applied represents a *1*.
- ❑ No voltage applied represents a *0*.

This number, added to the number indicated on the RANGE SELECT switch, is the digit that appears as the exponent on the bar graph. Table 3-3 is a truth table for this function.

For example, if the RANGE SELECT switch is set to 3 and a voltage is applied to R/L and MSB and no voltage is applied to LSB. The console is in remote mode as R/L has voltage. The binary number from MSB and LSB is 2, because MSB is a *1* and LSB is a *0*, together they make 10 binary, which is 2 in decimal form. 5 appears as the exponent as the RANGE SELECT switch is set to *3* and the binary number is 2 (3 + 2 = 5).

Table 3-2 Exponent Selection, Local Mode

Range Select										
Switch Setting	0	1	2	3	4	5	6	7	8	9
Smallest exponent displayed*	0	1	2	3	4	5	6	7	8	9
Next largest*	1	2	3	4	5	6	7	8	9	B
Next largest*	2	3	4	5	6	7	8	9	B	B
Largest exponent displayed*	3	4	5	6	7	8	9	B	B	B

B = Blank exponent

* = Exponents are changed by pressing RANGE DOWN/UP pushbuttons

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Table 3-3 Remote Exponent Control Truth Table

Range Select Switch	R/L *	MSB#	LSB*	Displayed Exponent
See Table 3-2	0	x	x	Local Control
0	1	0	0	0
0	1	0	1	1
0	1	1	0	2
0	1	1	1	3
1	1	0	0	1
1	1	0	1	2
1	1	1	0	3
1	1	1	1	4
2	1	0	0	2
2	1	0	1	3
2	1	1	0	4
2	1	1	1	5
3	1	0	0	3
3	1	0	1	4
3	1	1	0	5
3	1	1	1	6
4	1	0	0	4
4	1	0	1	5
4	1	1	0	6
4	1	1	1	7
5	1	0	0	5
5	1	0	1	6
5	1	1	0	7
5	1	1	1	8
6	1	0	0	6
6	1	0	1	7
6	1	1	0	8
6	1	1	1	9

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Table 3-3 Remote Exponent Control Truth Table (Continued)

Range Select Switch	R/L *	MSB#	LSB*	Displayed Exponent
7	1	0	0	7
7	1	0	1	8
7	1	1	0	9
7	1	1	1	Blank
8	1	0	0	8
8	1	0	1	9
8	1	1	0	Blank
8	1	1	1	Blank
9	1	0	0	8
9	1	0	1	Blank
9	1	1	0	Blank
9	1	1	1	Blank

*1 = Energized
2 = De-energized

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Gain-Selective Amplifier

The gain-selective amplifier on the I/O Control Board (PN L9057) facilitates the interfacing of external sensors to the *Leak Rate* output terminals located on the Controller rear panel. Set the gain at the jumper strip (J1) to coincide with the desired leak rate decade and to ensure an analog output of 0 to 10 VDC at the rear panel connector. This output is directly proportional to the leak rate being measured and will not exceed –200 mV and +10.7 VDC.

The new I/O board includes a jumper strip (J1) with two interchangeable shorting plugs.

To set the gain:

- ❑ Use tweezers or needle-nosed pliers to configure the shorting plugs as per Table 3-4 and Figure 3-1.

Table 3-4 Shorting Plug and Leak Rate Outputs

Leak Rate Decade	Shorting Plug	Shorting Plug	Leak Rate Output
10^{-5} std cc/sec (factory-set)	A	1	0 to 10 V (setting for log scale)
10^{-6} std cc/sec	A	2	0 to 10 V
10^{-7} std cc/sec	A	3	0 to 10 V
10^{-8} std cc/sec	B	4	0 to 1 OV

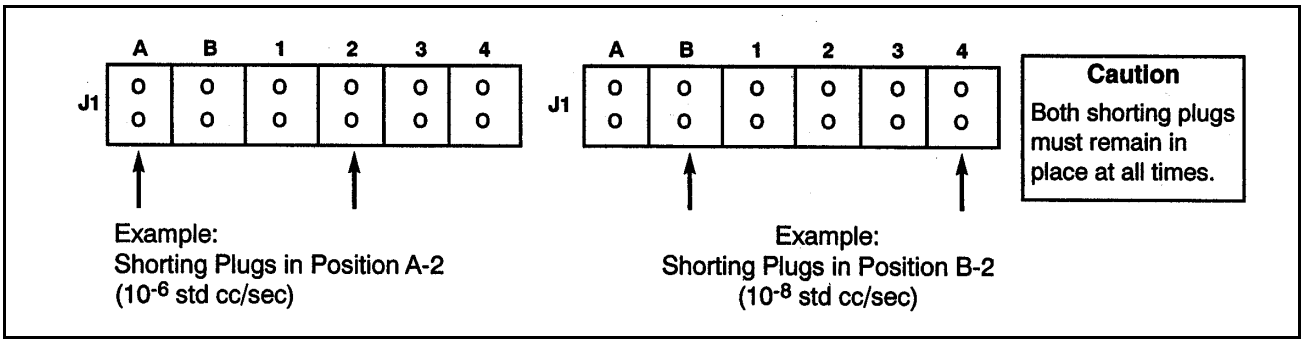


Figure 3-1 Setting the Gain via Shorting Plugs

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Startup and Shutdown

If the 990 CLD leak detector is to be idle for more than eight hours, the high vacuum pump-bearing life can be prolonged by turning off the MAIN POWER switch. Main power to the detector can also be cut without any damaging effects, as would be the case if the console were part of a larger system.

Before lighting the filament:

1. Ensure that the spectrometer tube pressure gauge reads in the green band.
2. Ensure that the HIGH VAC PUMP READY LED is lit.

NOTE



The leak detector contains circuitry to prevent the filament from being turned on if the pressure in the spectrometer tube is too high. This circuitry also turns off the filament if the pressure in the spectrometer tube rises to unfavorable levels. A unintentional interruption in main power to the leak detector causes the filament to turn off and the high vacuum pump to shut down. When main power is restored, the high vacuum pump recovers to its correct speed. The filament, however, must then be re-lighted. The four set points are non-volatile, thus they are not affected by interruptions of main power.

NOTE



The high vacuum pump controller in the leak detector protects the high vacuum pump against over-temperature or over-current conditions. However, for maximum high vacuum pump life, design the system in which the leak detector is used such that it can be powered only if backing pumps connected to the leak detector are also powered. If any part of the leak detector is to be removed from the vacuum system and transported, pack the parts in their original shipping containers with all appropriate protective covers in place. This minimizes damage and contamination that can occur during shipping.

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Section 4. Maintenance

NOTE



CLEANING THE SPECTROMETER TUBE — Due to the effective cleaning nature of VacuSolv solvent and its residue-free properties, the Vacuum Technologies Vacuum Component and Spectrometer Tube Cleaning Kit (PN 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.

Do not use silicone oil or silicone grease. Although these products are generally excellent for vacuum systems, they cause loss of sensitivity in mass spectrometer leak detectors through build-up of invisible insulating layers in the spectrometer tube.

CAUTION



Do not use Freon TF or other solvents on O-rings. Doing so causes deterioration and reduces their ability to hold a vacuum. Wipe with a clean, lint-free cloth and use a small amount — just enough to make the O-rings shiny — of Apiezon L grease (PN 5000695400004).

Where applicable, inspect for any damage to O-rings. Remove them carefully with your fingers. Do not use any metal tools for this task which can scratch the sealing surfaces.

CAUTION



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

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Like other sensitive test equipment, a mass spectrometer leak detector requires periodic maintenance to ensure continued reliable operation. For simplicity, the maintenance functions in this section are grouped by recommended frequency, as shown in Table 4-1, based on everyday use.

Figure 4-1 Scheduled Maintenance

Description	Daily	Annually
Calibration check and tuning adjustments. See "Tuning the Spectrometer Tube Using a Helium Reservoir Leak" on page 3-6 and "Calibrating the Leak Detector" on page 3-7.	x	
Complete overhaul, including spectrometer tube. See "Annual Maintenance – Complete Overhaul" on page 4-3.		x

The sensitivity should always be checked at least once a day. However, other functions may be carried out either more or less often, depending on the frequency of use.

Some maintenance functions may be required on a demand basis for example, changing an ion source after filament failure. These functions are listed in Table 4-5 and also included in the complete overhaul. Refer to "Annual Maintenance – Complete Overhaul" on page 4-3.

Table 4-5 As-Required Maintenance

Function	Most Common Symptom
Spectrometer tube cleaning. See "Removing, Cleaning, and Re-installing the Spectrometer Tube" on page 4-5.	Loss of sensitivity, increase in background, tuning is high on ion dial (near 10)
Ion source replacement. See "Ion Source Replacement" on page 4-8.	Filament failure – as soon as convenient after second filament is in use
Cold cathode gauge cleaning. See "Cold Cathode Gauge Cleaning" on page 4-9.	Instability in spectrometer tube pressure and leak rate display. Also, whenever ion source is replaced.

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Daily Maintenance

Leak Detector Sensitivity Check

- ❑ Perform the calibration check and tuning adjustments.
- ❑ If specifications cannot be met, call a Vacuum Technologies Service Representative.

Annual Maintenance – Complete Overhaul

After prolonged use, the leak detector accumulates contaminants from even the cleanest of products tested. These contaminants eventually impair operation but a thorough disassembly and cleaning of the spectrometer tube restores normal operation.

The three procedures given in “As-Required Maintenance”, if done annually for a leak detector in daily use, prevent deterioration and sustain a high level of performance. For heavy production use, more frequent overhauls may be needed. In most cases, this work is done by user maintenance personnel, but it can also be done by Vacuum Technologies under the terms of a service contract.

The following tools and parts are required for the overhaul:

Tools:
- ❑ Screwdrivers (regular and Phillips}
- ❑ 9/16” open-end wrench
- ❑ Retaining ring pliers

Parts:
- ❑ Ion Source
- ❑ O-rings
- ❑ Freon
- ❑ Methanol
- ❑ Lint-free cloth
- ❑ Scotchbrite™* abrasive metal finishing pads. Do not use crocus cloth.

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As-Required Maintenance

During normal operation of the leak detector, contaminants build up in the spectrometer tube, and eventually require it to be disassembled and thoroughly cleaned. While it is difficult to predict how long a spectrometer tube will operate satisfactorily between disassembly and cleaning, it is possible to recognize the signs of a tube approaching the need for maintenance. Careful tracking of the tuning parameters is often used to predict preventive maintenance intervals.

