

HP 5972A & HP 6890 Series
Mass Selective Detectors

Hardware Manual

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Safety Information

Safety class

The HP 5972A and HP 6890
Series Mass Selective Detectors
(MSD) are Safety Class I
instruments and have been
designed and tested in
accordance with IEC
Publication 348, Safety
Requirements for Electronic
Measuring Apparatus (HD401)

WARNING

Connecting an MSD to a power
source which is not equipped
with a protective earth contact
creates a shock hazard for the
operator and can damage the
instrument. Likewise,
interrupting the protective
conductor inside or outside the
MSD or disconnecting the
protective earth terminal
creates a shock hazard for the
operator and can damage the
instrument.

WARNING

Make sure that only fuses with
the required current rating and
of the specified type are used
for replacement. The use of
incorrect or makeshift fuses or
the short-circuiting of fuse
holders creates a shock hazard
for the operator and can
damage the instrument.

WARNING

Any adjustment, maintenance
or repair of the opened
instrument while it is
connected to a power source
should be avoided if possible
and, if required, should be
carried out only by trained
persons who are aware of the
hazards involved.

Noise Declaration

Deutsch

LpA << 70 dB am Arbeitsplatz
normaler Betrieb nach EN
27779:1991

English

LpA << 70 dB operator position
normal operation per ISO
7779:1988

Instrument Identification

The HP 5972A and HP 6890
Series MSDs are identified with
a 10-character serial number
on a label located on the back
of the instrument.

The first four characters are
the serial prefix. The fifth
character is the country of
origin:

A = USA
G = Germany

The last five characters are an
identification number unique
to each instrument.

When corresponding with
Hewlett-Packard about your
instrument, be sure to include
the model number and the full
10-character serial number.

Write the serial number of your
MSD here for reference:

Serial #:

Manual Conventions

Cautions

Cautions call attention to
procedures which, if not
correctly performed or adhered
to, could result in **damage to
the instrument**.

Warnings

Warnings call attention to
procedures which, if not
correctly performed or adhered
to, could result in **personal
injury**.

Part Numbers

In this manual, Hewlett-
Packard part numbers are
generally listed in parentheses
after the name of the part or in
tables in the *Parts* chapter.
Most Hewlett-Packard part
numbers are either four-digit-
by-four-digit (1234-1234)
numbers or five-digit-by-five-
digit (12345-12345) numbers.

A few tools and supplies listed
have no part numbers and are
not available from Hewlett-
Packard. Most of these can be
obtained from laboratory
supply companies.

**HP 5972A and HP 6890 Series
Mass Selective Detectors**

Hardware Manual

The HP 5972A and HP 6890 Series Mass Selective Detectors

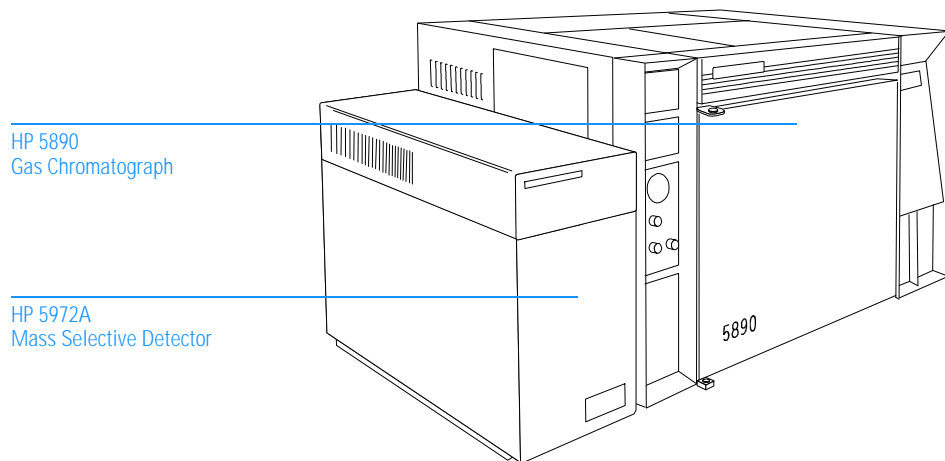
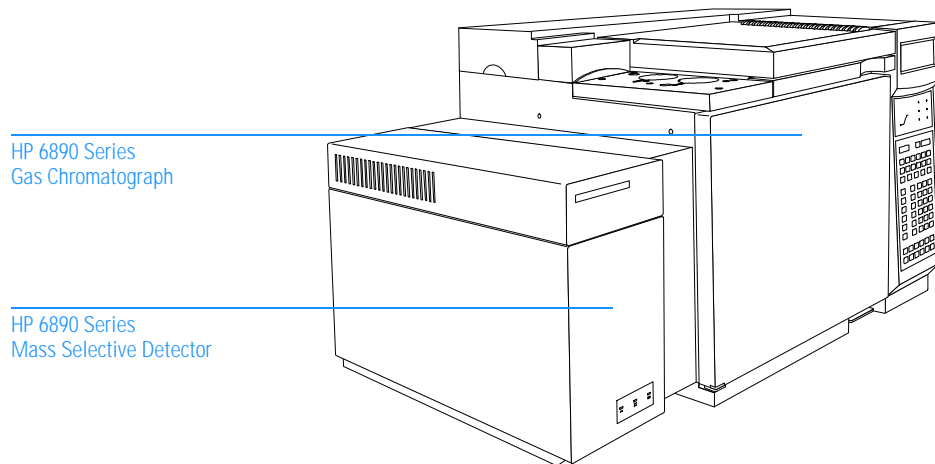
The HP 5972A and HP 6890 Series Mass Selective Detectors (MSDs) are stand-alone, capillary GC detectors. The HP 6890 Series MSD is designed for use with an HP 6890 Series Gas Chromatograph. The HP 5972A MSD is designed for use with an HP 5890 Gas Chromatograph.

Both MSDs feature:

- Machined aluminum vacuum manifold
- Vapor-diffusion, high vacuum pump
- Mechanical foreline pump
- Electron-ionization ion source
- Hyperbolic quadrupole mass filter
- Electron multiplier
- Instrument control electronics
- Power supplies
- GC interface

The differences between the two MSDs are minor

The primary difference between the two MSDs is in the GC interface. The heater in the GC interface of the HP 6890 Series MSD is powered by 40 V dc electricity from an HP 6890 Series GC. The heater in the GC interface of the HP 5972A MSD is powered by 110 V ac electricity from an HP 5890 GC. The upper cover on the HP 6890 Series MSD includes a sheetmetal extension that ensures the MSD is the proper distance from the GC. In all other respects, the two MSDs are essentially identical.



Operator interaction with the MSD is through the data system

The data system features Hewlett-Packard MS ChemStation software. It includes programs to calibrate (tune) the MSD, acquire data, and analyze the data. Tuning programs adjust voltages in the ion source, calibrate mass assignments, and control the scanning of the analyzer. Data acquisition programs allow you to monitor the total ion current, automatically storing the mass spectra of GC peaks as they elute (scan mode), or to monitor the concentrations of particular ions (selected ion monitoring mode (SIM)). Data analysis programs allow you to integrate chromatograms, generate ion chromatograms, view and manipulate mass spectral data, compare spectra to databases of reference spectra, and generate reports.

The MSD has several options and accessories

Options and accessories for the MSD include:

- HP 59864A Gauge Controller for measuring vacuum manifold (high vacuum) pressure. The gauge controller is connected to the triode gauge supplied on the MSD.
- HP 59765A GC/IRD/MSD Interface for interfacing the MSD with both an HP 5890 GC and an HP 5965 Infrared Detector (IRD). This interface is not compatible with the HP 6890 Series MSD and GC.
- HP G1072B CI Accessory which enables the MSD to perform chemical ionization analyses. It includes a new ion source and parts for modifying the GC interface.
- HP 59913A Jet Separator (glass jet) for connecting packed columns and large-diameter capillary columns to the MSD. The jet separator provides sample enrichment as well as reduction of total flow into the MSD. The HP 59913A Jet Separator is not currently compatible with the HP 6890 Series MSD and GC.

- HP 59913B Jet Separator (glass-lined metal jet) for connecting megabore (0.53-mm id) capillary columns to the MSD. The jet separator provides sample enrichment as well as reduction of total flow into the MSD. The HP 59913B Jet Separator is not currently compatible with the HP 6890 Series MSD and GC.

Installation and operation of the HP 59864A Gauge Controller is described in this manual. The GC/IRD/MSD interface, CI accessory, and jet separators are supplied with their own individual manuals.

In This Manual

Chapters 1 – 4 describe common operating, troubleshooting, and maintenance procedures for the HP 5972A and HP 6890 Series Mass Selective Detectors. Chapters 5 – 8 contain theory of operation and reference material. Chapter 9 is a parts reference.

The HP 6890 Series MSD and HP 6890 Series GC are shown in most of the illustrations in this manual. Most of the procedures, however, apply equally to the HP 5972A MSD and HP 5890 GC. Tasks that are significantly different for the two GC/MSD systems are duplicated with a separate procedure for each system.

Currently, the HP 5972A and HP 6890 Series MSDs are controlled by different versions of the MS ChemStation software. Also, the software is revised periodically. Therefore, if descriptions of the software in this manual do not match your software precisely, refer to the online help or manuals supplied with your software.

Refer to the manuals supplied with your gas chromatograph for detailed instructions on setting up, operating, and maintaining your GC.

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Installing GC Columns

How to connect GC columns to the MSD

Installing GC columns

Before you can operate your GC/MSD system, you must select, condition, and install a GC column. This chapter will show you how to condition and install a column.

Many types of GC columns can be used with the MSD but there are some restrictions

The rate of column flow into the MSD should not exceed 2.0 ml/minute during tuning or data acquisition. Optimum sensitivity generally occurs at 1.0 ml/minute or less. Therefore, there are limits to column length and flow.

- Narrow-bore columns (0.20 mm id, 0.30 mm od) can be installed directly into the GC interface.
- Wide-bore columns (0.32 mm id, 0.44 mm od) that are 50 meters long or longer can be installed directly into the GC interface. Some flow restrictions apply. Wide-bore columns of any length can be used if an effluent splitter is also installed.
- Megabore columns (0.53 mm id, 0.70 mm od) cannot be installed directly into the GC interface. Megabore columns of any length can be used if an effluent splitter or jet separator is also installed.
- Packed columns can be used only with a jet separator.

This information is summarized in Table 1. The dimensions listed are nominal values. The velocities and flows listed are calculated values at 70 °C. Actual values can vary from column to column and vary greatly with oven temperature. See *To measure column flow* on page 54 for instructions on how to measure actual flow in your column.

Table 1

GC column information						
Column diameter (mm) ¹	Column length (meters) ¹	Injection port type	Interface type	Head pressure (psi)	Linear velocity (cm/sec) ²	Column flow (ml/min) ²
0.100	10	C	CD	25.5	30	0.224
0.200	12	C	CD	3	44	0.58
	25	C	CD	10.4	30	0.56
	50	C	CD	35.5	30	1.12
0.250	30	C	CD	15	46.2	1.60
0.32 (wide-bore)	30	C	CD	3.5	46.3	1.60
	50	C	CD	4.9	30	1.12
	50	C	ES	15.3	30	2.00
0.53 (megabore)	30	C,P	ES/JET	3.2	30	3.85
	60	C,P	ES/JET	6.5	30	4.27
	90	C,P	ES/JET	9.9	30	4.71

1 Nominal dimensions

2 Calculated values at 70 °C with vacuum compensation turned on except for ES/JET which were calculated with vacuum compensation turned off

C = Capillary (split/splitless injection port)

CD = Capillary direct

ES = Effluent splitter

JET = HP 59913A/B Jet Separators

P = Packed-column injection port

Effluent splitters reduce the flow into the MSD

An effluent splitter vents part of the GC sample to atmosphere. This reduces the amount of sample entering the MSD. When an effluent splitter is used, the GC column is connected to the splitter. A restrictor (a special ultra-narrow 0.115 mm id capillary column) connects the splitter to the GC interface. Installation of an effluent splitter is described on pages 26 and 28.

A jet separator reduces flow and is more selective

A jet separator also reduces flow into the MSD. It preferentially sends heavier molecules into the MSD, so that an enrichment occurs (more sample enters the MSD relative to the amount of carrier gas). A short piece of capillary column connects the jet separator to the GC interface.

Two jet separators are available. The HP 59913A has a glass jet. The HP 59913B has a glass-lined metal jet. Currently, both jet separators are compatible only with the HP 5890 GC. Each jet separator includes a manual that describes how to install it in an HP 5890 GC.

Conditioning a column before it is installed into the GC interface is essential

A small portion of the capillary column stationary phase is often carried away by the carrier gas. This is called column bleed. Column bleed deposits traces of the stationary phase in the MSD ion source. This decreases MSD performance and makes cleaning of the ion source necessary.

Column bleed is most common in new or poorly cross-linked columns. It is much worse if there are traces of oxygen in the carrier gas when the column is heated.

To minimize column bleed, all capillary columns should be conditioned before they are installed in the GC interface or in a splitter or jet separator. Conditioning consists of:

1. Purging the carrier gas lines
2. Baking the column for several hours while flowing carrier gas through it

The temperature used is typically 10°C above the maximum temperature you expect to use for analyses.

CAUTION

Do not exceed the maximum temperature rating of the column.

Instructions for conditioning a capillary column are included in this chapter.

Conditioning ferrules is also beneficial

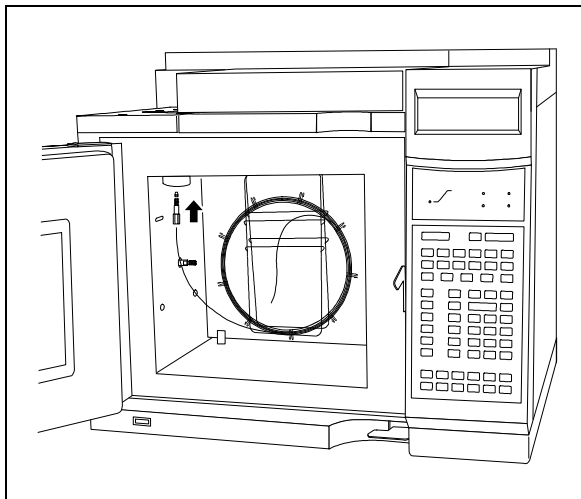
New ferrules tend to loosen after a few heating cycles in the GC oven. This can result in leaks. Heating ferrules to their maximum expected operating temperature for several hours before they are installed can minimize subsequent loosening. It also reduces possible chemical bleed from the ferrules.

1 Installing GC Columns
To condition a capillary column

To condition a capillary column

Materials needed:

- Carrier gas, (ultra-pure)
- Ferrules, injection port
 - 0.27-mm id, for 0.1-mm id columns (5062-3518)
 - 0.37-mm id, for 0.2-mm id columns (5062-3516)
 - 0.40-mm id, for 0.25-mm id columns (5181-3523)
 - 0.47-mm id, for 0.32-mm id columns (5062-3514)
 - 0.74-mm id, for 0.53-mm id columns (5062-3512)
- GC column
- Nut, injection port (18740-20870)
- Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



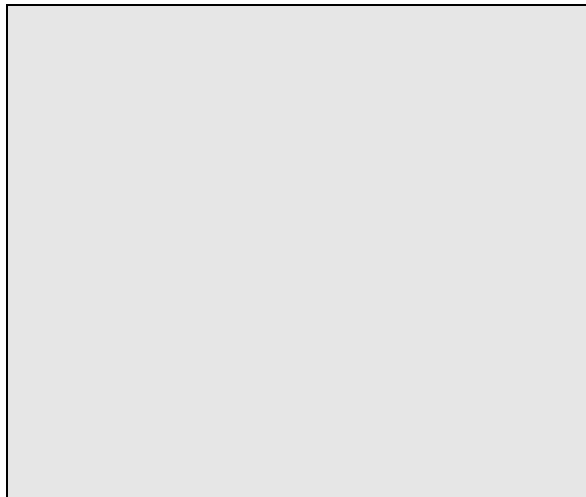
- 1** Install one end of the column in the injection port.
Use a ferrule that has been conditioned.

CAUTION

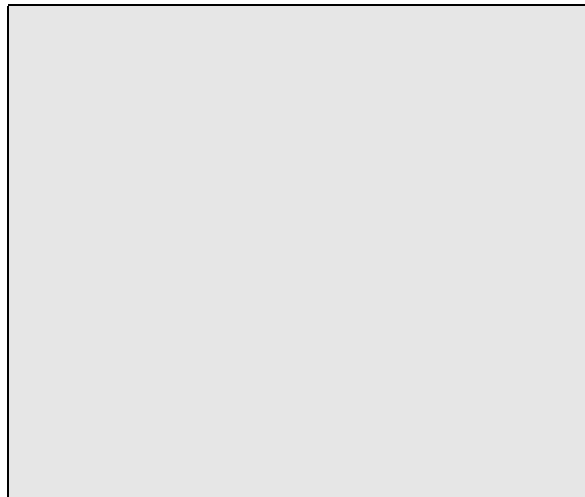
Do not exceed the maximum
temperature rating of the column.

- 2** Allow the carrier gas to flow through the column for 5 minutes without heating the GC oven.

- 3** Ramp the oven temperature at 5°C/minute to 10°C above your highest analytical temperature.



4 Hold this temperature. Allow the carrier gas to flow for several hours.



5 Return the column to a low standby temperature.

For more information about installing a capillary column, refer to pages 6 and 7 of the Hewlett-Packard application note:

Optimizing splitless injections on your GC for high performance MS analysis (5091-4587E).

1 Installing GC Columns
To install a capillary-direct column

To install a capillary-direct column

Materials needed:

Ferrules

0.3-mm id, for 0.1-mm id columns (5062-3507)

0.4-mm id, for 0.2-mm id columns (5062-3508)

0.5-mm id, for 0.32-mm id columns (5062-3506)

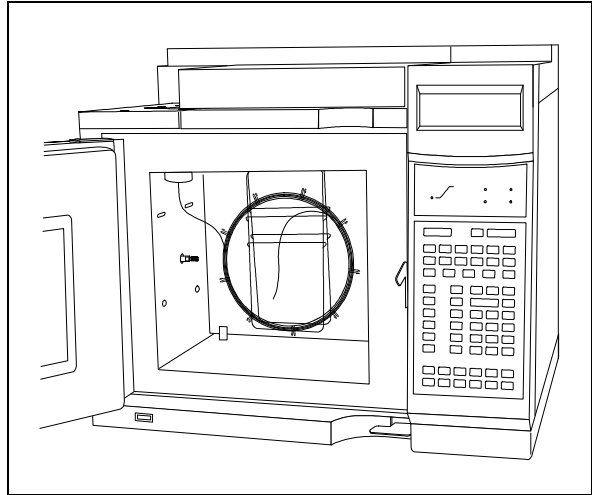
Gloves, clean

large (8650-0030)

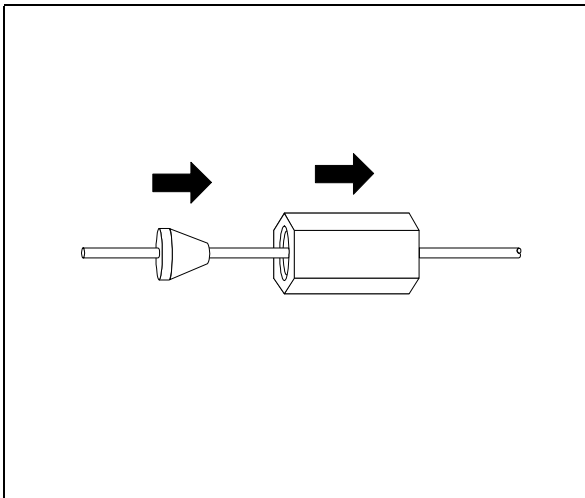
small (8650-0029)

Nut, column (05988-20066)

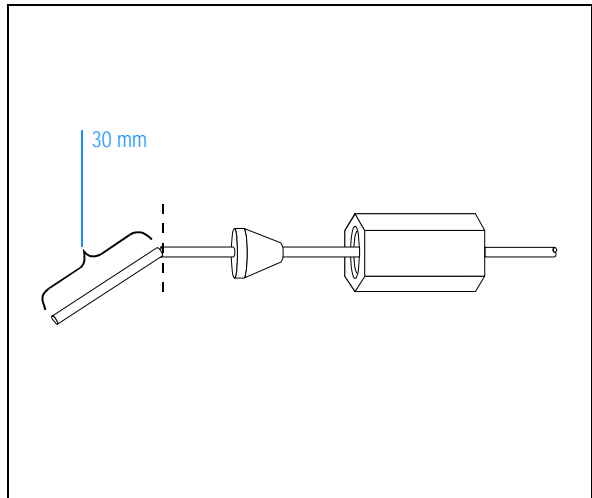
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



1 Condition the column as described on page 22.

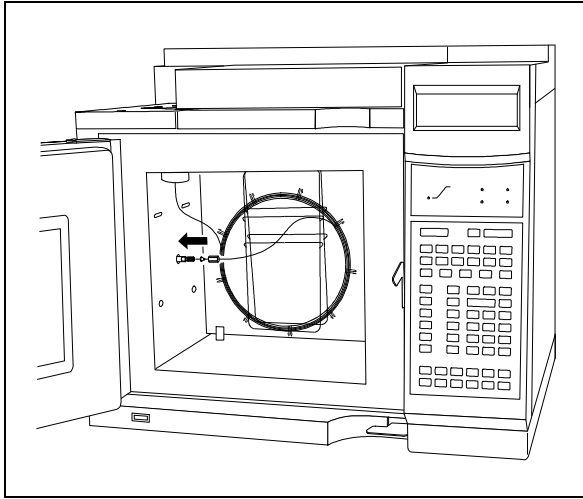


2 Slide a nut and conditioned ferrule onto the free end of the GC column.

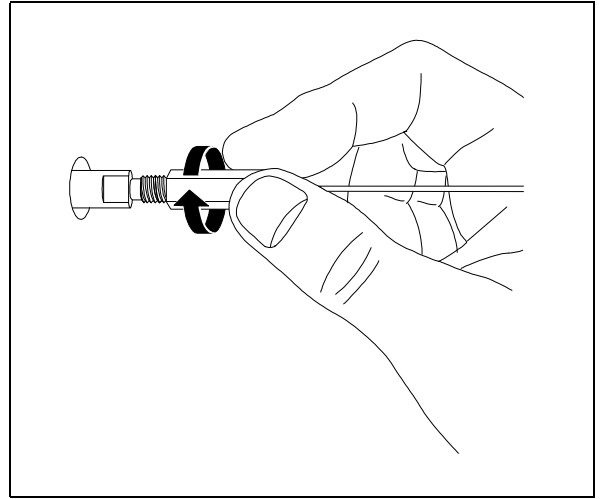


3 Score and break off the first 30 mm of the column. Make sure the break is even.

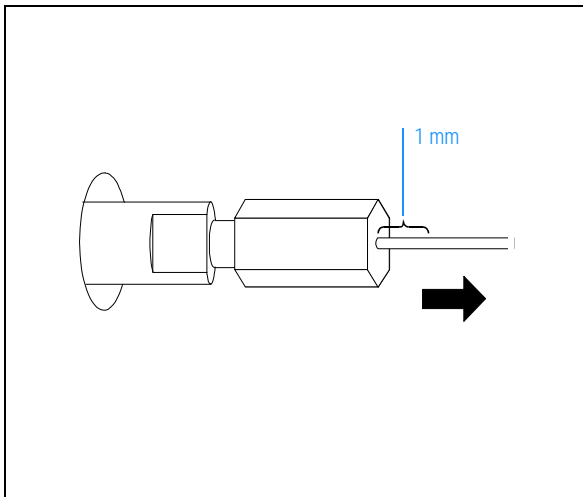
1 Installing GC Columns
To install a capillary-direct column



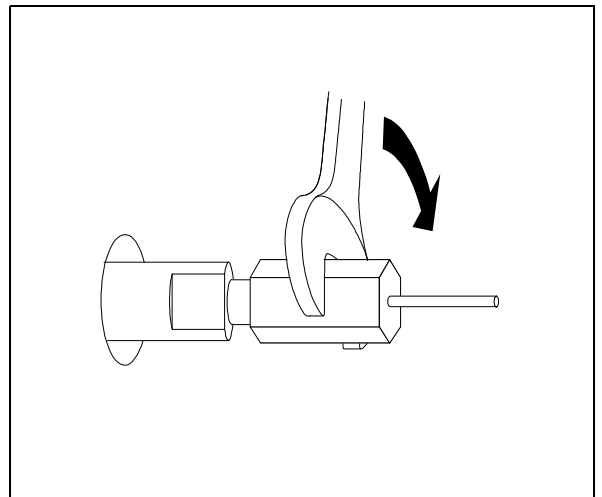
4 Slide the column into the GC interface until it stops (about 20 cm).



5 Hand tighten the nut.



6 Withdraw the column 1 mm.



7 Tighten the nut 1/4 to 1/2 turn. Old ferrules need less tightening than new ones.

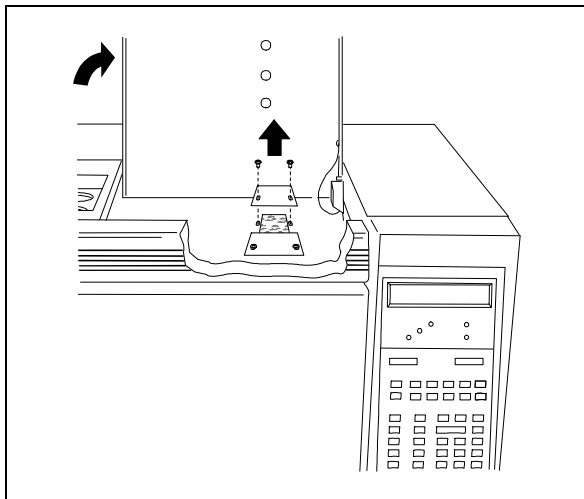
1 Installing GC Columns

To install a splitter in an HP 5890 GC

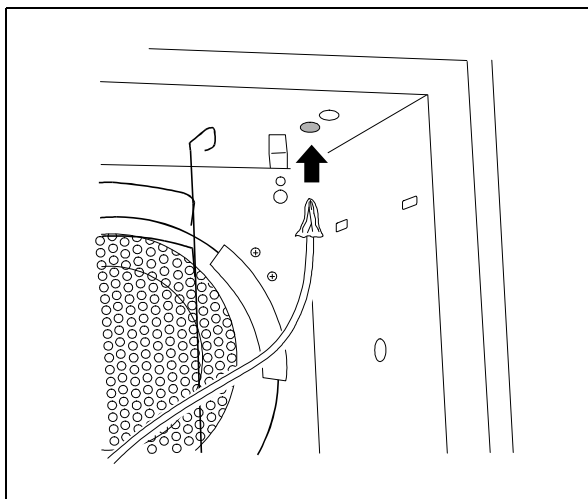
To install a splitter in an HP 5890 GC

Materials needed:

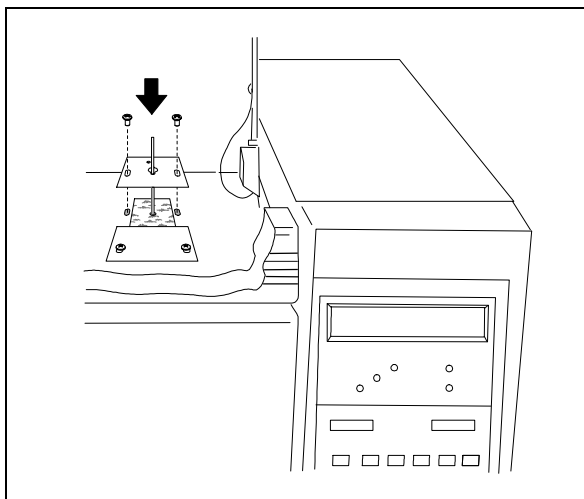
Aluminum foil, clean
Clamp, for vent tube (05988-00081)
Gloves, clean
 large (8650-0030)
 small (8650-0029)
Mounting plate, HP 5890 GC (05988-00080)
Nut, short (2740-0015)
Screwdriver, Pozidriv #2 (8710-0900)
Sealing ring (0905-0938)
Tee connector (05995-20174)
Vent tube (1530-2163)
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



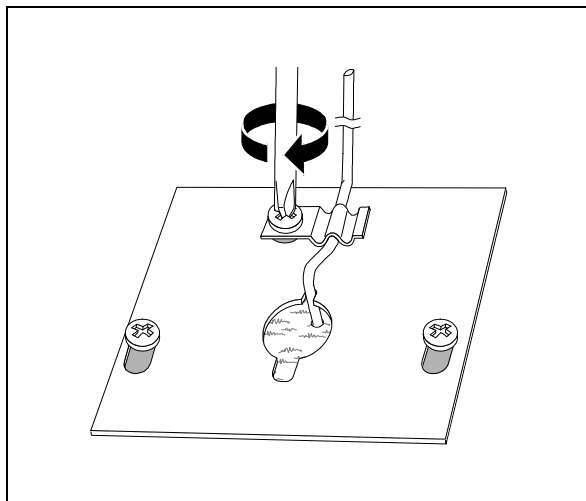
- 1 Remove the blank plate from the rear detector port of the GC.



- 2 Cover the end of the vent tube with foil. Push it up through the insulation in the roof of the GC oven.



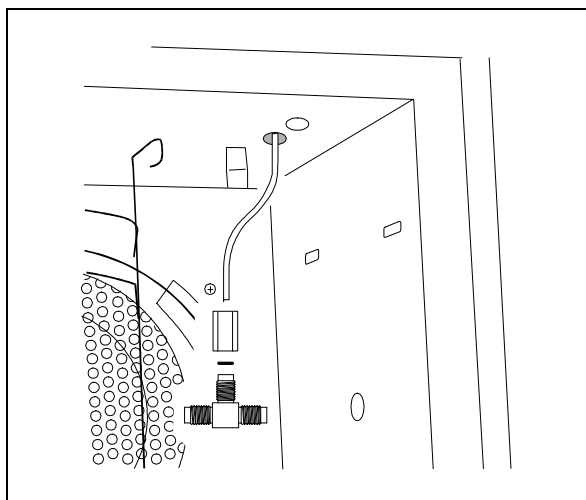
- 3 Install the mounting plate over the rear detector port.



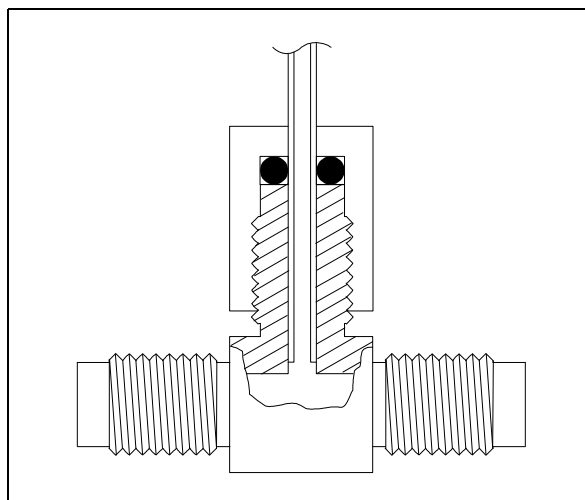
4 Fasten the clamp over the vent tube. Route the vent tube outside or to a fume hood.

WARNING

The gases exiting the vent tube are your carrier gas and sample. They may be dangerous and should never be vented directly into your laboratory.



5 Install the tee connector on the oven end of the vent tube. Tighten the nut.



6 The vent tube should not protrude too far into the tee connector.

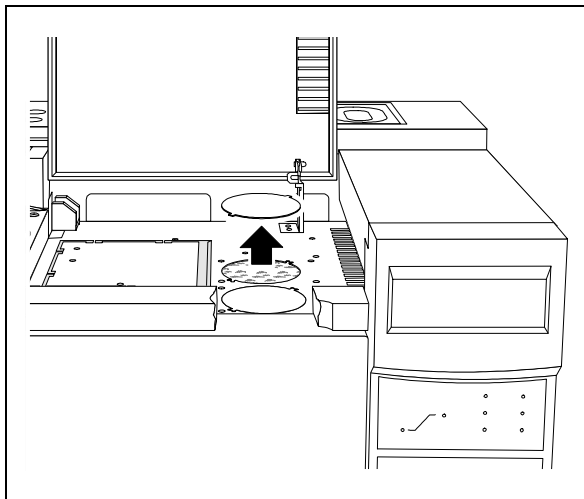
1 Installing GC Columns

To install a splitter in an HP 6890 Series GC

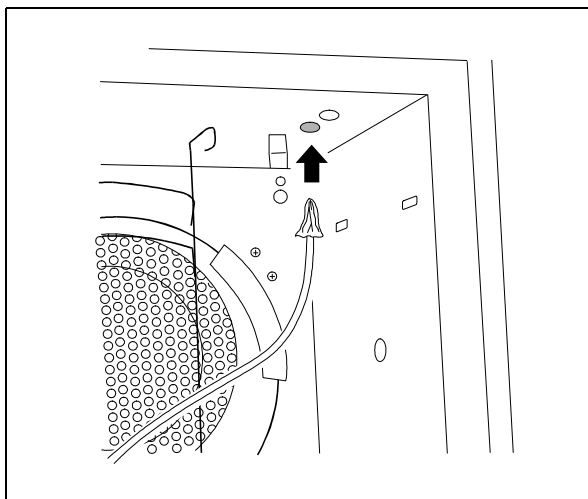
To install a splitter in an HP 6890 Series GC

Materials needed:

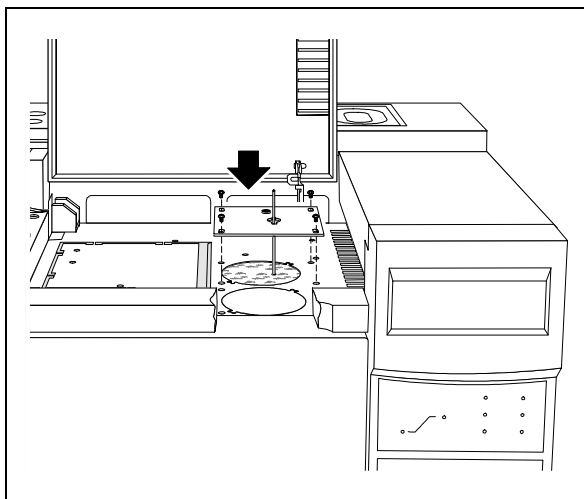
Aluminum foil, clean
Clamp, for vent tube (05988-00081)
Gloves, clean
 large (8650-0030)
 small (8650-0029)
Mounting plate, HP 6890 GC (05972-00017)
Nut, short (2740-0015)
Pliers, side-cutting (8710-0006)
Screwdriver, Pozidriv #2 (8710-0900)
Sealing ring (0905-0938)
Tee connector (05995-20174)
Vent tube (1530-2163)
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



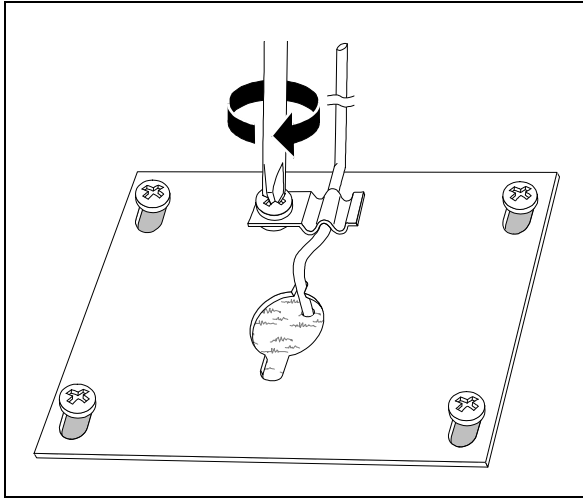
1 Use side-cutting pliers to remove the blank plate from the rear detector port of the GC.



2 Cover the end of the vent tube with foil. Push it up through the insulation in the roof of the GC oven.



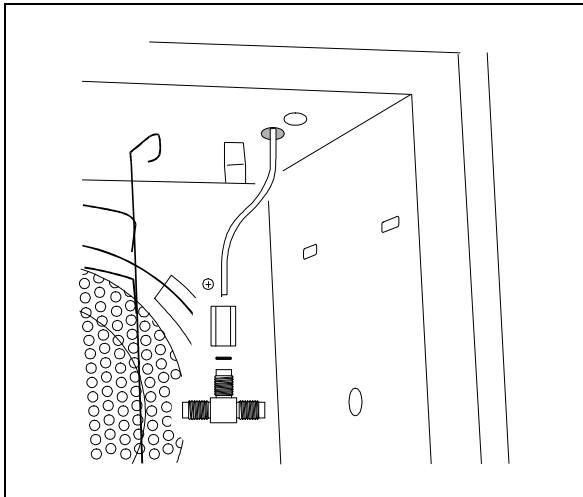
3 Install the mounting plate over the rear detector port.



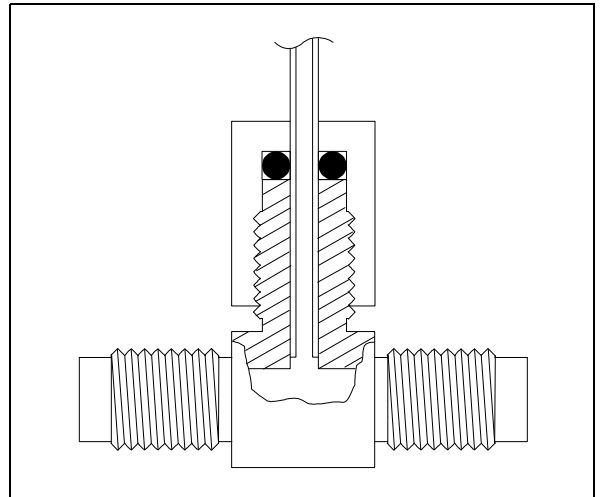
4 Fasten the clamp over the vent tube. Route the vent tube outside or to a fume hood.

WARNING

The gases exiting the vent tube are your carrier gas and sample. They may be dangerous and should never be vented directly into your laboratory.