During operation, organics from the parts being tested and the operating environment build up within the ion chamber of the spectrometer tube. The contaminants typically take the form of non-conductive organic deposits, usually dark brown in color, and are primarily deposited on the ion source, ground slit plate, and within the ion beam bending chamber in the tube. The level and location of these deposits result in changes to the tuning parameters as the deposits build up. Since deposits build up on all three areas of the spectrometer tube simultaneously, the effects described below typically occur together. In addition, these deposits usually increase the apparent background signal in the machine since they can trap helium within their layers over time. In extreme cases, the result is not being able to zero out the background, a condition often referred to as *running out of zero*.

Deposits on the ion source cause the ion beam exiting from the ion source to widen, de-focus, and vary in exit velocity and a loss of sensitivity in the leak detector. This shows up as requiring an increased amount of CAL gain to calibrate the leak detector. Maintenance is required when the CAL pot cannot be increased clockwise far enough to allow the machine to read the calibrated leak correctly. This condition is often referred to as *running out of electronic gain*. This loss of sensitivity is often accompanied by an increase in instability, particularly at the most sensitive range of the instrument.

Deposits on the ground slit plate cause shifts in the FOCUS adjustment. While cleaning or replacement of the ground slit plate sometimes partially remedies the problem, it is best to disassemble and clean the entire spectrometer tube when this condition is encountered.

Deposits in the ion beam bending chamber cause shifts in the ion voltage required to tune to helium. Normally, the instrument tunes with the ION dial set to about 4, indicating an ion voltage of about 250 V. As these deposits build up, the ION voltage must continually be increased to maintain tuning to helium. Correction of this condition requires disassembly and cleaning of the entire spectrometer tube.

Continually lowering ion voltages, until a peak cannot be obtained, is an indication of weakening magnets and that they need replacement. Contact the factory (1-800-8VARIAN, or 1-800-882-7426) to arrange for a spectrometer tube advance exchange.

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There are three types of maintenance, generally restricted to the spectrometer tube:

- ❑ For the procedure on removing, cleaning, and re-installing the spectrometer tube, refer to “Removing, Cleaning, and Re-installing the Spectrometer Tube” below.
- ❑ For instructions on replacing the ion source while the spectrometer tube is removed from the vacuum system, turn to “Enhancement Magnet Adjustment” on page 4-8.
- ❑ For instructions on cleaning the cold cathode gauge while the spectrometer tube is removed from the vacuum system, refer to “Ion Source Replacement” on page 4-8.

Removing, Cleaning, and Re-installing the Spectrometer Tube

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 atmosphere. Rebuilt spectrometer tubes are also available from Vacuum Technologies Products on an exchange basis. Contact the Vacuum Technologies Service Center (1-800-8VARIAN) for details.

Tools:
- ❑ Phillips head screwdriver

Parts:
- ❑ Scotchbrite™ pads
- ❑ Freon TF
- ❑ Methanol
- ❑ Lint-free cloth
- ❑ Ion source
- ❑ O-rings

1. Turn off the MAIN POWER switch on the front panel.
2. Remove the three electrical plugs at the top of the spectrometer tube and the bonding wire at the bottom of the spectrometer tube.
3. Remove the KF clamp on the spectrometer tube and break the vacuum connection.
4. Remove the spectrometer tube from the vacuum system.
5. Loosen the magnet pole piece set screws, remove three mounting screws, and remove the magnet assembly.

CAUTION



Do not disassemble the magnet assembly. Do not place the magnet on a steel or iron surface. Doing so weakens the magnetic field.

NOTE



Before proceeding, note the orientation of the anode of the cold cathode gauge by viewing it through the KF port of the spectrometer tube.

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6. Remove the cold cathode gauge housing, disconnect the high-voltage connector at the gauge header, and remove the ion source and preamplifier.
7. Discard the ion source or return it to Vacuum Technologies for exchange.

   Handle the other two parts by the flanged pin end only to prevent contamination by skin contact.
8. Slip out the baffle between the cold cathode gauge and the ion source cavities.
9. Carefully remove the ground slit plate from the ion source cavity, using a split-blade, screw-holding screwdriver.
10. Remove the four screws on each side of spectrometer tube body and slip out both pole pieces.
11. Discard O-rings.
12. Using a Scotchbrite™ pad, remove any heavy deposits from the surfaces of the baffle, ground slit plate, cold cathode gauge liner, and anode loop, until bare metal surfaces are exposed.

CAUTION



Under no circumstances use a chemical cleaner — especially strong detergents or alkaline cleaners. Do not use Alconox or a similar type of detergent. Do not use crocus cloth, as it leaves a residue.

13. Rinse the spectrometer tube body, pole pieces, baffle, ground slit plate, and cold cathode gauge parts in a Freon-type solvent (DuPont Freon TF or equivalent).
14. If foreign matter or stubborn stains remain, remove them with a Scotchbrite™ pad (metal finishing grade).
15. Rinse again in Freon-type solvent, then rinse with methanol.
16. Allow all parts to air-dry — DO NOT use compressed air to blow dry.
17. Using new O-rings, reassemble the spectrometer tube pole pieces (the pole pieces are interchangeable) and the magnet assembly.
18. Wipe all the O-rings clean with a lint-free cloth.
19. Install the ground slit plate with the prongs facing up.

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20. Align the slit at 90° with the side walls of the spectrometer tube.

    This also concentrically aligns the circular hole in the plate with the smaller guide hole in the bottom of the ion source cavity.

21. Install the baffle through the cavity for the cold cathode gauge — alignment is not necessary.

22. Wipe the new O-ring and mating surfaces with a clean lint-free cloth and place the new ion source in the cavity.

    The locating pin should be in the center of the guide hole. Be sure pins 1 and 8 are parallel to the sidewall of the spectrometer tube.

23. Tighten the hold-down flange evenly and firmly holding a straight edge against pins 1 and 8 of both octal arrays to assure parallelism.

24. Install the preamplifier and cold cathode gauge, using new O-rings.

25. Tighten the clamps evenly and securely.

26. Install the cold cathode gauge housing and check it for proper orientation.

    The anode should be visible when viewed through the KF port of the spectrometer tube.

27. Install the spectrometer tube in vacuum system.

28. Re-attach the magnet assembly, and before tightening the set screws, ensure that the cylindrical pole pieces make metal-to-metal contact with the spectrometer tube body.

29. Attach the spectrometer tube to the vacuum system.

30. Start the mechanical pump in the vacuum system and turn the MAIN POWER switch to the ON position.

31. When the spectrometer tube pressure is in the green band, proceed to re-tune the leak detector as described in “Tuning Adjustments and Calibration Check” on page 3-4.

    For optimum operation, allow the leak detector to stabilize for two hours after cleaning the spectrometer tube.

32. Tune and calibrate the leak detector.

    For instructions on tuning and calibrating the leak detector, refer to:

    - ❑ “Tuning the Spectrometer Tube Using a Helium Reservoir Leak” on page 3-6
    - ❑ “Calibrating the Leak Detector” on page 3-7.

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Enhancement Magnet Adjustment

This adjustment is normally needed only after a new ion source has been installed.

To perform this adjustement:

- ❑ Slowly rotate the each large, black knob on the spectrometer tube through 360° to find the respective points at which the leak rate reading is the greatest.

NOTE

It is possible to rotate each knob beyond 360° and thus repeat the high-low reading, however, this is not recommended since the knobs are preset at maximum at the factory prior to shipment, and should require very minor adjustment.

Ion Source Replacement

The ion source has two filaments. The spare is turned on by the filament selector switch (FILAMENT 1 or 2). Slight re-tuning may be necessary to obtain maximum sensitivity. It is recommended that the ion source be replaced as soon as convenient after the spare filament has been put into use. Replacement takes approximately three minutes.

Tool: Phillips-head screwdriver

Part: Ion Source

To replace the ion source:

1. Turn off the MAIN POWER switch on.
2. Vent the vacuum system to atmosphere by first loosening the spectrometer tube KF clamp, then carefully tipping the spectrometer tube from the turbo pump.

   This causes an inrush of air that floods both the spectrometer tube and turbo pump. The spectrometer tube can now easily be removed.
3. Remove the ion source connector at the spectrometer tube.
4. Remove the four screws that secure the ion source clamp, then gently slide the ion source out of spectrometer tube body.

   You can discard the ion source or return it to Vacuum Technologies for exchange.
5. Inspect the ground slit plate and ion source cavity to verify that they are clean.

   If not, follow the applicable instructions in steps 5 through 17 in “Removing, Cleaning, and Re-installing the Spectrometer Tube” on page 4-5 to clean the spectrometer body and the ground slit plate.
6. Perform steps 19 through 32 in “Removing, Cleaning, and Re-installing the Spectrometer Tube” on page 4-5 to install ground slit plate and ion source, and to prepare the leak detector for operation.

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Cold Cathode Gauge Cleaning

This procedure is usually performed whenever the ion source is changed.

Tools:
- ❑ Phillips-head screwdriver

Parts:
- ❑ Scotchbrite™ pad
- ❑ O-ring (2-025)
- ❑ Freon TF
- ❑ Methanol

To clean the gauge:

1. Perform steps 1 through 4 in “Removing, Cleaning, and Re-installing the Spectrometer Tube” on page 4-5.
2. Remove the cold cathode gauge housing and disconnect the high-voltage wire at the gauge header.
3. Remove the two screws that secure the cold cathode gauge header, then slide the cold cathode gauge and cathode liner out of spectrometer tube body.
4. If the cathode liner is dirty, clean it with a Scotchbrite™ pad or replace it.

   If the anode must be removed:

   a. Remove the side pole pieces.

   b. Prevent cracking the ceramic feedthrough by very carefully twisting the anode clockwise to loosen it while at the same time pulling it. Doing so appears to screw the loop onto the pin, but in fact, it loosens the grip of the anode onto the feedthrough.
5. Remove dirty deposits from all parts with Scotchbrite™ pad.
6. Rinse all parts, except the O-ring, with Freon and methanol.
7. Re-assemble the parts in reverse order, except the anode loop. This must be turned in the same direction as during removal.
8. Install the cold cathode gauge, preferably with a new O-ring, then wipe the O-ring and mating surface with a clean, lint-free cloth.
9. Perform steps 19 through 32 in “Removing, Cleaning, and Re-installing the Spectrometer Tube” on page 4-5 to install ground slit plate and ion source, and to prepare the leak detector for operation.