5 Install the tee connector on the oven end of the vent tube. Tighten the nut.



6 The vent tube should not protrude too far into the tee connector.

1 Installing GC Columns

To install a wide-bore (0.32-mm id) column

To install a wide-bore (0.32-mm id) column

Materials needed:

Ferrules

0.3-mm id, for restrictor, both ends (5062-3507)

0.47-mm id, injection port end of column (5062-3514)

0.5-mm id, splitter end of column (5062-3506)

Gloves, clean

large (8650-0030)

small (8650-0029)

Nut

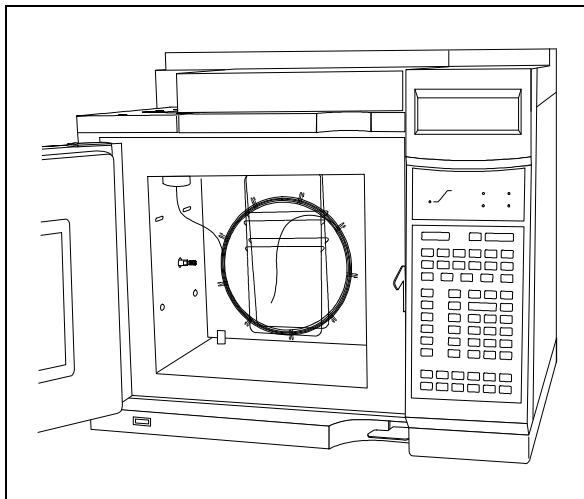
GC interface and splitter (05988-20066)

injection port (18740-20870)

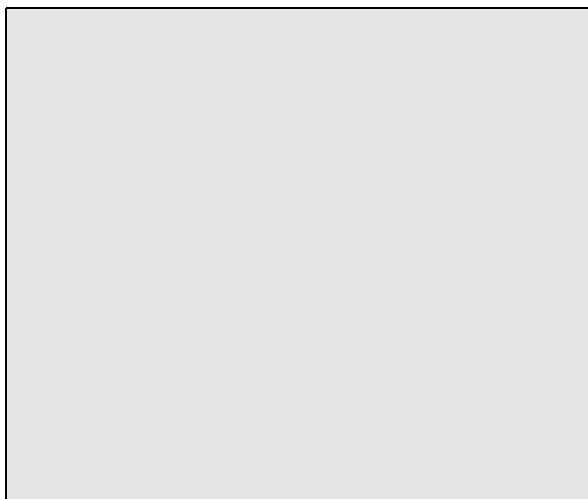
Restrictor, 0.115-mm id (05971-20590)

Split tube (05988-20224)

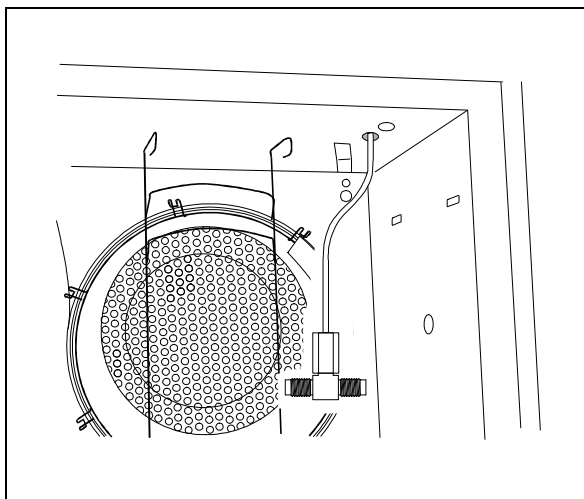
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



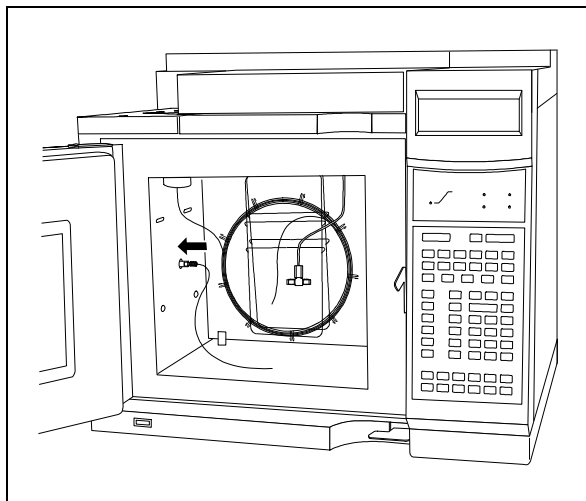
1 Install the GC column into the injection port. See your GC manual.



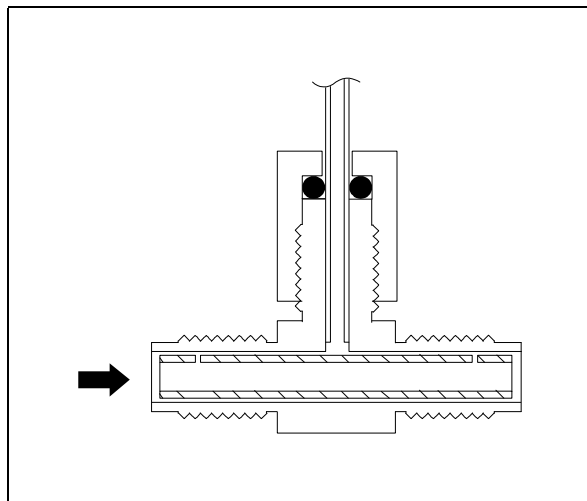
2 Condition the column as described on page 22.



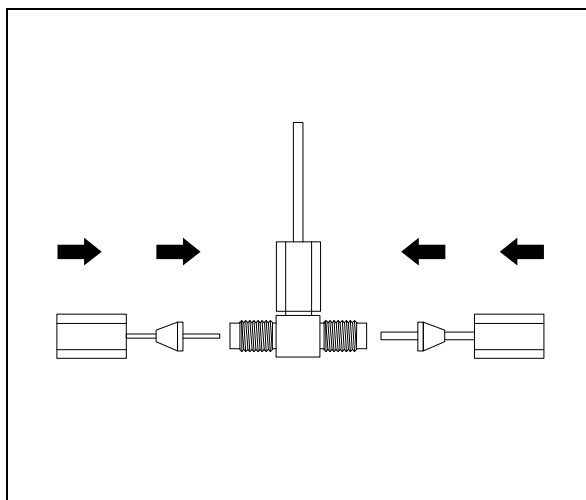
3 Install the splitter into the GC oven as described on page 26 or 28.



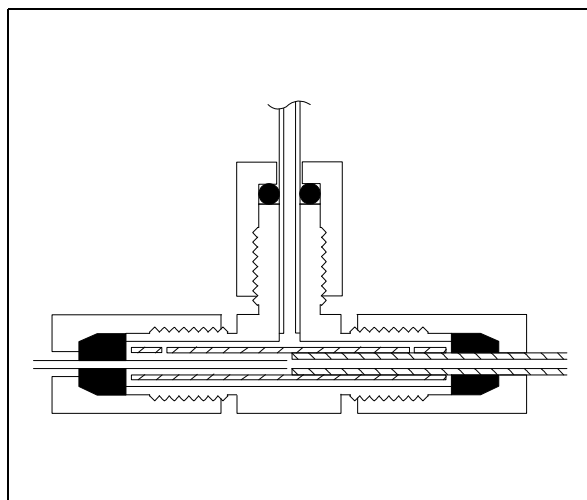
4 Install the restrictor column capillary direct into the GC interface (see page 24).



5 Slide the split tube into the tee connector.



6 Connect the restrictor and the GC column to the tee connector. Tighten the nuts.



7 The restrictor column and GC column should not quite meet inside the tee connector.

1 Installing GC Columns

To install a megabore (0.53-mm id) column

To install a megabore (0.53-mm id) column

Materials needed:

Ferrules

0.3-mm id, for restrictor, both ends (5062-3507)

0.74-mm id, injection port end of column (5062-3512)

0.8-mm id, splitter end of column (5062-3538)

Gloves, clean

large (8650-0030)

small (8650-0029)

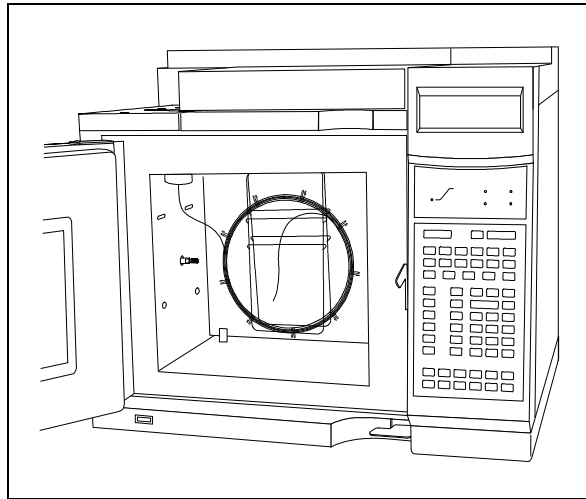
Nut

GC interface (05988-20066)

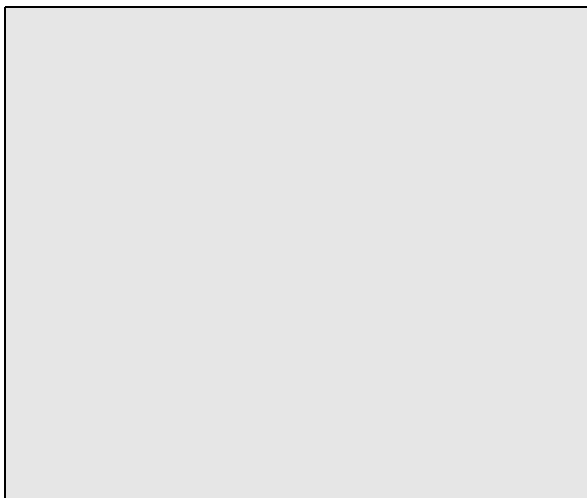
injection port (18740-20870)

Restrictor, 0.115-mm id (05971-20590)

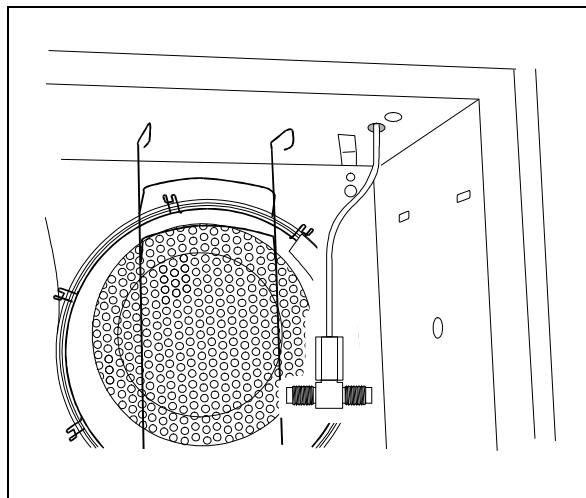
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



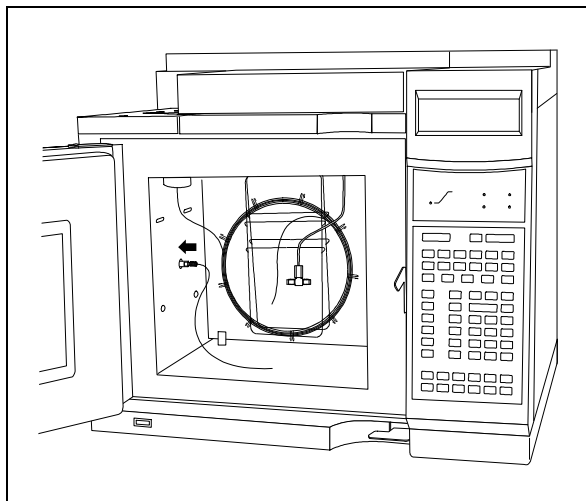
1 Install the GC column into the injection port. See your GC manual.



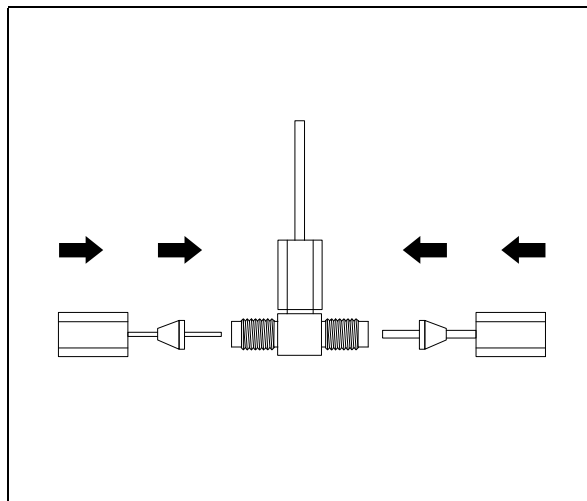
2 Condition the column as described on page 22.



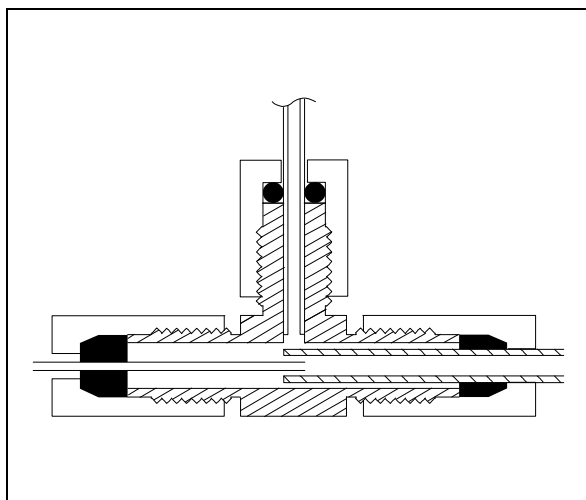
3 Install the splitter into the GC oven as described on page 26 or 28.



4 Install the restrictor column capillary direct into the GC interface (see page 24).



5 Connect the restrictor and the GC column to the tee connector. Tighten the nuts.



6 The restrictor column should protrude slightly into the end of the GC column.

To pump down the MSD, 40
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To connect the gauge controller, 44
To monitor vacuum manifold pressure, 46
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To vent the MSD, 58
To move or store the MSD, 60

Operating the MSD

How to perform some basic operating procedures for the MSD

Operating the MSD

Operation of the MSD is primarily from the data system

Except for the main power switch, the MSD has no switches, knobs or other physical controls. You control the MSD through a data system equipped with MS ChemStation software. This includes tasks such as pumpdown, monitoring pressures, setting temperatures, tuning, and venting. These tasks are described in this chapter. It also includes tasks such as data acquisition and data analysis. These tasks are described in the manuals and online help supplied with your data system software.

Different versions of the software control the HP 5972A and HP 6890 Series MSDs

Currently, HP 5972A and HP 6890 Series MSDs are controlled by different versions of the MS ChemStation software. Both versions feature graphical user interfaces with windows and menus. There are, however, significant differences between them. The procedures in this chapter do not provide details of the software operation. For those details, refer to the manuals and online documentation supplied with your MS ChemStation software.

Some conditions must be met before you turn on the MSD

Verify the following before you turn on or attempt to operate the MSD.

- The MSD is connected to a grounded power source.
- The GC interface is attached to the MSD and extends into the GC oven.
- A capillary column is installed in the GC oven and the GC interface.
- The capillary column was conditioned before it was installed in the GC interface.
- The GC is on, but the heated zone that controls the GC interface is off.
- Carrier gas is flowing through the column.
- The foreline pump is connected to the MSD.
- The foreline pump exhaust is properly vented.

W A R N I N G

Connecting the MSD to an ungrounded power source creates a shock hazard for the operator and can damage the instrument.

W A R N I N G

The exhaust from the foreline pump contains trace amounts of the chemicals you are analyzing. Do not vent the pump exhaust into your laboratory.

The data system helps you pump down the MSD

Pumpdown is mostly automated. Once you turn on the main power switch, the MSD basically pumps down by itself. The data system software contains a program that allows you to monitor pumpdown. It reminds you to turn on the GC interface heater and tells you when your MSD is ready to operate.

Pressure in the MSD can be monitored two ways

All MSDs are equipped with a gauge that measures foreline pressure. Foreline pressure can be monitored only through the data system.

All MSDs are also equipped with a triode gauge tube. If your MSD is equipped with the optional HP 59864A Gauge Controller, the triode gauge can measure the pressure in the vacuum manifold. The high-vacuum pressure monitored by the triode gauge cannot be monitored through the data system. It is displayed by LEDs on the gauge controller.

The gauge controller is calibrated for nitrogen (N₂). If you use helium (typical) as a GC carrier gas, the pressure reading on the gauge controller will not be absolutely accurate. The indicated pressure will be lower than the actual pressure by approximately a factor of 6. This difference is not critical. All of the pressures listed in this manual are indicated pressures for helium carrier gas.

Temperatures are controlled through the data system

The MSD has one heater. It is located in the GC interface. The GC interface heater is powered by one of the heated zones (heater circuits) in the GC. In the HP 6890 Series MSD, the GC interface is powered by 40 V dc electricity from the auxiliary 2 (Aux 2) heated zone of the HP 6890 Series GC. In the HP 5972A MSD, the GC interface is powered by 120 V ac electricity from either the detector B (Det B) or auxiliary (Aux) heated zone of the HP 5890 GC.

A temperature sensor is located next to the heater. The GC interface temperature can be monitored from the data system or from the GC keypad. The temperature setpoint can also be changed from the data system or from the GC keypad.

The MSD has a second temperature sensor located near the ion source. Its temperature can be monitored only from the data system. In the software, this temperature is labeled MS temperature.

Column flow is set from the GC but can be measured by the MSD

Carrier gas flow through the GC column is controlled by head pressure in the GC. The controls vary depending on which GC you have and how it is equipped. For a given head pressure, the column flow will decrease as the GC oven temperature increases.

The MSD can be used to measure column flow. You inject a small amount of air, inert gas, or an unretained chemical and time how long it takes to reach the MSD. With this time, you can calculate the column flow.

The data system aids in venting

Venting must be done correctly. Otherwise, the MSD can be damaged by backstreaming of diffusion pump fluid. A program in the data system guides you through the venting process. It switches off the diffusion pump heater at the correct time. It also lets you monitor temperatures in the MSD and indicates when to vent the MSD.

CAUTION

Removing the column from the GC interface is the only correct way to allow air into the vacuum manifold.

WARNING

Make sure the GC interface is cool before you remove the column.

If you plan to move your MSD, or if it will remain vented for an extended time, a few additional precautions are required.


The MSD can still be vented if the data system is not working correctly. Disconnecting the blue foreline connector from the foreline gauge turns off the diffusion pump heater. After 10 minutes, the MSD can be switched off and the column removed from the GC interface.

To pump down the MSD

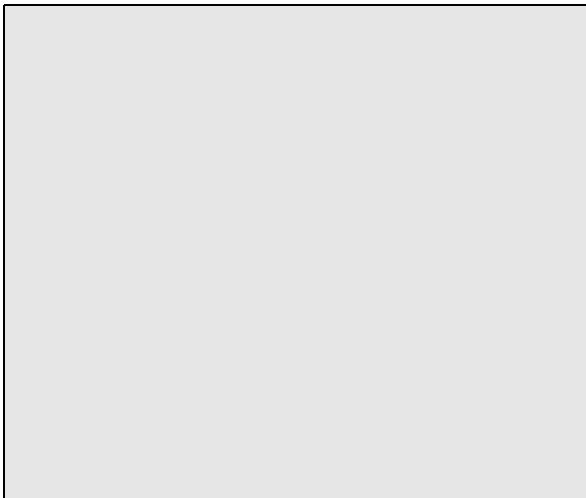
Materials needed:

None

The software is revised periodically. If the steps in this procedure do not match your MS ChemStation software, refer to the manuals and online help supplied with the software for more information.



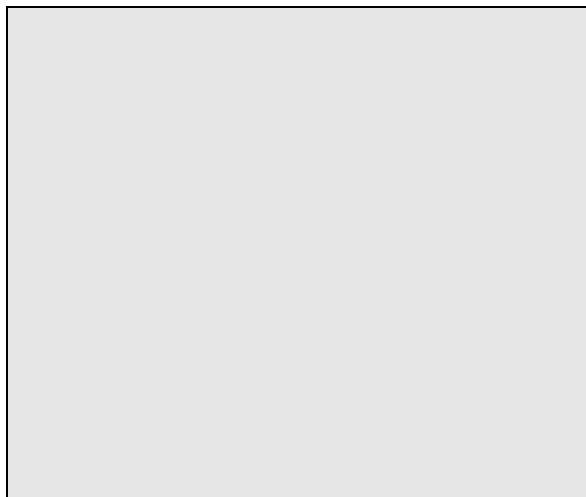
1 Make sure your MSD meets all of the conditions listed on page 36.



2 Select the **Diagnostics/Vacuum Control** program. Refer to your software documentation.



3 Select **Vacuum** from the Diagnostics/Vacuum Control menu.



4 Select **Pump Down** from the Vacuum menu.

The software will prompt you to switch on the MSD. Next it will prompt you to turn on the GC interface heater and GC oven. Once you have done this, the software monitors the interface temperature. It provides an estimate of the time remaining until the MSD is ready.

Even when the software tells you the MSD is ready, you should wait *at least 4 hours* for the MSD to reach thermal equilibrium before you tune or acquire data. Allowing the MSD to stabilize overnight is best.

CAUTION

Data acquired before the MSD has reached thermal equilibrium might not be reproducible and should not be used for quantitation.

Data acquired before the MSD has reached thermal equilibrium may be used to determine whether the system is free from leaks and is functioning properly.

To monitor the foreline pressure

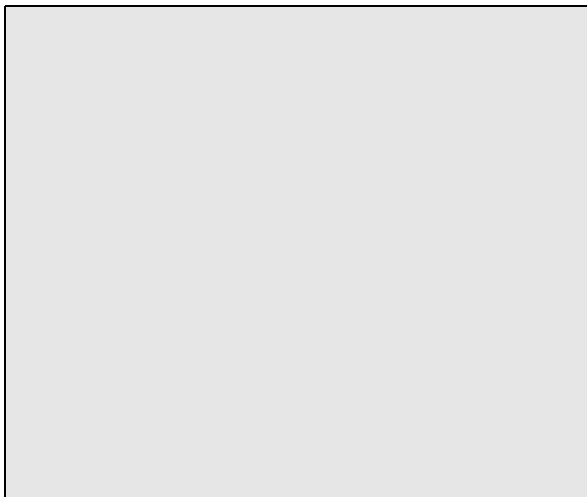
Materials needed:

None

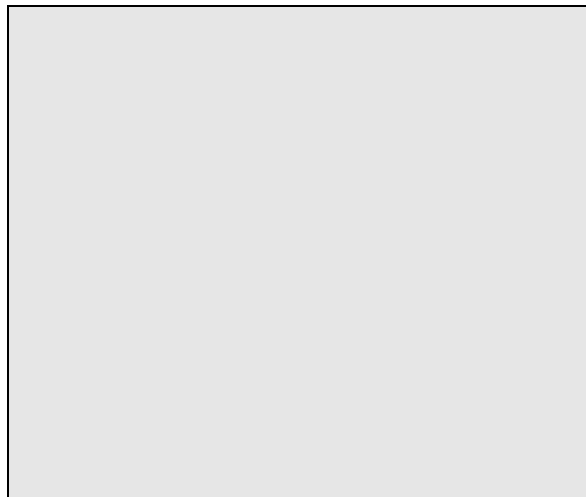
The software is revised periodically. If the steps in this procedure do not match your MS ChemStation software, refer to the manuals and online help supplied with the software for more information.



1 Select the **Manual Tune** program. Refer to your software documentation.



2 Select **Status** from the Manual Tune window.



3 Select **Vacuum/Temp Status** from the Status menu.

Unless you have just begun the pumpdown process, the foreline pressure must be less than 0.4 Torr (400 mTorr). Normally, the foreline pressure will be less than 0.1 Torr (100 mTorr).

The Vacuum/Temp Status box will display MS temperature and diffusion pump status as well as foreline pressure.

Foreline pressure can also be monitored from other programs in the software.

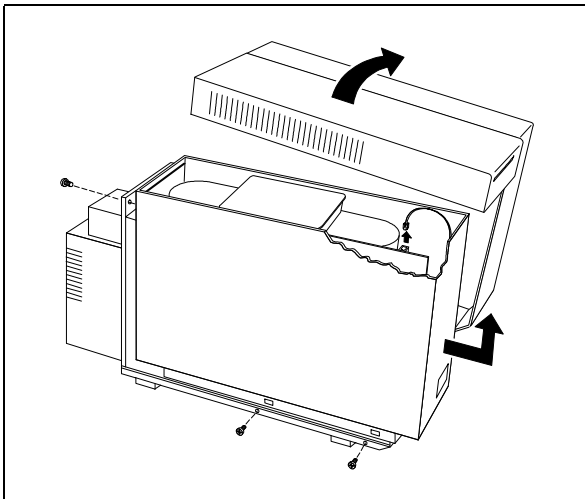
To connect the gauge controller

Materials needed:

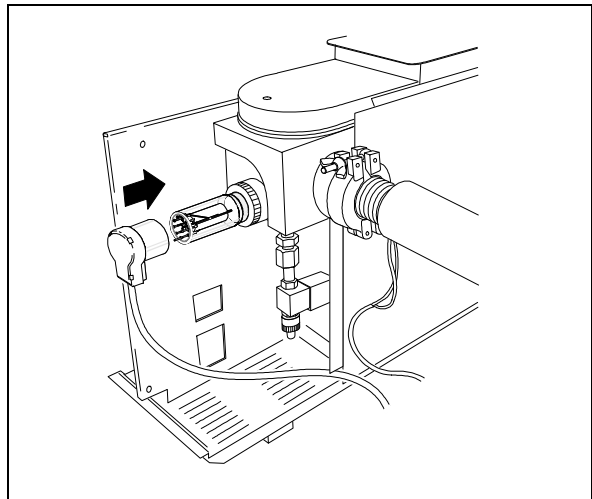
Cable (8120-6573)
Gauge controller (59864-89007)
Power cord
Screwdriver, TORX T-15 (8710-1622)
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)

WARNING Never connect or disconnect the cable from the triode gauge tube while the MSD is under vacuum.

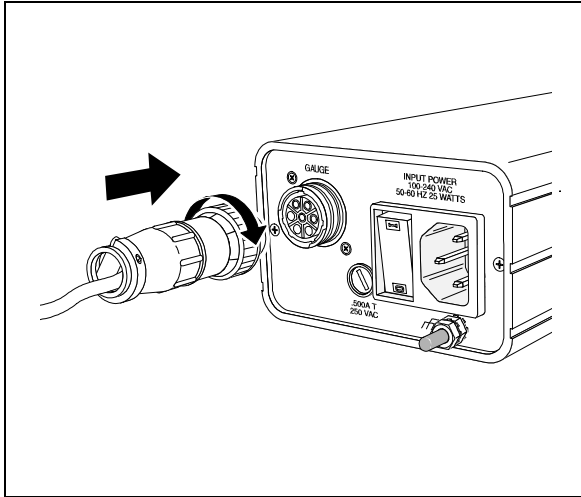
1 Vent and switch off the MSD (page 58).



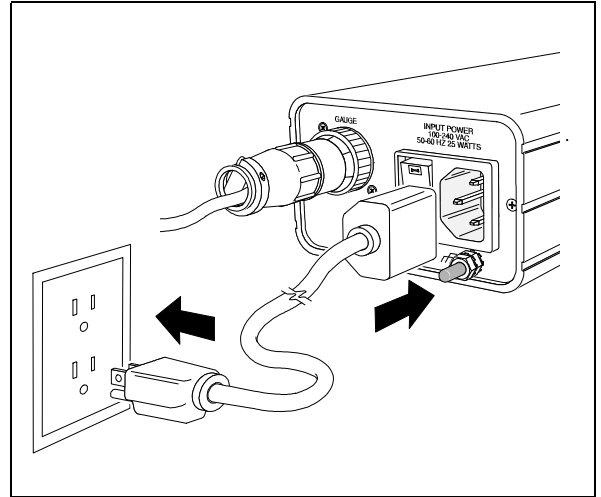
2 Remove the upper and lower MSD covers. Remember to disconnect the status display cable.



3 Connect the cable to the triode gauge tube. Route the cable as shown.



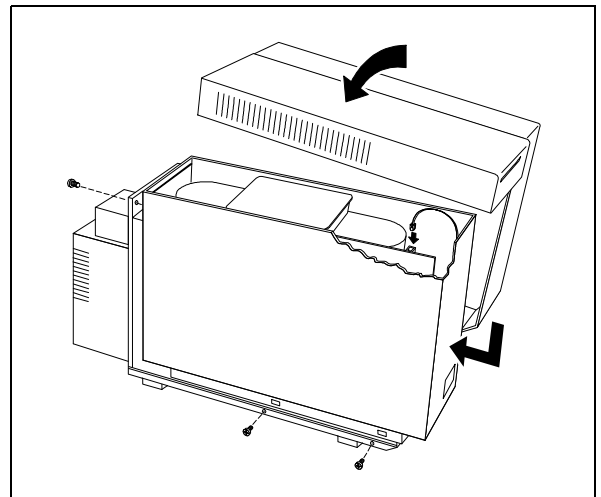
- 4** Connect the other end of the cable to the gauge controller.



- 5** Connect the power cord to the gauge controller and then to an appropriate electrical outlet.

The gauge controller has a universal power supply. It can operate on all voltages between 100 and 240 volts ac (nominal). It can operate at ac frequencies of 50 to 60 hertz. The fuse in the gauge controller is appropriate for all voltages in the allowed range.

A 2-meter power cord is supplied with a connector appropriate for the country from which the order was placed.



- 6** Reinstall the MSD covers and reconnect the status display cable. Pump down the MSD (page 40).

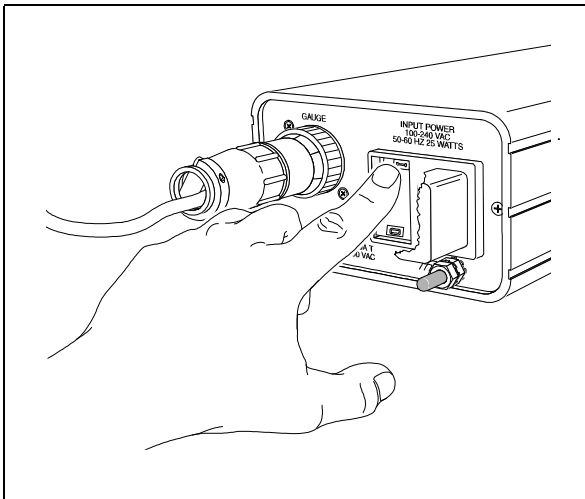
To monitor vacuum manifold pressure

Materials needed:

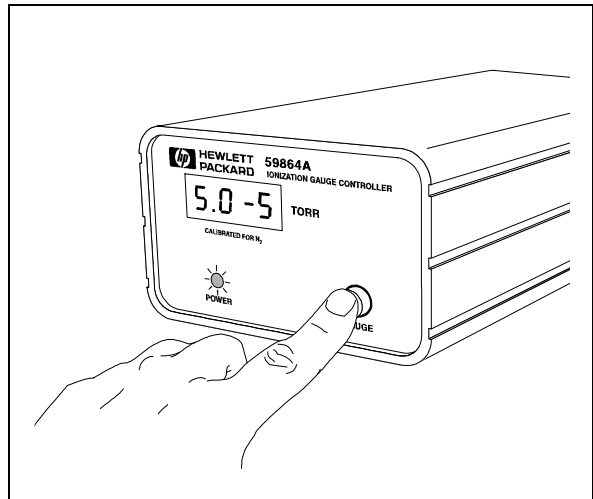
Cable (8120-6573)
Gauge controller (59864-89007)

WARNING Never connect or disconnect the cable from the triode gauge tube while the MSD is under vacuum.

- 1 Connect the gauge controller to the triode gauge tube (page 44) and pump down the MSD (page 40).



- 2 Switch on the power switch on the back of the gauge controller.



- 3 Press and release the GAUGE button. After a few seconds, the pressure should be displayed.

Pressure is displayed in the format $X.X - X$ where $-X$ is the base 10 exponent. Units are Torr.

The gauge controller will not turn on if the pressure in the MSD is above approximately 8×10^{-3} Torr. The gauge controller will display all 9s and then go blank. The triode gauge tube and gauge controller can measure pressures between approximately 8×10^{-3} and 8×10^{-6} Torr. The gauge controller is calibrated for nitrogen, but all pressures listed in this manual are for helium carrier gas.

The largest influence on operating pressure is the carrier gas (column) flow. Higher carrier gas flows result in higher pressures. The following table lists typical pressures for various helium carrier gas flows. These pressures are approximate and will vary from instrument to instrument.

Table 2

Typical MSD vacuum manifold pressures for various carrier gas flow rates

Carrier gas flow (ml/min)	Typical pressure (in Torr)	Carrier gas flow (ml/min)	Typical pressure (in Torr)
0.2	1.6×10^{-5}	0.9	7.0×10^{-5}
0.3	2.4×10^{-5}	1.0	7.7×10^{-5}
0.4	3.2×10^{-5}	1.2	9.1×10^{-5}
0.5	4.0×10^{-5}	1.4	1.0×10^{-4}
0.6	4.7×10^{-5}	1.6	1.2×10^{-4}
0.7	5.4×10^{-5}	1.8	1.3×10^{-4}
0.8	6.2×10^{-5}	2.0	1.4×10^{-4}

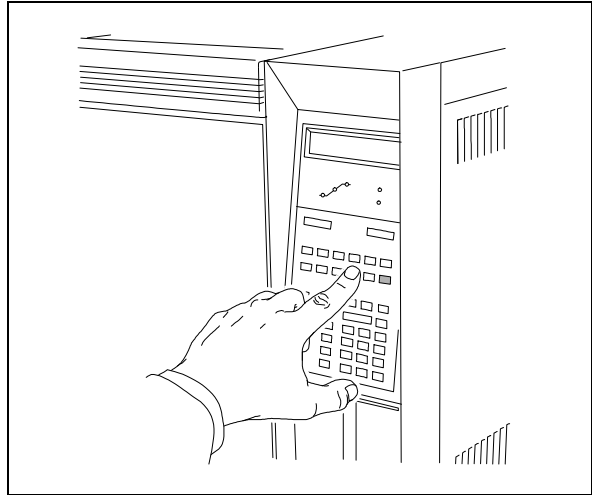
If the pressure is consistently higher than those listed, there may be a leak in the detector. See *Finding air leaks* on page 124.

If the pressure rises above approximately 8×10^{-3} Torr, the gauge controller will turn off the triode gauge tube. The gauge tube **does not** turn on automatically if the pressure falls below that level again.

To set the GC interface temperature from an HP 5890 GC

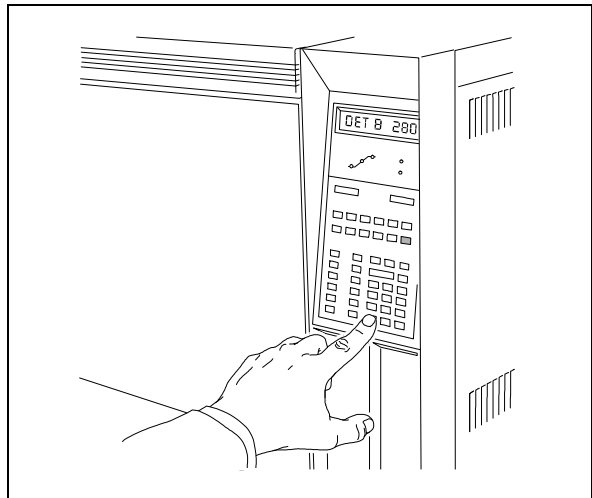
Materials needed:

None



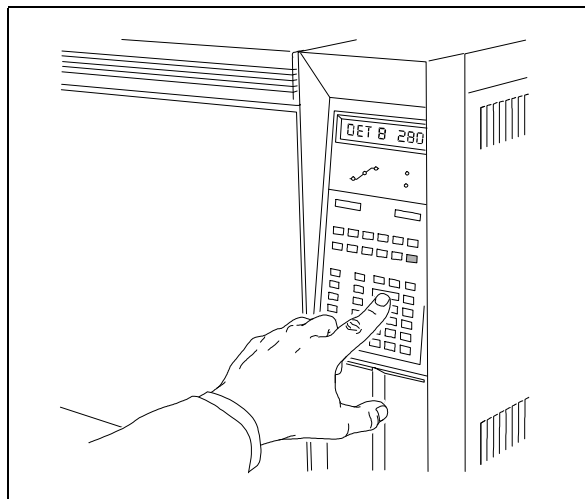
1 Press the **Det B Temp** key on the numeric keypad of the GC.

If your GC/MSD system is configured so that the GC interface heater is powered by the auxiliary (Aux) heated zone, press the shift (gold) key before you press the Det B Temp key.



2 Use the number keys to type in the new temperature setpoint.

A typical setpoint is 280 °C. The limits are 0°C and 320°C. In practice, any temperature setpoint below ambient simply turns off the interface heater.



3 Press the **Enter** key.

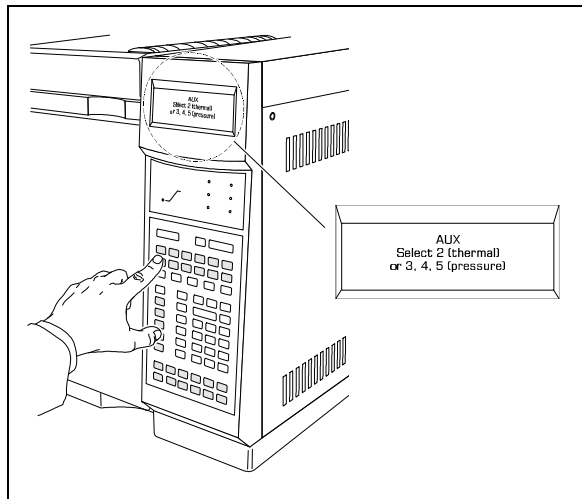
2 Operating the MSD

To set the GC interface temperature from an HP 6890 GC

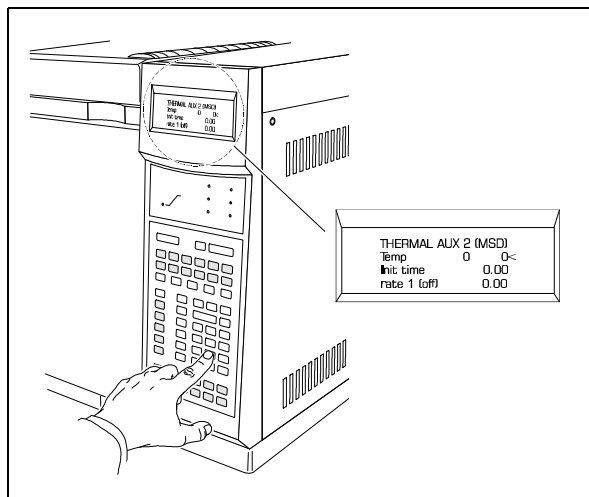
To set the GC interface temperature from an HP 6890 GC

Materials needed:

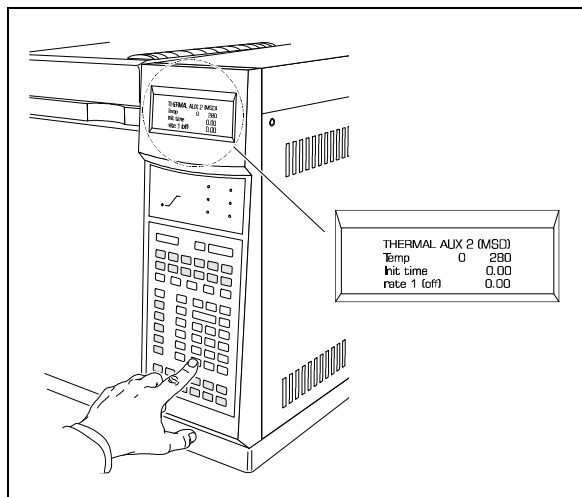
None



1 Press the **Aux #** key.



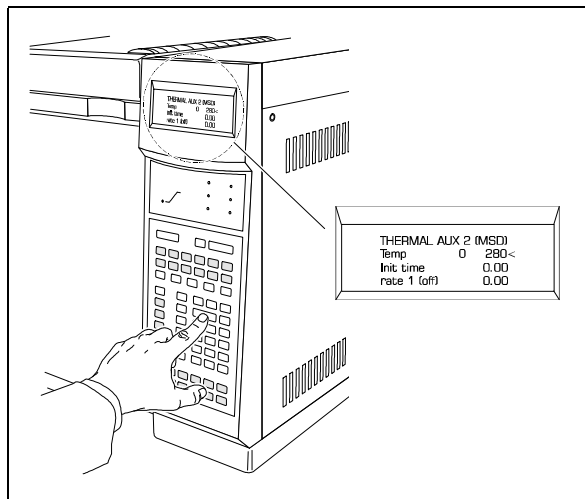
2 Press 2 (the GC interface is powered by auxiliary heated zone 2 on the HP 6890 Series GC).



3 Use the number keys to type in the new temperature setpoint.

To set the GC interface temperature from an HP 6890 GC

A typical setpoint is 280 °C. The limits are 0 °C and 320 °C. In practice, any temperature setpoint below ambient simply turns off the interface heater.



4 Press the Enter key.

To set the GC interface temperature from the ChemStation

Materials needed:

None

The software is revised periodically. If the steps in this procedure do not match your MS ChemStation software, refer to the manuals and online help supplied with the software for more information.

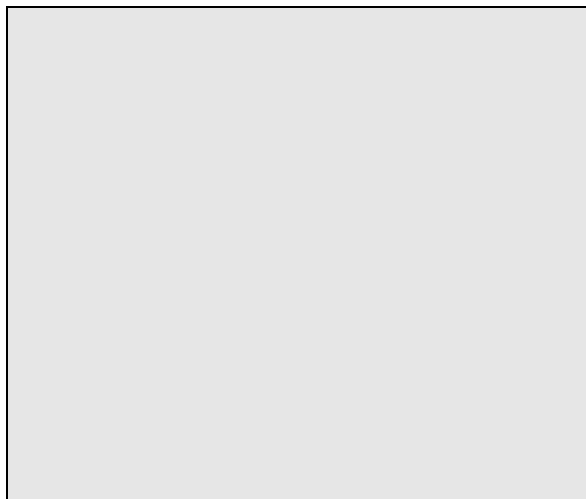
- 1 Select the temperature control program from the software. Refer to your software documentation.

For HP 5890 GC / HP 5972A MSD systems, the GC interface heater is controlled by either the detector B (Det B) heated zone or the auxiliary (Aux) heated zone.

For HP 6890 Series GC/MSD systems, the GC interface heater is controlled by the auxiliary 2 (Aux 2) heated zone.

A typical setpoint is 280 °C. The limits are 0 °C and 320 °C. In practice, any temperature setpoint below ambient simply turns off the interface heater.

- 2 Type the new temperature setpoint in the appropriate heated zone.

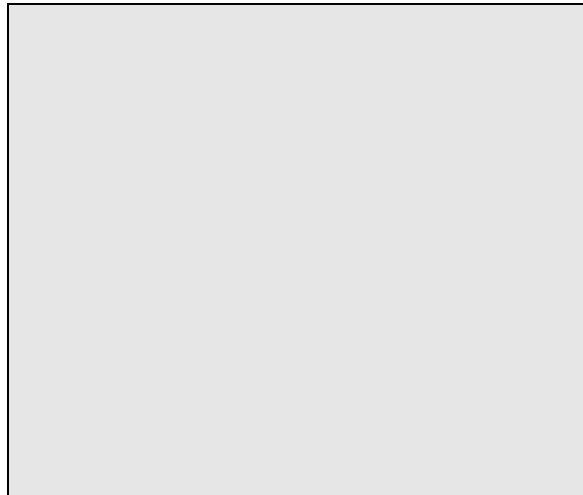


3 Click **OK** or **Apply** to download the setpoint to the GC.

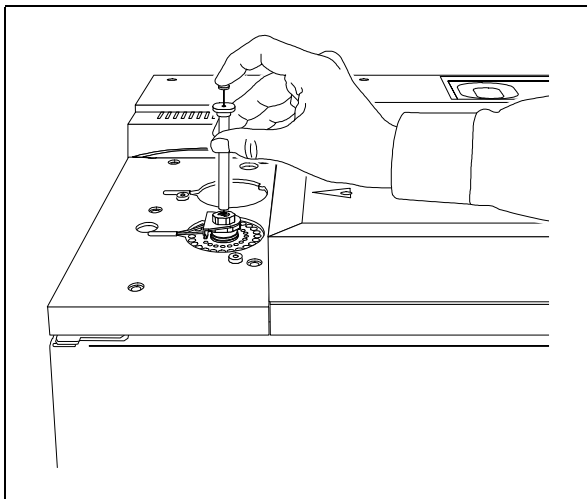
To measure column flow

Materials needed:

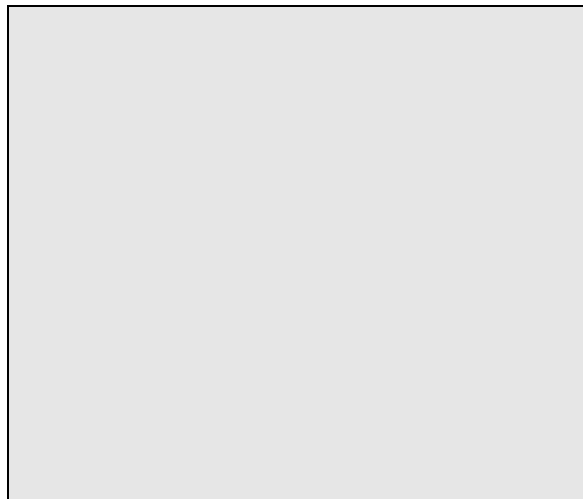
Syringe



1 Use either Tune or Data Acquisition to set up selected ion monitoring (SIM) of m/z 28.



2 Inject about 4 μ l of air into the injection port and click **Start Run**.



3 Wait until a peak elutes at m/z 28. Measure the retention time.

$$\text{Average linear velocity (cm/sec)} = \frac{100 L}{t}$$

where:

L = length of the column in meters
 t = retention time in seconds

$$\text{Average volumetric flow rate (ml/min)} = \frac{v D^2}{2.12}$$

where:

v = average linear velocity
 D = column internal diameter in millimeters

4 Calculate the average linear velocity.

5 Calculate the volumetric flow rate.

When calculating the average linear velocity, be sure to account for any pieces of column broken off. A 1-meter section missing from a 25-meter column can yield a 4% error.

CAUTION

The column flow rate into the MSD should not exceed 2.0 ml/minute during tuning or data acquisition. Optimum sensitivity generally occurs at 1.0 ml/minute or less.

The equations in steps 4 and 5 can be replaced by a single equation:

$$\text{Volumetric flow rate (ml/min)} = \frac{0.785 D^2 L}{t}$$

where:

D = internal column diameter in millimeters
 L = the column length in meters
 t = the retention time in minutes

However, the average linear velocity found in step 4 is sometimes helpful in optimizing chromatography.

To tune the MSD

Materials needed:

None

The software is revised periodically. If the steps in this procedure do not match your MS ChemStation software, refer to the manuals and online help supplied with the software for more information.

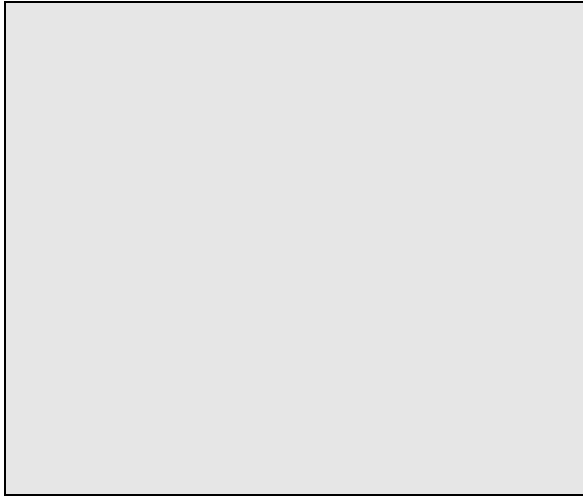
- 1 Locate the tune programs in the MS ChemStation software. Refer to your software documentation.

If you select **Max Sensitivity Autotune**, **Standard Spectra Autotune**, or **Quick Tune**, the tune program will start immediately.

If you select **Manual Tune**, **Target Tune**, **User Tune** or **CI Tune**, you will be presented with additional menu choices.

See the manuals or online help provided with your data system for additional information about the various tune programs.

- 2 Select the tune program you want to use.



Save tune reports. They can be very helpful in diagnosing performance problems and determining when to clean the ion source.

- 3 Wait for the tune program to finish. It will automatically generate a tune report.

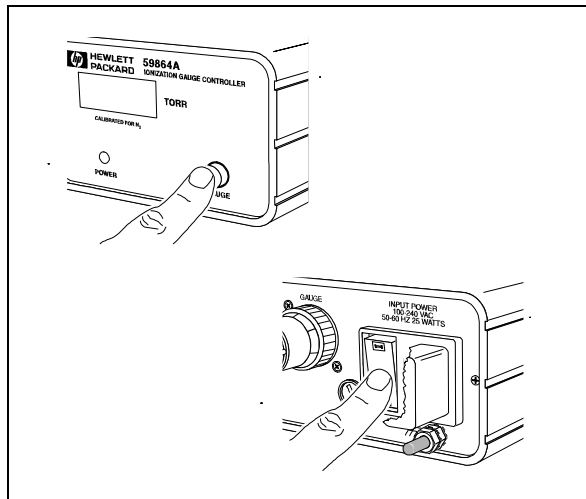
To vent the MSD

Materials needed:

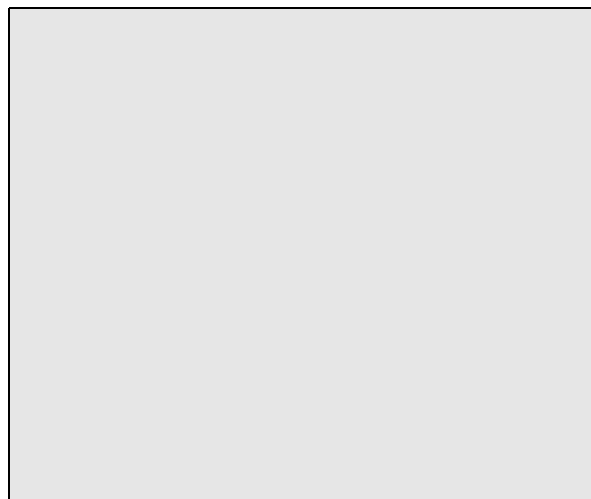
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)

The software is revised periodically. If the steps in this procedure do not match your MS ChemStation software, refer to the manuals and online help supplied with the software for more information.

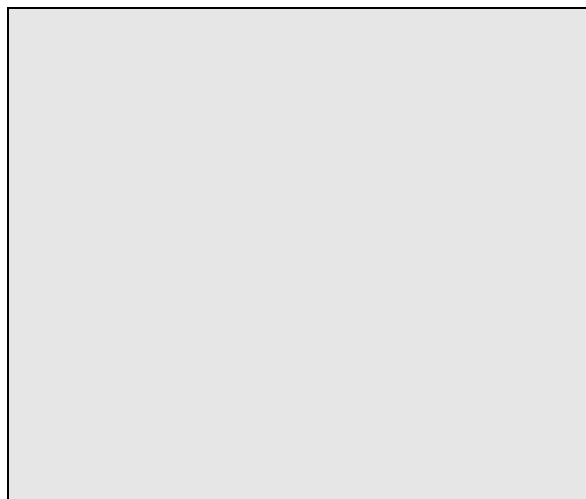
If the data system is not working correctly, the MSD can still be vented. See page 39.



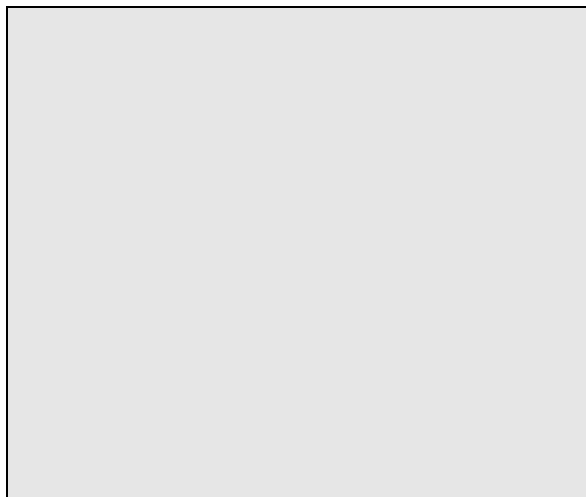
- 1 If your system is equipped with a gauge controller, switch off the triode gauge and gauge controller.



- 2 Select the **Diagnostic/Vacuum Control** program. Refer to your software documentation.



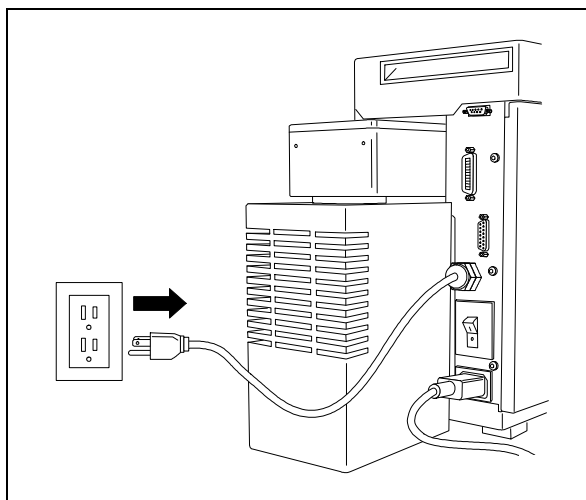
- 3 Select **Vacuum** from the Diagnostic/Vacuum Control menu.



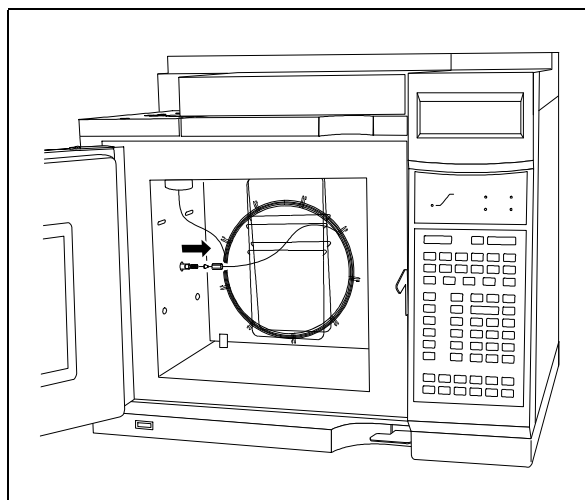
The vent program instructs you to turn off the GC interface heater and GC oven. The program turns off the diffusion pump heater. The program displays an estimate of the time it will take the diffusion pump and analyzer to cool. When the time reaches 0, or when the program prompts you, switch off the MSD power switch.

If absolutely necessary, you can switch off the MSD and vent as soon as the diffusion pump is cool and the MS temperature is below 100 °C.

4 Select **Vent Cycle** from the Vacuum menu. Follow the instructions presented.



5 Disconnect the MSD power cord.

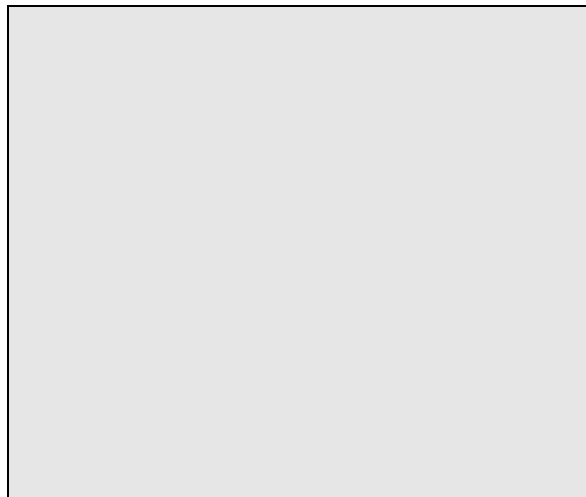


6 Loosen the column nut and remove the transfer line (capillary column) from the GC interface.

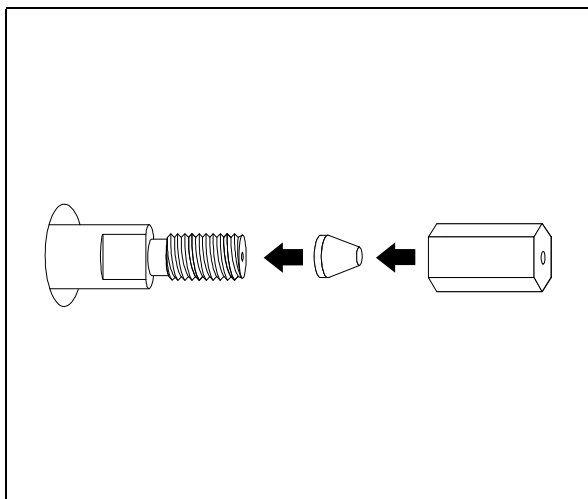
To move or store the MSD

Materials needed:

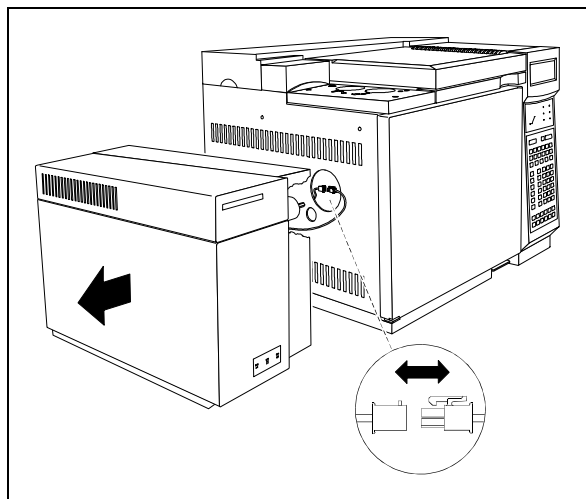
Ferrule, blank (0100-0691)
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



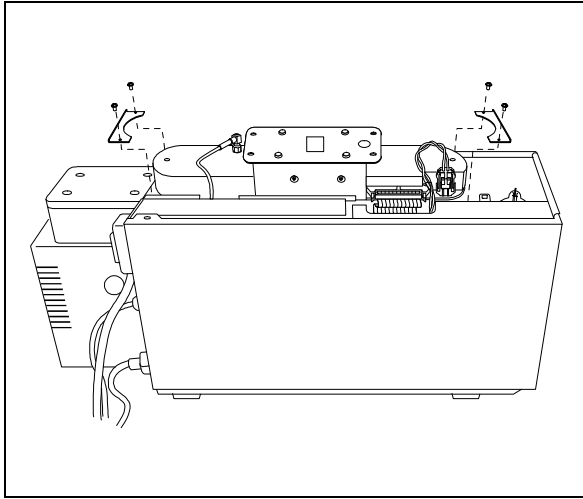
1 Vent the MSD (page 58) and switch off the GC.



2 Install a blank ferrule and column nut on the end of the GC interface.



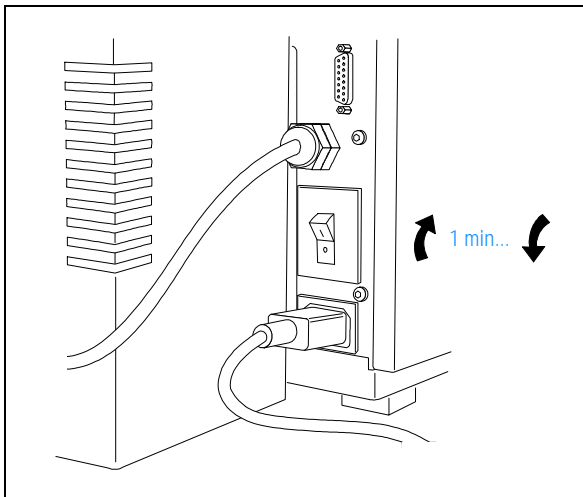
3 Slide the MSD away from the GC. Unplug the GC interface cable from the GC.



- 4 Remove the upper MSD cover and install the shipping clamps. Reinstall the upper MSD cover.

The MSD is now ready to be moved. If you are going to store the MSD or if more than 24 hours will elapse before you operate it again, follow step 5.

CAUTION Extreme tipping or inverting of the MSD will result in contamination of the vacuum manifold and analyzer by diffusion pump fluid.



- 5 Switch the MSD on for 1 minute to re-establish a rough vacuum. Switch the MSD off.

The MSD can now be stored or moved. If the MSD is moved, the foreline pump must be moved with the MSD. They cannot be disconnected. Make sure the MSD is *never* tipped on its side or inverted.

Symptoms, 65
Finding air leaks, 124
Checking for contamination, 136
Testing, 141

Troubleshooting the MSD

How to find and correct problems in your MSD

Troubleshooting the MSD

This chapter will help you diagnose problems in the operation of your HP 5972A or HP 6890 Series Mass Selective Detector (MSD). It is divided into four sections:

- Symptoms, 65
- Finding air leaks, 124
- Checking for contamination, 136
- Testing, 141

If the material in this chapter proves insufficient to help you diagnose a problem, contact your Hewlett-Packard Customer Engineer.

Symptoms

This section lists common symptoms of problems in an MSD. Related symptoms are grouped together in the following categories:

- General symptoms
- Performance symptoms
- Pressure symptoms
- Temperature symptoms
- Error messages

These categories are briefly described in the following material. The symptoms are then listed in the above order with no introductions between the categories.

General symptoms occur when you turn on the MSD

This section describes symptoms that you may observe during start up and pump down of the MSD. Some of the symptoms may also occur at other times.

- If the MSD does not turn on, 70
- If the MSD is on but the fan is not operating, 71
- If the MSD is on but the foreline pump is not operating, 72
- If the MSD is on but the status LEDs are all blinking, 73

Performance symptoms appear in analytical results

Performance symptoms are symptoms that can be observed in the chromatograms and mass spectra generated by tuning or by data acquisition. Some symptoms only occur during tuning. Others occur in data acquisition or in both tuning and data acquisition.

The following table lists common performance symptoms and groups them according to where they occur most often.

Table 3

Performance symptoms and where they commonly occur

Symptom, page number	Tune	Acquisition
If the relative abundance of m/z 502 is lower than expected, 74	✓	
If peak widths are inconsistent (narrow or wide peak at m/z 219), 76	✓	
If peak widths are < 0.45 amu or > 0.65 amu, 78	✓	
If mass spectra show excessive, periodic noise, 79	✓	✓
If isotopes are missing or isotope ratios are incorrect, 80	✓	✓
If mass spectra show high background, 82	✓	✓
If there are peaks at m/z 18, 28, and 32, 83	✓	✓
If no peaks are present, 84	✓	✓
If sensitivity is low, 88		✓
If repeatability is poor, 90		✓
If high-mass sensitivity is poor, 92		✓
If mass assignments are incorrect, 94		✓

Pressure symptoms

Abnormal vacuum pressure sometimes indicates a problem in the MSD. In the standard MSD, the foreline gauge monitors pressure at the exit of the diffusion pump. Foreline pressure above 300 mTorr will generate an error message.

If your MSD is equipped with the optional gauge controller, you can directly monitor the pressure in the vacuum manifold. The following symptoms are described in this section:

- If the foreline or vacuum manifold pressure is too low, 95
- If the foreline or vacuum manifold pressure is too high, 96
- If the gauge controller displays 9.9+9 and then goes blank, 98
- If the power indicator on the gauge controller does not light, 100

Temperature symptoms can be observed through the data system

Two temperature zones in the MSD can be monitored by the operator. The GC interface temperature is controlled by the GC. It can be monitored, and its setpoint can be changed, from either the GC keypad or from the data system. The analyzer temperature in the MSD is monitored by the data system where it is called the MS temperature. You can check this temperature through the data system.

In addition, there are two thermal switches on the diffusion pump. They cause the pump to be switched off if it gets too hot or too cold. The diffusion pump temperature can not be monitored by the operator.

Some temperature problems will cause an error message to be generated. Others can be observed by the operator through the data system. The following symptoms are described in this section:

- If the analyzer temperature is too low, 102
- If the GC interface does not heat up, 104

Error messages appear on your data system

Sometimes, a problem in your MSD will cause an error message to appear on the data system monitor. Some error messages appear only during tuning. Other messages will appear during tuning or data acquisition.

Some error messages are “latched”. These messages remain active in your data system even if the condition that caused the message has corrected itself. If the cause is removed, these messages can be removed by checking instrument status through the data system.

The following error messages are described in this section:

- Cannot achieve constant peak widths, 106
- Difficulty in the mass filter electronics (MS error 4), 108
- Difficulty with the detector HV supply (MS error 512), 109
- The diffusion pump is or was too hot (MS error 32), 110
- The diffusion pump is too cold (MS error 128), 112
- The foreline pressure has exceeded 300 mTorr (MS error 64), 116
- Mass spectrometer interface card is not active, 118
- MS does not respond, 119
- No peaks found, 120
- There is no emission current (MS error 8), 121
- There is not enough signal to begin the tune, 122

If the MSD does not turn on

This refers to a condition in which nothing happens when the MSD is switched on. The foreline pump does not start up, the fan does not start up, and none of the status display LEDs on the front of the MSD light.

Check the MSD power switch

The power switch (circuit breaker) should be in the ON (1) position. If you switch the power switch on and it returns to a neutral position (not off or on), this indicates a serious problem. Contact your Hewlett-Packard Customer Engineer.

Check the MSD power cord

The power cord should be securely plugged into an appropriate electrical outlet.

Check the line voltage at the electrical outlet

Make sure power is present and that it is the correct voltage for your MSD.

W A R N I N G

Only a trained electrician should check the line voltage.

If the MSD is on but the fan is not operating

This refers to a condition where the MSD is receiving power (at least the foreline pump is operating) but the diffusion pump fan is not blowing air out the rear of the instrument. If this occurs, first switch off the MSD. Wait about one minute and switch the MSD back on. If the fan is still not operating, check the following:

- **Check the connection between the fan wiring connector and the power distribution board**
 - 1 Shut down and vent the MSD.
 - 2 Remove the diffusion pump and fan.
 - 3 Make sure the fan wiring connector is securely connected to the power distribution board.

- **Check the fan**
 - 1 Shut down and vent the MSD.
 - 2 Remove diffusion pump and fan.
 - 3 Make sure the fan blades rotate freely. Occasionally the fan wires interfere with the rotation of the fan.
 - 4 Make sure the fan rotates smoothly and quietly. Bad bearings will make noise or feel rough as the fan turns.
 - 5 Use an ohmmeter to check the resistance of the fan motor. Resistance should be about 300 ohms in a 110/120 V ac fan or about 900 ohms in a 220/240 V ac fan. Hold the fan still while you take this measurement; otherwise the resistance varies as the fan turns.
 - 6 If the fan is bad, replace it.

- **Contact your Hewlett-Packard Customer Engineer**

If the MSD is on but the foreline pump is not operating

This refers to a condition when you can tell the MSD is receiving power (the fan is operating and the power LED on the status display is lit) but the foreline pump is not operating.

Check the on/off switch on the foreline pump

Make sure the switch is on. This switch should not normally be used to switch the foreline pump on and off. The foreline pump should be controlled by the power switch on the MSD.

Check the power cord of the foreline pump

Make sure the cord is securely plugged into the socket on the back of the MSD. If the pump is plugged in but is not operating, replace the foreline pump or contact your Hewlett-Packard Customer Engineer.

If the MSD is on but the status LEDs are all blinking

This is normal when the MSD is initially turned on. The status lights will blink until the data system software is started or the pumpdown cycle is initiated. The data system then downloads the instrument control software to the HP-IB/MS control card. When this occurs, the status LEDs will all light for a few seconds and then begin to operate normally, leaving the power LED on and the others off. If the status LEDs do not stop blinking, check the following:

- **Check the cable between the MSD and the data system**
 - 1 Make sure the appropriate cable is connected between the MSD and the data system.
 - 2 Make sure the cable is securely connected at both ends.
 - 3 If necessary, clean the connector contacts or tighten the connector screws.
 - 4 If that does not correct the problem, replace the cable.

- **Check the cable between the HP-IB/MS control card and the HP-IB connector on the back panel of the MSD**
 - 1 Shut down the MSD (follow the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
 - 2 Remove the upper and lower MSD covers.
 - 3 Remove the safety cover from over the HP-IB/MS control card.
 - 4 Make sure the cable between the HP-IB/MS control card and the HP-IB connector (I/O connector) is securely connected at both ends.

- **Check the output of the +5 V dc power supply**

See Also

To test the power supply, page 148

- **Contact your Hewlett-Packard Customer Engineer**

If the relative abundance (percentage) of m/z 502 is lower than expected

This refers to a condition where the abundance of m/z 502 is lower than expected relative to the abundance of m/z 69. The standard spectra autotune should give an m/z 502 relative abundance of 2 – 4%. The maximum sensitivity autotune should give an m/z 502 relative abundance of 0.2 – 2.0%.

This symptom should not be confused with general low abundance at high masses. Sensitivity at high masses can be excellent even if the relative abundance of m/z 502 is low. In fact, the maximum sensitivity autotune typically produces **better** high mass sensitivity than the standard spectra autotune even though its **relative abundance** of m/z 502 is **lower** than the relative abundance produced by the standard spectra autotune. If your instrument is producing low abundance at high masses, refer to the symptom *If high mass sensitivity is poor* on page 92.

Check to see which tune program was used

If the relative abundance you observe is not appropriate for the tune program used, refer to the other check steps in this module.

Check to see how long the MSD has been on

Contaminants that interfere with the relative abundance of m/z 502 may still be present in the instrument. Wait until the MSD has been on at least 8 hours, then try autotune again.

Check the foreline pressure or vacuum manifold pressure

At normal column flow rates, foreline pressure is typically between 20 and 100 mTorr. Vacuum manifold pressure is typically between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too low, check the column flow. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also

To measure column flow, page 54

Finding air leaks, page 124

If the relative abundance (percentage) of m/z 502 is lower than expected

Check the column flow

Column flow should not exceed 2.0 ml/minute during tuning or data acquisition. Reduce the column flow and retune the MSD.

See Also *To measure the column flow, page 54*

Check for poor filament operation

- 1 Use the MS ChemStation software to select the other filament.
- 2 Retune the MSD. If sensitivity improves, continue to use the new filament.
- 3 Replace the original filament when convenient.

See Also *To test the filaments, page 142*
To reinstall a filament, page 222

Check for a dirty ion source

Test for a dirty ion source. If necessary, clean the ion source.

See Also *To test the ion source, page 156*
To clean the ion source, page 212

Check the dc polarity on the quadrupole mass filter

- 1 Change the dc polarity on the quadrupole mass filter.
- 2 Retune the MSD.
- 3 If performance improves, continue to use the new dc polarity.

Contact your Hewlett-Packard Customer Engineer

If peak widths are inconsistent (narrow or wide peak at m/z 219)

Check the MSD tuning

Retune the MSD. Do not acquire data if the MSD is not operating well enough to pass autotune or allow a satisfactory manual tune.

Check (adjust) the width of the peak at m/z 219

This can be done automatically or manually.

Automatically

- 1 Call up the Manual Tune program.
- 2 Select **Calibrate** from the Manual Tune menu.
- 3 Select **PW Linearity**. This will adjust the peaks so that they are nearly equal.

Manually

- 1 Call up the Manual Tune program.
- 2 Select **Edit MS Params** from the AdjParam menu.
- 3 Perform a profile scan and see whether the m/z 219 peak is wider or narrower than the other peaks.
- 4 Raise or lower the 219 width parameter.
- 5 Select **Mass #3 widths** from the Calibrate (Calibration) menu. This adjusts peaks 1 and 3 until the peaks are 0.55 ± 0.03 amu wide.
- 6 Repeat steps 3 through 5 until the peak widths are nearly equal.
- 7 Save the new settings to your autotune file.

If peak widths are inconsistent (narrow or wide peak at m/z 219)

□ Check for ground-fault loops

If the MSD and GC are connected to separate power sources, the grounds may be at different potentials. This creates a current path (ground-fault loop) through the GC interface and analyzer. A ground-fault loop can cause noise in your data. If possible, connect the MSD and GC to the same power source. If this is not possible (for example, because the MSD and GC operate on different voltages), make sure the grounds for the power sources are at the same potential.

W A R N I N G

Checking for a ground-fault loop should be done by a qualified electrician.

□ Contact your Hewlett-Packard Customer Engineer

If peak widths are < 0.45 amu or > 0.65 amu

Check the peak width targets

- 1 Select the **Set Peak Width Target** item in the Tune menu of the Manual Tune window.
- 2 If necessary, set the peak width targets to 0.55 amu.

Check the MSD tuning

Retune the MSD. Do not acquire data if the MSD is not operating well enough to pass autotune or allow a satisfactory manual tune.

Check the amu gain and amu offset

- 1 Call up the Manual Tune program.
- 2 Select **Edit MS Params** from the AdjParam menu.
- 3 Perform a profile scan.
- 4 Raise or lower the AmuGain parameter to raise or lower the peak widths of the peaks at m/z 69 and 502.
- 5 Raise or lower the AmuOffs parameter to equalize all three peak widths.
- 6 Repeat steps 3 through 5 until the peak widths are nearly equal.
- 7 Save the new settings to your autotune file.

The **PW Linearity** and **Mass #3 width** options in the Calibrate (calibration) menu can be used to accomplish the same as the above.

Check the repeller voltage

A high repeller voltage can cause or contribute to this problem. This only applies to modes of operation that allow variable repeller voltage such as maximum sensitivity autotune. Lower the repeller voltage. If results improve, continue to adjust the repeller voltage until you find the optimum voltage.

Contact your Hewlett-Packard Customer Engineer

If mass spectra show excessive, periodic noise

This refers to electronic noise that appears as a jagged baseline throughout the mass spectra. Specifically, noise that is periodic and nearly equal at all masses.

□ Check for ground-fault loops

If the MSD and GC are connected to separate power sources, the grounds may be at different potentials. This creates a current path (ground-fault loop) through the GC interface and analyzer. A ground-fault loop can cause noise in your data. If possible, connect the MSD and GC to the same power source. If this is not possible (for example, because the MSD and GC operate on different voltages), make sure the grounds for the power sources are at the same potential.

W A R N I N G

Checking for a ground-fault loop should be done by a qualified electrician.

□ Check for a loose signal cable

- 1 Shut down the MSD (follow the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper and lower MSD covers.
- 3 Remove the safety cover from over the main board.
- 4 Check the connections at both ends of the signal cable. Tighten the connections if necessary.

□ Check the electron multiplier for loose electrical connections

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Check the electrical connections to the electron multiplier. Tighten the connections if necessary.

□ Check to see if the electron multiplier is loose

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Make sure the electron multiplier is securely fastened to the ceramic quadrupole support at the end of the radiator.

If isotopes are missing or isotope ratios are incorrect

Check the MSD tuning

Retune the MSD. Do not acquire data if the MSD is not operating well enough to pass autotune or allow a satisfactory manual tune.

Check for incorrect resolution of adjacent peaks

Peaks that are too wide sometimes give higher-than-normal isotope ratios or cause missing isotopes. Peaks that are too narrow sometimes give lower-than-normal isotope ratios. If necessary, retune your MSD. Narrow or widen the peak width targets as necessary.

Check for a dirty ion source

Test for a dirty ion source. If necessary, clean the ion source.

See Also

To test the ion source, page 156

To clean the ion source, page 212

Check for high background

The ion at m/z 70 is very sensitive to high background. High background is most common after the MSD has been open to the atmosphere. This is especially true if parts such as the ion source were cleaned. Give the instrument plenty of time to pump down with the GC interface heater on.

See Also

If mass spectra show high background, page 82

Check the electron multiplier voltage

High electron multiplier voltages can cause or contribute to this problem. Lower the electron multiplier voltage about 200 V. If the results improve, continue to adjust the electron multiplier voltage until you find the optimum voltage.

If isotopes are missing or isotope ratios are incorrect**□ Check the repeller voltage**

A high repeller voltage can cause or contribute to this problem. This only applies to modes of operation that allow variable repeller voltage such as maximum sensitivity autotune. Lower the repeller voltage. If results improve, continue to adjust the repeller voltage until you find the optimum voltage.