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Electronics System

This section is limited to electronic adjustments and replacement at the PCB level.

The following procedures are associated with the leak detector electronics and are performed as necessary:

- ❑ "Emission Control Adjustment"
- ❑ "Ion Source Voltages Range Validation" on page 4-11
- ❑ "Overpressure Protection Adjustment" on page 4-12
- ❑ "Amplifier Offset Adjustment" on page 4-13
- ❑ "Residual Background Check" on page 4-14

For all of the following adjustments, it is assumed that:

- ❑ The leak detector has been previously started up.
- ❑ There is a calibration leak or tuning leak attached to the vacuum system and that the leak detector is displaying the leak rate.

Emission Control Adjustment

Make a front panel screwdriver adjustment after an ion source replacement, when there is not enough sensitivity to calibrate to the value of the standard leak in use, or to significantly lower the sensitivity for locating large leaks. It may also be necessary if the SENSITIVITY switch is placed in the LOW position, and still must be calibrated to a reduced sensitivity.

To adjust the emission control:

1. Verify that filament 1 or 2 is turned on.

WARNING *High voltages are present on the main electronics console.*



2. Remove the metal and plexiglass safety cover on the front panel.

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3. Use a DC voltmeter to measure the voltage between test points TP4 (Gnd) and TP5 (+).

CAUTION



Adjusting the voltage in the following step to more than 1.50 VDC may shorten the life of the ion source filaments.

4. Adjust the screwdriver EMIS control to peak the leak rate display.

   When tuning, the emission control may be re-adjusted to obtain more sensitivity, however, the preceding Caution should be carefully noted. See "Tuning the Spectrometer Tube Using a Helium Reservoir Leak" on page 3-6.

5. Tune and calibrate the leak detector in accordance with "Tuning the Spectrometer Tube Using a Helium Reservoir Leak" on page 3-6.

Ion Source Voltages Range Validation

Sometimes it is important to know if the ion source tuning voltages have sufficient span or are in the correct range. This is especially true after ion source replacement or when it is not possible to tune the spectrometer tube so that it is sensitive to helium. Comparison with the following steps indicates if the voltages are in the correct range.

To check the ion source voltages:

1. Set the ION and FOCUS controls fully counterclockwise.
2. Set the RESIDUAL BACKGROUND switch to the CHECK position.
3. Using a voltmeter with an input impedance of at least 100,000 Ohms/V, measure the ion voltage between test points TP1 (+) and TP4 (-) on the front panel, then rotate the ION control fully clockwise and measure the voltage again.

   The following readings should be obtained (± 10%):

TPI -TP4	Ion Voltage	ccw = 160 VDC cw = 330 VDC

   Leave the ION control in the fully clockwise position.

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4. Measure the repeller voltage between TP2(+) and TP4(-). Then move the RESIDUAL BACKGROUND switch to the RUN position.

   The following readings should be obtained (± 10%):

TP3 -TP4	Repeller Voltage	CHECK = 330 VDC RUN = 430 VDC

   Leave the switch in RUN position.

5. Measure the focus voltage between TP3(+) and TP4(-). Then rotate the FOCUS control fully clockwise and measure the voltage again.

   The following readings should be obtained (± 10%):

TP3 -TP4	Focus Voltage	ccw = 310 VDC cw= 250 VDC

   If all the voltages are within the designated ranges, the ion source should be working properly. It may then be necessary to readjust the ION and FOCUS controls in order to properly tune the spectrometer tube.

Overpressure Protection Adjustment

This adjustment is made with the cover of the leak detector and the main electronics safety shield removed.

To adjust the overpressure protection:

1. Set the MAIN POWER switch to the OFF position.

   WARNING *The high-voltage lead has a potential of 2000 V when the MAIN POWER switch is ON. Be sure the switch is off before making the following connection.*

2. Remove the plug from the cold cathode gauge SHV connector on the rear panel and connect a 50 MOhm, 2 W (minimum) resistor between the center pin and ground of the SHV receptacle.
3. When the resistor is properly positioned, set the MAIN POWER switch to the ON position.

   The SPECTROMETER TUBE pressure meter should indicate two-thirds of the way down the green band (from right to left).

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4. Set the FILAMENT switch to the ON position to energize the spectrometer tube filament and verify that the green FILAMENT indicator is lit.
5. Adjust R58 counterclockwise very slowly until the FILAMENT indicator turns off.

   This turns off the ion source filament whenever the spectrometer tube pressure rises above the top of the green band (0.25 milliTorr).
6. With a voltmeter attached to the general connector I/O pins 5 (+) and 6 (-), adjust R19 on the I/O PCB assembly in the rear of the unit for 4 V on the meter.
7. Replace the safety shield on the main electronics and replace the cover when servicing adjustments are completed.
8. Ensure to set the MAIN POWER switch to OFF. Remove the 50 MOhm resistor from the SHV connector.

Amplifier Offset Adjustment

There are four amplifiers associated with the spectrometer tube and the leak rate display: a preamplifier module in the spectrometer tube body and three amplifiers in the controller. If the amplifiers require re-zeroing.

To re-zero amplifier offset:

1. Make certain that connectors JMP 1 and JMP 2 on the upper right-hand corner of the I/O Control Board (the smaller of the two boards at the back of the Controller) have jumpers across their upper two pins.

   Make certain that connector J1 on the I/O Control Board (on the left side in the center of the board) has jumpers across pins A and 1.
2. With the power shut off, remove the preamp connector on the rear panel of the Controller.
3. Short together pins 8, 14, and 15 on the preamp connector mounted on the rear of the Controller.
4. Connect a mV meter to the LEAK RATE pins GENERAL 110 connector.
5. Disconnect the plug from J3 on the soldered side of the display PCB and turn on the Controller.
6. Adjust R22 on the 110 Control Board until the mV meter reads 0 V ± 0.5 mV.
7. With the bargraph set to the most sensitive scale, adjust R77 on the display PCB so that 1 bar is lighted on the bargraph, then remove the shorts on the preamp connector, and reconnect the plug to J3.
8. Calibrate the leak detector as described in “Calibrating the Leak Detector”.
9. Replace the safety shield and the top metal cover on the Controller.

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Residual Background Check

Once testing is complete and helium is no longer entering the leak detector through a leak, the vacuum system rapidly removes the remaining helium. However, a small residual amount, called background, is usually present. Normally, this background is steady and can be cancelled by zeroing the leak-rate display. It is sometimes useful to measure background as an indication of a dirty system which needs cleaning or overhaul.

To run a residual background check:

1. Start and run the leak detector.
2. Verify that the leak detector is tuned and calibrated.
3. *Valve-off* the test chamber.
4. Place the RESIDUAL BACKGROUND switch in the CHECK position to make the leak detector almost completely insensitive to all gases, including helium.
5. Select the most sensitive RANGE.
6. Adjust the fine and course ZERO controls until the leak rate display indicates zero, then set the RESIDUAL BACKGROUND switch to the RUN position. The resulting reading is background.
7. Re-zero the leak rate display before using the leak detector.

   If the background reading is more than one-half scale in the second most sensitive range, the vacuum system may be contaminated or it may have a leak.

Subassembly Replacement

If a problem is isolated to a subassembly, replace the entire subassembly so that leak testing can continue without prolonged interruption. Refer to 5“Parts List” for a list of replacement subassemblies and their corresponding Vacuum Technologies part numbers.

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Troubleshooting

This section is a general guideline to help diagnose and correct common problems that may be encountered on 990 CLD-based leak testing systems. For additional assistance on specific 990 CLD leak detector issues, please contact Vacuum Technologies.

General

Start by recording all symptoms encountered, including any quantitative data. Be sure to keep a calibration and maintenance log, and keep it current.

Prior to the discussion of the symptoms listed below, it is assumed that you have already verified some very basic corrective actions that apply to all of the symptoms:

- ❑ The power cord is connected.
- ❑ All cables between the 990 Controller and the turbo pump and spectrometer tube are properly installed, and that the cable clamps at the spectrometer tube are in place.
- ❑ All connections between the 990 Controller and the testing station are properly installed.
- ❑ If applicable, that the oil level and color in all mechanical pumps has been checked or that the oil was recently changed.
- ❑ All OPTO-22 input modules are firmly attached to the connectors at the rear of the 990 Controller.
- ❑ Re-check that all controls for calibration and that set points are in their proper positions. Consult your maintenance log and setup processes for this information.

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Leak Detector Self-Test

Accuracy, reliability, and stability of any mass spectrometer leak detector depends on the leak-free integrity of its own vacuum system. Inherent helium background and its effect on sensitivity demands elimination of all detectable leaks. If performance degrades during operation or after some part of the vacuum system has been opened for service, a methodical leak check can eliminate the possibility of a leak as the cause.

The following suggestions apply whether leak-checking components, systems, or the leak detector itself:

- ❑ When spraying suspected leak locations, always apply helium sparingly, starting at the highest points first, since helium rises. If drafts, such as from a cooling blower, exist in the area, apply helium downstream from the source first, or deflect the draft until leak checks are completed.
- ❑ If vent grooves exist at flanges or other assembled seals, apply helium sparingly to these points rather than broadly spraying the area with helium. Minimizing the use of helium saves time and increase the accuracy of locating the leak.
- ❑ Locate and repair large leaks before attempting to locate extremely small leaks.
- ❑ Limit search to a general area of the test piece by isolation methods. Bagging, masking, or shielding with tape, plastic film, or duct seal, if applied properly, shortens the time required to locate both large and small leaks.

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Symptom Checklist

- ❑ "High Vacuum Pump Ready Light Does Not Illuminate"
- ❑ "Spectrometer Tube Pressure is High (above the green band)" on page 4-18
- ❑ "Filament Does Not Turn On" on page 4-18
- ❑ "There Is No Helium Response" on page 4-18
- ❑ "Station Fails to Pump Down While Displaying Gross Vacuum Failures" on page 4-20
- ❑ "There is an unusually High Number of Rejects" on page 4-20
- ❑ "Miscellaneous Problems" on page 4-21

High Vacuum Pump Ready Light Does Not Illuminate

1. Verify that the turbo fore pump is powered, running, and producing a foreline pressure less than 5 Torr (5000 milliTorr) while the leak detector is operating in the low sensitivity mode (maximum is 1 Torr when in the high sensitivity mode). This applies to the Vacuum Technologies Model V70D MacroTorr pump only.If the system contains a Vacuum Technologies Model V70 Turbo pump, the forepressure must be less than 0.5 Torr (500 milliTorr) while the leak detector is operating in the low sensitivity mode (maximum is 200 milliTorr when in the high sensitivity mode). If it is greater than either value, the turbo pump or controller may trip off on an overload. To resume operation, determine and correct the cause of high forepressure, then turn the controller off then back on to reset the circuit.
2. With the power on:

   Foreline pressure should be:

   - ❑ ≤ 5 Torr for low sensitivity for the V70D
   - ❑ ≤ 1 Torr for high sensitivity for the V70D
   - ❑ ≤ .5 Torr for low sensitivity for the V70
   - ❑ ≤ .2 Torr for high sensitivity for the V70
3. Check the HI VAC PUMP fuse. If blown, it may be safely replaced with a 3 A Slo-Blo fuse for 120 V units or a 1.5 A fuse for 240 V units.
4. Check for a disconnected or damaged turbo pump cable.