□ Check the scan speed

High (fast) scan speeds can cause or contribute to this problem. Lower the scan speed by increasing the samples (scan mode) or by increasing the dwell time (SIM mode).

□ Contact your Hewlett-Packard Customer Engineer

If mass spectra show high background

Background is the mass spectrum of all the residual substances present in the MSD in the absence of a sample. When a sample is injected, the mass spectrum becomes the spectrum of the background plus the spectrum of the sample. A new MSD, or one that has recently been vented, typically has many background peaks. This type of background tends to decrease with time. It eventually reaches acceptable equilibrium values. The possible causes listed below refer to high background that is still present after more than one day under vacuum.

Check the foreline pressure or vacuum manifold pressure

Excessive pressure can result in higher-than-normal background. At normal column flow rates, foreline pressure is typically between 20 and 100 mTorr. Vacuum manifold pressure is typically between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also *To measure column flow*, page 54

Check for air leaks

See if the background peaks correspond to peaks associated with air leaks. If they do, check for air leaks.

See Also *Finding air leaks*, page 124

Check for other contamination

See if the background peaks correspond to peaks associated with contamination other than air. If they do, clean the ion source or take other action as appropriate for the type of contamination detected.

See Also *Checking for contamination*, page 136

If there are peaks at m/z 18, 28, and 32

These, along with a peak at m/z 44, are the classic peaks seen when an MSD has an air leak. Small peaks at these masses are normal. If these peaks get larger, or if they are interfering with your analyses, check the following:

- Check for an air leak**

See Also *Finding air leaks*, page 124

- Contact your Hewlett-Packard Customer Engineer**

If no peaks are present

This refers to a situation in which you run an autotune or analyze a sample and no peaks are present, only noise. The first step in finding the cause of this symptom is to determine whether the cause is in the electron multiplier (or related electronics) or whether the cause is unrelated to the electron multiplier.

- 1 Use the appropriate tune program to initiate a repeat profile scan.
- 2 Increase the electron multiplier voltage.

If the abundance of the noise increases, the problem is probably not related to the electron multiplier or its electronics. If the abundance of the noise does not increase, the problem is probably in the electron multiplier or related electronics. Consult the following material for further help in locating the cause of this symptom.

If the noise increases

Check the chromatography

If you are analyzing an actual sample, make sure the chromatography is correct. Make sure the sample concentration is correct.

Check the foreline pressure or vacuum manifold pressure

Excessive pressure can reduce or even eliminate the signal level. At normal column flow rates (0.1 to 2.0 ml/minute), foreline pressure should be between 20 and 100 mTorr. Vacuum manifold pressure should be between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also

To measure column flow, page 54

Finding air leaks, page 124

□ **Check the PFTBA level in the calibration vial**

- 1 Remove the upper and lower MSD covers.
- 2 Check the PFTBA level calibration vial. If necessary, add PFTBA.

See Also *To fill and reinstall the calibration vial, page 188*

□ **Check the calibration valve**

- 1 Initiate an autotune.
- 2 Listen for a click when the calibration valve is supposed to operate. If you don't hear the click, either the valve or the electronics controlling it are not working properly.

See Also *To test the calibration valve, page 152*

□ **Check for poor filament operation**

- 1 Use the data system to select the other filament.
- 2 Retune the MSD. If peaks appear, continue to use the new filament.
- 3 Replace the original filament when convenient.

See Also *To reinstall a filament, page 222*

To test the filaments, page 142

□ **Check the filament cable connections**

- 1 Shut down the MSD (use the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper MSD cover.
- 3 Make sure the filament cable is firmly connected at both ends. The filament cable is the twisted pair of thick white wires near the front of the MSD.

3 Troubleshooting the MSD

If no peaks are present

Check the ion source connections

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Make sure all leads to the ion source are securely connected. Make sure they are not shorted to a grounded surface.

Contact your Hewlett-Packard Customer Engineer

If the noise does not increase

Check the signal cable connections

The signal cable is the slim cable that connects the rear half of the top board to the silver box on the main board. The signal cable has square, metal right-angle connectors on both ends.

- 1 Shut down the MSD (follow the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper and lower MSD covers.
- 3 Remove the safety cover from over the main board.
- 4 Check both ends of the signal cable. Make sure the connections are secure. A 5/16-inch wrench may be required to tighten the top board end of the cable.

Check the electrical leads to the electron multiplier

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Look at the electron multiplier connections. Make sure the leads are properly connected. Make sure they are not shorted to the vacuum chamber wall, top plate, or electron multiplier frame.

Replace the electron multiplier horn

See Also

To reinstall the electron multiplier horn, page 226

Contact your Hewlett-Packard Customer Engineer

If sensitivity is low

Check for GC problems

Some of the most common causes of low GC/MSD sensitivity are related to the GC. Make sure the GC column is installed correctly. Make sure the injection port is configured correctly. See the Hewlett-Packard GC/MS application note *Optimizing splitless injections on your GC for high performance MS analysis* (5091-4587E) for more information.

Check the GC injection type specified in the data acquisition program

The injection type specified must match the injection type used (split or splitless). If they do not match, change one of them so they match.

Check for air leaks

Look in the mass spectra for peaks associated with air leaks (m/z 18, 28, 32, 44). If you find significant peaks at these masses, check for air leaks.

See Also

Finding air leaks, page 124

Check the foreline pressure or vacuum manifold pressure

At normal column flow rates, foreline pressure is typically between 20 and 100 mTorr. Vacuum manifold pressure is typically between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too low, check the column flow. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also

To measure column flow, page 54

Check the tune file specified in the method

The tune file specified in the method must be a valid file. It must be appropriate for the analytical technique and for the type of sample you are analyzing.

Check the MSD tuning

Retune the MSD using an appropriate tune program. Do not acquire data if the MSD is not operating well enough to pass autotune or allow a satisfactory manual tune.

Check the electron multiplier voltage

Increase the electron multiplier voltage and see if sensitivity improves. If increasing the voltage does not improve sensitivity, or if the electron multiplier voltage is at its limit, check other possible causes.

Check for a dirty ion source

Test for a dirty ion source. If necessary, clean the ion source.

See Also

To test the ion source, page 156

To clean the ion source, page 212

Check for an old electron multiplier

If the electron multiplier voltage set by autotune is consistently at or near the upper limit of 3000 V, it may be necessary to replace the electron multiplier horn.

See Also

To reinstall the electron multiplier horn, page 226

Check for poor filament operation

- 1 Use the data system software to select the other filament.
- 2 Retune the MSD. If sensitivity improves, continue to use the new filament.
- 3 Replace the original filament when convenient.

See Also

To reinstall a filament, page 222

To test the filaments, page 142

Check the dc polarity on the quadrupole mass filter

Switch the dc polarity on the quadrupole mass filter. Retune the MSD. If performance improves, continue to use the new dc polarity.

Check the GC interface temperature and MS temperature

The GC interface temperature should generally be between 250° and 320°C. The MS temperature should be at least 150°C.

Contact your Hewlett-Packard Customer Engineer

If repeatability is poor

Check the injection needle

A dirty injection needle is a very common cause of poor repeatability.

Check the GC

Problems in the GC, especially in the injection port, can cause poor repeatability. Make sure the injection port was installed correctly. See the Hewlett-Packard GC/MS application note *Optimizing splitless injections on your GC for high performance MS analysis* (5091-4587E) for more information.

Check for variations in pressure, flow rate, and temperature

Keep the foreline pump and diffusion pump serviced. Make sure the carrier gas supply is steady and well-regulated. Avoid large changes in the ambient temperature. Keep the MSD out of drafts and direct sunlight.

Check for a dirty ion source

Test for a dirty ion source. If necessary, clean the ion source.

See Also

To test the ion source, page 156

To clean the ion source, page 212

Check for loose connections in the analyzer

- 1 Shut down and vent the MSD.
- 2 Check the external analyzer wiring connections. Correct any loose connections.
- 3 If the external connections were secure, remove the analyzer.
- 4 Check all the internal analyzer wiring connections. Correct any loose connections.

Check for ground-fault loops

If the MSD and GC are connected to separate power sources, the grounds may be at different potentials. This creates a current path (ground-fault loop) through the GC interface and analyzer. A ground-fault loop can cause noise in your data. If possible, connect the MSD and GC to the same power source. If this is not possible (for example, because the MSD and GC operate on different voltages), make sure the grounds for the power sources are at the same potential.

W A R N I N G

Checking for a ground-fault loop should be done by a qualified electrician.

Check the stability of the line voltage

Make sure the line voltage is stable.

W A R N I N G

Checking the line voltage should be done by a qualified electrician.

Contact your Hewlett-Packard Customer Engineer

If high-mass sensitivity is poor

This refers to a condition where the **absolute abundance** at the upper end of the mass range is poor. Absolute abundance should not be confused with the relative abundance (percentage) of m/z 502 to m/z 69. Sensitivity at high masses can be excellent even if the relative abundance of m/z 502 is low. In fact, the maximum sensitivity autotune typically produces **better** high-mass sensitivity than the standard spectra autotune even though its **relative abundance** of m/z 502 is **lower** than the relative abundance produced by the standard spectra autotune.

If your MSD's relative abundance is incorrect for the tune program used, refer to the symptom *If the relative abundance of m/z 502 is lower than expected on page 74*. If the relative abundance is correct but absolute abundance at high masses is poor, check the following:

Check to see which tune program was used

The maximum sensitivity autotune or manual tuning generally produce the best high-mass sensitivity.

Check to see how long the MSD has been on

Contaminants that interfere with high-mass sensitivity may still be present in the instrument. Wait until the MSD has been on at least 8 hours, then tune it again.

Check the foreline pressure or vacuum manifold pressure

At normal column flow rates, foreline pressure is typically between 20 and 100 mTorr. Vacuum manifold pressure is typically between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too low, check the column flow. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also

To measure column flow, page 54

Finding air leaks, page 124

□ **Check for poor filament operation**

- 1 Use the data system software to select the other filament.
- 2 Retune the MSD. If sensitivity improves, continue to use the new filament.
- 3 Replace the original filament when convenient.

See Also *To reinstall a filament, page 222*

To test the filaments, page 142

□ **Check for a dirty ion source**

Test for a dirty ion source. If necessary, clean the ion source.

See Also *To test the ion source, page 156*

To clean the ion source, page 212

□ **Check the dc polarity on the quadrupole mass filter**

- 1 Change the dc polarity on the quadrupole mass filter.
- 2 Retune the MSD.
- 3 If performance improves, continue to use the new dc polarity.

□ **Contact your Hewlett-Packard Customer Engineer**

If mass assignments are incorrect

Small (acceptable) shape changes at the top of the mass peaks can cause ± 0.1 amu shifts in mass assignments. Shifts greater than ± 0.2 amu indicate a possible malfunction.

Check the MSD tuning

Retune the MSD. Do not acquire data if the MSD is not operating well enough to pass autotune or allow a satisfactory manual tune.

Contact your Hewlett-Packard Customer Engineer

If the foreline or vacuum manifold pressure is too low

At typical column flow rates (0.1 – 2.0 ml/minute), the foreline pressure will be **approximately** 20 to 100 mTorr. The vacuum manifold pressure will be **approximately** 1×10^{-6} to 1.4×10^{-4} Torr. If the pressures you observe are below 20 mTorr or 1×10^{-6} Torr, check the following:

Check the column flow

Make sure the column is not plugged. Make sure the column flow has not been reduced or turned off. Heating a capillary column with insufficient column flow can damage the column.

See Also

To measure the column flow, page 54

Check the carrier gas supply

Make sure the carrier gas supply is not empty.

Check the carrier gas tubing

Make sure the carrier gas tubing is not bent, pinched, or blocked.

Contact your Hewlett-Packard Customer Engineer

If the foreline or vacuum manifold pressure is too high

At typical column flow rates (0.1 – 2.0 ml/minute), the foreline pressure will be **approximately** 20 to 100 mTorr. The vacuum manifold pressure will be **approximately** 1×10^{-6} to 1.4×10^{-4} Torr. If the pressure you observe is significantly above 100 mTorr or 1.4×10^{-4} Torr, or if the pressure you observe for a given column flow has increased over time, check the following:

Check the column flow

Column flow should not exceed 2.0 ml/minute during tuning or data acquisition. It should never exceed 2.5 ml/minute. If necessary, reduce the column flow.

See Also *To measure the column flow, page 54*

Check for air leaks

See if the background peaks correspond to peaks associated with air leaks. If they do, check for air leaks.

See Also *Finding air leaks, page 124*

Check the fluid level in the diffusion pump

If its fluid level is low, the diffusion pump will not work effectively. Replace the diffusion pump fluid

See Also *To check the diffusion pump fluid, page 180*

Check the fluid level in the foreline pump

If the fluid level is low, the foreline pump will not work effectively. Add foreline pump fluid or replace the foreline pump fluid.

See Also *To check and add foreline pump fluid, page 168*

To fill the foreline pump, page 172

Replace the pellets in the foreline trap

If the adsorbent pellets (molecular sieve) are saturated, they will not work effectively.

CAUTION

Vent the MSD before opening the foreline trap. Otherwise, diffusion pump oil will backstream into the vacuum manifold. This contaminates the analyzer.

See Also

To add foreline trap pellets, page 176

Contact your Hewlett-Packard Customer Engineer

If the gauge controller displays 9.9+9 and then goes blank

This can happen when you try to turn on the triode gauge or when the triode gauge is already on. It indicates the pressure in the vacuum manifold is above 8×10^{-3} Torr. The triode gauge will not turn on if the pressure is above that level. It automatically turns off if the pressure rises above 8×10^{-3} Torr.

This may happen routinely if you are doing on-column injections. The solvent peak raises manifold pressure above 8×10^{-3} Torr. If this is a recurring problem, it may be best to leave the triode gauge off.

Check to see how long the MSD has been on

If you have recently turned on the MSD, allow the system more time to pump down. If, after 20 minutes, the triode gauge will not turn on, check other causes.

Check the cable between the triode gauge and the gauge controller

Make sure the cable is securely connected to the gauge controller.

Check the foreline pressure

With normal column flow rates, foreline pressure is typically between 20 and 100 mTorr. If the foreline pressure is significantly above 100 mTorr, reduce the column flow and/or check for air leaks.

See Also

To measure column flow, page 54

Finding air leaks, page 124

Check the triode gauge filament

- 1 Turn off the gauge controller.
- 2 Shut down and vent the MSD.
- 3 Remove the upper and lower MSD covers.
- 4 Inspect the triode gauge tube. If the filament is broken, replace the triode gauge tube.

See Also

To reinstall a triode gauge tube, page 200

If the gauge controller displays 9.9+9 and then goes blank

Check the level of the fluid in the diffusion pump

If the diffusion pump fluid level is low, it will prevent the diffusion pump from producing normal pressure levels.

See Also

To check the diffusion pump fluid, page 180

Check the line voltage at the electrical outlet

Make sure the line voltage is within the acceptable range for the gauge controller.

W A R N I N G

Only a qualified electrician should check the line voltage.

Replace the cable between the gauge controller and the triode gauge

Contact your Hewlett-Packard Customer Engineer

If the power indicator on the gauge controller does not light

If the power indicator (LED) on the gauge controller does not light when the gauge controller power switch is on, check the following:

Check the gauge controller power cord

Make sure the power cord is connected to an electrical outlet.

Check the line voltage at the electrical outlet

Make sure the line voltage is within the acceptable range for the gauge controller.

W A R N I N G

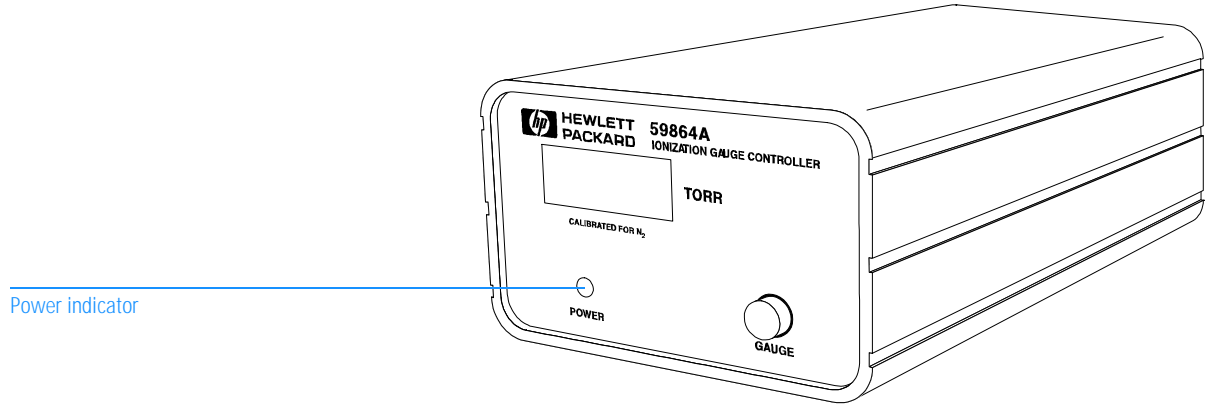
Only a trained electrician should check the line voltage.

Check the gauge controller fuse

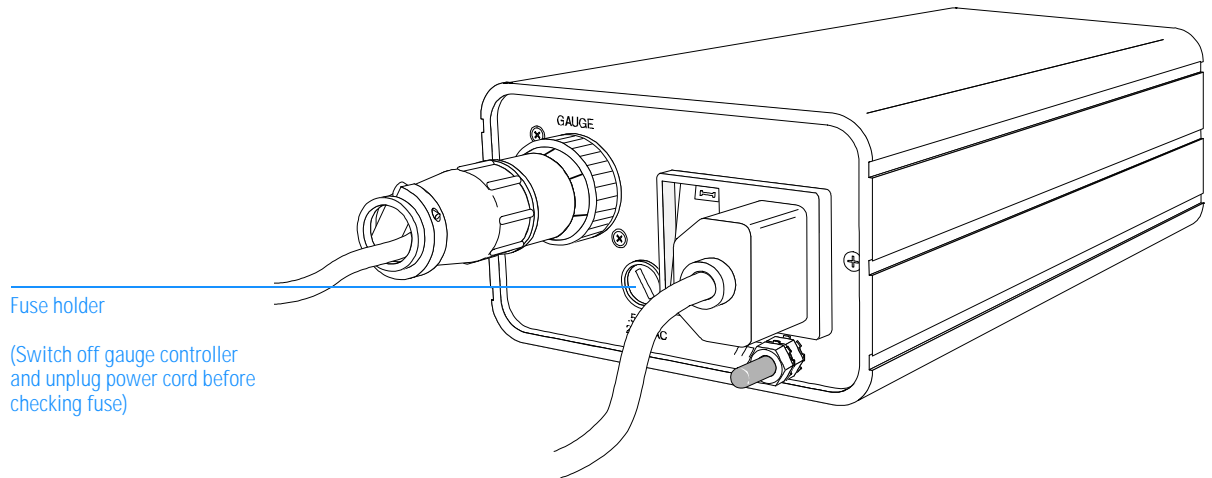
- 1 Switch off the gauge controller.
- 2 Disconnect the power cord from the gauge controller.
- 3 Remove and inspect the gauge controller fuse. If the fuse has failed, replace it with one of the same rating. Try to determine the cause for the fuse failure.

Contact your Hewlett-Packard Customer Engineer

If the power indicator on the gauge controller does not light



Power indicator



Fuse holder

(Switch off gauge controller and unplug power cord before checking fuse)

If the analyzer temperature is too low

The analyzer is conductively heated by the GC interface. The *Radiator* section (page 278) in Chapter 7 discusses the relationship between GC interface temperature and analyzer (MS) temperature. If the analyzer temperature is outside the range listed for a given GC interface temperature, one of the following may be the cause:

□ **Check how long the GC interface heater has been on**

The analyzer requires at least 4 hours to reach thermal equilibrium after the GC interface is turned on. Wait at least 4 hours before tuning or acquiring data. It is better if more time has passed; overnight is ideal.

□ **Check the GC**

Make sure the appropriate GC heated zone is on (detector B or auxiliary on the HP 5890 GC, auxiliary 2 on the HP 6890 Series GC). Sometimes a GC fault can cause the heated zone to turn off.

□ **Check the contact between the GC interface and the interface socket on the analyzer**

Dirty or damaged contact surfaces can result in poor heat transfer. Poor alignment of the contact surfaces, or an interface socket that is not fully threaded into the radiator, can also result in poor heat transfer.

- 1 Shut down and vent the MSD.
- 2 Move the MSD away from the GC.

WARNING

The GC interface may be extremely hot. Do not touch it until it has cooled.

- 3 Loosen the KF clamp and remove the GC interface from the MSD.
- 4 Inspect the GC interface surface that contacts the interface socket. It should be clean and smooth with no dents or scratches. If the interface is dirty, it should be cleaned. If it is damaged, it should be replaced.
- 5 Remove the analyzer assembly from the vacuum manifold.
- 6 Make sure the interface socket is present. It should be firmly threaded into the radiator. The inner surface of the socket should be clean and not dented or scratched.

□ **Check the heater sleeve**

The heater sleeve should be tightly clamped to the interface assembly. If the sleeve is loose, it will result in poor heat transfer.

- 1 Shut down and vent the MSD.
- 2 Move the MSD away from the GC.
- 3 Remove the insulation from around the GC interface.

W A R N I N G

The GC interface may be extremely hot. Do not touch it until it has cooled.

- 4 Make sure the sleeve is tight; you should not be able to rotate or move it. If the sleeve is not tight, tighten it. Try to apply the same torque to each screw.

If the GC interface does not heat up

The GC interface heater is controlled by one of the heated zones of the GC. If the GC interface will not heat up, check the following:

Check the GC

Make sure the GC is on. Make sure the detector heated zone that controls the GC interface heater is on and an appropriate setpoint has been entered. On an HP 5890 GC, this is either the detector B heated zone or the auxiliary heated zone. On an HP 6890 Series GC, this is the auxiliary 2 heated zone.

Check to make sure the GC interface is connected to the GC

If the GC interface is not connected, checking the appropriate heated zone through the GC keypad will generate an error message or a temperature reading of 824°C.

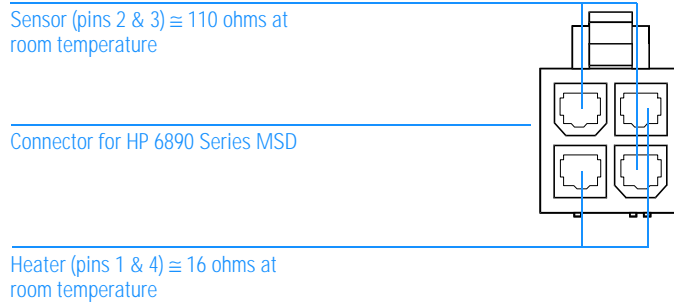
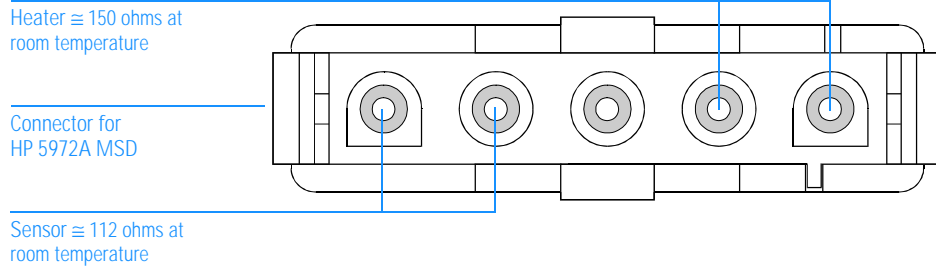
Check the GC interface heater

- 1 Shut down and vent the MSD.
- 2 Move the MSD away from the GC.
- 3 Switch off the GC.

W A R N I N G

If the GC is on, dangerous voltages will be present at the connector.

- 4 Disconnect the GC interface cable from the GC.
- 5 Measure the resistance between the heater pins on the connector. If the resistance is nearly infinite, or if the resistance is nearly 0, then the heater/sensor assembly is malfunctioning and should be replaced.



Cannot achieve constant peak widths

□ Check the initial tuning parameter settings

The initial tuning parameters may be too far from the correct settings. Use the Manual Tune program to find initial settings that are closer to being correct. Then, either finish tuning manually or use the values as a starting point for autotune. If necessary, select **Reset to Defaults** from the File menu in the Manual Tune window.

□ Check the calibration valve

- 1 Initiate an autotune.
- 2 Listen for a click when the valve is supposed to open. If you do not hear the click, either the valve or the electronics controlling it are not working properly.

See Also

To test the calibration valve, page 152

□ Check the PFTBA level in the calibration vial

- 1 Remove the upper and lower MSD covers.
- 2 Check the calibration vial. If necessary, add PFTBA.

See Also

To fill and reinstall the calibration vial, page 188

□ Check the signal cable connections

- 1 Shut down the MSD (use the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper and lower MSD covers.
- 3 Remove the safety cover from over the main board.
- 4 Check the signal cable (the small coaxial cable that connects the top board to the main board). Make sure both ends of the cable are securely connected.

Check for a dirty ion source

Test for a dirty ion source. If necessary, clean the ion source.

See Also

To test the ion source, page 156

To clean the ion source, page 212

Check for an old electron multiplier

If the electron multiplier voltage set by autotune is consistently at or near the upper limit of 3000 V, it may be necessary to replace the electron multiplier horn.

See Also

To reinstall the electron multiplier horn, page 226

Contact your Hewlett-Packard Customer Engineer

Difficulty in the mass filter electronics

This is a latched error message. It will remain until you correct the problem and check the instrument status through the data system.

Check to see if the RF coils are correctly adjusted (dipped)

CAUTION

Get instruction from your Hewlett-Packard Customer Engineer before attempting to adjust the coils. Incorrect adjustment can have a very bad effect on MSD performance.

If the RF coils are already adjusted correctly, contact your Hewlett-Packard Customer Engineer. If the RF coils are incorrectly adjusted but can be adjusted, do so and check instrument status to remove the error message. If the message returns, contact your Hewlett-Packard Customer Engineer. If the RF coils cannot be adjusted, check the mass filter leads.

See Also

To adjust the RF coils, page 240

Check the mass filter (quadrupole) electrical leads

This message can be caused by an open or grounded mass filter lead.

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Inspect the mass filter electrical leads. Make sure all the leads are connected and they are not touching the top plate or any other grounded surface. Reconnect or reposition the leads as necessary.
- 4 Adjust the RF coils.

Contact your Hewlett-Packard Customer Engineer

Difficulty with the detector HV supply

This message is generated when the voltage supplied to the electron multiplier is less than that specified by the data system.

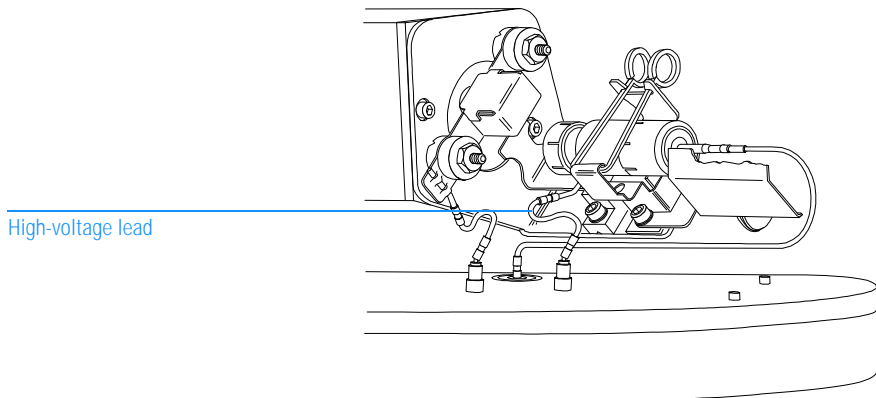
□ Check the MSD electronics

- 1 Set the electron multiplier voltage to 0.
- 2 Turn the MS electronics on (MSON).
- 3 Read the MS status. If the fault persists, the problem is probably on the main board.
- 4 Set the electron multiplier voltage above 1000 V. If the fault returns, the problem is probably in the top board or in the wiring in the vacuum manifold.
- 5 Contact your Hewlett-Packard Customer Engineer.

□ Check the high-voltage lead to the electron multiplier

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Look at the electron multiplier connections. Make sure the high voltage lead is connected to the proper pin. Make sure it is not shorted to the vacuum chamber wall, top plate, or electron multiplier frame.

□ Contact your Hewlett-Packard Customer Engineer



The diffusion pump is or was too hot

This is a latched error message. Overheating causes the diffusion pump to turn off. Switch the MSD off for 1 minute. Then, switch the MSD on. This resets the diffusion pump.

Check for air flow behind the MSD

If there is no air flow, or only a very weak air flow, the fan is not operating correctly.

See Also

If the MSD is on but the fan is not operating, page 71

Check the environment in which the MSD is operating

Do not operate the MSD in ambient temperatures above 35°C.

Check the air intakes on the MSD for blockages

Make sure the vent slots on the side of the MSD are not covered or blocked.

Check the diffusion pump cable

- 1 Shut down and vent the MSD.
- 2 Remove the diffusion pump cover.

W A R N I N G

The diffusion pump may still be dangerously hot.

- 3 Make sure the diffusion pump cable is securely connected to the connector on the back panel of the MSD.

Check the fluid level in the diffusion pump

If the diffusion pump fluid level is too low the pump may become too hot.

See Also *To check the diffusion pump fluid, page 180*

Check the cable between the power distribution board and the diffusion pump connector on the back panel

A problem with this cable is unlikely unless the electronics panel has been removed recently.

- 1 Shut down and vent the MSD.
- 2 Remove the diffusion pump.

W A R N I N G

The diffusion pump may still be dangerously hot.

- 3 Remove the fan.
- 4 Make sure the cable from the diffusion pump connector on the back panel is securely connected to the power distribution board.

See Also *To remove the diffusion pump, page 178*

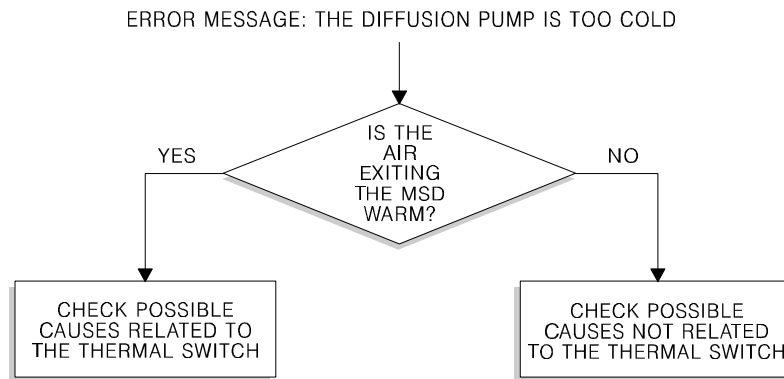
Check the too hot (upper) thermal switch

See Also *To test the diffusion pump, page 154*

Contact your Hewlett-Packard Customer Engineer

The diffusion pump is too cold

This message occurs when the diffusion pump temperature falls below its minimum operating temperature. If the air exiting the diffusion pump is warm, pay particular attention to the possible causes related to the thermal switch. If the air exiting the diffusion pump is cool, refer to the possible causes not related to the thermal switch.



*Possible causes related
to the thermal switch*

□ Check the function of the too cold (lower) thermal switch

- 1 Remove the diffusion pump cover.

W A R N I N G

The diffusion pump may still be dangerously hot.

- 2 Use a screwdriver or short piece of wire to connect the two terminals of the lower thermal switch. If the pump is hot and the message disappears, then the switch is bad and it should be replaced. Contact your Hewlett-Packard Customer Engineer.

□ Check the contact between the too cold (lower) thermal switch and the diffusion pump

Poor contact prevents good heat transfer.

- 1 Shut down and vent the MSD.
- 2 Remove the diffusion pump cover.

W A R N I N G

The diffusion pump may still be dangerously hot.

- 3 Make sure the screws that hold the too cold (lower) thermal switch in place are tight. A commercial heat-sink compound should be used between the thermal switch and the diffusion pump.

3 Troubleshooting the MSD

The diffusion pump is too cold

*Possible causes
not related to the
thermal switch*

Check how long the MSD has been on

At a room temperature of 25°C, the diffusion pump normally takes 10 – 15 minutes to reach operating temperature. If the room is cooler, it takes a little longer. Give the diffusion pump enough time to warm up.

Check the diffusion pump cover

If the diffusion pump cover is off, the diffusion pump may cool too efficiently. Do not operate your MSD without a diffusion pump cover.

Check the temperature of the air in your laboratory

If the air temperature is below 15°C, the diffusion pump may cool too efficiently. Increase the temperature in your laboratory.

Check for other error messages

Another fault (too hot, excess foreline pressure, etc.) can cause the diffusion pump to turn off. The pump cools causing the too cold switch to open. If this is the cause, another error message (too hot, excess foreline pressure) should appear with the too cold message. Correct the cause of that message.

Check the diffusion pump cable connection

If the diffusion pump cable is not firmly connected, the pump may not heat up.

1 Remove the diffusion pump cover.

W A R N I N G

The diffusion pump may still be dangerously hot.

2 Make sure the diffusion pump cable is securely connected to the connector on the back panel of the MSD.

Check for variations in the line voltage

If the ac line power drops below the minimum allowed voltage for more than 4 seconds, the pump switches off. Switch the MSD power switch off and, after a few seconds, back on. This resets the diffusion pump heater circuitry. If the pump shuts off repeatedly, check your ac power source.

□ Check the diffusion pump fuses

If the diffusion pump fuses fail repeatedly, contact your Hewlett-Packard Customer Engineer.

See Also *To replace the diffusion pump fuses, page 248*

□ Check the diffusion pump heater

If the diffusion pump heater has failed contact your Hewlett-Packard Customer Engineer.

See Also *To test the diffusion pump, page 154*

□ Contact your Hewlett-Packard Customer Engineer

The foreline pressure has exceeded 300 mTorr

Check to make sure the foreline pump is on

- 1 Make sure the foreline pump power cord is securely plugged into the outlet on the MSD.
- 2 Make sure the power (on/off) switch on the foreline pump is on.
- 3 If the foreline pump is plugged in and switched on but not operating, refer to the symptom *If the MSD is on but the foreline pump is not operating* on page 72.

Check the foreline gauge connector

The data system interprets an unplugged foreline gauge connector as a failed foreline pump. Make sure the connector is firmly connected to the foreline gauge.

Check the GC column

Make sure the column is not broken. Replace the column if necessary.

Check the hose between the diffusion pump and the foreline pump

Make sure the hose has not collapsed. If it has collapsed, shut down and vent the MSD. Replace the hose.

Check for a large air leak (foreline pump exhaust flow greater than 5 ml/minute)

- 1 If the MSD will still operate, test for air leaks.
- 2 If the MSD will not operate, or if you were unable to locate a leak, shut down and vent the MSD.
- 3 Inspect the foreline hose, foreline trap, GC interface nut, KF fittings, and manifold O-ring. Look for broken or split hoses, loose fittings, and loose nuts.

See Also

Finding air leaks, page 124

□ **Replace the pellets in the foreline trap**

CAUTION

Vent the MSD *before* opening the foreline trap. Otherwise, diffusion pump oil will backstream into the vacuum manifold. This contaminates the analyzer.

See Also

To add foreline trap pellets, page 176

□ **Check the foreline pump**

The foreline pump may be working but not providing enough vacuum.

- 1 Shut down and vent the MSD.
- 2 Disconnect the foreline gauge fitting from the diffusion pump. Do not disconnect the foreline gauge cable.
- 3 Plug the fitting with a rubber stopper.
- 4 Switch on the MSD. The foreline gauge will still work.
- 5 Monitor the foreline pressure. If the vacuum fails to fall below 300 mTorr (0.3 Torr), then the foreline pump is defective. Contact your Hewlett-Packard Customer Engineer.

□ **Replace the foreline gauge**

See if the message returns.

See Also

To reinstall the foreline gauge, page 192

Mass spectrometer interface card is not active

Check to make sure the MSD is on

Check the HP-IB cable between the MSD and the data system

Make sure the cable is securely connected at both ends.

Check the HP-IB communications

A momentary malfunction in one of the devices on the HP-IB bus can disrupt HP-IB communications. Switch off all of the HP-IB devices including the data system. Then, one device at a time, switch the devices back on. Switch on the data system first and the ALS (if one is present) last.

See Also

To test HP-IB communications, page 144

Check the HP-IB/MS control card

See Also

To test the HP-IB/MS control card, page 145

MS does not respond

- Check the output of the +5 V dc power supply**

See Also

To test the power supply, page 148

- Contact your Hewlett-Packard Customer Engineer**

No peaks found

Check the threshold setting

If the threshold setting is too high, no peaks will be found. Reduce the threshold setting to 0.

Check the emission current setting

If the emission current has accidentally been set to 0 there will be no peaks. Set the emission current to 50.

Check the electron multiplier voltage

Gradually raise the electron multiplier voltage and see if peaks appear.

Contact your Hewlett-Packard Customer Engineer

See Also

If no peaks are present, page 84

There is not enough signal to begin the tune, page 122

There is no emission current

This message indicates power is being sent to a filament, but no electrons are being emitted from that filament. When the filament is switched on, the fault circuitry allows time for the filament to warm up before testing the emission current. Therefore, this message is not caused by insufficient warm-up time.

□ Check for poor filament operation

- 1 Use the data system software to select the other filament.
- 2 Retune the MSD. If sensitivity improves, continue to use the new filament.
- 3 Replace the original filament when convenient.

See Also

To test the filaments, page 142

To reinstall a filament, page 222

□ Check the filament cable connections

- 1 Shut down the MSD (use the venting procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper MSD cover.
- 3 Make sure the filament cable is firmly connected at both ends. The filament cable is the twisted pair of thick white wires near the front of the MSD.

□ Contact your Hewlett-Packard Customer Engineer

There is not enough signal to begin the tune

Check the amu (mass) calibration

Poor amu (mass) calibration can cause the actual mass peak to fall outside the window assigned to that mass. Use the Manual Tune program to widen the window. See your software documentation for more information.

Check the foreline pressure or vacuum manifold pressure

Excessive pressure can significantly reduce signal levels. At normal flow rates (0.1 to 2.0 ml/minute), foreline pressure should be between 20 and 100 mTorr. Vacuum manifold pressure should be between 1×10^{-6} and 1.4×10^{-4} Torr. If pressure is too high, reduce the column flow and/or check for air leaks.