NOTE



Allow up to 45 minutes for a newly-installed pump to reach full speed (the HIGH VACUUM PUMP READY light is lit). If the light fails to light, replace the 990 Controller to determine if the controller is at fault. Replace the pump if a new Controller doesn't solve the problem.

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Spectrometer Tube Pressure is High (above the green band)

1. Test the cold cathode gauge by removing the cable. The spectrometer tube pressure reading should go into the green band.
2. Remove coaxial cable and the spectrometer tube pressure reading should go into the green band. **To reviewer: What if it does not? Is the Controller replaced?**

NOTE



With the COLD CATHODE cable removed from the spectrometer tube, if the pressure drops to the bottom of the green band, replace the cold cathode gauge or the entire spectrometer tube. Either the cold cathode gauge insulator feedthrough is dirty or a vacuum leak exists in the spectrometer tube.

Filament Does Not Turn On

Verify that the HIGH VACUUM PUMP READY light is lit and that the SPECTROMETER tube pressure meter is in the green band.

- ❑ If the FILAMENT light flashes on and off (indicating that your PLC is trying to turn it on), the filament is probably burned out. Switch to the other filament, replace the ion source (or the entire spectrometer tube).
- ❑ If the 990 Controller was just replaced, it may be necessary to increase the EMISSION adjustment by turning it approximately five turns clockwise.
- ❑ If the filaments check OK using a continuity check, manually turn on the filament using the leak detector front panel switch. If it fails to stay on, check the back of the leak detector to ensure that the PLC is turning on:
  - ❑ Check the FILAMENT ON OPTO-22 module to see if it is lit, or
  - ❑ Check if the FILAMENT OFF OPTO-22 is held on, keeping the filament off.
- ❑ If the FILAMENT OFF signal is asserted but the conditions are OK to turn it on, check that the SPEC TUBE PRESSURE OK and HI VAC PUMP OK signals are asserted in the PLC status code. If either is not but the front panel of the leak detector indicates that they are OK, ensure the connectors are fully seated in the leak detector, check the wiring to the PLC, or replace the 990 Controller.

There Is No Helium Response

1. Check that the RUN/CHECK switch is in the RUN position.
2. Check that the SENSITIVITY HIGH/LOW switch is set to HIGH.
3. Check that the calibrated leak is installed in the system with the valve open.
4. If the helium standard (calibrated leak) rattles when shaken, replace it.
5. Check the FILAMENT light on. See Symptom 3.
6. Check the HIGH VACUUM PUMP READY light on. See Symptom 1.

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7. Check that the valves are properly oriented and actuating when commanded.
   - ❑ Press the RANGE button marked DOWN to display the smallest leaks.
     - ❑ If necessary, use the ZERO and COARSE ZERO knobs to lower the LEAK RATE display near *0* with ten rise, fall, and rise again. At each peak reading, close the valve on the calibrated leak to determine which peak is helium.
     - ❑ If the helium peak occurs near *0*, replace the spectrometer tube or have the magnet recharged or reassembled correctly.
     - ❑ If the helium peak occurs near *10*, replace the spectrometer tube or have it cleaned.
     - ❑ If no peak occurs, but the display rises or falls slowly, measure the ion source voltages, as listed next, to diagnose a shorted ion source.
8. Turn the ION dial to 4.00 and measure the voltages between TP4 (ground) and TP1, TP2, and TP3 in succession.

   Indicators should read as follows:

ION voltage (TP1)	+250 VDC
REPELLER voltage (TP2)	+350 VDC with BACKGROUND switch set at RUN +250 VDC with BACKGROUND switch set at CHECK
FOCUS voltage (TP3)	+ 170 to +230 VDC

NOTE



Note: All of the above voltages are +10%.

   - ❑ If all voltages are more than 10 percent low, or two of them are equal, disconnect the ion source cable while measuring the ION voltage (TP1). If the voltage changes more than 1.0 V, replace the ion source or the entire spectrometer tube the ion source may be shorted.
   - ❑ If no change occurs and the voltage remains more than 10 percent low, replace the 990 Controller to determine if the controller or its cable is defective. If replacing the controller does not solve the voltage problem, refer to *Shorted Controller Cable* listed under 6“Fundamentals of Leak Detection” on page 6-1.
9. Verify that the ground slit plate has ben properly positioned, the ion source is correctly aligned, and that the magnet pole piece inserts are fully inserted and secured in place with set screws.

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Station Fails to Pump Down While Displaying Gross Vacuum Failures

1. Verify that the fixture is completely closed.
2. Verify that the O-ring on the fixture is not damaged.
3. Verify that the fixture vacuum gauge is working.
   - ❑ Verify that the vacuum gauge cable connected.
   - ❑ Check for continuity between all four pins of this tube.
     - ❑ If any pin is open-circuited, replace the thermocouple gauge tube.
   - ❑ If the vacuum gauge controller is new, make sure that shorting bars and other preparation-related items have been performed.
4. Verify that the fixture manifold is not plugged with a product or component.
5. Verify that no filters are plugged.
6. Check for leaks:
   - ❑ A partial pumpdown indicates a large leak in the system.
   - ❑ Continued gurgling indicates a very large leak in the system, such as a partially-open fixture, or a disconnected or broken valve.

There is an unusually High Number of Rejects

These types of problems are 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 real 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 in the parts. If the standard leak is read substantially out of tolerance, then the problem is most likely in the station.

See “Helium Background Management” on page 6-5.

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Miscellaneous Problems

The LEAK RATE bar graph stays fully lit on all ranges under all conditions, regardless of the state of test.

While, this condition may indicate a helium-swamped system, it can be caused by a blown preamplifier, if the preamplifier cable is not connected to the spectrometer tube, or by a wrong revision controller and cable assembly.

1. Check that the preamplifier cable is attached.
2. If the condition persists and you are sure that it is not helium swamping (which clears up quickly) and the controller has not been recently replaced, then turn off the leak detector, unplug the preamplifier from the spectrometer tube, and plug it into either a known good spectrometer tube or a known good preamplifier.
3. Install the known good preamplifier in the spectrometer tube to run this test. The spectrometer tube need not be evacuated for this test. Be sure to handle the preamplifier assembly very carefully and observe proper static-sensitive component handling procedures.
4. Turn on the leak detector.
   After the initial lamp test (a few seconds), the bar graph should not be on in all ranges. However, there may be a significant up-scale reading and this is normal.
   - ❑ If the bar graph acts normally, then the problem is a blown preamplifier. Follow the procedures in the instruction manual for removal and replacement of the preamplifier assembly.
   - ❑ If the problem persists, then the controller may be the wrong revision for the cable in the system or the controller may be defective. Perform 990 Controller cable tests for a shorted cable.
5. Check that the spectrometer tube cables are properly connected, then remove the cable clamping plates (retainers).
6. Measure the DC voltage between the cable clamp on the ion source and preamplifier to the spectrometer tube ground stud. If the voltage is greater than 1 V, the cable is shorted to the clamp. Replace it and continue the diagnostics. If there is no short in the cable assembly, turn off the leak detector MAIN POWER switch, then remove the connector from the ion source and preamplifier.
7. Turn on the MAIN POWER switch then re-measure the ion, repeller, and focus voltages on the leak detector front panel. If they are:
   - ❑ Correct, turn off the MAIN POWER switch, plug in the preamplifier and re-measure the voltages. If they are still correct, replace the ion source.
   - ❑ Not correct, replace the preamplifier, it has developed a short.

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Section 5. Parts List

To simplify the purchase of repair and replacement parts, Vacuum Technologies has repair parts available for sale. Included in this section are the following parts lists:

- ❑ “Major Components” on page 5-2
- ❑ “Independent Electrical Components Kits” on page 5-3
- ❑ “Electrical Components Kit” on page 5-4
- ❑ “Independent Mechanical Items” on page 5-4
- ❑ “Mechanical Components Kit” on page 5-5
- ❑ “Spectrometer Tube Components Kit” on page 5-5

How to Order Parts

1. Determine the complete part numbers, descriptions, and quantities of parts required.
2. Call the Vacuum Technologies Sales and Service Office closest to you. The offices are listed on the rear cover of this document.
3. Place the order with the operator, describing the item name, model number, and serial number of the equipment on which the part is used. Give the complete part number of the part being ordered, the description as shown, and the quantity required.