See Also *To measure column flow, page 54*
Finding air leaks, page 124

Check for air leaks

See Also *Finding air leaks, page 124*

Check the electron multiplier voltage

Increase the electron multiplier voltage to 3000 V by 100-V increments. If the message persists, and you have ruled out the other possible causes, it may be necessary to replace the electron multiplier horn.

Check the calibration valve

- 1 Initiate an autotune.
- 2 Listen for a click when the valve is supposed to open. If you don't hear the click, either the valve or the electronics controlling it are not working properly.

See Also *To test the calibration valve, page 152*

□ Check the PFTBA level in the calibration vial

- 1 Remove the upper and lower MSD covers.
- 2 Check the PFTBA level in the calibration vial. If necessary, add PFTBA.

See Also

To fill and reinstall the calibration vial, page 188

□ Check the signal cable connections

- 1 Shut down the MSD (follow the vent procedure and switch off the MSD but do not remove the capillary column from the GC interface).
- 2 Remove the upper and lower MSD covers.
- 3 Remove the safety cover over the main board.
- 4 Check the signal cable (the small coaxial cable that connects the top board to the main board). Make sure both ends of the cable are securely connected.

□ Check the electrical leads to the electron multiplier

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Check the electron multiplier leads. Make sure the leads are properly connected. Make sure they are not shorted to the vacuum chamber wall, top plate, or electron multiplier frame.

□ Check the electrical leads to the ion source

- 1 Shut down and vent the MSD.
- 2 Remove the analyzer.
- 3 Make sure all leads to the ion source are properly connected.

Finding air leaks

Air leaks are a problem for any instrument that requires a vacuum to operate. Leaks are generally caused by vacuum seals that are damaged or not fastened properly. Symptoms of leaks include:

- Higher than normal vacuum manifold or foreline pressure
- Higher than normal background
- Peaks characteristic of air (m/z 18, 28, 32, and 44)
- Poor sensitivity
- Low relative abundance of m/z 502 (this varies with the tune program used)

Perform the following steps to confirm the presence of an air leak and to isolate its source:

Step 1. To confirm the presence of a leak, page 125

Step 2. To isolate the source of a leak, page 126

Step 3. To find an air leak in the GC, page 127

Step 4. To find an air leak in the MSD, page 128

Use the following procedures to correct an air leak:

To correct a column nut leak, page 130

To correct a manifold O-ring leak, page 131

To correct a leak in a KF fitting, page 132

To correct a leak in the triode gauge tube fitting, page 133

To correct a calibration valve leak, page 134

Step 1. To confirm the presence of a leak

Do not use the air and water check described below if you have recently vented the MSD. It can take up to 4 hours for the abundance of m/z 28 (nitrogen) to fall to an appropriate level. It can take up to 24 hours for the abundance of m/z 18 (water) to fall to an appropriate level.

1 Initiate the air and water check program from your data system.

See the manuals and online help supplied with the MS ChemStation software for more information.

2 Compare the abundances of m/z 28 (nitrogen) and m/z 18 (water).

The abundance of m/z 28 should be less than the abundance of m/z 18.

3 Compare the abundances of m/z 18 (water) and m/z 69 (PFTBA).

The abundance of m/z 18 should be less than 10% of the abundance of m/z 69.

4 Compare the abundances of m/z 28 (nitrogen) and m/z 69 (PFTBA).

The abundance of m/z 28 should be less than 10% of the abundance of m/z 69.

5 Compare the abundances of m/z 28 (nitrogen) and m/z 32 (oxygen).

If an air leak is present, the ratio of m/z 28 to m/z 32 will be about 5:1. If the abundance of m/z 28 is well over 5 times the abundance of m/z 32, then there may be another chemical present with an ion at m/z 28 such as CO or C₂H₄. If CO is present, there is typically a large peak at m/z 44 (CO₂) also.

If the air and water check confirms an air leak, go to *Step 2. To isolate the source of a leak* on page 126.

Step 2. To isolate the source of a leak

Leaks can originate in the GC or in the MSD. Troubleshooting is easier if you can isolate where the leak originates. The following procedure provides a way to determine where the leak is located.

1 Run an air and water check. Save the results.

2 Remove the GC column from the injection port.

3 Cap the end of the column with a septum.

4 Wait 15 – 20 minutes.

Steps 2 and 3 allow a small amount of air into the MSD. If you continue before the MSD has a chance to pump away this air, the results of this test will be invalid.

5 Run another air and water check.

6 Compare the results of the first check with the second check.

If the results are essentially the same, the leak is in the MSD or in the column nut on the end of the GC interface. If the results are significantly different, the leak is probably in the injection port of the GC.

7 Remove the septum.

8 Score and break off the first 30 mm of the capillary column.

9 Reinstall the column in the injection port.

Depending on the location of the leak, go to *Step 3. To find an air leak in the GC* on page 127 or to *Step 4. To find an air leak in the MSD* on page 128.

Step 3. To find an air leak in the GC

Most air leaks in the GC occur at one of three places, the column nut on the end of the GC interface, the injection port, or the septum. Leaks around the column nut are covered in Step 4 with the MSD leaks.

Leaks in split/splitless injection ports can sometimes be confirmed by switching the injection port purge on and off and checking the abundance of the ions associated with leaks (primarily m/z 28 and m/z 32). If the abundance of these ions with the purge off is much greater ($\times 100$) than the abundance of these ions with the purge on, this is confirmation of a leak in the injection port.

A septum will leak after too many injections. The septum should be replaced at least every 100 injections. Keeping a beaker of septa in an oven at 250°C at all times will eliminate the need to condition a new septum once it is in place.

A Merlin Microseal™ is highly recommended over conventional septa. The microseal eliminates the need for septa and lasts for tens of thousands of injections without leaking. It is most appropriate for use with the HP 7673 autosampler. It only works with untapered, blunt-tip syringes.

See Also

The Hewlett-Packard application note *Optimizing splitless injections on your GC for high performance MS analysis* (5091-4587E).

Step 4. To find an air leak in the MSD

The easiest way to find an air leak in your MSD is to use the MSD itself as a detector while spraying potential leak sites with an inert gas.

Materials needed

Argon, lecture (0.6 liter) bottle
Screwdriver, TORX T-15 (8710-1622)

- 1 If your GC is equipped with a split/splitless injection port, turn the injection port purge on during leak checking.**
- 2 If your MSD is equipped with a gauge controller, turn off the triode gauge and gauge controller before proceeding.**
- 3 With the MSD still on, remove the upper and lower MSD covers and the diffusion pump cover.**

W A R N I N G

Do not remove the safety covers over the main board, HP-IB/MS control card, and top board. Dangerous voltages are present under these covers. The diffusion pump will be dangerously hot. The ion gauge may be dangerously hot.

- 4 Call up the Manual Tune program in your data system.**
- 5 Close the calibration valve.**
- 6 Set the data system to monitor *m/z* 40, the main peak for argon.**
If you choose to use an inert gas other than argon, set the data system to monitor the main ion of that gas.
- 7 Select the repeat profile scan.**

Step 4. To find an air leak in the MSD

8 One point at a time, spray argon at the potential leak sites listed below.

After spraying each point, observe the peak profile on the data system. If, after 2 to 5 seconds, you see an abrupt and significant increase at m/z 40, there is a leak where you just sprayed. If, after 5 to 20 seconds, you see a gradual increase at m/z 40, there is a leak near, but not at, the point you just sprayed.

- a. Column nut (in the GC oven on the end of the GC interface)
- b. GC interface KF25 fitting
- c. Manifold O-ring (all the way around)
- d. Triode gauge tube fitting
- e. Calibration valve (with the valve closed)
- f. Calibration valve (after using the data system to open the valve)
- g. Diffusion pump KF50 fitting

9 After you have located and repaired a leak, test that point again to make sure it is repaired.

If repairing a leak requires shutting down or venting the MSD, you may want to check the remaining points before repairing the first leak.

10 Test the remaining points to make sure there was not more than one leak.

To correct a column nut leak

The nut may not have been tightened enough when it was installed. Temperature cycling of the GC oven sometimes loosens a new column nut and ferrule.

- 1 Tighten the column nut.**
- 2 Check again for a leak.**
If the leak is still present, the ferrule may be old and fully compressed.
- 3 Shut down and vent the MSD.**
- 4 Replace the column nut and ferrule.**
- 5 Retighten the nut after it has gone through a few temperature cycles.**

See Also

To install a capillary-direct column, page 24

To correct a manifold O-ring leak

The manifold O-ring is the seal between the top plate and the vacuum manifold. If you detect a leak in the manifold O-ring:

1 Shut down and vent the MSD.

2 Remove the analyzer.

3 Inspect the bottom of the top plate.

If the surface of the top plate is damaged, it can damage the O-ring. Correct the problem and then replace the manifold O-ring.

4 Inspect the O-ring groove in the vacuum manifold for damage.

If the groove is damaged, it can damage the O-ring. Correct the problem and then replace the manifold O-ring.

5 Inspect the manifold O-ring for dust or damage.

If the manifold O-ring is dirty or damaged, replace it. Wear clean gloves when installing a new O-ring. The seam in the O-ring should remain horizontal. Do not twist or roll the O-ring.

See Also

To vent the MSD, page 58

To remove the analyzer, page 204

To correct a leak in a KF fitting

KF fittings can leak either because the clamp is not tightened enough or because the O-ring assembly or coseal is worn or damaged. If you find a KF fitting that is leaking:

W A R N I N G

Both the GC interface and the diffusion pump operate at dangerously high temperatures. Shut down and cool the appropriate part before proceeding.

- 1 Tighten the KF clamp.**
- 2 Retest the fitting.**
If tightening the clamp does not correct the leak, proceed.
- 3 Shut down and vent the MSD.**
- 4 Disassemble the leaking fitting.**
- 5 Replace the O-ring assembly or coseal.**

To correct a leak in the triode gauge fitting

The triode gauge fitting is a threaded fitting with an O-ring seal. If you find a leak there:

- 1 **Switch off the triode gauge and gauge controller.**
- 2 **Remove the upper and lower MSD covers.**
- 3 **Gently wiggle the triode gauge tube and tighten the triode gauge fitting.**

W A R N I N G

Do not over tighten this fitting, it is possible to break the triode gauge tube.

- 4 **If tightening the fitting does not eliminate the leak, shut down and vent the MSD.**
- 5 **Remove the triode gauge tube and replace the O-ring in the fitting.**

See Also

To reinstall a triode gauge tube, page 200

To correct a calibration valve leak

The proper procedure for correcting a calibration valve leak depends on whether the leak occurs when the valve is open or closed.

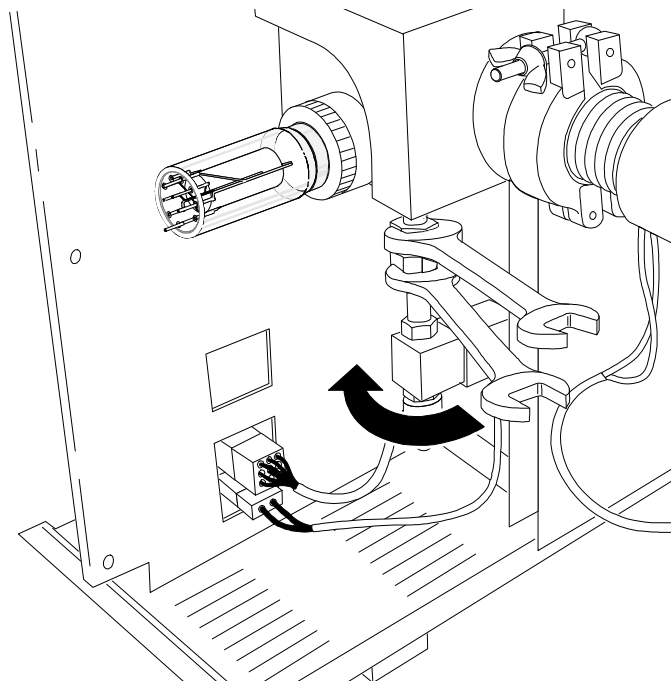
*If the leak occurs
when the valve is
closed*

- 1 Switch off the triode gauge and the gauge controller.**
- 2 Remove the upper and lower MSD covers.**
- 3 Tighten the largest nut above the calibration valve.**
Use a second wrench to prevent the nut just above the largest one from turning.
- 4 Retest the calibration valve for leaks.**
If tightening the nut does not correct the leak, proceed.
- 5 Shut down and vent the MSD.**
- 6 Remove the calibration valve assembly.**
- 7 Replace the calibration valve fitting.**
- 8 Reinstall the calibration valve assembly.**

See Also

To remove the calibration valve, page 194

To reinstall the calibration valve, page 196



*If the leak occurs
only when the valve
is open*

- 1 Tighten the thumbscrew that holds the vial in place.**
- 2 Retest the calibration valve for leaks.**

It is possible, but unlikely, that the calibration valve itself is leaking, allowing the tuning compound into the vacuum manifold. The argon leak test will not detect this type of leak. A leaking valve can be diagnosed by excessive background peaks matching peaks in the tuning compound. If the valve itself is leaking, replace the calibration valve assembly.

See Also

To remove the calibration valve, page 194

To reinstall the calibration valve, page 196

Checking for contamination

Contamination is usually identified by excessive background in the mass spectra. It can come from the GC or from the MSD. The first thing to do when contamination becomes evident is to determine which instrument is responsible for the contamination. Use the procedure outlined in *Step 2. To isolate the source of a leak* on page 126.

The source of the contamination can sometimes be determined by identifying the contaminants. Some contaminants are much more likely to originate in the GC. Others are more likely to originate in the MSD.

The following table lists some of the more common contaminants, the ions characteristic of those contaminants, and the likely sources of those contaminants.

Table 4

Common contaminants		
Ions (<i>m/z</i>)	Compound	Possible source
18, 28, 32, 44	H ₂ O, N ₂ , O ₂ , CO ₂	Air
28, 44	CO, CO ₂	Fragments from hydrocarbon contaminants
31, 51, 69, 100, 119, 131, 169 181, 214, 219, 264, 376, 414 426, 464, 502, 576, 614	PFTBA and related ions	PFTBA (tuning compound)
31	Methanol	Cleaning solvent
43, 58	Acetone	Cleaning solvent
77	Benzene or xylene	Cleaning solvent
91, 92	Toluene or xylene	Cleaning solvent
105, 106	Xylene	Cleaning solvent
151, 153	Trichloroethane	Cleaning solvent
69	Foreline pump fluid or PFTBA	Saturated foreline trap pellets or calibration valve leak
73, 147, 207, 221, 281, 295, 355, 429	Dimethylpolysiloxane	Septum or methyl silicone column coating
77, 94, 115, 141, 168, 170, 262, 354, 446	Diffusion pump fluid and related ions	Diffusion pump fluid
149	Plasticizer (phthalates)	Vacuum seals (O-rings) damaged by high temperatures
Peaks spaced 14 amu apart	Hydrocarbons	Fingerprints, foreline pump fluid, saturated foreline trap pellets

To find the source of contamination in a GC

Contamination originating in the GC typically comes from one of these sources:

- Column or septum bleed
- Dirty injection port
- Injection port liner
- Contaminated syringe
- Poor quality carrier gas

Column or septum bleed

These can frequently be identified by an intense peak at 207 amu (dimethylpolysiloxane). Non cross-linked capillary columns are a major cause. High-bleed septa are also a common cause. We recommend cross-linked capillary columns for almost all applications. We also recommend low-bleed septa such as the Hewlett-Packard “red” septa (5181-3383).

A simple test to detect column bleed is to increase the GC oven temperature 20° or 30°C. A corresponding increase in background indicates column bleed. Column bleed can be prevented or minimized by conditioning the column.

See Also

To condition a capillary column, page 22

Dirty injection ports, liners, syringes, and contaminated carrier gas

These are harder to diagnose because the background spectra you see will depend on the contaminants. If the contamination problem is coming from the GC, but it is not septum or column bleed, try:

- Cleaning the injection port
- Replacing the injection port liner
- Cleaning or replacing the syringe
- Switching to a different source of carrier gas and/or replacing the gas traps
- Replacing the carrier gas tubing with new (clean) tubing

See Also

The Hewlett-Packard application note *Optimizing splitless injections on your GC for high performance MS analysis* (5091-4587E)

To find the source of contamination in an MSD

Contamination originating in the MSD typically comes from one of the following sources:

- Air leak
- Cleaning solvents
- Diffusion pump fluid
- Foreline pump fluid
- Fingerprints

The action required to remove contamination depends on the type of contamination and the level of contamination. Minor contamination by water or solvents can usually be removed by allowing the system to pump (with a flow of clean carrier gas) overnight. Serious contamination by pump fluid or fingerprints is much more difficult to remove; it may require extensive cleaning. Contact your Hewlett-Packard Customer Engineer.

Air leaks

Air leaks can occur in many places as discussed previously. Air leaks can be identified by characteristic peaks at m/z 18, 28, 32, and 44. Also, if an air leak is present, the abundance of m/z 28 (nitrogen) is typically greater than the abundance of m/z 18 (water).

See Also

Finding air leaks, page 124

Cleaning solvents

It is common to see cleaning solvent peaks in the mass spectra shortly after the ion source is cleaned. To avoid this, dry all cleaned metal parts in the GC oven before reassembling and reinstalling them. Use a temperature above the boiling point of the solvent but below the limit of the column. Make sure carrier gas is flowing through the column.

Avoid contact between solvents and O-rings. Do not bake O-rings or parts that contain Teflon.

3 Troubleshooting the MSD

To find the source of contamination in an MSD

<i>Diffusion pump fluid</i>	If the diffusion pump is allowed to operate with no column (carrier gas) flow into the vacuum system, vapor from the diffusion pump fluid can drift up into the vacuum manifold. More serious is fluid back streamed into the vacuum manifold by sudden or improper venting of the vacuum system. If a diffusion pump has back streamed, a prominent peak will often be seen at m/z 446 and the spectral baseline will exhibit small peaks at most masses. It may also be possible to see a fluid film on parts in the vacuum manifold.
<i>Foreline pump fluid</i>	Foreline pump fluid contamination is characterized by peaks spaced 14 amu apart (hydrocarbons). Contamination with foreline pump fluid is less common than contamination with diffusion pump fluid, but can occur if the foreline pump is allowed to operate for an extended time with the diffusion pump off and no carrier gas flow into the system.
<i>Fingerprints</i>	Fingerprints contain hydrocarbons that can appear in mass spectra. Fingerprint contamination is characterized by a series of mass peaks 14 amu apart. The abundances of these peaks decrease as peak mass increases. Fingerprint contamination is usually caused by the failure to wear clean gloves during ion source cleaning or GC inlet maintenance. Use special care to avoid recontaminating parts after you clean them.

Testing

This section includes the following test procedures:

- To test the filaments, 142
- To test HP-IB communications, 144
- To test the HP-IB/MS control card, 145
- To test GC and ALS communications, 147
- To test the power supply, 148
- To test the calibration valve, 152
- To test the diffusion pump, 154
- To test the ion source, 156

These test procedures can be used to identify the causes of some performance problems in your MSD.

W A R N I N G

Some of these procedures involve exposure to potentially hazardous voltages. They are clearly labeled. Do not perform these procedures unless you have been trained to service electronic equipment and work with hazardous voltages.

To test the filaments

The following material describes how to test the filaments and related circuits.

W A R N I N G

This procedure involves exposure to potentially hazardous voltages. Do not perform this procedure unless you have been trained to service electronic equipment and work with hazardous voltages.

This procedure requires a high-impedance voltmeter that draws less than 50 microamps at 70 V dc. The voltmeter must also be capable of reading 30 kHz ac.

Materials needed

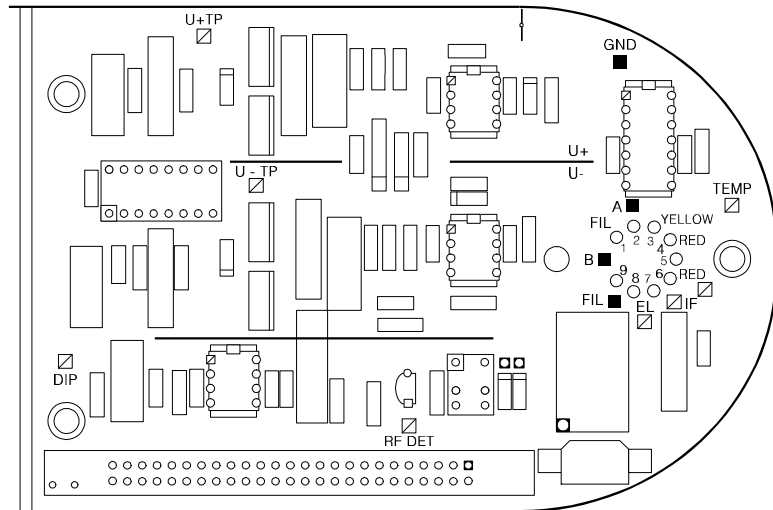
Screwdriver
TORX T-10 (8710-1623)
TORX T-15 (8710-1622)
Voltmeter, HP E2378A or equivalent

- 1 With the MSD on, remove the upper MSD cover.**
- 2 Disconnect the filament cable and ribbon cable from the top board.**
The filament cable is the twisted pair of white wires.
- 3 Remove the black plastic cover from the front of the top board.**

W A R N I N G

Dangerous voltages are present on the top board.

- 4 Measure the resistance between the FIL A and FIL test points.**
If filament A is good, the resistance will be less than 1 ohm. An open circuit indicates the filament is burned out or not connected.
- 5 Measure the resistance between the FIL B and FIL test points.**
If filament B is good, the resistance will be less than 1 ohm. An open circuit indicates the filament is burned out or not connected.



6 Measure the resistance between the FIL A, FIL B, or FIL test point and ground (GND).

The resistance should be greater than 1 megohm. A lower resistance indicates that one of the filaments is shorted to ground.

7 Reconnect the filament cable and ribbon cable.

8 Measure the dc voltage between the FIL test point and ground (GND).

The impedance of your voltmeter must be greater than 1 megohm. The voltage measured should be about -70 V dc. If this voltage is not present, replace the filament cable. If that does not correct the problem, contact your Hewlett-Packard Customer Engineer.

9 Measure the ac voltage between the FIL test point and the test point corresponding to the active filament (filament 1 = FIL B, filament 2 = FIL A).

The ac component is typically about 1 V but any ac voltage can be regarded as a successful test. If no ac voltage is present, replace the filament cable. If that does not correct the problem, contact your Hewlett-Packard Customer Engineer.

10 Reinstall the safety cover on the top board and reinstall the MSD cover.

To test HP-IB communications

An error message such as *Mass spectrometer interface card is not active* indicates the possibility of a problem with the data system, HP-IB/MS control card, GC, ALS, or cables. Use the following checklist to eliminate some of the more common and easily corrected causes of system communication problems.

- Verify communication with the GC by entering the Acquisition program.**
- Verify that the HP-IB addresses of the MSD, GC, and ALS correspond to the addresses assigned to those devices in the data system software.**
- Ensure that all HP-IB connections are tight.**
- Verify that the HP-IB interface cable is in place on the GC.**
- Verify that the GC has memory Revision G, or later (HP 5890 GCs only).**
- Check that only the GC, MSD, and ALS are connected to the HP-IB loop.**
- If the problem persists, switch all instruments on the HP-IB loop off and then on.**

If the error message continues to appear, see *To test the HP-IB/MS control card* on page 145.

See Also

HP 19257A HP-IB/RS-232 Interface Kit Installation and Setup Manual

To test the HP-IB/MS control card

If the initial checklist in *To test HP-IB communications* revealed no obvious causes for the error message, use the following test to verify that the HP-IB/MS control card is operating correctly.

Part 1

- 1 Make sure the MSD is on.**
- 2 Test the +5 V power supply (page 148).**
- 3 Make sure the HP-IB/MS control card is plugged in and cabled correctly.**
Check both the HP-IB connector cable (internal) and the external HP-IB cable.
- 4 Switch the MSD off, then on. This is called “power cycling” the MSD.**

CAUTION

Do not power cycle the MSD if the diffusion pump is warm. If the pump is warm, disconnect the cable from the foreline gauge, wait 10 minutes, reconnect the cable, and then power cycle the MSD.

- 5 Bring up the Manual Tune program.**
- 6 Enter the SCINIT command on the command line to initialize the HP-IB/MS control card.**
- 7 If the HP-IB/MS control card does not respond, disconnect the GC and ALS HP-IB cables.**
Make sure the data system and MSD are the only devices on the HP-IB loop.
- 8 Power cycle the MSD.**
- 9 Enter the SCINIT command on the command line to initialize the HP-IB/MS control card.**

If the message *MS interface initialized* appears (in 5 – 10 seconds), the HP-IB/MS control card is probably not the cause of the problem. Proceed to the GC/ALS test. If the HP-IB/MS control card still does not respond, proceed to *Part 2*.

3 Troubleshooting the MSD
To test the HP-IB/MS control card

Part 2

- 1 **If the HP-IB/MS control card is still not responding, replace the internal HP-IB connector cable.**
- 2 **Power cycle the MSD.**
- 3 **Enter the SCINIT command on the command line to initialize the HP-IB/MS control card.**
- 4 **If the HP-IB/MS control card still does not respond, replace the external HP-IB cable.**
- 5 **Power cycle the MSD.**
- 6 **Enter the SCINIT command on the command line to initialize the HP-IB/MS control card.**
- 7 **If the HP-IB/MS control card still fails to respond, replace it or contact your Hewlett-Packard Customer Engineer.**

To test GC and ALS communications

Before proceeding with the following test, the first 9 steps of *To test the HP-IB/MS control card* on page 145 must have been completed successfully. This establishes that the HP-IB/MS control card operates correctly when the GC and ALS are disconnected, but not when they are connected.

To determine if the problem is associated with the GC or the ALS, proceed as follows:

1 Reconnect the GC to the HP-IB loop but leave the ALS disconnected.

2 Bring up the Edit MS Parameters panel in the Manual Tune program.

3 Power cycle the MSD.

4 Use the SCINIT command to reinitialize the HP-IB/MS control card.

If the message *MS interface initialized* appears (in 5 – 10 seconds), it indicates that the HP-IB/MS control card and the GC are operating correctly. The problem is most likely with the ALS.

5 To determine if the ALS is the cause of the problem, reconnect the ALS.

6 Power cycle both the GC and the MSD.

7 Use the SCINIT command to reinitialize the HP-IB/MS control card.

If the HP-IB/MS control card fails to initialize, it is likely that the problem is with the ALS. Contact your Hewlett-Packard Customer Engineer.

To test the power supply

To test the power supply

If you suspect the power supply is not working properly, use the following procedure to test it.

W A R N I N G

This procedure involves exposure to potentially hazardous voltages. Do not perform this procedure unless you have been trained to service electronic equipment and work with hazardous voltages.

Materials needed

Screwdriver, TORX T-15 (8710-1622)
 Voltmeter, HP E2378A or equivalent

- 1 With the MSD on, remove the upper and lower MSD covers.**
- 2 Remove the safety cover from over the main board.**

W A R N I N G

Dangerous voltages are present under the safety cover. Do not touch any wiring or components except with the voltmeter test probes.

- 3 Measure the voltages between each of the four voltage test points and one of the ground (GND) test points.**

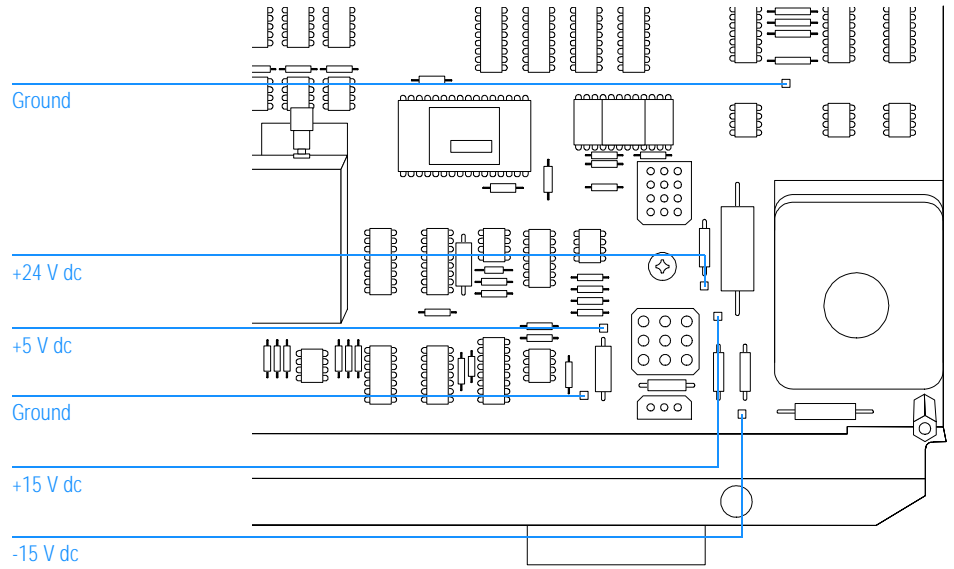
The test points are located on the lower right corner of the main board. The following table lists the acceptable voltage range for each test point.

Table 5

Expected voltages for power supply test points on the main board

Test point	Voltage range (V dc)
+24V	+23.92 to +28.08
+15V	+14.25 to +15.75
-15V	-15.75 to -14.25
+5V	+4.75 to +5.15

3 Troubleshooting the MSD To test the power supply



3 Troubleshooting the MSD

To test the power supply

All voltages are zero

If all the voltages are zero, there are several possible causes.

- No connection between the power supply and the main board
- No connection between the power distribution board and the power supply
- Failed fuse on the power supply

1 Make sure the cable from the power supply board to the main board is connected properly.

The cable connects to the back side of the main board below the calibration valve.

2 Shut down and vent the MSD (page 58).

3 Remove the electronics panel (page 243).

W A R N I N G

Never attempt to remove this panel while the MSD is on.

4 Make sure the cable from power supply to the power distribution panel is connected properly.

5 Check the fuse on the power supply.

If this fuse fails, it indicates an event or power supply condition so serious that the entire power supply should be replaced. Contact your Hewlett-Packard Customer Engineer.

Voltages are outside acceptable ranges

If voltages are present at the test points but outside the ranges listed as acceptable, the problem can be:

- A poor connection between the power supply cable and the main board
- A malfunctioning power supply (if the voltages are out of range by more than 10%)

1 Make sure the cable from the power supply board to the main board is connected properly.

The cable connects to the back side of the main board below the calibration valve.

2 Contact your Hewlett-Packard Customer Engineer.

To test the calibration valve

If symptoms indicate that the calibration valve in your MSD is not operating correctly, use the following procedure to test it.

W A R N I N G

This procedure involves exposure to potentially hazardous voltages. Do not perform this procedure unless you have been trained to service electronic equipment and work with hazardous voltages.

Materials needed

Screwdriver, TORX T-15 (8710-1622)
Voltmeter, HP E2378A or equivalent

1 With the MSD on, remove the upper and lower MSD covers.

2 Check the calibration valve cable.

Make sure the cable is securely connected to the back of the main board.

3 Remove the safety cover from over the main board.

W A R N I N G

Hazardous voltages (approximately 250 V dc) will be present on the main board.

4 Connect a voltmeter across diode CR18.

Diode CR18 is located along the lower edge of the main board.

5 Initiate an autotune.

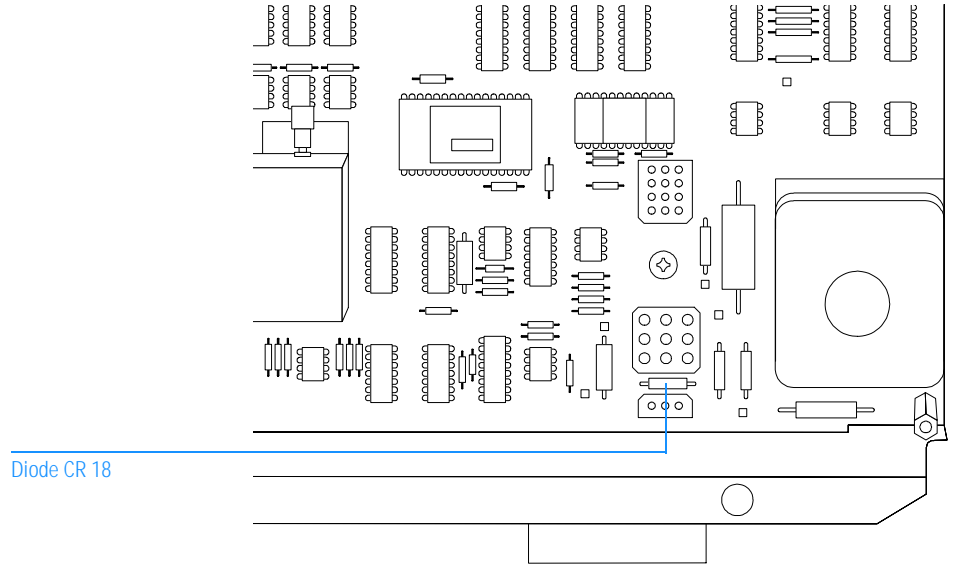
If the voltmeter registers in the 24 to 26 V dc range, then the calibration valve electronics are working correctly. Replace the valve or contact your Hewlett-Packard Customer Engineer. If zero voltage is registered, or if the voltage measured is significantly outside the range listed, then the electronics are not working correctly. Contact your Hewlett-Packard Customer Engineer.

See Also

To remove the calibration valve, page 194

To reinstall the calibration valve, page 196

3 Troubleshooting the MSD To test the calibration valve



To test the diffusion pump

To test the diffusion pump

If symptoms or error messages indicate that the diffusion pump is not working correctly, use this procedure to test the diffusion pump thermal switches and heater.

Materials needed

Screwdriver, TORX T-15 (8710-1622)
Ohmmeter or multimeter, HP E2378A or equivalent

- 1 Shut down and vent the MSD.**
- 2 Remove the diffusion pump cover.**

W A R N I N G

The diffusion pump may still be very hot. Make sure it has cooled before proceeding.

- 3 Disconnect the diffusion pump cable from the connector below the fan.**
- 4 Measure the resistances of the thermal switches and heater through the diffusion pump cable.**

If the values you measure do not match the values listed in the following table, contact your Hewlett-Packard Customer Engineer.

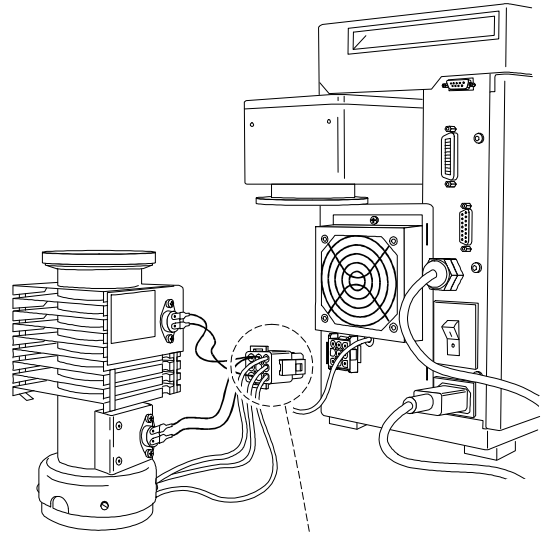
Table 6

Diffusion pump resistance values

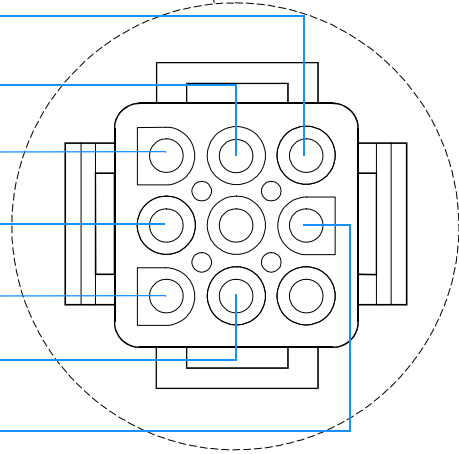
	Too cold switch (pins 8 & 9)	Too hot switch (pins 6 & 7)	Heater, 110 V (pins 2 & 3)	Heater, 220 V (pins 2 & 3)	Heater to ground (pins 1 & 2)
Operating temperature	< 0.5 ohms	< 0.5 ohms	≅ 32 ohms	≅ 130 ohms	> 20 megohms
Room temperature	> 20 megohms	< 0.5 ohms	≅ 32 ohms	≅ 130 ohms	> 20 megohms

3 Troubleshooting the MSD

To test the diffusion pump



- 9 Too cold (white)
- 6 Too hot (red)
- 3 Heater neutral (white)
- 2 Heater line (white/blue)
- 1 Ground (green/yellow)
- 7 Too hot (red)
- 8 Too cold (white)



To test the ion source

A dirty ion source is one of the more common causes of poor sensitivity and other performance problems. All ion sources eventually become dirty. How quickly the ion source in your MSD will become dirty depends on several factors:

- Number of samples analyzed
- Type of samples analyzed
- Operating conditions

Even if it were easy to inspect, a dirty ion source does not always look dirty. Fortunately, clues to the condition of the ion source can be determined from tune reports. It is best if you have kept a log of tune reports. Historical trends can provide much valuable information.

If, after following this procedure, you determine that the ion source is dirty, its performance can be restored by following the cleaning procedure in Chapter 4.

See Also

To clean the ion source, page 212

Materials needed

None (log of tune reports is helpful)

1 Examine the log of tune reports.

The following progressive changes over time can indicate the ion source is becoming dirty:

- Steadily increasing ion focus voltage
- Steadily decreasing entrance lens offset (in standard spectra autotune)
- Steadily increasing repeller voltage (the repeller voltage is fixed in the standard spectra autotune)
- Steadily increasing electron multiplier voltage
- Steadily poorer low-mass resolution
- Steadily decreasing relative abundance of m/z 502

2 Perform either a standard spectra autotune or a maximum sensitivity autotune.

With a standard sensitivity autotune, signs of a dirty ion source include:

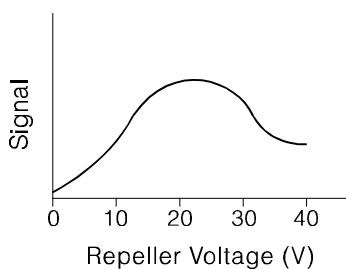
- A relative abundance of m/z 502 less than 2%
- Entrance lens offset less than 1.0

With the maximum sensitivity autotune, signs of a dirty ion source include:

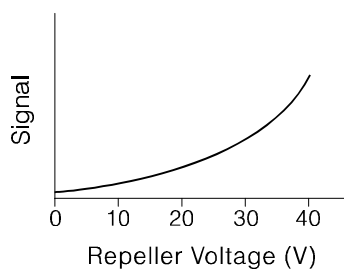
- A relative abundance of m/z 502 less than 0.15%
- A relative abundance of m/z 219 less than 20%
- The repeller is at maximum (the default maximum is 30 V)

3 Ramp the repeller voltage.

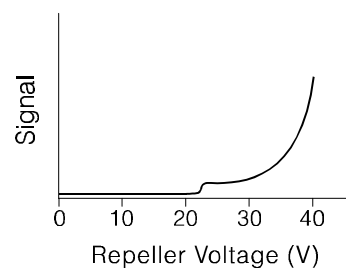
Call up the Manual Tune program. Ramp the repeller voltage. A clean ion source will generate a response curve with a single, well-defined peak between 15 and 30 volts. As an ion source becomes dirty, the peak will shift higher and higher until it occurs at the maximum repeller voltage (42.8 V). A dirty ion source can also show little or no response at lower repeller voltages with a sudden step and a steep response curve after the step. With this type of response, the peak is still at the maximum repeller voltage. If the step occurs above 25 V, the standard spectra autotune, which runs the repeller at a fixed 25 volts, will not function properly.



Clean



Dirty



Dirty

Before starting, 160
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Maintaining the analyzer, 202
Maintaining the GC interface, 229
Maintaining the electronics, 238

Maintaining the MSD

How to perform common maintenance procedures for the MSD

Before starting

You can perform most of the maintenance required by your MSD. For your safety, read all of the information in this introduction before performing any maintenance tasks.

Some parts of the MSD require regularly scheduled maintenance

Common maintenance tasks are listed in Table 7. Performing these tasks on a regular basis can reduce operating problems, prolong system life, and reduce overall operating costs.

Keep a record of system performance (tune reports) and maintenance operations performed. This makes it easier to identify variations from normal operation and to take corrective action.

Table 7

Maintenance schedule

Task	Every week	Every 3 weeks	Every 6 months	Every year	As needed
Tune the MSD					✓
Check the foreline pump fluid level	✓				
Check and, if necessary, refill the calibration vial		✓			
Replace the foreline pump fluid			✓		
Replace the foreline trap pellets			✓		
Check and, if necessary, replace the diffusion pump fluid				✓	
Clean the ion source					✓
Check the carrier gas trap					✓
Replace the worn out parts such as filaments and the electron multiplier					✓

Maintenance requires the proper tools, spare parts, and supplies

Some of the required tools, spare parts, and supplies are included in the MSD shipping kit or MSD tool kit. Others you must supply yourself. Each maintenance procedure includes a list of the materials required for that procedure. Tables 8 summarizes these.

Table 8

Tools	
Description	HP part number
Ball driver	
1.5-mm	8710-1570
2.0-mm	8710-1804
Hex nut driver, 1/4-inch	8720-0002
Pliers, long-nose (1.5-inch nose)	8710-1094
Ruler, metal, metric	_____
Screwdriver	
flat-blade, large	8730-0002
Pozidriv, #1 (small)	8710-0899
Pozidriv, #2 (large)	8710-0900
TORX, T-10 (small)	8710-1623
TORX, T-15 (large)	8710-1622
Tweezers, non-magnetic	8710-0907
Wrench, open-end, 1/4-inch x 5/16-inch	8710-0510

Table 9

Spare parts and supplies

Description	HP part number
Abrasive paper	5061-5896
Alumina abrasive powder	8660-0791
Aluminum foil, clean	_____
Beakers, glass, 50 ml and 500 ml	_____
Cloths, clean, lint-free	05980-60051
Cotton swabs	5080-5400
Diffusion pump fluid	6040-0809
Electron multiplier horn	05971-80103
Filament assembly	05972-60053
Foreline pump fluid	
1 liter	6040-0834
1 gallon	6040-0798
Foreline trap pellets (molecular sieve)	9301-1104
GC interface heater/sensor assembly	
HP 5972A MSD (110 V ac heater)	05971-60105
HP 6890 Series MSD (40 V dc heater)	05972-60106
Gloves	
chemical-resistant	_____
clean, lint-free (large)	8650-0030
clean, lint-free (small)	8650-0029
PFTBA sample kit	05971-60571
Solvents, reagent-grade	
acetone	_____
methanol	_____
methylene chloride	_____
Ultrasonic bath	_____

Many parts of the MSD carry high voltages that are potentially dangerous

Whenever the MSD is plugged in, even if the power switch (circuit breaker) is off, potentially dangerous voltage (110/120 V ac or 220/240Vac) exists on:

- The wiring between where the power cord enters the instrument and the power switch

When the power switch is on, potentially dangerous voltages exist on:

- Main board
- Power distribution board
- Power supply
- Top board
- Wires and cables between these boards
- Wires and cables between these boards and the connectors on the back panel of the MSD

Normally, all of these parts are shielded by safety covers. As long as these safety covers are in place, it should be difficult to accidentally make contact with dangerous voltages.

One or two procedures in this chapter require access to the inside of the MSD while it is on. In each procedure, there is no reason to remove any of the electronics safety covers. The danger of accidental shock will be small as long as the procedures are followed carefully.

W A R N I N G

Under no circumstances should any maintenance procedure which requires the removal of an electronics safety cover be performed unless the MSD is switched off and its power cord disconnected.

If your instrument is equipped with the optional gauge controller, potentially dangerous voltage also exists where the cable from the gauge controller connects to the triode gauge tube. Turn off the gauge controller if you are going to be working near the triode gauge tube.

Many parts are hot enough to be dangerous

Many parts in the MSD operate at or reach temperatures high enough to cause serious burns. These parts include but are not limited to:

- GC interface
- Radiator
- Ion source
- Quadrupole mass filter
- Diffusion pump
- Foreline pump

Never touch these parts while the instrument is on. After the MSD is turned off, give these parts plenty of time to cool before handling them. This is especially true of the GC interface and diffusion pump.

W A R N I N G

Because the temperature of the GC interface is controlled by the GC, the interface can be on and at a dangerously high temperature even though the MSD is off. After it is turned off, the GC interface cools very slowly. This is especially true if the GC oven is at an elevated temperature.

Chemical residue is another potential danger

Not all of your sample is ionized by the ion source. The majority of any sample passes through the ion source without being ionized and is pumped away by the vacuum system. As a result, the exhaust from the foreline pump will contain traces of the carrier gas and your samples. Treat pump exhaust as toxic.

W A R N I N G

Exhaust from the foreline pump may contain toxic chemicals and should never be vented into the laboratory.

Use a hose to vent the exhaust from the foreline pump outside or into a fume hood. Be sure to comply with your local air quality regulations.

The fluids in the diffusion pump and foreline pump also collect traces of the samples being analyzed. All used pump fluid should be considered hazardous waste and handled accordingly. Dispose of used fluid correctly, as specified by your local regulations.

W A R N I N G

When replacing pump fluid, use chemical-resistant gloves and safety glasses. Avoid all contact with the fluid.

Electrostatic discharge is a threat to the MSD electronics during maintenance

All of the printed circuit boards in the MSD contain components that can be damaged by electrostatic discharge (ESD). Do not handle or touch these boards unless absolutely necessary. When you must handle these boards, always use a grounded wrist strap and take other anti-static precautions. The grounded wrist strap should be connected to the main MSD ground point. The ground point is located near the main power wiring. It is labeled with the international symbol for ground. Handle printed circuit boards by their edges and avoid touching components or traces.

CAUTION

In order to be effective, an anti-static wrist strap must fit snugly (not tight). A loose strap provides little or no protection.

CAUTION

Even anti-static precautions are not 100% effective. Handle electronic circuit boards as little as possible.

Maintaining the vacuum system

The vacuum system requires some periodic maintenance

As listed earlier in Table 7, some maintenance tasks for the vacuum system must be performed periodically. These include:

- Checking the foreline pump fluid (every week)
- Checking the calibration vial (every 3 weeks)
- Replacing the foreline pump fluid (every 6 months)
- Replacing the foreline trap pellets (every 6 months)
- Checking the diffusion pump fluid (every year)

Failure to perform these tasks as scheduled can result in decreased instrument performance. It can also result in damage to your instrument.

Other procedures should be performed as needed

Tasks such as replacing a foreline vacuum gauge or triode gauge should be performed only when needed. See Chapter 3, *Troubleshooting the MSD*, on page 63 for symptoms that indicate this type of maintenance is required.

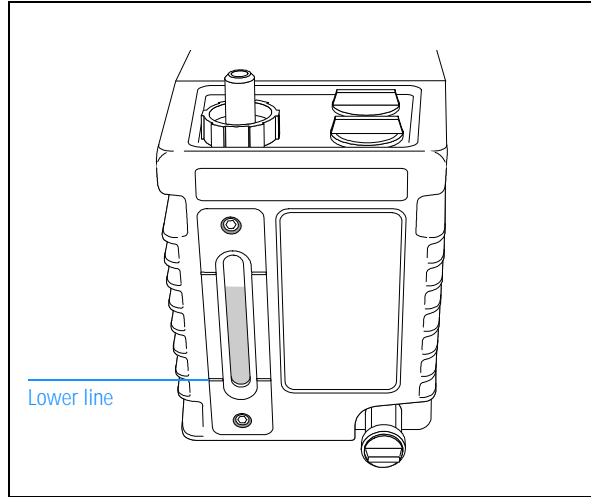
More information is available

If you need more information about the locations or functions of vacuum system components, refer to Chapter 5, *Vacuum System* on page 249.

To check and add foreline pump fluid

Materials needed:

Foreline pump fluid (6040-0834)
Funnel

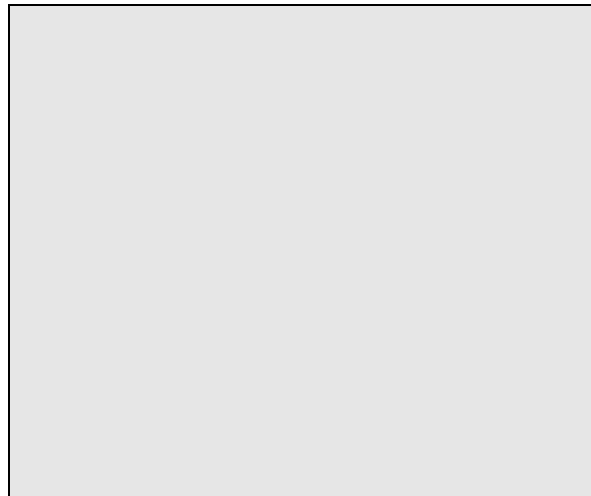


- 1 Examine the pump fluid window. The fluid level should be well above the lower line.

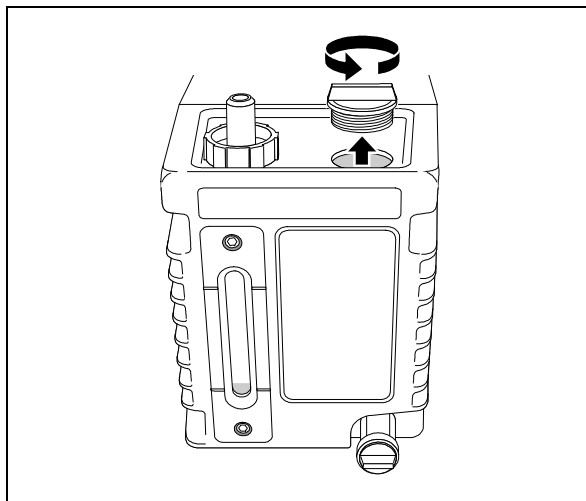
If the fluid level is near or below the lower mark, add foreline pump fluid. Follow the remaining steps in this procedure to add pump fluid.

WARNING Never attempt to add pump fluid while the foreline pump is on.

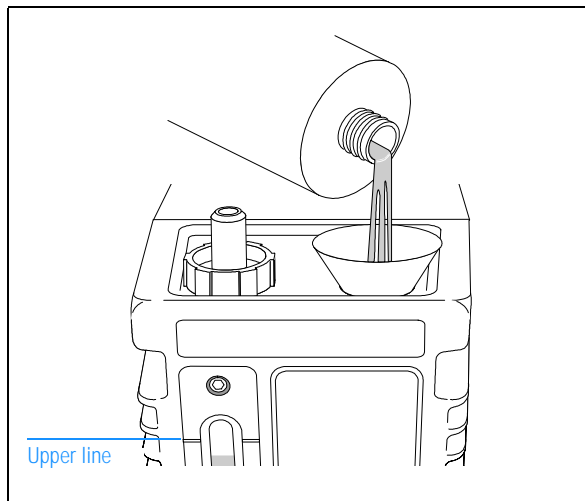
If your MSD is nearing its scheduled time for replacement of the foreline pump fluid, replace the fluid instead of just adding pump fluid.



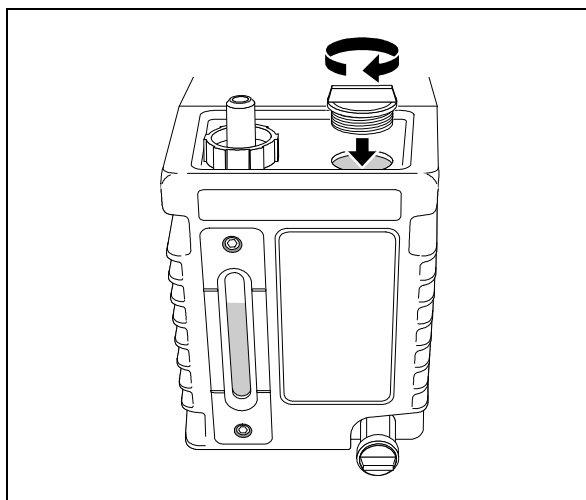
- 2 Vent and switch off the MSD (page 58).



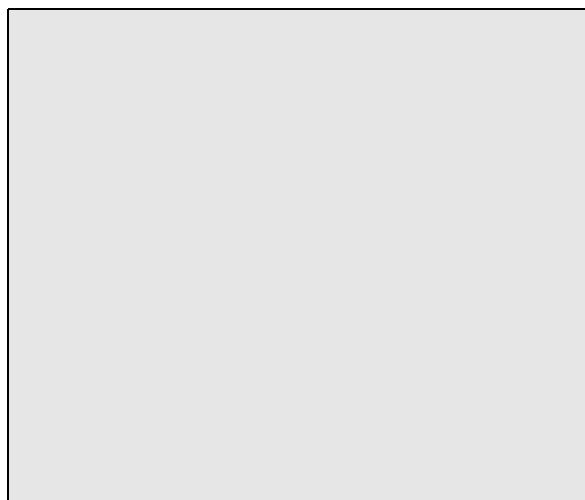
3 Remove the fill cap from the top of the foreline pump. There are two fill caps. Either one will work.



4 Add pump fluid until the fluid level in the window is near, but not above, the upper line.



5 Reinstall the fill cap.



6 Reinstall the GC column. Start up and pump down the MSD (page 40).

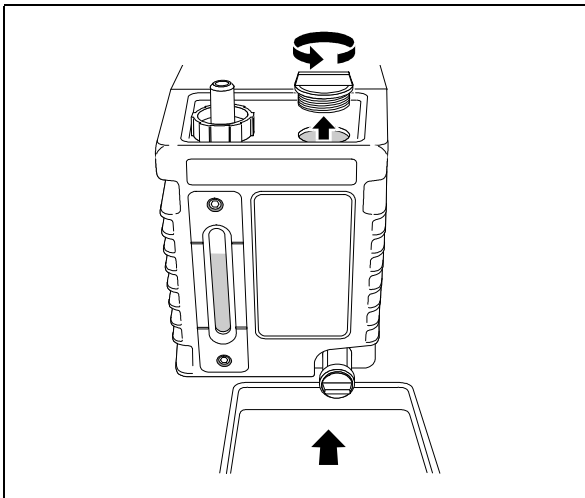
To drain the foreline pump

Materials needed:

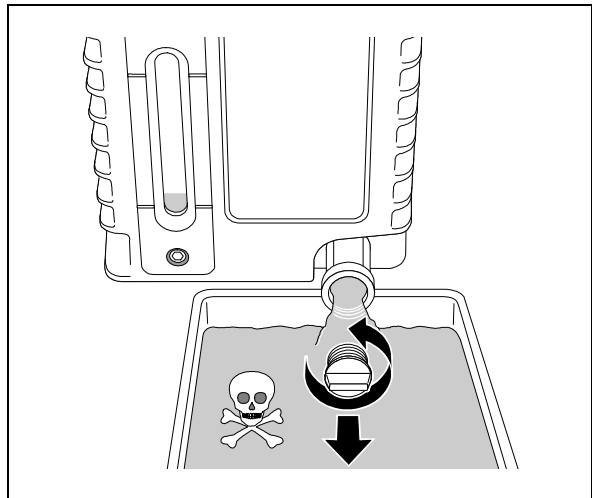
Container for catching old pump fluid, 500 ml
Gloves, chemical-resistant



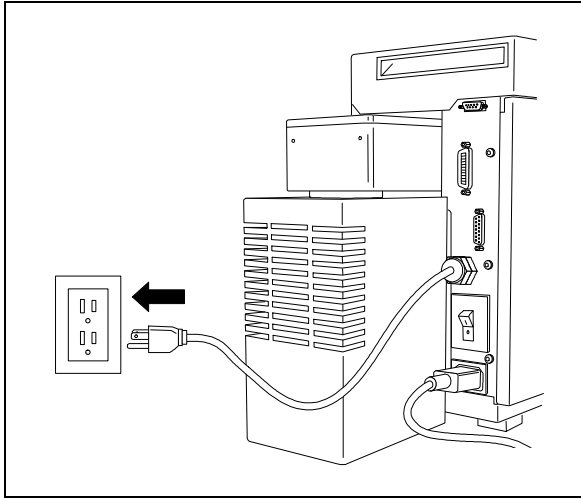
1 Vent and switch off the MSD (page 58).



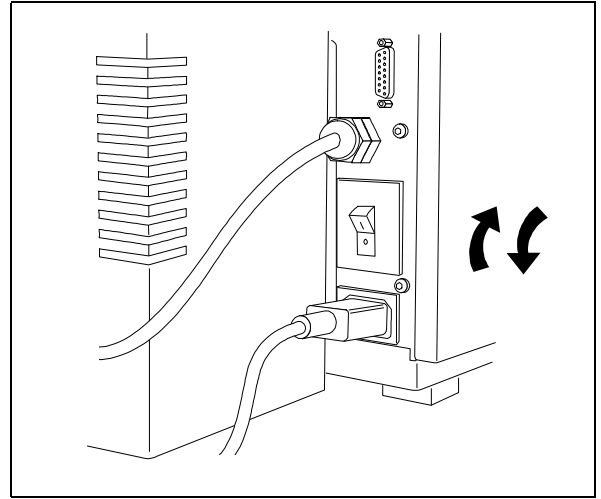
2 Remove the fill cap. Place a container under the drain plug.



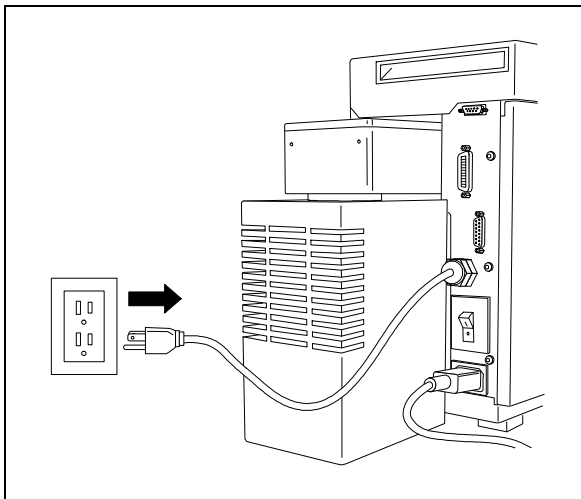
3 Remove the drain plug. Allow the pump fluid to drain out.



4 Plug the MSD power cord into its electrical outlet.



5 Switch the MSD power switch on and immediately off. Do not leave it on.



6 Unplug the MSD power cord from its electrical outlet.

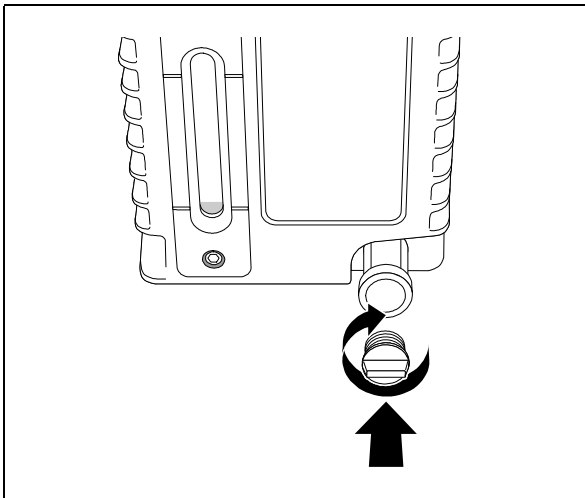
To fill the foreline pump

Materials needed:

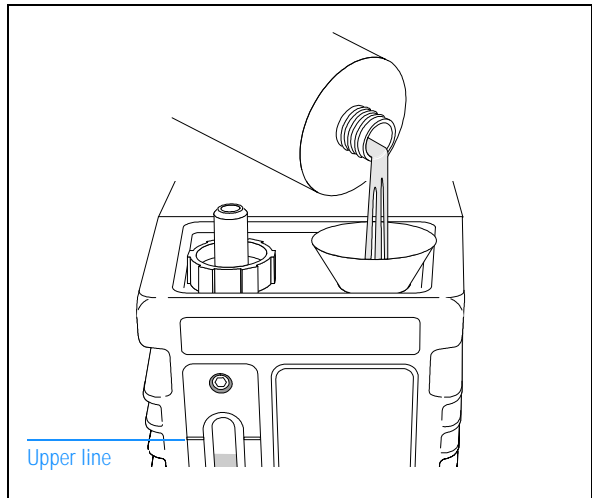
Foreline pump fluid (6040-0834)
Funnel
Gloves, chemical-resistant
Screwdriver, flat-bladed, large (8730-0002)



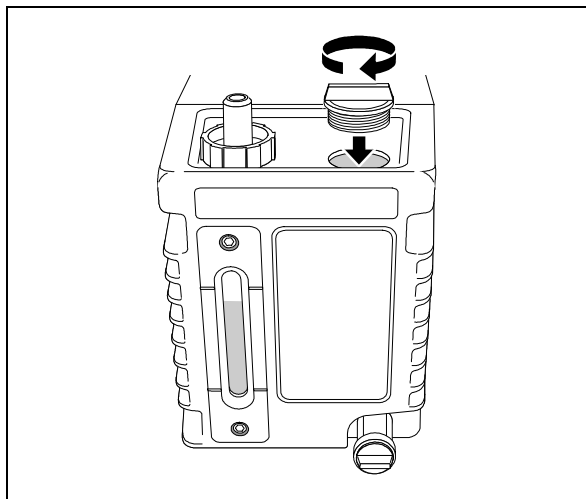
1 Drain the foreline pump fluid (page 170).



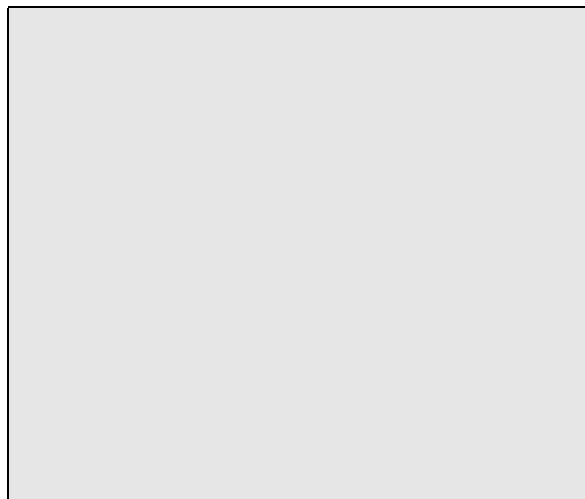
2 Reinstall the drain plug.



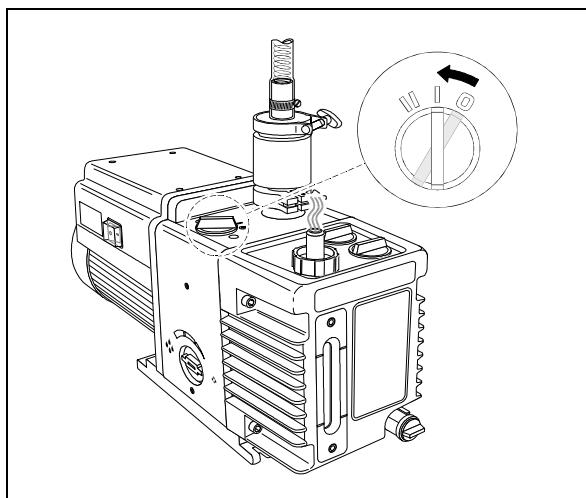
3 Add foreline pump fluid until the fluid level in the window is near, but not above, the upper line.



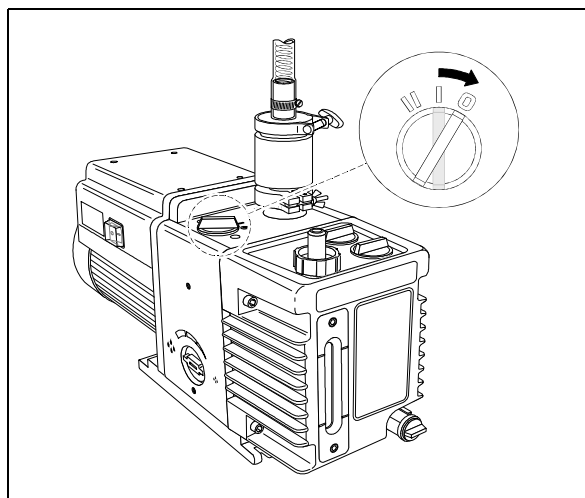
4 Reinstall the fill cap.



5 Reinstall the GC column. Start up and pump down the MSD (page 40).



6 Turn the ballast switch to position 1. The pump will become noisier. Wait 10 minutes.



7 Turn the ballast switch back to position 0. Always use position 0 for normal operation.

4 Maintaining the MSD
To remove the foreline trap pellets

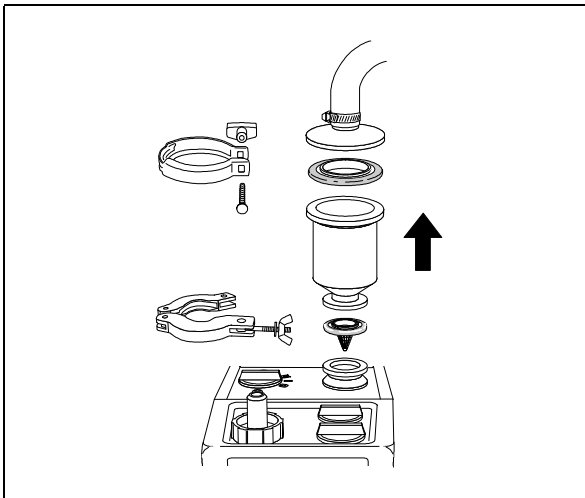
To remove the foreline trap pellets

Materials needed:

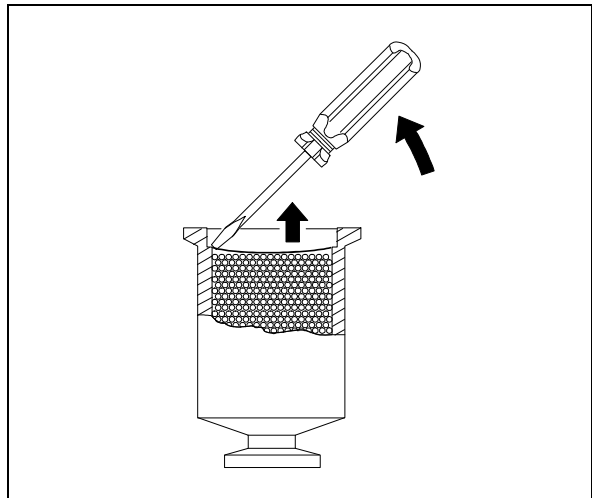
Cloths, clean, lint-free (05980-60051)
Gloves, chemical-resistant
Screwdriver, flat-bladed, large (8730-0002)



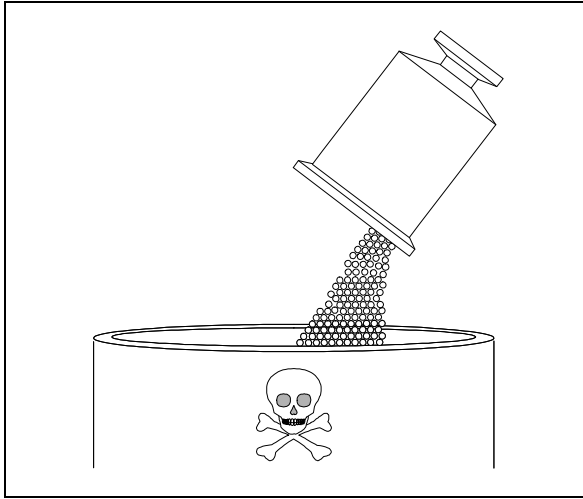
1 Vent and switch off the MSD (page 58).



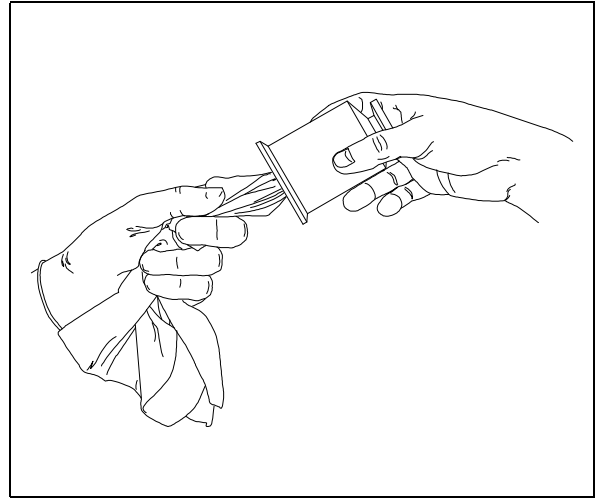
2 Disconnect the foreline trap from the foreline pump.
Remove the top of the trap.



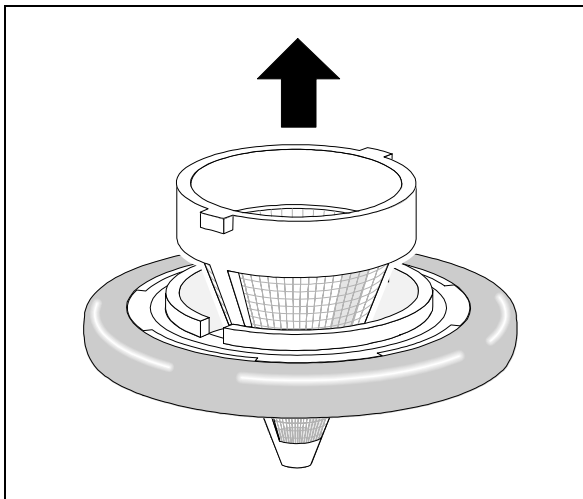
3 Remove the screen from the top of the trap. Do not
remove the second screen at the bottom of the trap.



4 Dispose of the pellets in the trap. Treat the pellets as hazardous waste.



5 Wipe the interior of the trap with a clean, lint-free cloth.



6 Inspect the inlet filter. If the filter is dirty, remove it and rinse it in a solvent such as isopropyl alcohol.

CAUTION

Remove the inlet filter from the O-ring assembly before rinsing the filter. Solvents will damage the O-ring.

CAUTION

Reinstall the filter pointed-end first through the O-ring assembly. If incorrectly assembled, the filter will disable the anti-suckback valve.

The inlet filter is not essential to pump operation. If you cannot clean it, you can discard it. If the O-ring is dirty, wipe it with a clean, lint-free cloth.

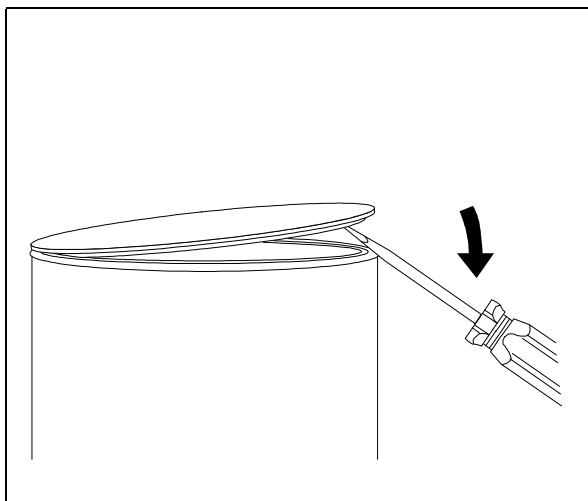
To add foreline trap pellets

Materials needed:

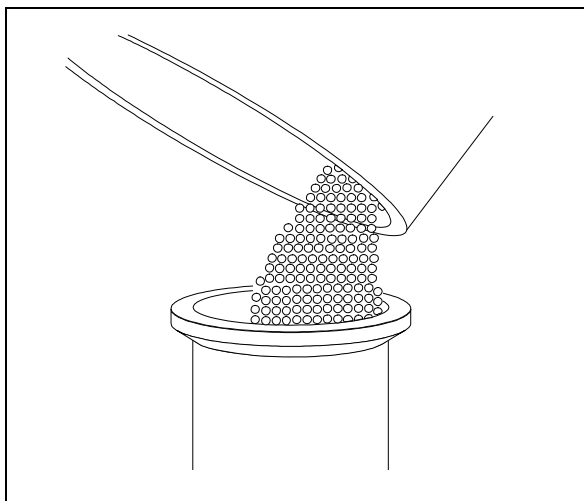
Gloves, chemical-resistant
Pellets, molecular sieve (9301-1104)



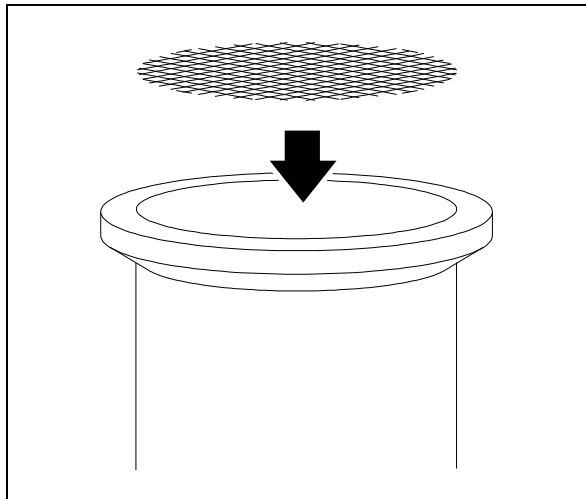
1 Remove the old foreline trap pellets (page 174).



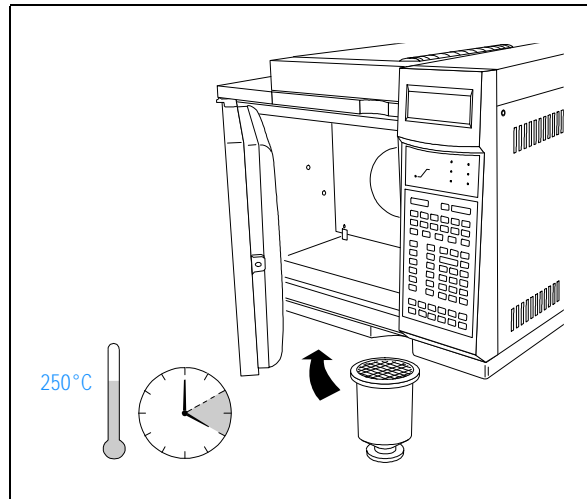
2 Open a new can of foreline trap pellets (molecular sieve).



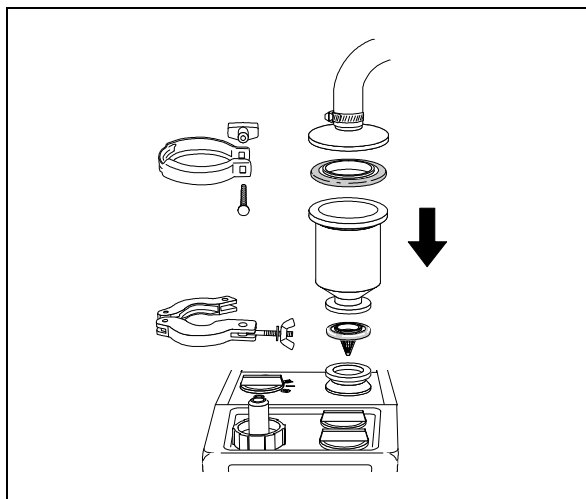
3 Pour the new pellets into the trap until it is almost full.



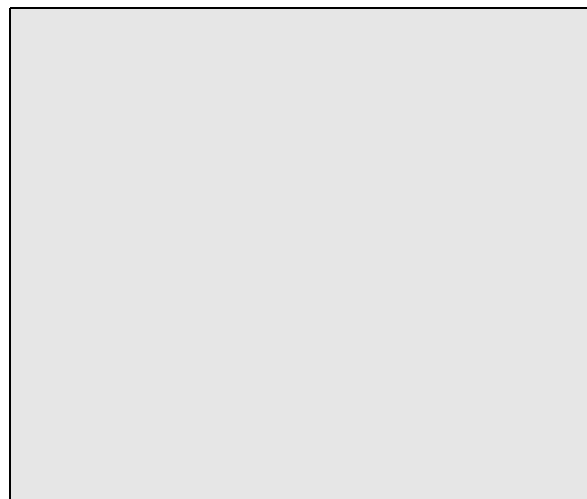
4 Reinstall the screen.