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Major Components

Table 5-1 Major Components

Description	Part Number
Spectrometer Tube Exchange Program	GGL9070301
Turbo Pump Exchange Program	EX9699357
MacroTorr Turbo Pump Exchange Program	EX9699361
990 Controller Exchange Program	GGL900305 (115 V) GGL900306 (220 V)
Spares Kit (miscellaneous parts and O-rings)	L9186301
Spectrometer Tube Cleaning Kit	670029096
Spectrometer Tube Cable	L9023305 (5′) L9023310 (10′) L9023315 (15′)
OPTO-22 Input Module, 120 VAC	949150005
OPTO-22 Input Module, 35-60 VDC	949150010
OPTO-22 Input Module, 2.50-28 VDC	949150015
OPTO-22 Input Module, 220 VAC	949150020
Ion Source, Thoriated Iridium	82850302
Preamplifier	L9030301
Cold Cathode Gauge	82849301
Main Electronics Board	K9506301
I/O Control Board	L9057301
Display Board	L9015301
I/O Assemble (I/O Board and I/O Control Board)	L9074310
High Voltage Board	K3053301

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Independent Electrical Components Kits

Table 5-2 Independent Electrical Items, Part Number L9022

Item	Description	Part Number
1	A/C Harness Assembly	L9013301
2	Display PCB Assembly	L9015301
3	I/O PCB Assembly	L9018301
4	I/O Control PCB TBD	L9057301
5	Main Power Cable Kit	L9028301
6	Set Point Cable	L9082301
7	Cable Assembly	L9077301
8	DC Harness Assembly	L9024301
9	HV Power Supply PCB Assembly	K5053301
10	Power Transformer	L6071301
11	Control Transformer	L6072301
12	High Voltage Transformer	00244
13	Spectrometer Tube Meter	08060
14	Potentiometer, Tandem to DWG	09135
15	Electronics Board Harness	K9864301
16	Turbo Cable Assembly	L9080301
17A	Cable, Beldon	59166
17	Wire Assembly, Cold Cathode	L9089301

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Electrical Components Kit

Table 5-3 Electrical Components Kit, Part No. L9086301

Item	Description	Part Number	Quantity
18	Fuse Carrier	645600502	2
20	Fuse, Slo Blo	645300001	1
22	Bulkhead Receptacle	64870 72682	1
28	Filter, Line Voltage	642971003	1
44	Potentiometer, Bournes	3852A 654532404	2
45	Potentiometer, Bournes	354 654532074	1
46	Potentiometer, Bournes	82 654532084	1
48	Potentiometer, Bournes	3540s 654532072	1
50	Switch	642105025	1
51	Switch	642105028	1
52	Switch	642105118	1
	Fuse, Littlefuse	645300002	2

Independent Mechanical Items

Table 5-4 Independent Mechanical Items

Item	Part No.
Spectrometer Tube	L9070301
Pre-Amplifier	L9030301
Ion Source, Thoriated	82850302
Cold Cathode Gauge	82849301
Adapter Bracket	L9027301
Knob Set, Modified	L6503301
Speaker, 30C25Z8	670009968
Fan, 24 VDC 0	1661300030
OPTO 22 Module, 120 VAC	649150005
OPTO 22 Module, 35- 60 VDC	649150010
OPTO 22 Module, 2.5- 28 VDC	649105015

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Mechanical Components Kit

Table 5-5 Mechanical Components Kit, Part No. L9087301

Item	Description	Part Number	Quantity
10	Rogan Knob	6602551325	3
11	Dial, Beckman	26 660257206	1
13	Bushing, Heyco 280	648019338	4
14	Trimmer Adjustment Tool	699009190	1
17	Fuse Holder	645600501	2
25	Finger Guard	670009136	1
27	Knob	660251625	1
38	Handle	660237049	2
39	Lock	660356137	1
40	Catch	641323110	1
41	Bracket	641309111	1
42	Strike	641323114	1

Spectrometer Tube Components Kit

Table 5-6 Spectrometer Tube Components Kit, Part No. L9186301

Item	Description	Part No.	Quantity
	O-ring, Viton, Parker No.2-025	660892025	10
	O-ring, Viton, Parker No.2-320	660892320	2
	Screw, Truss hd	614820314	22
	Washer, Neoprene	618971030	4
	Ground Plate	K3088001	2
	Baffle Assembly	K9780001	2
	Flange Cap	82852001	2
	Cold Cathode Liner	82849008	2

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Table 5-6 Spectrometer Tube Components Kit, Part No. L9186301 (Continued)

Item	Description	Part No.	Quantity
16	O-ring, Viton, Parker No.2-320	660892320	2
23	Screw, Pan hd	614420035	8
24	Washer, Ansi Type A	618120018	8
25	Washer, Lock, No.6	618320018	8

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Section 6. Fundamentals of Leak Detection

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 leak testing techniques, leak rates in the $2x10^{-10}$ 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. First, the reasons for leak testing can be grouped as follows.

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 multi-pin 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: electron tubes, 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).

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Terminology

The following terminology applies throughout this manual:

Flow	std cc/sec	One cubic centimeter of gas per second at a pressure of one standard atmosphere (760 Torr at 0 °C or 32 °F).
	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 (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. The rate of rise is usually expressed in Torr or microns (milliTorr) per hour.

Conversions

1 std cc/sec	=	0.76 Torr-liter/sec for practical purposes, equal
1 torr-liter sec	=	1.3 std cc/sec
1 std cc/sec	=	9.7x104 micron cubic feet per hour
		or practically 10^5 micron CFH (υCFH)
1 CFH	=	practically 10^{-5} std cc/sec
1 std cc/sec	=	0.1 Pascal cubic meters/sec

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:

$1x10^{-1}$	=	1x1110	=	0.1
$1x10^{-2}$	=	1x1110 x1110	=	0.01
$5x10^{-3}$	=	5x1110x1110x1110	=	0.005
$1x10^{-3}$	=	1x1110x1110x1110	=	0.001
$1x10^{-6}$	=	1x1110x1110x1110x1110x1110x1110	=	0.000001

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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	Bubbles rising in water:	10^{-4} std cc/sec or larger
	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 may be slightly smaller. Diffusion of helium through glass may 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 may 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.

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Methods of Testing for Leaks

There are many methods of testing for leaks in enclosures — either systems or containers. The more commonly used methods and their accuracy ranges are listed below.

Water Immersion (Air Bubble Observation)

Probably the oldest method, water immersion 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, because of its low cost.

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 degree of isolation of radiation required.) It also requires a radiation safety officer.

Helium Method

This method is good to 2×10^{-12}* std cc/sec, and is capable of finding leaks of any larger size. This method is useful for testing hermetic seals, vacuum enclosures, and vacuum systems. It is the most versatile of industrial and laboratory leak detection testing methods.

* Using Vacuum Technologies Model 960 or another equivalent system.

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Helium Mass Spectrometer Leak Detection (MSLD)

Helium as an Ideal Tracer Gas

Helium is an excellent trace gas because it is the lightest of the inert gases and 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. Also, helium is readily available at a reasonable cost, and is completely non-toxic and non-reactive. The basic principles of1he helium MSLD technique are discussed in following paragraphs.

Helium Background Management

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 done at 100 milliTorr, with 500 PPM helium in the air, the indicated leak rate would probably appear as a low 1 x 10^{-5} atm cc/sec signal.

If your reject set point is at 1 E-5, this high background would lead to a 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 pumpdown cycle, it is probably more economical to remove the source of helium to reduce the background.

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 (although such a device can be adjusted to indicate hydrogen. The mass spectrometer tube is relatively simple The principle is to ionize the gases in vacuum, accelerate the various ions through magnetic field. A slit, properly placed, allows only helium ions to pass through and be collected. The resulting current is amplified and a meter indicates the presence and amount of helium.

Application as a Leak Detector

A mass spectrometer leak detector consists of a spectrometer tube, the electronics to operate it and interpret its output and a high vacuum system to maintain proper vacuum. In addition, means are provided for connecting a test object, and a *rough vacuum* pomp and a system of 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.

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The Reason to Vacuum

It should be noted that the purpose of the vacuum system is to support operation of the 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 high-vacuum pump.

If helium continuously applied to a leak is being pumped out at the same rate as it is entering, the concentration in the spectrometer tube rises sharply at first, then reaches equilibrium.

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 the output signal of the spectrometer tube.

Spectrometer Tube -What It Does, in brief

In the spectrometer tube, gas molecules are ionized, given a positive electrical charge), by bombarding them with electrons from a hot iridium filament. Ions thus formed, are accelerated into a magnetic field where the mass 4 (helium) ions are deflected 90°. Only helium ions, reach the collector. Heavier ions (mass 6 and up) are deflected too little to be collected. Lighter ions (masses 3 and 2) are deflected too much to be collected.

An extremely stable spectrometer provides an electron current to the collector, which measures the current produced by the collection of helium ions. This current is presented on the leak rate meter. Since this current is directly proportional to the number of helium ions striking the collector per unit time, the leak rate meter indicates 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 and therefore an increased deflection of the leak rate meter. In addition to the electrometer, the electronics also provide suitable voltages to operate the spectrometer tube and controls and the instrumentation for the vacuum system.

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

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Glossary of Terms

Absolute Pressure	An engineering term to indicate pressure above the absolute zero corresponding to empty space as distinguished from *gauge* pressure In vacuum technology, pressure is always absolute pressure, and therefore the term *absolute pressure* is redundant.
Absorption	The binding of gas in the interior of a solid (or liquid)
Adsorption	The condensing of gas on the surface of a solid.
Atmospheric Pressure	The pressure of the atmosphere at a specified place and time. The standard atmosphere, or normal atmosphere, is defined (independently of barometric height) as a pressure of 1,013,250 dyne/cm^2.
Audible Leak Indicator	An auxiliary component of a leak detector, which converts the output signal to an audible note whose frequency is a function of the leak size.
Background	An output signal of the leak detector due to entrapment of the tracer gas or other substance to which the detecting element responds in the vacuum system, which cannot be quickly removed by pumping. A virtual leak of the tracer gas.
Background Signal	The steady or fluctuating output signal of the leak detector caused by the presence or residual tracer gas or other substance to which the detecting element responds.
Bake-Out	The degassing of a vacuum system by heating during the pumping process.
Bomb Test	A form of leak test in which enclosures are pressurized with tracer gas for the purpose of driving through possible leak passages and thus into the internal cavities. Subsequent leak testing is done by evacuation or immersion. See “Helium Bombing” below.
Bubble Test	A form of leak testing gas–containing enclosures in which a leak is indicated by the formation of a bubble at the site of a leak.
Calibrated Leak	An orifice or membrane through which an accurately known amount of helium passes in a given amount of time The leak is usually accompanied by a reservoir of helium.
Cold Trap	A vessel designed to hold a refrigerant and which, when inserted into a vacuum system, traps on its surface condensable vapors present in the vacuum system. Most traps operate with liquid nitrogen at a temperature of –196 °C (–320 °F).