5 Place the trap in the GC oven. Bake it at 250°C for 2 hours. Do not bake O-rings.



6 Reassemble the trap. Reinstall it on the foreline pump.



7 Reinstall the GC column. Start up and pump down the MSD (page 40).

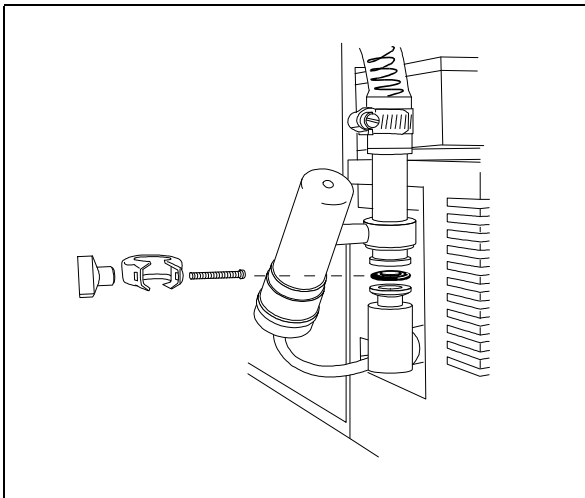
To remove the diffusion pump

Materials needed:

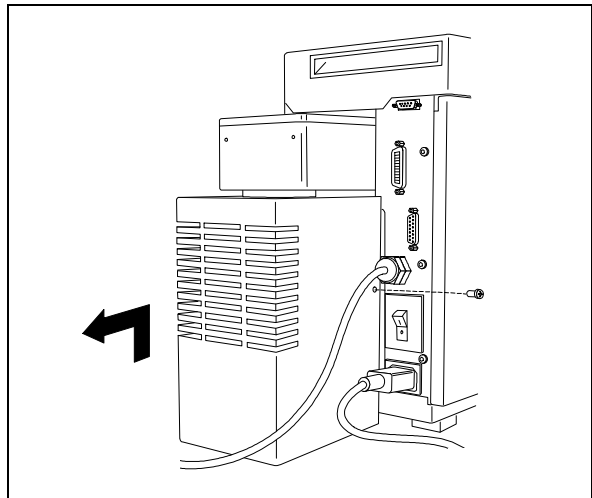
Screwdriver, TORX T-15 (8710-1622)



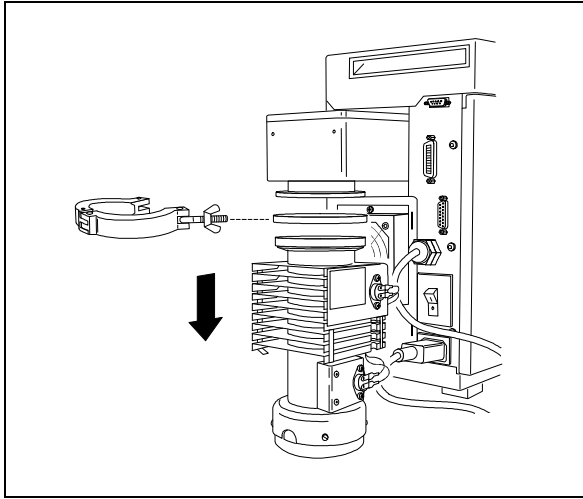
1 Vent and switch off the MSD (page 58).



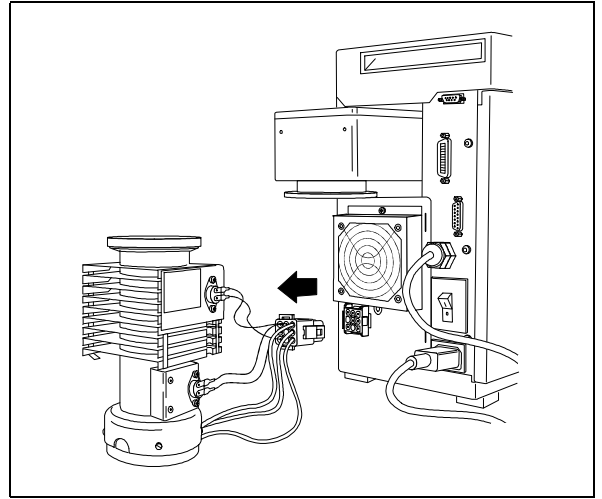
2 Disconnect the foreline vacuum gauge fitting from the diffusion pump outlet.



3 Remove the diffusion pump cover.



4 Remove the KF50 clamp. Lower the diffusion pump to the table.



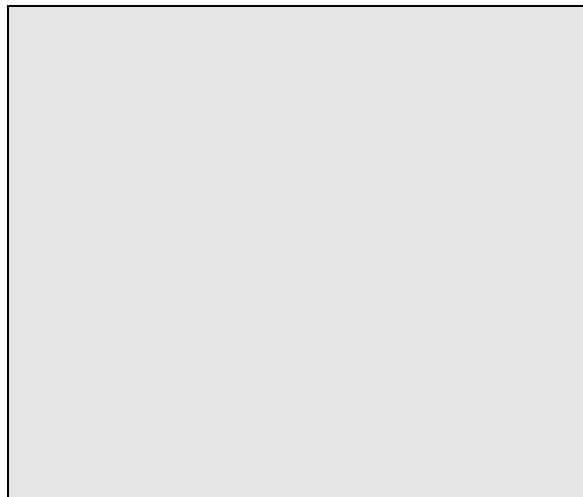
5 Disconnect the diffusion pump cable from the connector on the back panel.

4 Maintaining the MSD
To check the diffusion pump fluid

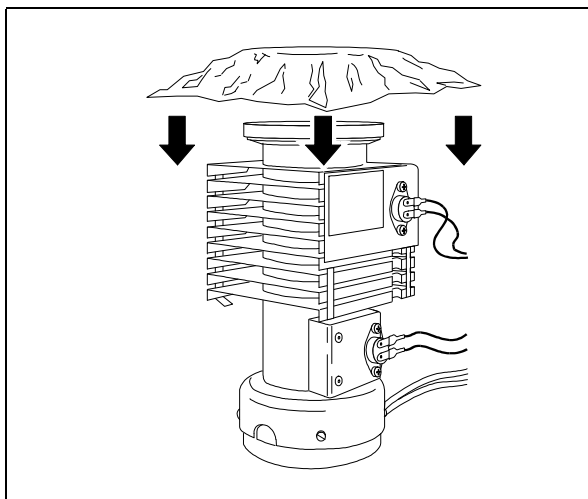
To check the diffusion pump fluid

Materials needed:

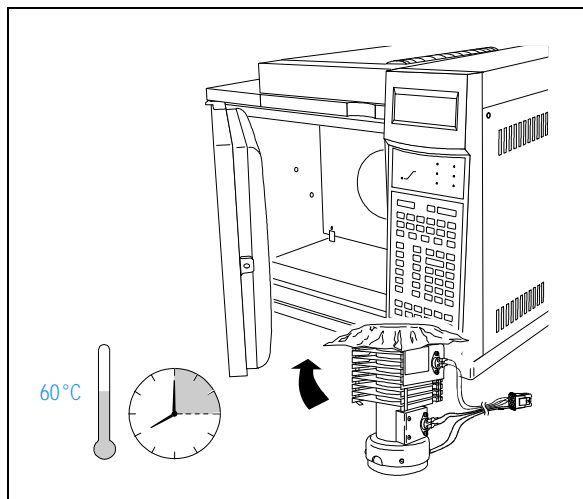
Aluminum foil, clean
Gloves, chemical-resistant
Pliers, long-nosed (8710-1094)
Ruler, metal, metric



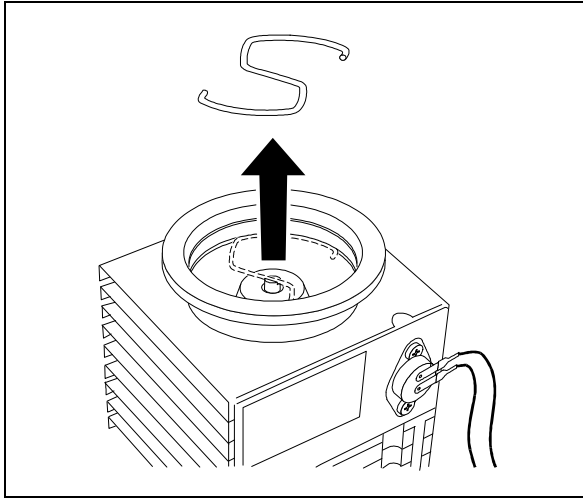
1 Remove the diffusion pump (page 178).



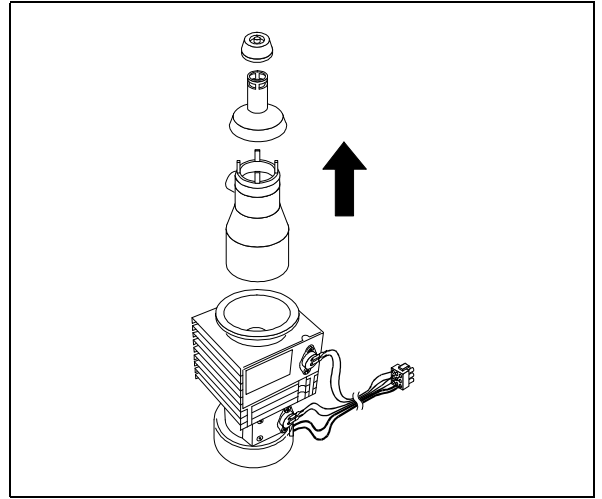
2 Remove the coseal (O-ring assembly). Cover the top of the diffusion pump with aluminum foil.



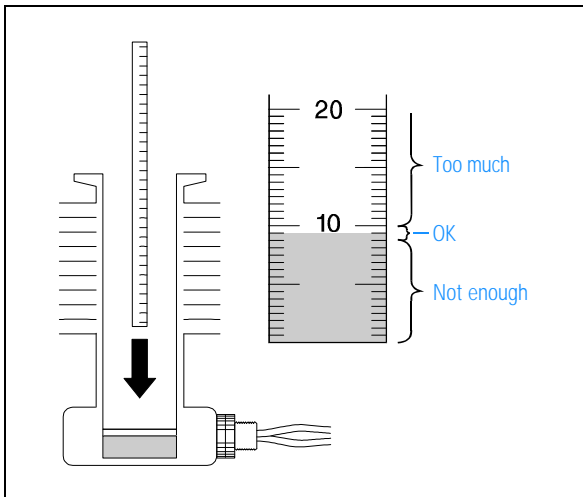
3 Place the diffusion pump in your GC oven. Heat it at 60°C for 15 minutes.



4 Remove the retaining clip from the top of the diffusion pump stack.



5 Remove the components of the diffusion pump stack.



6 Dip a metal ruler into the diffusion pump fluid. The fluid should be 8 to 10 mm deep.

The diffusion pump fluid should be clear or slightly tinted. Cloudy or dark fluid can indicate an air leak or excessive water in the system. If the fluid is cloudy or dark, replace it (page 182). Check for air leaks (page 124) and correct any leaks you find.

7 Check the color of the pump fluid.

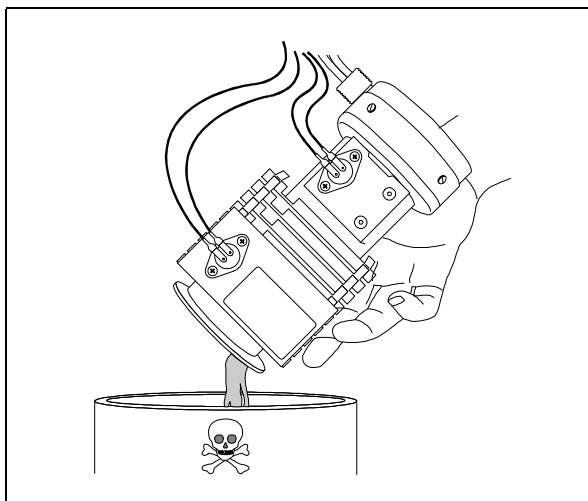
To replace the diffusion pump fluid

Materials needed:

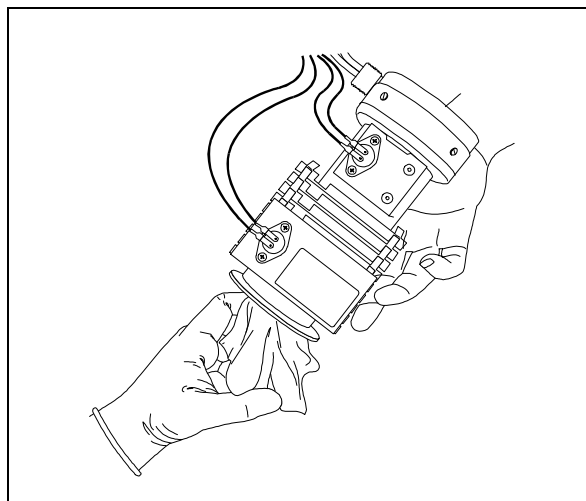
Cloths, clean, lint-free (05980-60051)
Diffusion pump fluid (6040-0809)
Gloves, chemical-resistant
Methylene chloride, reagent-grade



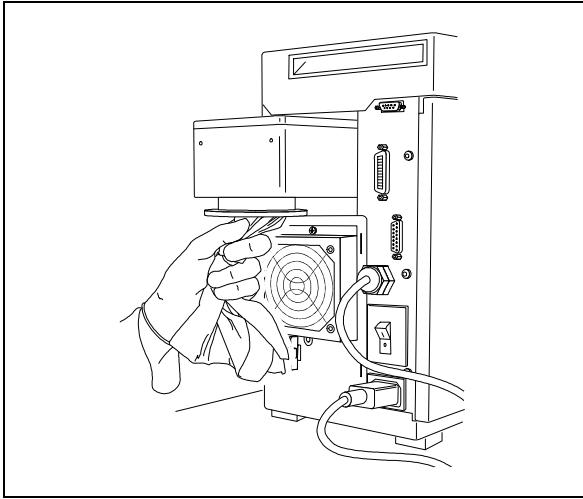
1 Follow steps 1 through 5 of *To check the diffusion pump fluid* on page 180.



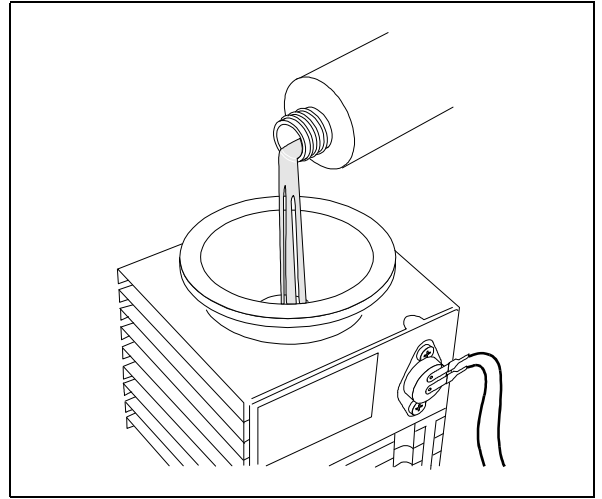
2 Drain the old diffusion pump fluid. Treat the old pump fluid as hazardous waste.



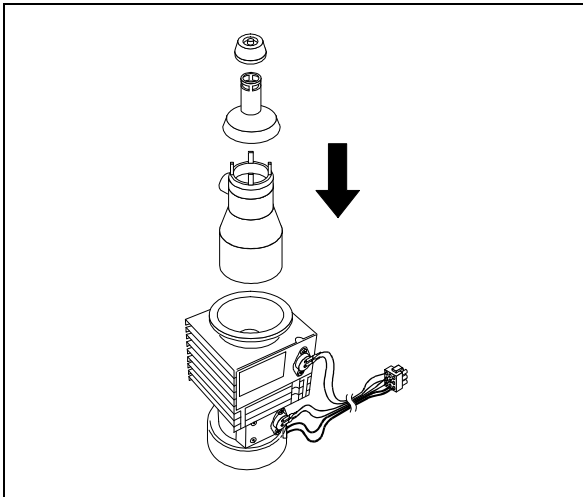
3 Rinse the interior of the pump with methylene chloride. Wipe it clean with a clean cloth.



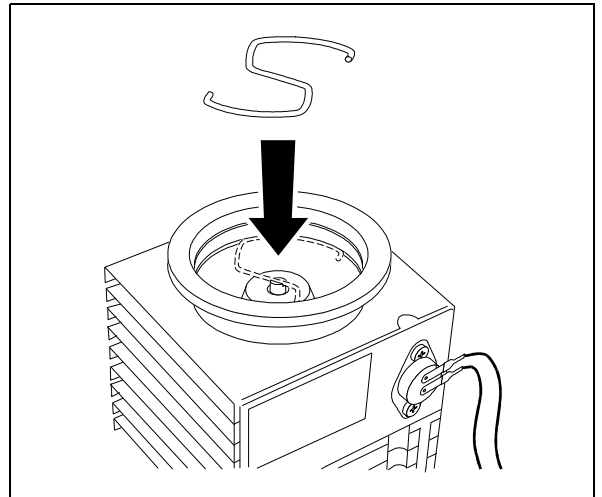
4 Wipe clean the interior of the vacuum manifold above where the pump attaches.



5 Pour the pre-measured tube of diffusion pump fluid into the diffusion pump.



6 Reinstall the stack components.

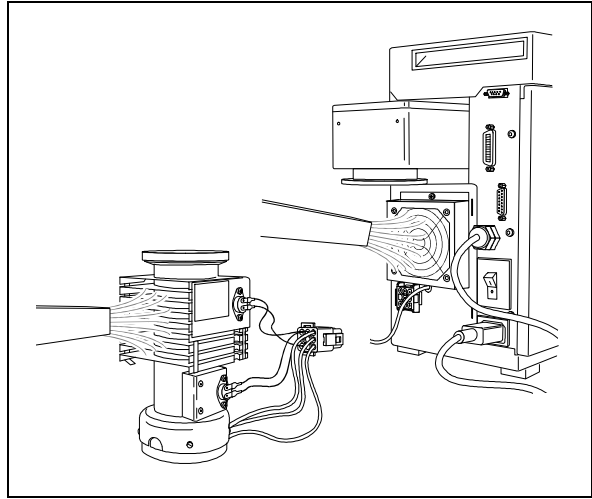


7 Reinstall the stack retaining clip.

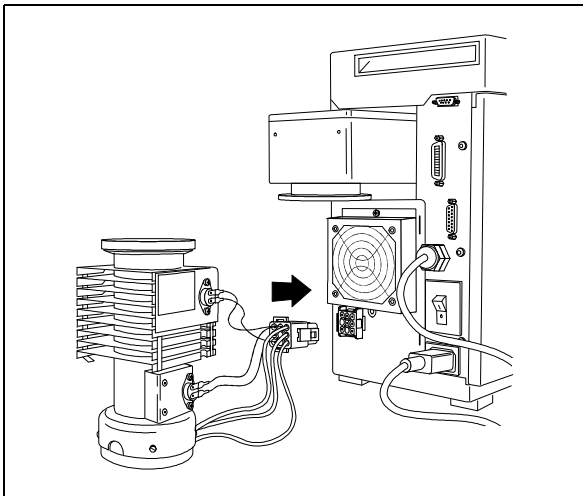
To reinstall the diffusion pump fluid

Materials needed:

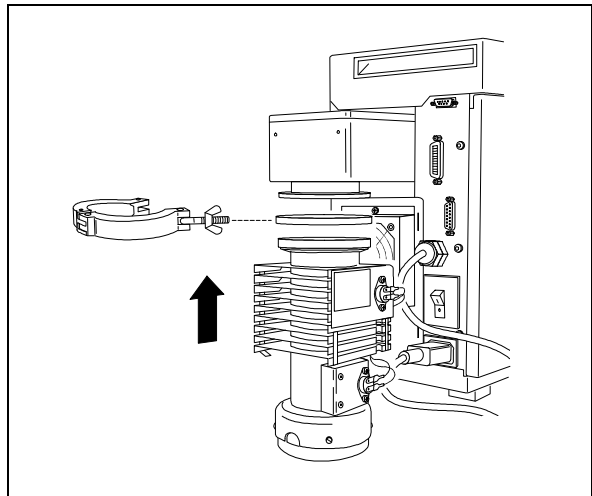
Screwdriver, TORX T-15 (8710-1622)
Vacuum cleaner, non-ESD generating (HP 92175V
or equivalent)



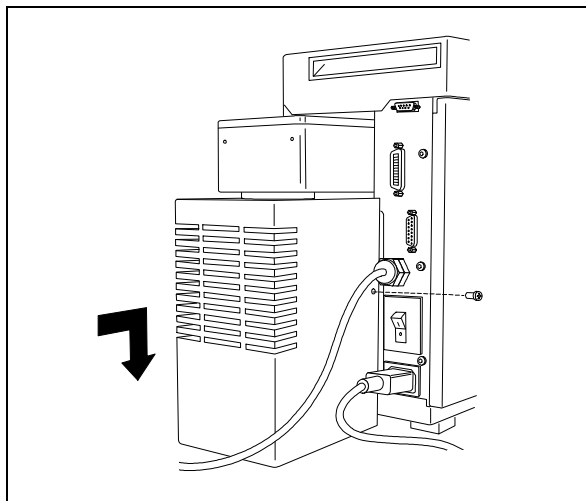
1 Vacuum the fan and the cooling fins on the diffusion pump to remove accumulated dust.



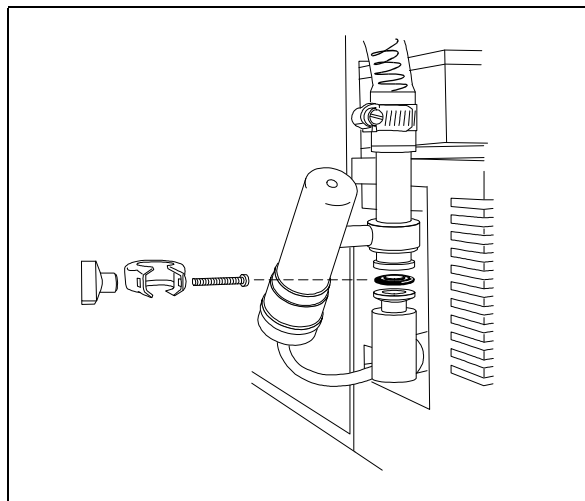
2 Reconnect the diffusion pump cable to the connector on the back panel.



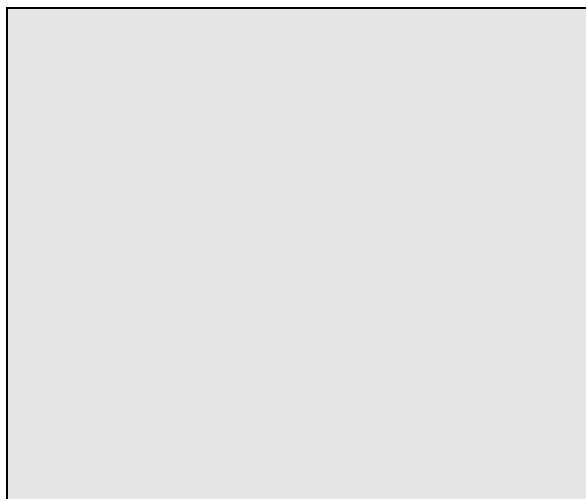
3 Reinstall the diffusion pump and clamp. Do not forget the coseal (O-ring assembly).



4 Reinstall the diffusion pump cover.



5 Reconnect the foreline vacuum gauge fitting to the outlet of the diffusion pump.



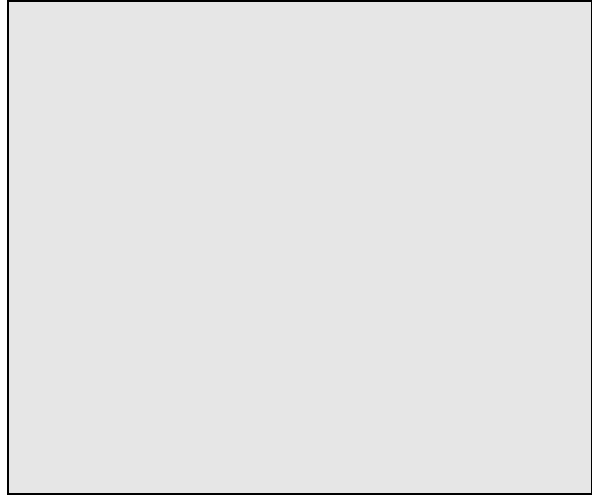
6 Reinstall the GC column. Start up and pump down the MSD (page 40).

4 Maintaining the MSD
To remove the calibration vial

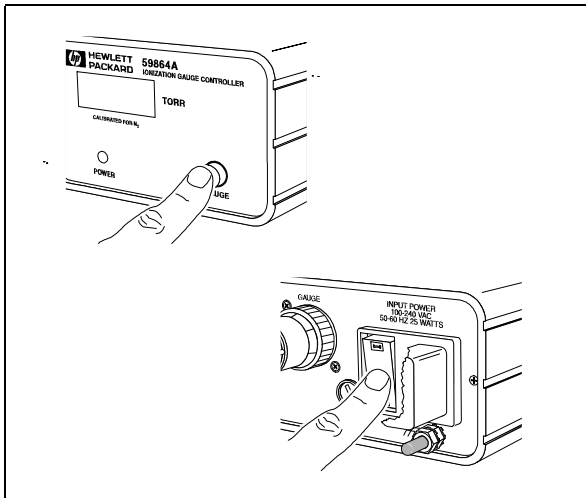
To remove the calibration vial

Materials needed:

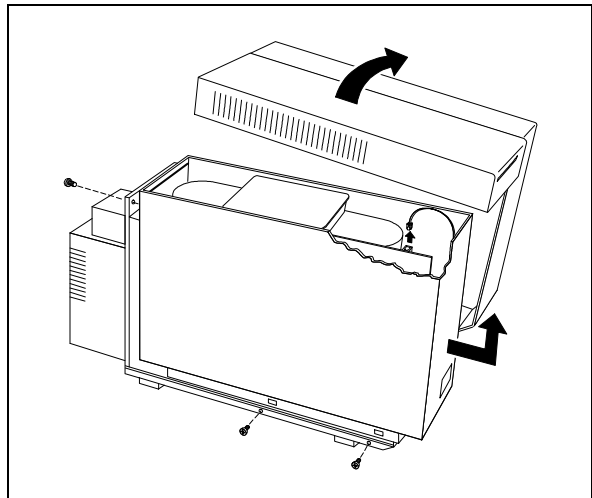
Screwdriver, TORX T-15 (8710-1622)



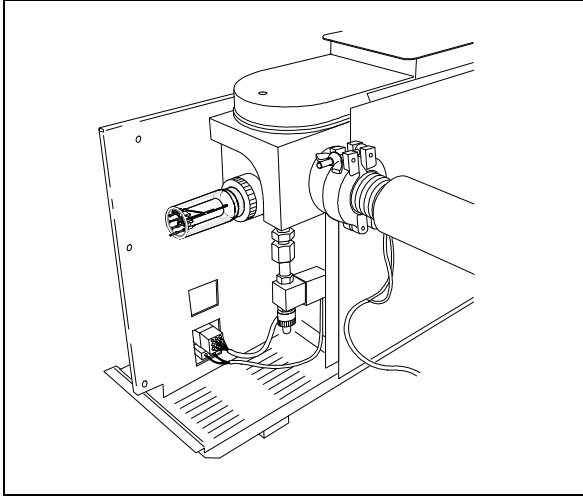
- 1 Stop any tuning or data acquisition in progress. Turn off the analyzer (MSOFF command).



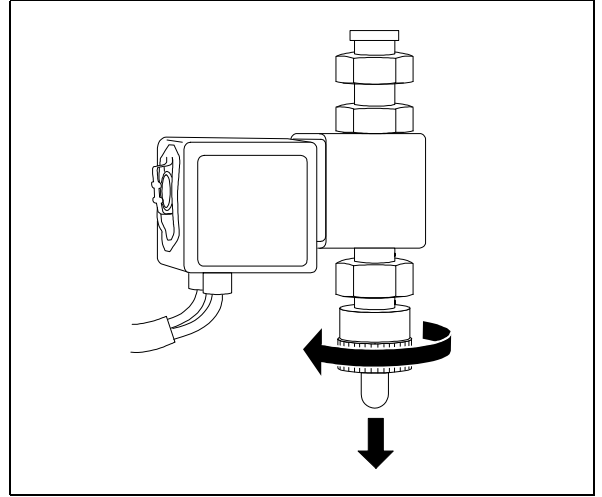
- 2 If your MSD is equipped with a gauge controller, switch off the triode gauge and the gauge controller.



- 3 Remove the upper and lower MSD covers. Remember to disconnect the status display cable.



4 Locate the calibration valve.

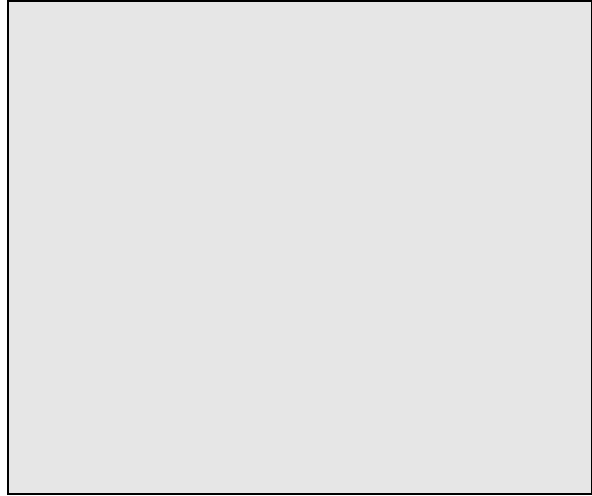


5 Loosen the fitting. Pull the calibration vial out. You may feel some resistance due to residual vacuum.

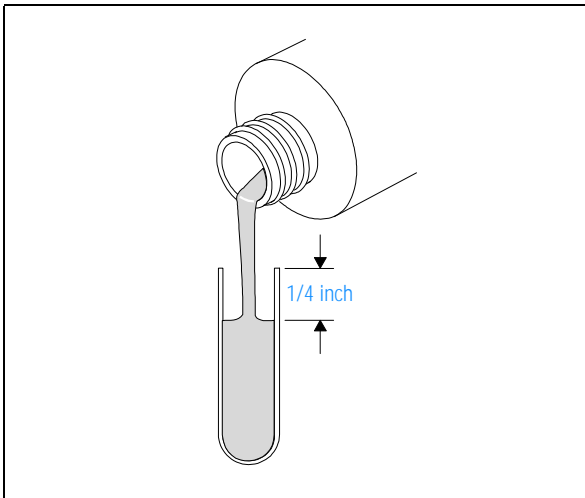
To fill and reinstall the calibration vial

Materials needed:

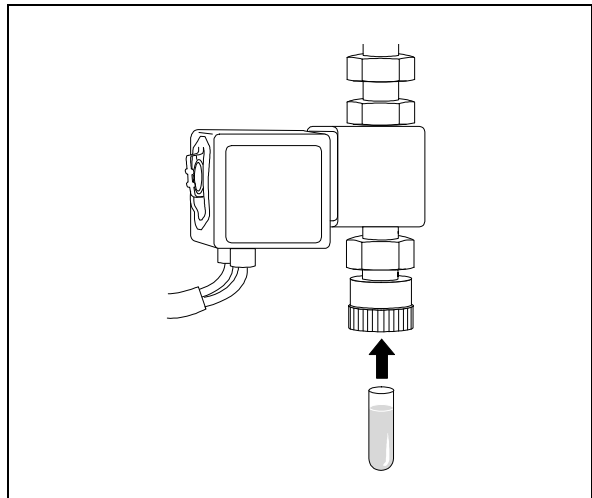
PFTBA (05971-60571) or other tuning compound
Screwdriver, TORX T-15 (8710-1622)



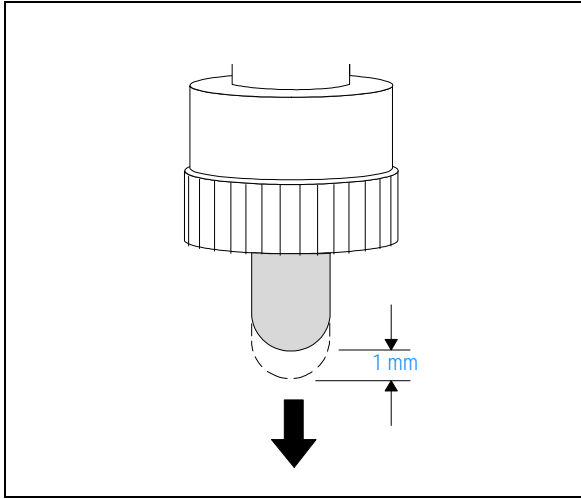
1 Remove the calibration vial (page 186).



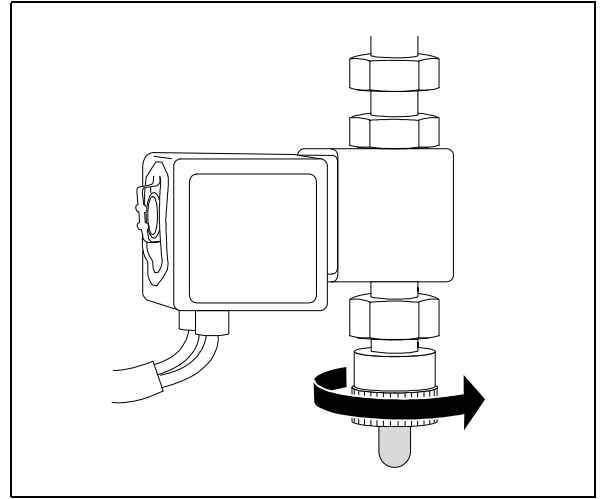
2 Pour the calibration compound into the vial. Leave 1/4-inch of the vial unfilled.



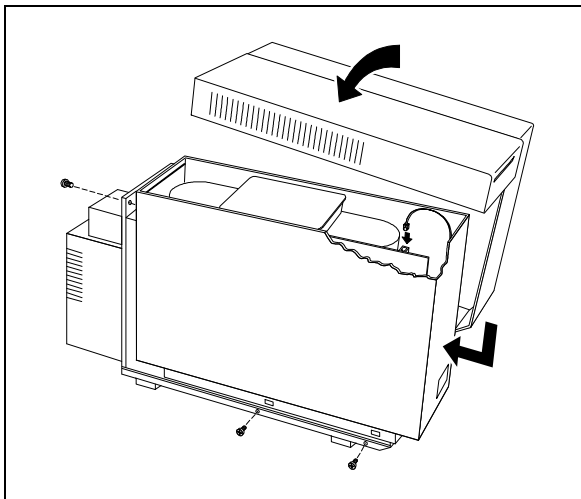
3 Push the calibration vial into the valve as far as it will go.



4 Withdraw the vial 1 mm. This prevents damage when the thumbscrew is tightened.



5 Tighten the fitting.



6 Reconnect the status display cable. Reinstall the MSD covers.

CAUTION

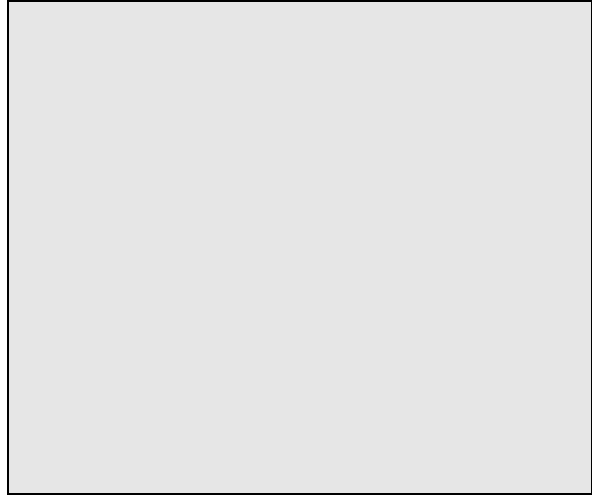
Failure to purge the calibration valve will result in damage to the electron multiplier.

7 Select **Purge Cal Valve** from the Vacuum menu to purge the air from the calibration valve.

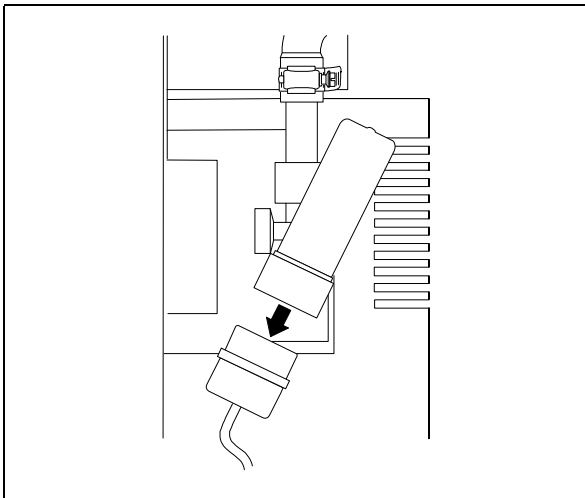
To remove the foreline gauge

Materials needed:

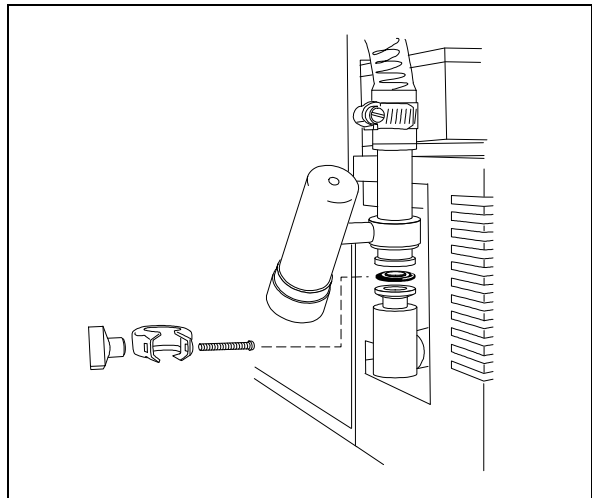
Screwdriver, flat-bladed, large (8730-0002)



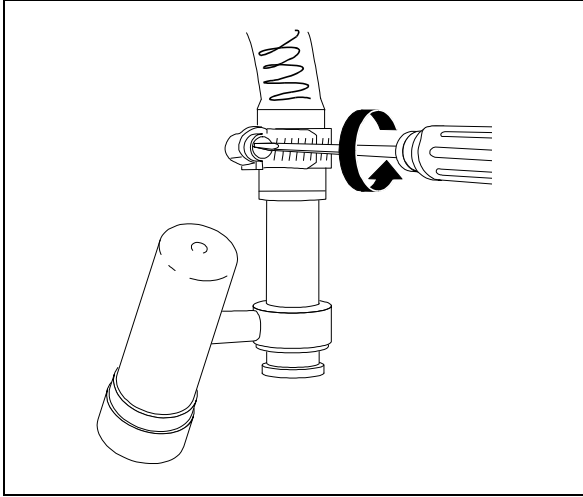
1 Vent and switch off the MSD (page 58).