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Contra-Flow™	A technique that utilizes the differences in the maximum compression ratios of the tracer gases (such as helium) and other gases found in the air. When the tracer, gas exceeds Its maximum compression ratio, it diffuses backwards through the diffusion pump and is detected by the spectrometer tube.
Diffusion Pump	A vapor pump having boiler pressure less than a few Torr and capable of pumping gas at intake pressure not exceeding about 2 milliTorr and discharge pressures (forepressures) not exceeding about 500 milliTorr.
Fine Leak	A leakage rate of less than 10^{-4} std cd/sec.
Foreline Valve	A vacuum valve placed in the foreline to permit isolation of the diffusion pump from its forepump.
Forepump	The pump that produces the necessary fore vacuum for a pump that is incapable of discharging gases at atmospheric pressure. Sometimes called the backing pump.
Gross Leak	A leakage rate never more than 10^{-4} std cd/sec.
Helium Bombing	A method of testing for leaks in which hermetically-sealed units containing an internal volume are subjected to a helium pressure. If leaks are present in the sealed unit, the helium pressure drives some helium into the internal volume and this may be subsequently detected during bell jar testing or immersion in a hot fluid to detect bubbles (See “Bomb Test” above).
Ion	A molecule whose net charge has been altered from neutral for the purpose of magnetically or electrostatically moving it from one place to another.
Ion Source	That part of a leak detector tube in which the trace gas is ionized prior to being detected.
Leak Rate	The rate of flow through a leak with a specified gas (at a specIfied pressure on the inlet and exit sides). Preferred units: Standard cc/sec of a specified gas Standard gas conditions: 760 mm 66 pressure (absolute), 25 °C (77 °F) temperature
Mass Spectrometer Leak Detector	A mass spectrometer adjusted to respond only to the tracer gas. Helium is commonly used as the tracer gas, and thus, the instrument is normally referred to as a helium leak detector.
Millisecond	One one/thousandth of a second.
MilliTorr	A unit of pressure equal to 10^{-3} Torr (1/1000 Torr).

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Minimum Detectable Leak Rate	The magnitude of the smallest leak rate that can be unambiguously detected by a given leak detector (in the presence of noise and background).
Outgassing	The evolution of gas from a material in a vacuum.
Parameter Testing	The controlled circumstances under which a test is conducted.
Pressure Testing	A leak testing procedure in which tracer gas is introduced under pressure into or around the enclosure under examination, and detected as it is emitted from a leak.
Probe	A tube having a fine opening at one end, used for directing or collecting a stream of tracer gas.
Probe Test	A leak lest in which the tracer gas is applied by means of a probe so that the area covered by the tracer gas is localized. This enables individual leaks to be located.
Rough Pump	A vacuum pump used for the initial evacuation to a vacuum system.
Roughing	The initial evacuation of a vacuum system.
Roughing Valve	A vacuum valve placed m a roughing line to isolate the test port and vacuum system from the roughing pump.
Sensitivity	In the case of a leak detector, the response of the detector to tracer gas leakage (that is, scale division per unit leak rate).
Spectrometer Tube	The sensing element of a helium leak detector.
Standard Leak	1. A capillary or porous wall leak, usually in a glass or metal tube, whose dimensions have been adjusted to give a specified leak rate of a gas at a standard temperature with specified inlet and exit pressures. 2. A device that permits a tracer gas to be introduced into a leak detector or leak testing system at a known rate to facilitate tuning and calibration of the leak detector Also known as a calibrated leak.
Torr	Pressure unit used to replace the term millimeter of mercury (mm or Hg). The Torr is defined as 1/760 of a standard atmosphere or 1,013,250 dynes/cm^2.
Turbo Molecular Pump	A high-speed, multiple-stage, bladed compressor with an overall compression ratio of approximately one million and exhaust pressure in the mid vacuum range.
Turbo Molecular Drag Pump	A high-speed, mixed technology, multiple-stage, compressor with an overall compression ratio of approximately 1 million and an exhaust pressure in the low vacuum range.

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Valve Block	A series of valves that perform the function of a leak detector. A valve block might include one or more roughing valves, fine test valves, calibrated leak valves, vent valves, or split flow valves.
Virtual Leak	The semblance of a leak m a vacuum system caused by slow release of trapped gas.

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Appendix A. Understanding the 990 CLD Analog Leak Rate Output

Understanding the 990 CLD Analog Leak Rate Output

The 990 CLD leak detection system is designed for wide flexibility in adapting to your specific leak testing application. As such, the 990 CLD leak detector offers complete flexibility in adjusting the various controls during process setup to allow direct reading of the leak rate on the front panel bar graph and exponent display. The leak detector also offers two types of analog output voltages that track the front panel leak rate display: Linear and Logarithmic. Each has advantages in particular applications and is described below.

Linear Analog Voltage Output

The accompanying chart labeled Linear Output Voltage (Figure A-1 on page A-5) is useful in converting from leak rate to output voltage and from output voltage back to leak rate. The six lines labeled *0* to *6* along the right hand margin represent the six settings of the RANGE SELECT switch. Note that the output voltage scale along the bottom has been expanded to aid in reading the lower decades.

This output is derived directly from the leak rate signal. The voltage output is in direct proportion to the leak rate. Correlated with the front panel display is the setting of the RANGE SELECT switch (SW7). The output voltage is calculated by multiplying the front panel leak rate by 10 raised to the RANGE SELECT switch setting. For example, if you are reading a leak rate of 1×10^{-3} standard cubic centimeters per second (std cc/sec) on the front panel bar-graph and exponent display, and the RANGE SELECT switch is set to 2, then the output voltage is:

$(1 \times 10^{-3}) \times (102) = 0.1$ VDC

For a leak rate of 1×10^{-5} std cc/sec with the same setup, the output voltage is:

$(1 \times 10^{-5}) \times (102) = 0.001$ VDC

or 1 mV. Correspondingly, if the leak rate is 10^{-1} std cc/sec with the same setup, the output voltage is:

$(1 \times 10^{-1}) \times (102) = 10\ 0981$ DC

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Another way of expressing this type of output voltage is to say that the most sensitive decade produces an output voltage of between 1 and 10 mV (0.001 to 0.01 V), the next least sensitive decade 10 mV to 100 mV (0.01 to 0.1 V), the next least sensitive decade 0.1 to 1 V, and the least sensitive decade 1 to 10 V.

Remember, the 990CLD covers four decades of sensitivity; selecting which of the four decades to which the machine can be calibrated is a function of mechanical pump speed and high vacuum pump speed setting.

Why Use a Linear Analog Output?

The linear output is useful in two types of applications: 1) when the testing takes place in only one decade, near the least sensitive range of the leak detector, and 2) when a simple mathematical function is desired to relate output voltage to leak rate.

Use of the least sensitive range of the leak detector is desirable with the linear output to obtain the highest possible resolution from the Analog to Digital converter in your Programmable Logic, Controller or computer. Many PLCs have A-to-D converters with 12 bits of resolution and a maximum input voltage of 10 V. This means that over this 10 V range, the converter resolves 1 part in 4096, or about 2.4 mV. If you want to test for leaks of 1×10^{-1} std cc/sec with the RANGE SELECT switch set at 2, then you are operating in the least sensitive decade of the leak detector. The resolution, in that decade, with a 12-bit A-to-D converter is:

(0.0024 V) I (10 V for the least sensitive decade) x 100 = 0.024 percent

Now, try looking for a leak of 1×10^{-4} with the same setup, and you are operating in the most sensitive decade of the leak detector. The output voltage in that situation is only 1 mV and the resolution for that decade is:

(0.0024) I (0.01 V for the least sensitive decade) x 100 = 24%.

Obviously, it is undesirable to test in this range using a linear analog output fed into the PLC or computer. It is important to remember that percentage resolution per decade is not constant for the linear analog output. Resolution for the least sensitive decade (with a 12-bit A-to-D converter) is 0.024 percent, for the next most sensitive decade, 0.24 percent, for the next most sensitive decade, 2.4 percent, and for the most sensitive decade, 24 percent. Although the output does go to zero with a zero leak rate displayed, use of this level should be avoided due to the small voltages encountered.

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Logarithmic Analog Output Voltage

The 990 CLD leak detector offers two logarithmic analog output voltages: 2 V/decade, and 3 V/decade. We will focus on 2 V/decade in this description. Figure A-2 on page A-6 labeled Logarithmic Output Voltage is the graphic conversion chart for 2 V/decade reference, while Figure A-3 on page A-7 covers three V/decade. Three V/decade is useful to obtain higher resolution per decade, but reads only part of the least sensitive decade due to output voltage clipping set at about 10.7 V.

Again, as in the linear output conversion chart, there are six lines on the chart corresponding to the six RANGE SELECT switch settings.

The logarithmic analog output voltage is derived from an amplifier whose output is a logarithm of the input voltage. The output voltage is obtained by first multiplying the front panel leak rate display by 10 raised to the RANGE SELECT switch setting +3. The logarithm (base 10) of this result is then taken, and multiplied by 2 (for 2 V/decade) or 3 (for 3 V/decade). Using the same setup as in the first linear output example, the analog output voltage corresponding to a leak of 1×10^{-3} std cc/sec with the RANGE SELECT switch set to 2 would be:

$$2 \times \text{Log}((1 \times 10^{-3}) \times 10(2 + 3)) = 4.00 \text{ VDC}$$

If you needed to read leaks at 1×10^{-5} and 1×10^{-1} std cc/sec, as in the second and third linear output examples, the voltages would be:

$$2 \times \text{Log}((1 \times 10^{-5}) \times 10(2 + 3)) = 0.00 \text{ VDC}$$

and

$$2 \times \text{Log}((1 \times 10^{-1}) \times 10(2 + 3)) = 8.00 \text{ VDC}$$

respectively.

Note that while the Logarithmic output is 2 V/decade covering the full decade, the output is not linear within the decade. For example, assume the system is set up to read a full scale leak of I1x10^{-2} std cc/sec in the most sensitive decade with the RANGE SELECT switch set to 0. The output in this situation would read 2 V. If you read an output of 1 V instead, ***it is not half that leak rate.*** The leak rate with 1 V output in this setup is:

10(Output Voltage/2)/10(Range Switch Setting +3) = 10(1/2)/ 10(0+3) = 3.1×10^{-3} std cc/sec

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Why Use Logarithmic Analog Output Voltage?

The key point to note with logarithmic output is that it allows for uniform resolution per decade from PLC or computer A-to-D converter, since a fixed voltage covers each decade. As in the linear output example, if you need to search for a leak of $1x10^{-1}$ std cc/sec with the RANGE SELECT switch set to 2 and a PLC A-to-D resolution of 12 bits (1 in 4096), then the average resolution for this decade is:

(0.0024 V) / (2 V/decade) x 100 = 0.12%

While this is about five times lower resolution than the corresponding example for the linear output, *the resolution remains the same for each decade.* This is in contrast to the linear output example where the resolution fails by a factor of 10 for each decade of increasing sensitivity. For example, the resolution of a leak of $1x10^{-5}$ std cc/sec with a RANGE SELECT switch setting of 2 is 24% for the linear output and is 0.12% for the logarithmic output.

As in the case of the linear output, the range between 0 and 1 on the most sensitive decade should be avoided for noise reasons. In this region, the logarithmic amplifier output is noisy due to the very low signal voltages.

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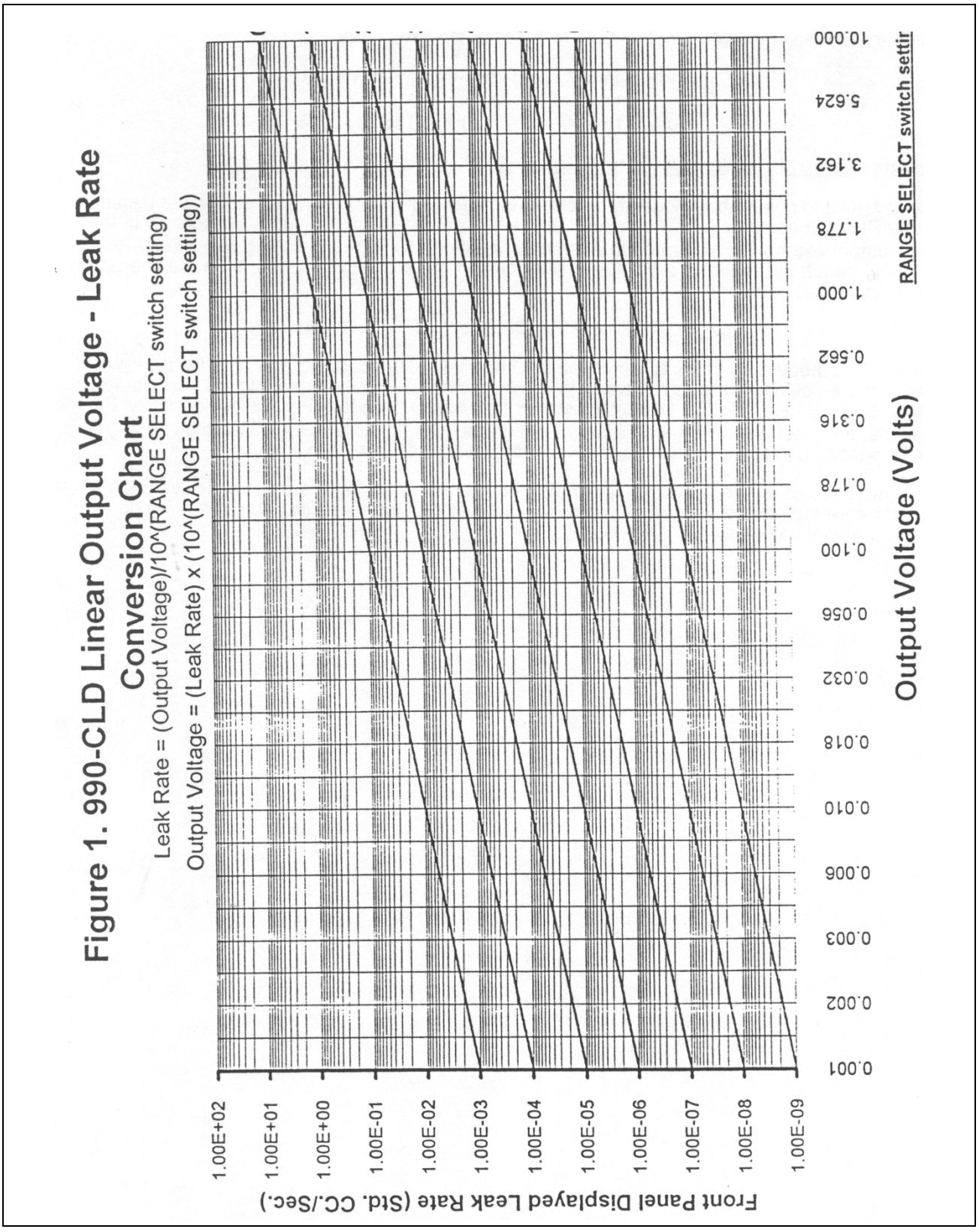


Figure A-1 990 CLD Leak Detector Linear Output Voltage - Leak Output Voltage (V)

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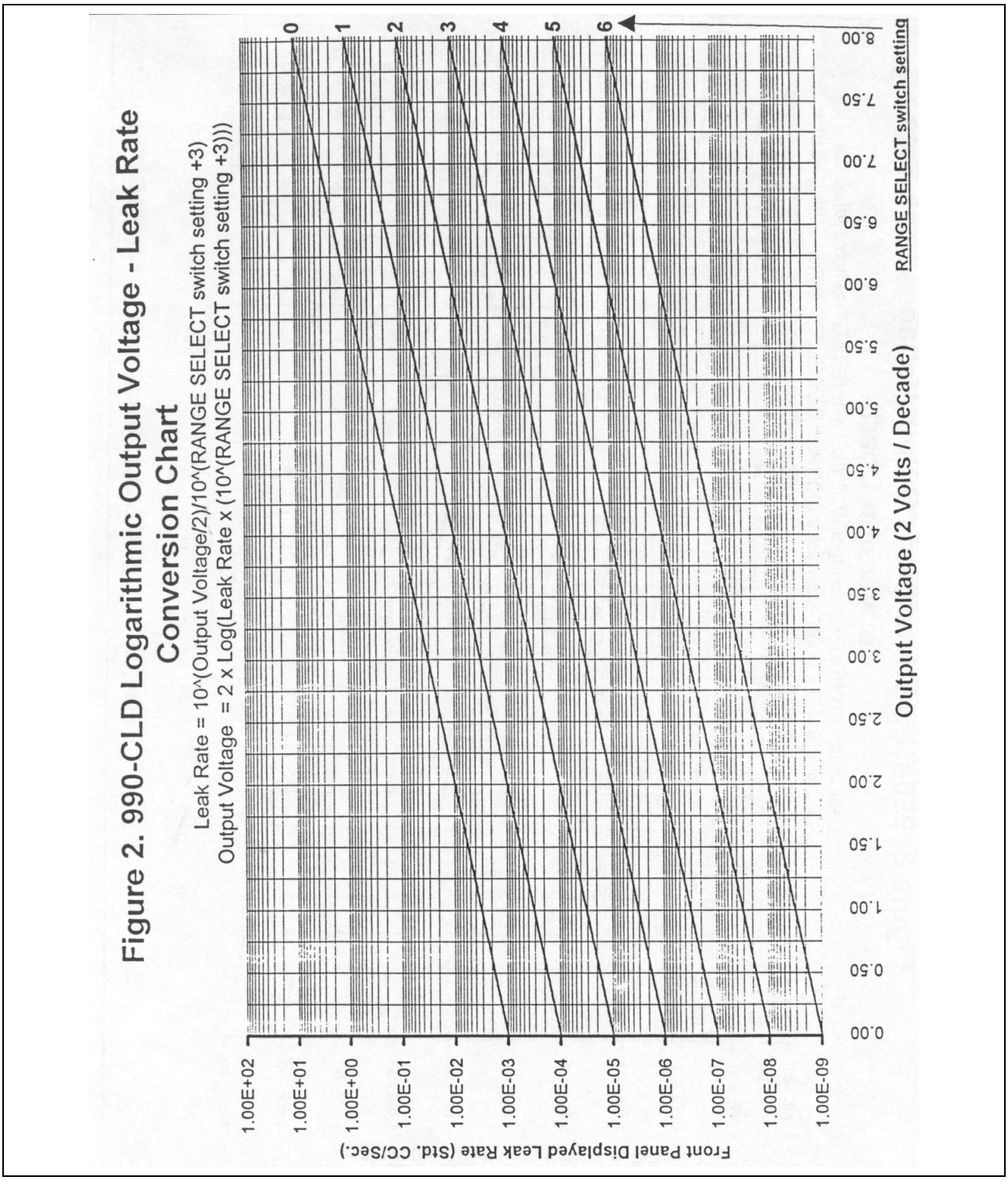


Figure A-2 990 CLD Leak Detector Linear Output Voltage - Leak Rate Conversion Chart (2 V/decade)

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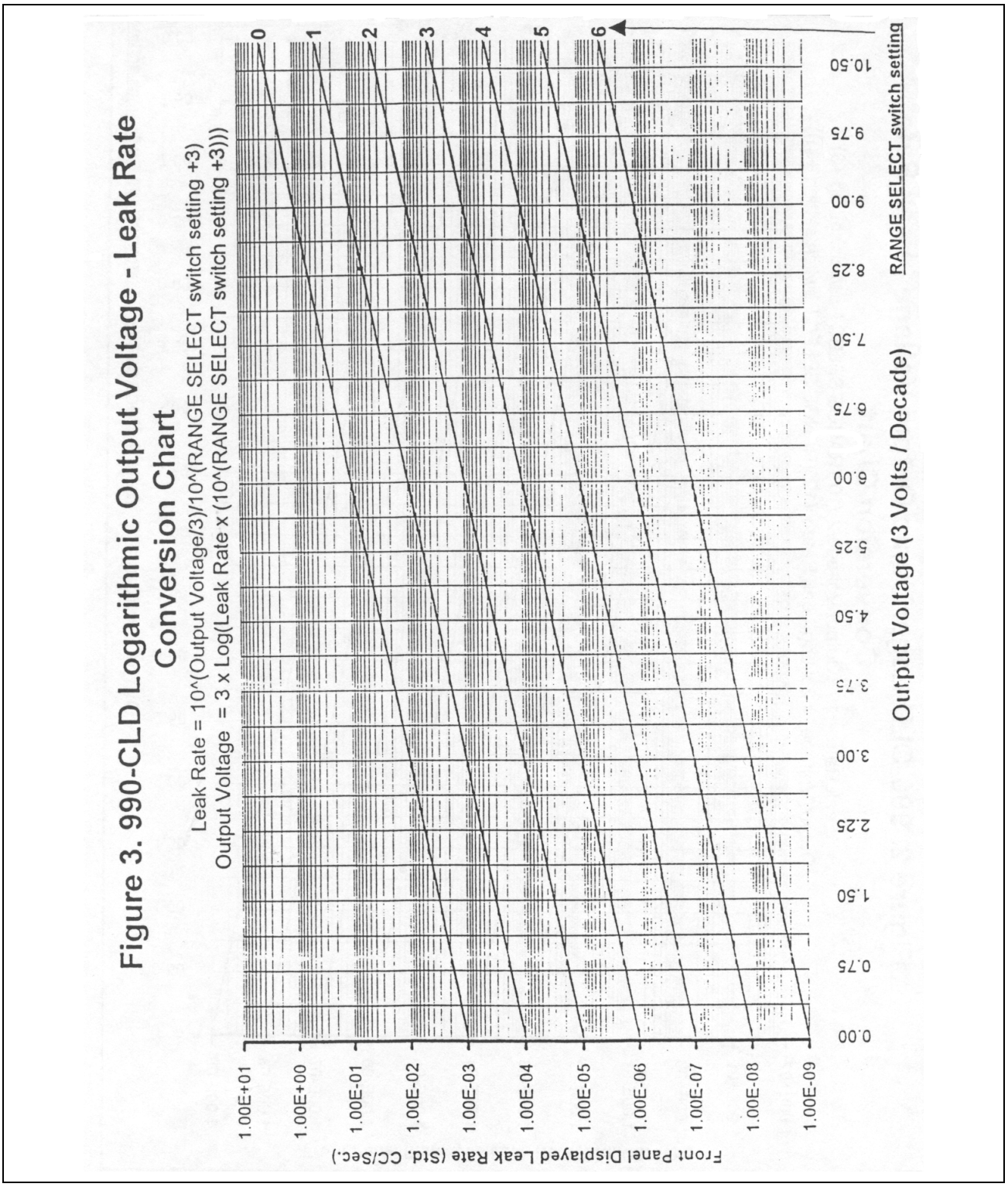


Figure A-3 990 CLD Leak Detector Linear Output Voltage - Leak Rate Conversion Chart (3 V/decade)

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Appendix B. Specifications

Specifications

Detailed specifications for the 990 CLD leak detector are provided in Table B-1. Detailed specifications for the V70 and V70D Turbo Pumps are listed in Table B-2.

Table B-1 990 CLD Leak Detector, Detailed Specifications

Minimum detectable signal/sensitivity in accordance with AVS Standard 2.1	2×10^{-10} atm cc/sec for helium, or 8×10^{-11} atm cc/sec for air **Note** *The sensitivity of the 990 CLD leak detector is influenced by the selection of the high-vacuum pump and by the pumping speed of the mechanical pump. These specifications are obtained with a Vacuum Technologies SD-90, 3.2 cfm pump. A minimum detectable signal is registered as a one-segment change when tuned for direct readout on the most sensitive leak rate range.*
Response time	0.5 second for helium in accordance with AVS Standard 2.1
Amplifier drift	Less than 2% of most sensitive scale in accordance with AVS Standard 2.1
Noise level	Less than 2% of full scale, peak-to-peak, in accordance with AVS Standard 2.1
Leak indicator	50-segment bar graph. Four decades of sensitivity each selected by the RANGE SELECT switch.
External inputs and outputs	See Table 1-5 on page 1-9 for Inputs/Outputs
Spectrometer tube	Preamplifier is a temperature-compensated, solid-state device, located in the vacuum enclosure. The entire tube can be quickly removed for maintenance. Dual-filament, disposable, all-welded ion source.
High Vacuum (Optional turbo or macroTorr turbo pump)	Operating position: any Noise level: < 45 dB at 1 meter Operating ambient temperature: 41 °F to 122 °F (+5 °C to +50 °C) (depending on foreline pressure) Maximum recommended operating temperature: 130 °F (55 °C) with cooling fan; 123 °F (50.6 °C) without cooling fan

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Table B-1 990 CLD Leak Detector, Detailed Specifications (Continued)

Electronics	Maximum recommended operating temperature: 167 °F (75 °C)
Vacuum gauges	Cold cathode gauge active at all times inside the spectrometer tube.
Power requirements	115 VAC; 3 A/230 VAC, 1.5 A
Main Electronics Console	51/4″(H) by 17″ (D) by 19″ (W) standard rackmounted cabinet with a hinged door that provides easy access to calibration controls.
Weight	50 lbs (approximately) Shipping weight – 60 lbs (approximately)

Table B-2 High Vacuum Pump, Detailed Specifications

	V70 Turbo	V70D MacroTorr Turbo Drag
High-vacuum flange	ISO 63	ISO 63
Foreline flange	NW 16 KF	NW 16 KF
Pumping Speed at max. rpm:		
N_2	65 liters/sec	60 liters/sec
He	55 liters/sec	25 liters/sec
H_2	45 liters/sec	15 liters/sec
Compression ratio at max. rpm:		
N_2	5×10^7	5×10^7
He	4×10^3	6×10^3
H_2	4×10^2	1×10^3
Startup time	120 sec	120 sec
Operating Position	Any	Any
Noise level (at 1 meter)	≤ 45 DB (A)	≤ 45 DB (A)
Cooling requirements	Fan-cooled	Fan-cooled

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VARIAN

Request for Return
Health and Safety Certification

ISO 9001 REGISTERED

1. Return authorization numbers (RA#) **will not** be issued for any product until this Certificate is completed and returned to a Varian, Inc. Customer Service Representative.
2. Pack goods appropriately and drain all oil from rotary vane and diffusion pumps (for exchanges please use the packing material from the replacement unit), making sure shipment documentation and package label clearly shows assigned Return Authorization Number (RA#) VVT cannot accept any return without such reference.
3. Return product(s) to the nearest location:

North and South America
Varian, Inc.
Vacuum Technologies
121 Hartwell Ave.
Lexington, MA 02421
Fax: (781) 860-9252

Europe and Middle East
Varian S.p.A.
Via F.lli Varian, 54
10040 Leini (TO) – ITALY
Fax: (39) 011 997 9350

Asia and ROW
Varian Vacuum Technologies
Local Office

For a complete list of phone/fax numbers see www.varianinc.com/vacuum

4. If a product is received at Varian, Inc. in a contaminated condition, **the customer is held responsible** for all costs incurred to ensure the safe handling of the product, and **is liable** for any harm or injury to Varian, Inc. employees occurring as a result of exposure to toxic or hazardous materials present in the product.

CUSTOMER INFORMATION

Company name: .....

Contact person: Name: ..... Tel: .....

Fax: ..... E-mail: .....

Ship method: Shipping Collect #: ..... P.O.#: .....

Europe only: VAT Reg Number: ..... *USA only:* ❒ Taxable ❒ Non-taxable

Customer ship to: ..... Customer bill to: .....

....

....

PRODUCT IDENTIFICATION

Product Description	Varian, Inc. Part Number	Varian, Inc. Serial Number

TYPE OF RETURN (check appropriate box)

❒ Paid Exchange	❒ Paid Repair	❒ Warranty Exchange	❒ Warranty Repair	❒ Loaner Return
❒ Credit	❒ Shipping Error	❒ Evaluation Return	❒ Calibration	❒ Other

HEALTH and SAFETY CERTIFICATION

VACUUM TECHNOLOGIES CANNOT ACCEPT ANY BIOLOGICAL HAZARDS, RADIOACTIVE MATERIAL, ORGANIC METALS, OR MERCURY AT ITS FACILITY. CHECK ONE OF THE FOLLOWING:

❒ I confirm that the above product(s) has (have) **NOT** pumped or been exposed to any toxic or dangerous materials in a quantity harmful for human contact.

❒ I declare that the above product(s) has (have) pumped or been exposed to the following toxic or dangerous materials in a quantity harmful for human contact (Must be filled in):

Print Name..... Signature ..... Date .....

PLEASE FILL IN *THE FAILURE REPORT SECTION* ON THE NEXT PAGE

Do not write below this line
Notification (RA) #: ..... Customer ID #: ..... Equipment #: .....

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VARIAN

Request for Return
Health and Safety Certification

ISO 9001 REGISTERED

FAILURE REPORT
(Please describe in detail the nature of the malfunction to assist us in performing failure analysis):

TURBO PUMPS AND TURBOCONTROLLERS

Claimed Defect		**Position**	**Parameters**	
❒ Does not start	❒ Noise	❒ Vertical	Power:	Rotational Speed:
❒ Does not spin freely	❒ Vibrations	❒ Horizontal	Current:	Inlet Pressure:
❒ Does not reach full speed	❒ Leak	❒ Upside-down	Temp 1:	Foreline Pressure:
❒ Mechanical Contact	❒ Overtemperature	❒ Other	Temp 2:	Purge flow:
❒ Cooling defective	❒ Clogging		Operation Time:	
Describe Failure:				
Turbocontroller Error Message:				

ION PUMPS/CONTROLLERS

❒ Bad feedthrough	❒ Poor vacuum
❒ Vacuum leak	❒ High voltage problem
❒ Error code on display	❒ Other .....
Describe failure:	
Customer application:	

VALVES/COMPONENTS

❒ Main seal leak	❒ Bellows leak
❒ Solenoid failure	❒ Damaged flange
❒ Damaged sealing area	❒ Other .....
Describe failure:	
Customer application:	

LEAK DETECTORS

❒ Cannot calibrate	❒ No zero/high background
❒ Vacuum system unstable	❒ Cannot reach test mode
❒ Failed to start	❒ Other .....
Describe failure:	
Customer application:	

INSTRUMENTS

❒ Gauge tube not working	❒ Display problem
❒ Communication failure	❒ Degas not working
❒ Error code on display	❒ Other .....
Describe failure:	
Customer application:	

ALL OTHER VARIAN, INC.

❒ Pump doesn't start	❒ Noisy pump (describe)
❒ Doesn't reach vacuum	❒ Overtemperature
❒ Pump seized	❒ Other .....
Describe failure:	
Customer application:	

DIFFUSION PUMPS

❒ Heater failure	❒ Electrical problem
❒ Doesn't reach vacuum	❒ Cooling coil damage
❒ Vacuum leak	❒ Other .....
Describe failure:	
Customer application:	

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Sao Paulo 04548 005
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Central coordination through:
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121 Hartwell Avenue
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Varian Vacuum Technologies

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Italy
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Fax: (39) 011 997 9 350

Customer Support and Service:

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Tel: 1 (800) 882-7426 (toll-free)
vtl.technical.support@varianinc.com

Europe
Tel: 00 (800) 234 234 00 (toll-free)
vtl.technical.support@varianinc.com

Japan
Tel: (81) 3 5232 1253 (dedicated line)
vtj.technical.support@varianinc.com

Korea
Tel (82) 2 3452 2452 (dedicated line)
vtk.technical.support@varianinc.com

Taiwan
Tel: 0 (800) 051 342 (toll-free)
vtw.technical.support@varianinc.com

Worldwide Web Site,
Catalog and On-line Orders:
www.varianinc.com

Representatives in most countries

VARIAN

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