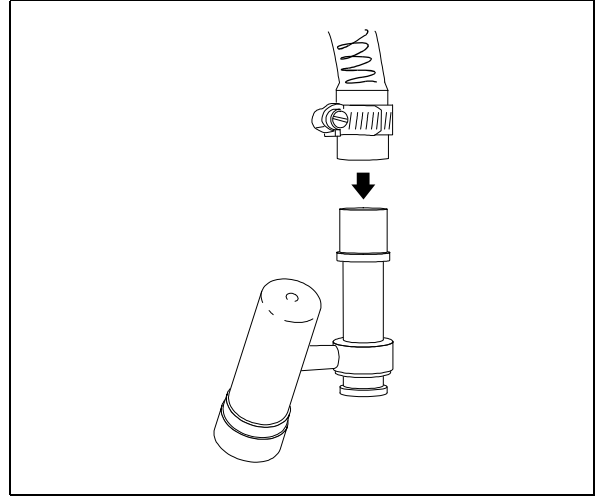
2 Unplug the blue connector from the foreline gauge.



3 Disconnect the foreline gauge fitting from the outlet of the diffusion pump.



4 Loosen the hose clamp.

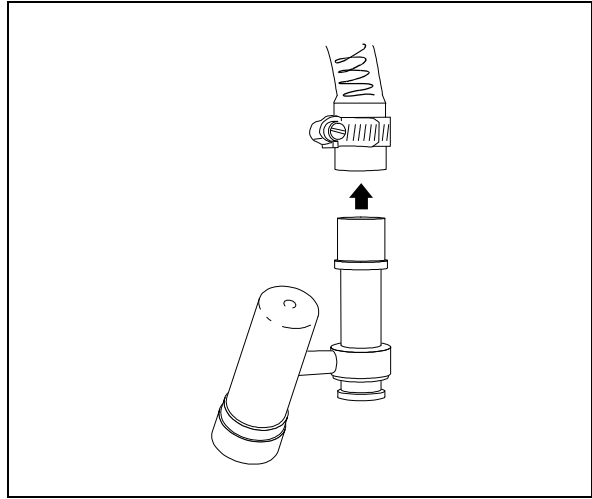


5 Pull the foreline gauge assembly out of the foreline hose.

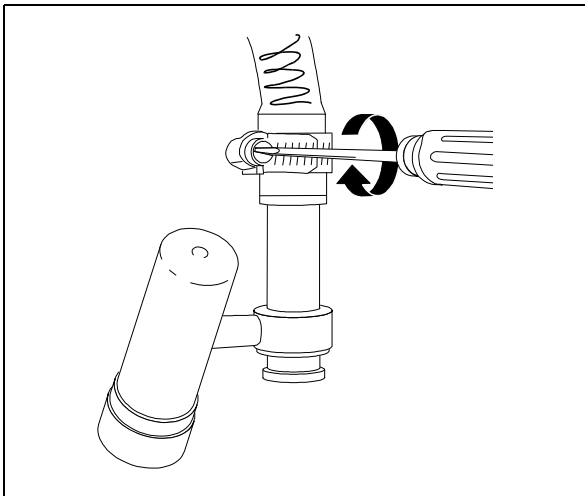
To reinstall the foreline gauge

Materials needed:

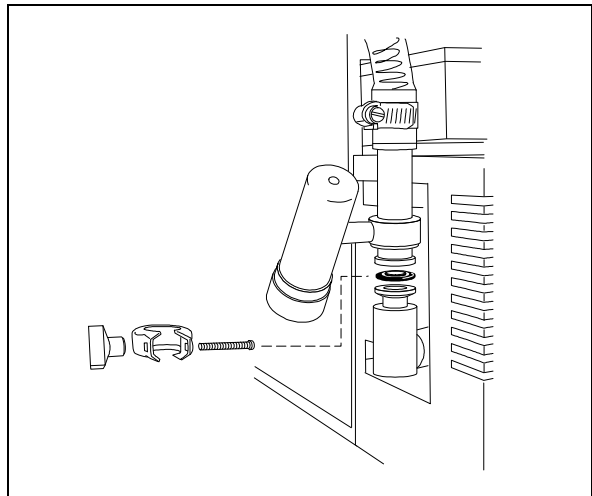
Foreline gauge assembly (05972-60545)
Screwdriver, flat-bladed, large (8730-0002)



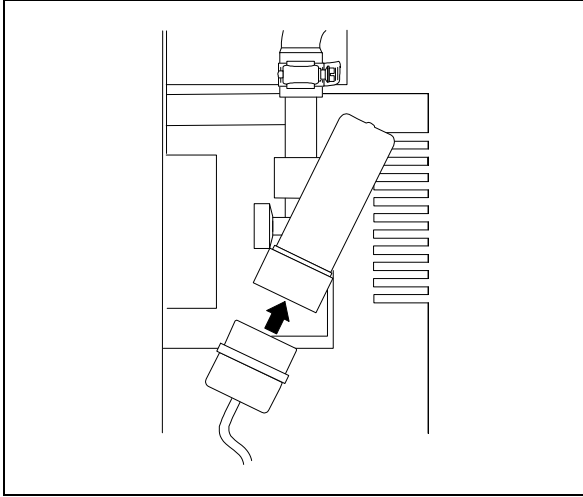
1 Connect a new foreline gauge assembly to the foreline hose.



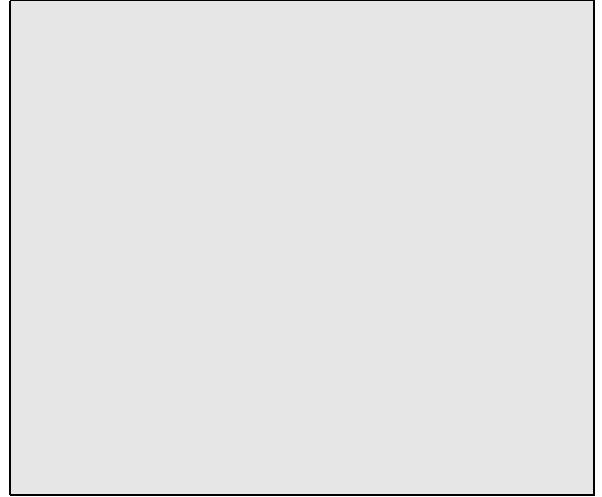
2 Tighten the hose clamp.



3 Reconnect the foreline gauge fitting to the outlet of the diffusion pump.



4 Reconnect the blue connector to the foreline gauge.



5 Reinstall the GC column. Start up and pump down the MSD (page 40).

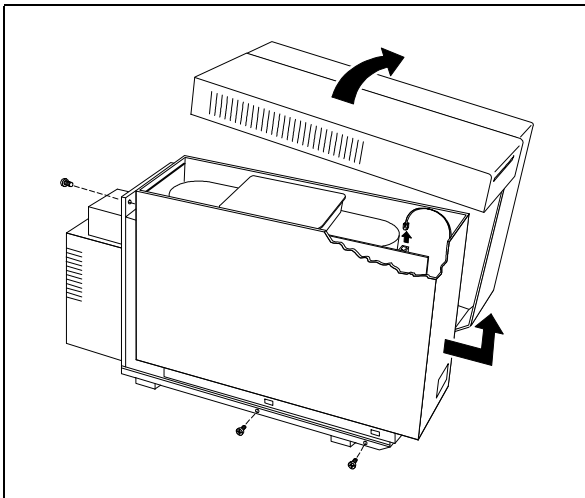
To remove the calibration valve

Materials needed:

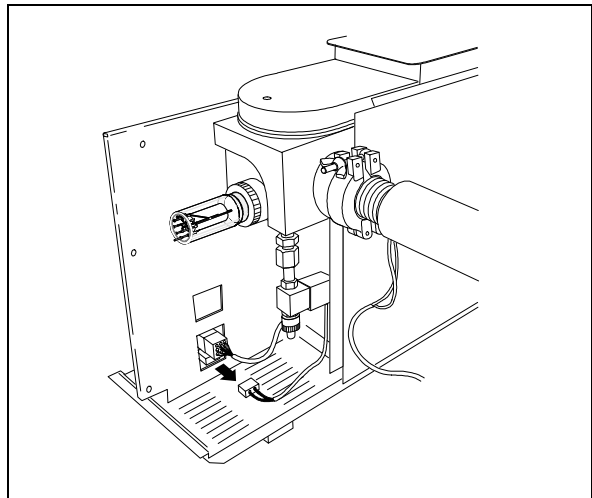
Screwdriver, TORX T-15 (8710-1622)
Wrench
11/16-inch, open-end
3/4-inch, open-end



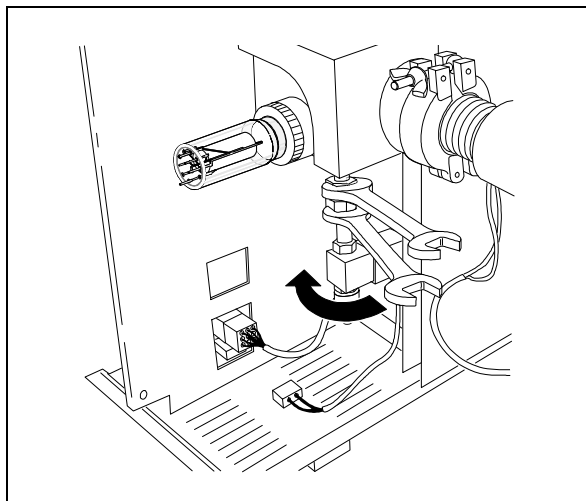
1 Vent and switch off the MSD (page 58).



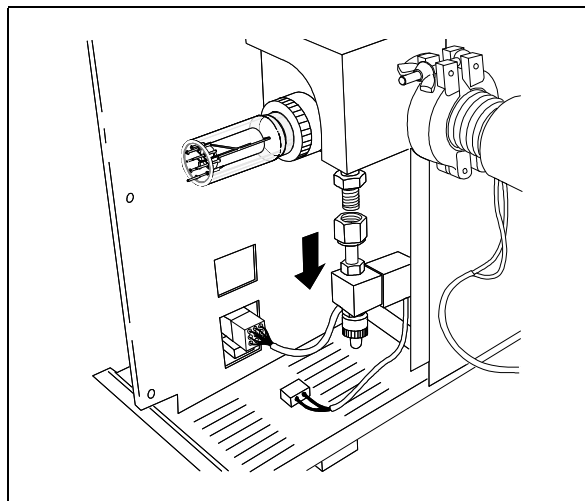
2 Remove the upper and lower MSD covers. Remember to disconnect the status display cable.



3 Disconnect the calibration valve cable from the back of the main board.



4 Loosen the calibration valve nut. Use a second wrench to prevent the upper nut from turning.



5 Remove the calibration valve assembly.

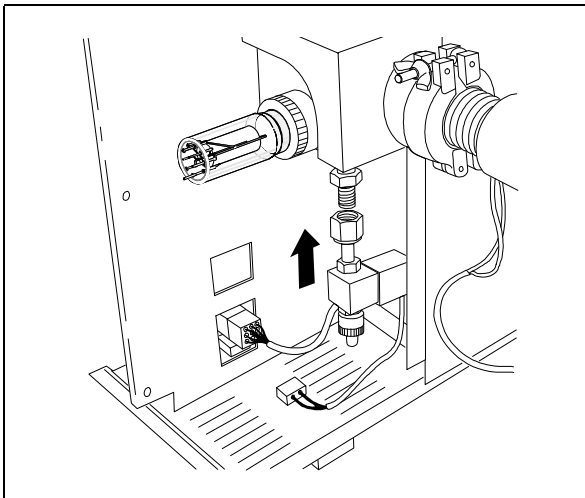
To reinstall the calibration valve

Materials needed:

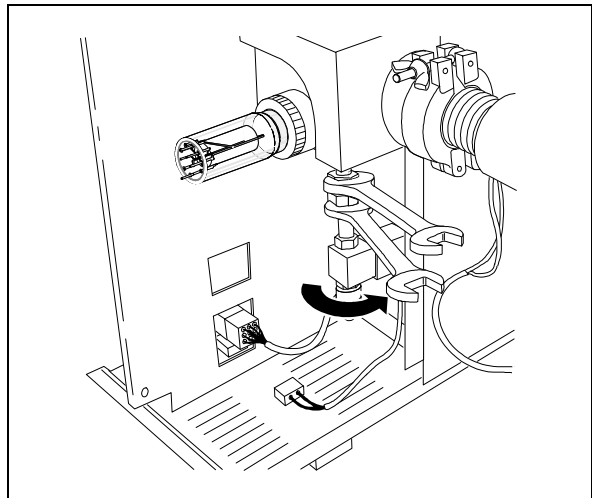
Screwdriver, TORX T-15 (8710-1622)
Wrench
11/16-inch, open-end
3/4-inch, open-end



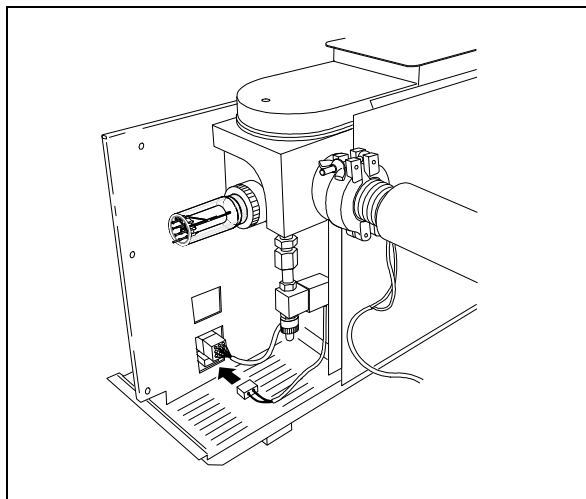
1 Remove the old calibration valve (page 194).



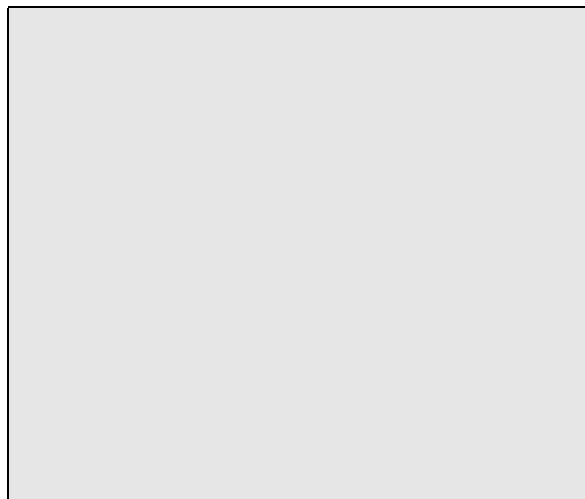
2 Unpack the new calibration valve. Slide it onto the fitting.



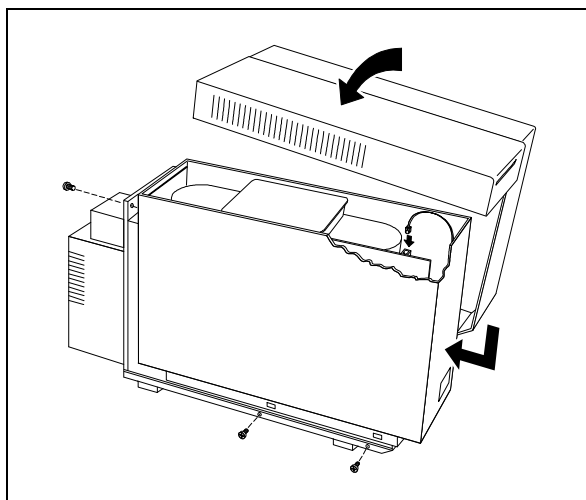
3 Tighten the calibration valve nut. Use a second wrench to keep the upper nut from turning.



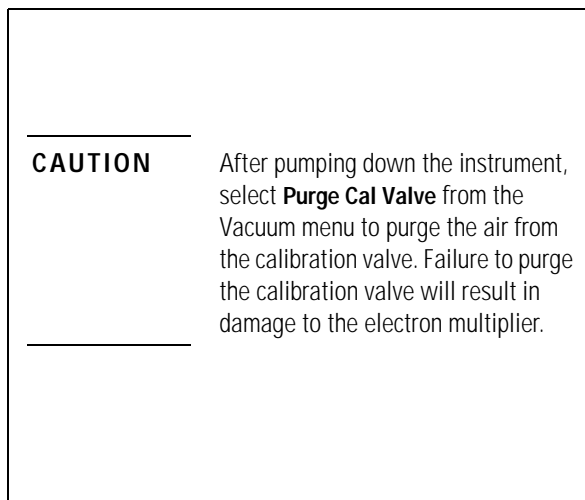
4 Connect the calibration valve wiring to the connector on the main board.



5 Fill the calibration vial (page 188).



6 Reconnect the status display cable. Reinstall the MSD covers.



CAUTION

After pumping down the instrument, select **Purge Cal Valve** from the Vacuum menu to purge the air from the calibration valve. Failure to purge the calibration valve will result in damage to the electron multiplier.

7 Reinstall the GC column. Start up and pump down the MSD (page 40).

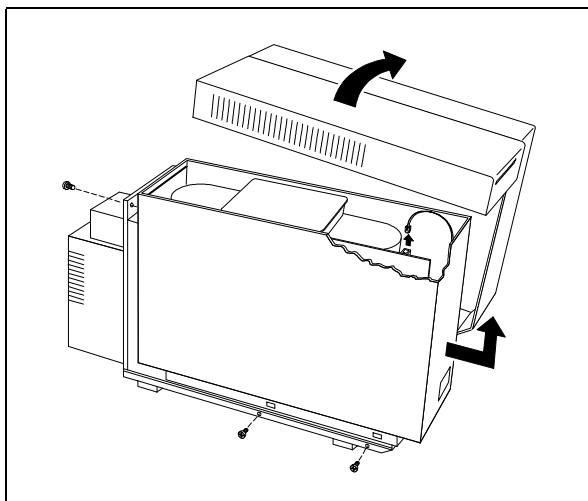
To remove the triode gauge tube

Materials needed:

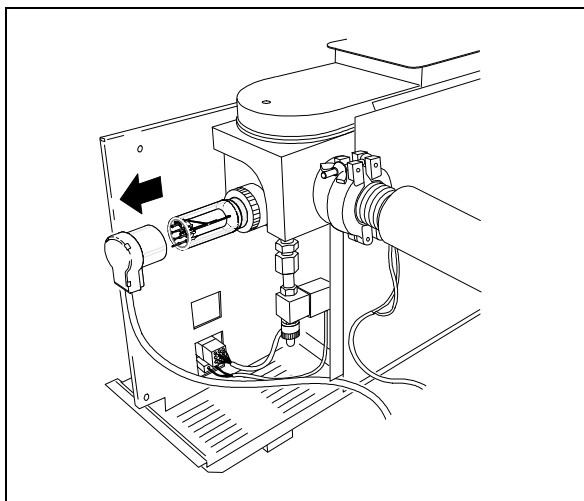
Screwdriver, TORX T-15 (8710-1622)



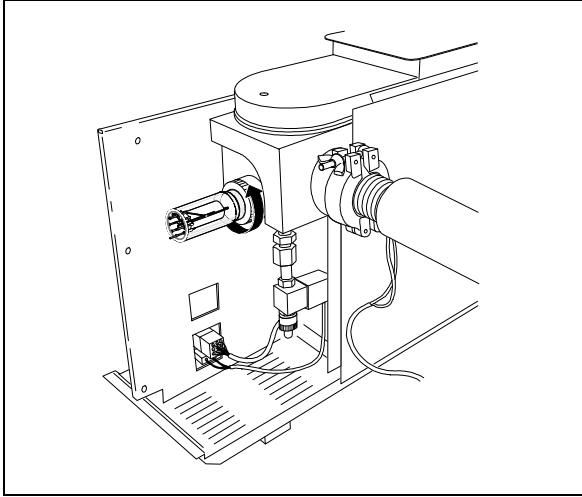
1 Vent and switch off the MSD (page 58).



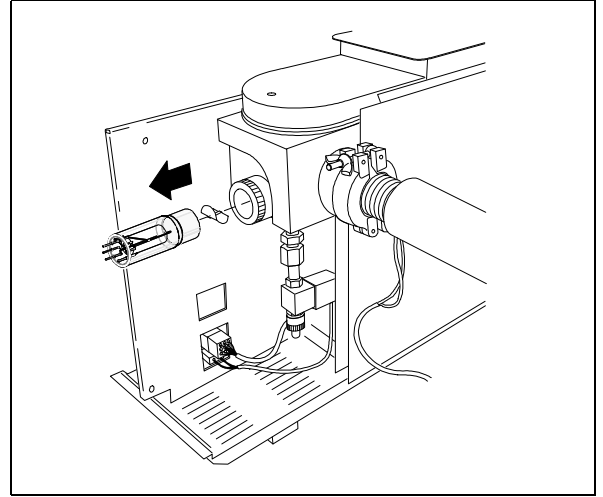
2 Remove the upper and lower MSD covers. Remember to disconnect the status display cable.



3 Disconnect the blue connector from the triode gauge tube.



4 Loosen the knurled O-ring collar by turning it counterclockwise.

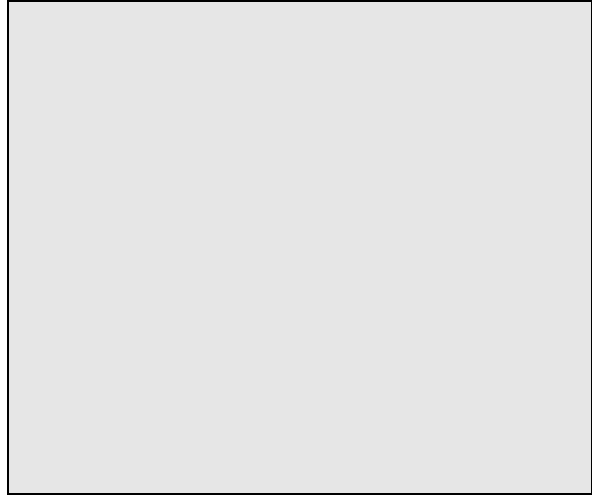


5 Pull the triode gauge tube out of the fitting. Remove the baffle from the stem of the tube.

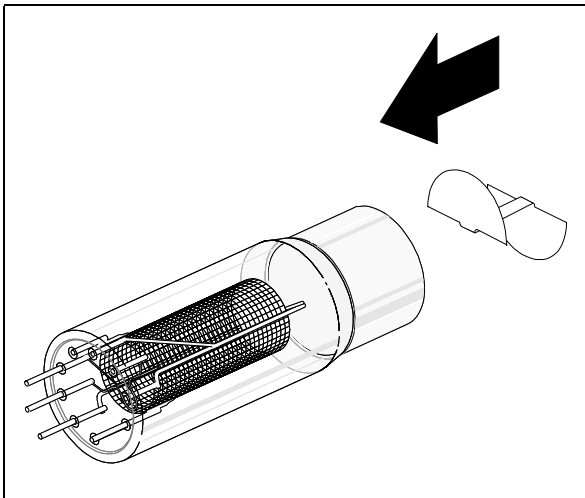
To reinstall a triode gauge tube

Materials needed:

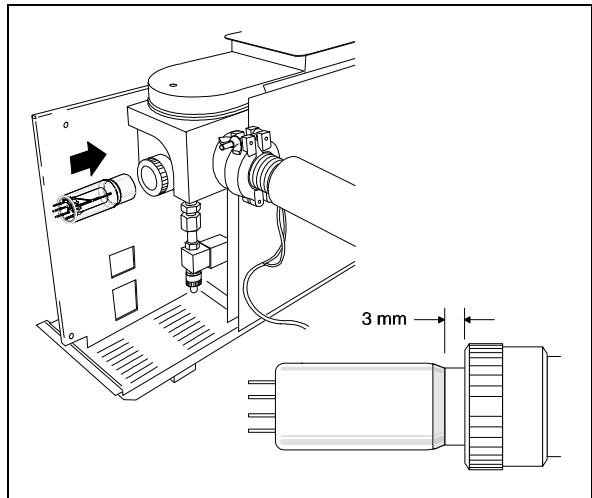
Screwdriver, TORX T-15 (8710-1622)
Triode gauge tube (0960-0897)



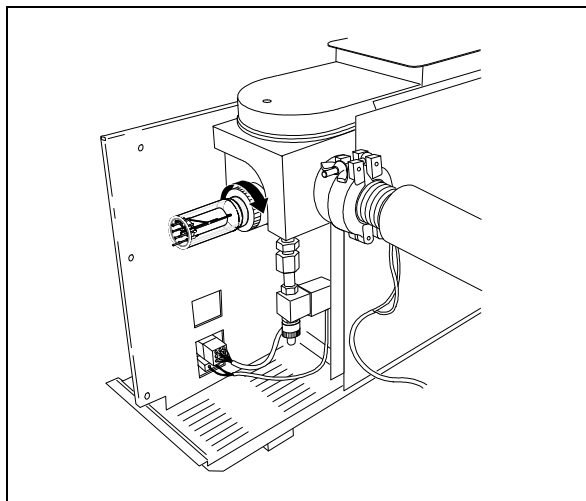
1 Remove the old triode gauge tube (page 198).



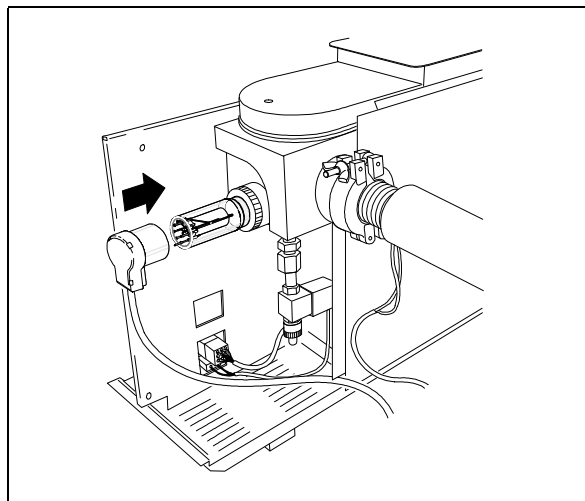
2 Slide the baffle into the stem of the new triode gauge tube.



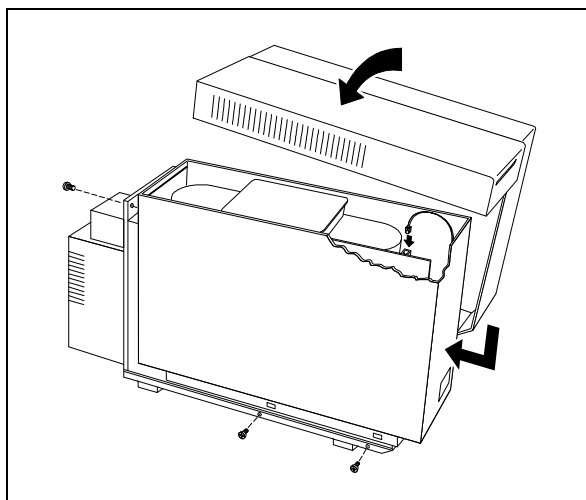
3 Install the tube into the fitting. Leave 3 mm of the metal sleeve exposed.



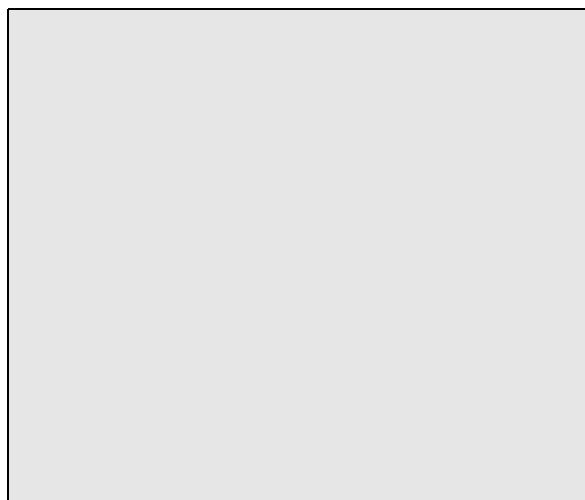
4 Tighten the knurled O-ring collar. Do not over-tighten, you can break the tube.



5 Reconnect the connector to the triode gauge tube.



6 Reconnect the status display cable. Reinstall the MSD covers.



7 Reinstall the GC column. Start up and pump down the MSD (page 40).

Maintaining the analyzer

The analyzer requires no periodic maintenance

None of the analyzer components requires periodic maintenance. Some tasks, however, must be performed when MSD performance indicates they are necessary. These tasks include:

- Cleaning the ion source
- Replacing filaments
- Replacing the electron multiplier horn

Chapter 3, *Troubleshooting the MSD*, on page 63 provides more information about symptoms that indicate the need for analyzer maintenance.

Care must be taken during analyzer maintenance to keep components clean

All analyzer maintenance involves removing the analyzer from the MSD. Clean gloves should be worn during all analyzer maintenance procedures. After cleaning the ion source, the parts must be thoroughly dried before they are reinstalled.

CAUTION

If not done correctly, analyzer maintenance can introduce contaminants into the MSD.

Some analyzer parts should not be disturbed

The quadrupole mass filter requires no periodic maintenance. It should never be removed or otherwise disturbed.

CAUTION

The mass filter can be damaged by water and solvents with free chloride. They should never be used near the mass filter.

If necessary, acetone, hexane, and freon can be used safely near the mass filter.

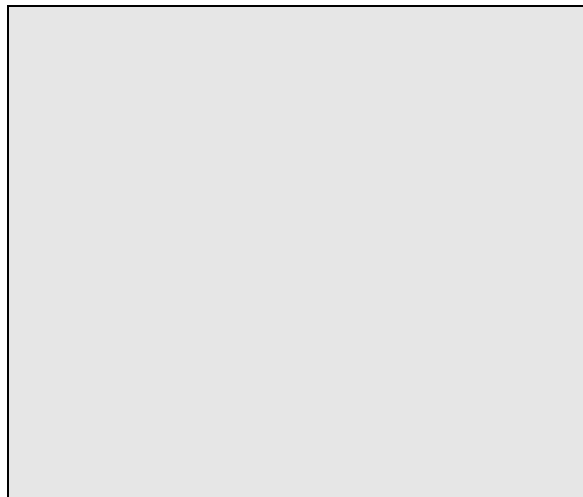
More information is available

If you need more information about the locations or functions of analyzer components, refer to Chapter 5, *Vacuum System*, on page 249.

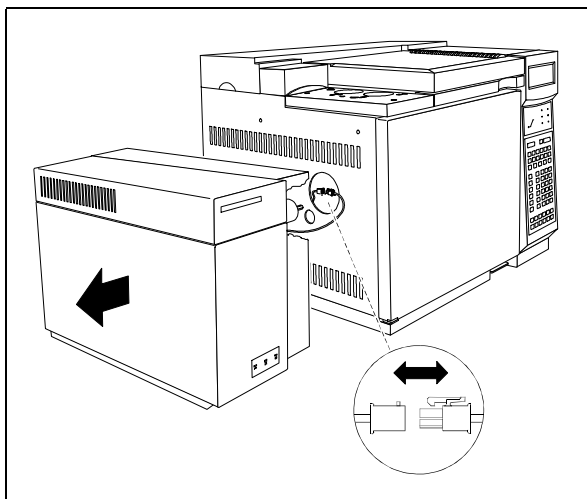
To remove the analyzer

Materials needed:

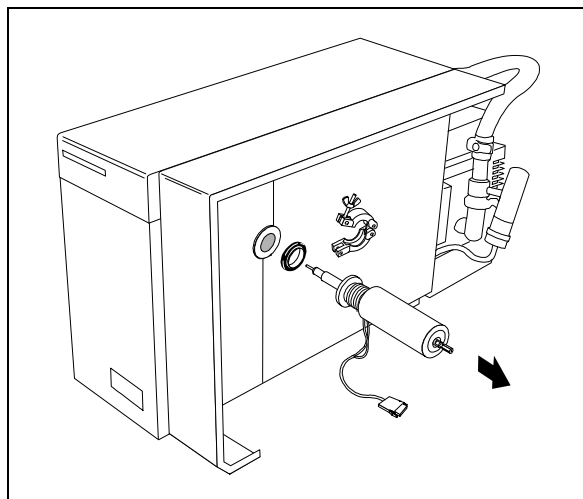
Gloves, clean, lint-free
 large (8650-0030)
 small (8650-0029)
Screwdriver, TORX T-15 (8710-1622)
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



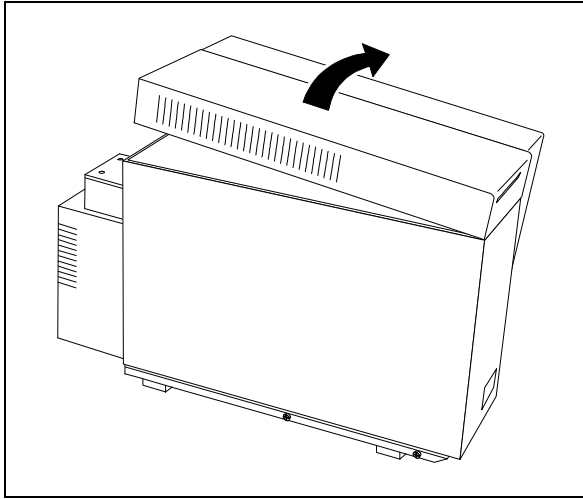
1 Vent and switch off the MSD (page 58).



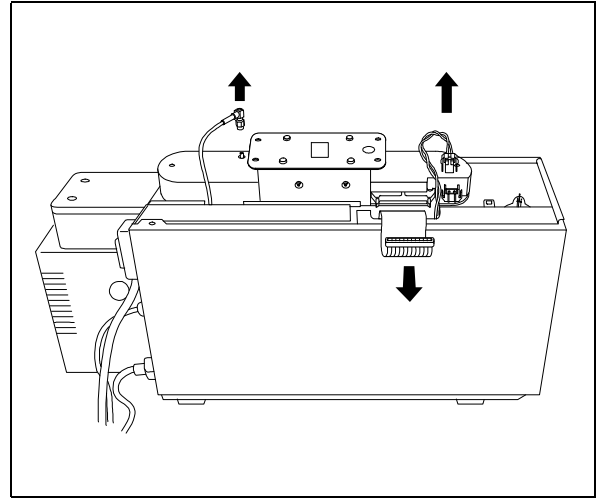
2 Slide the MSD away from the GC. Switch off the GC and then disconnect the GC interface cable.



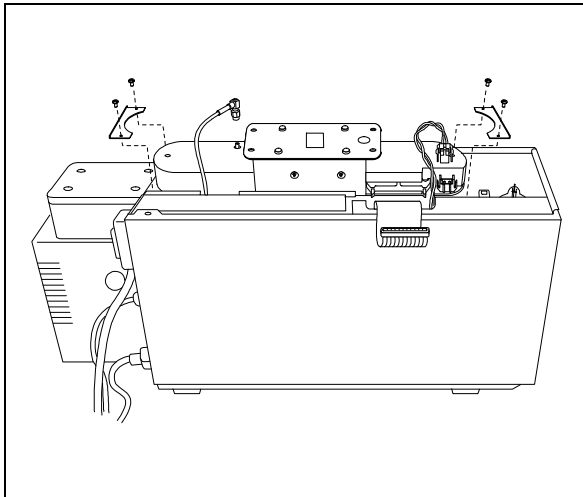
3 Disconnect and remove the GC interface.



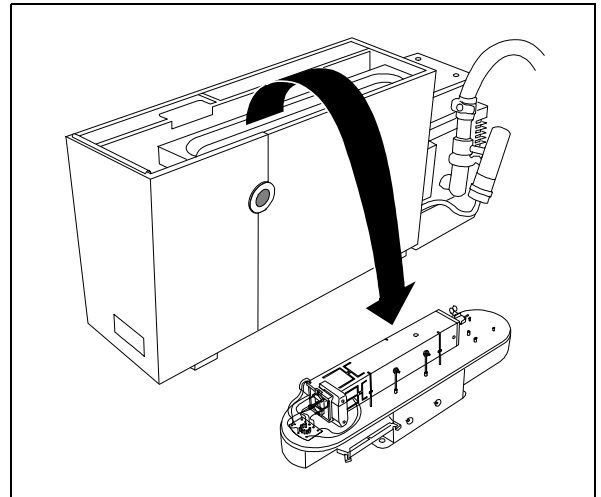
4 Remove the upper cover of the MSD.



5 Disconnect the ribbon cable, filament cable, and signal cable.



6 Remove the shipping clamps if they are still in place.



7 Lift the analyzer out of the MSD. Turn the analyzer over and set it on its rubber feet.

To reinstall the analyzer

Materials needed:

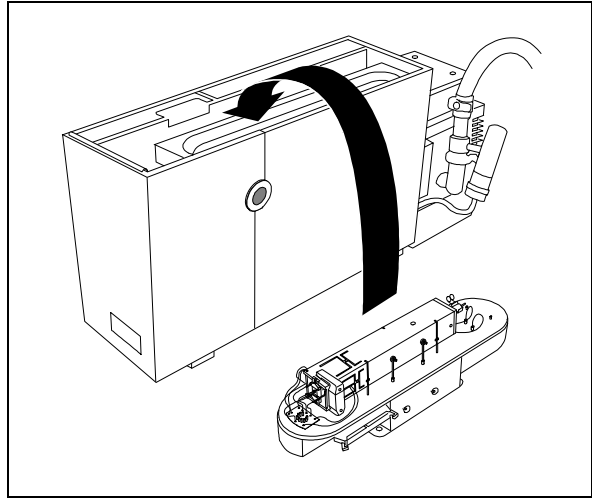
Gloves, clean, lint-free

large (8650-0030)

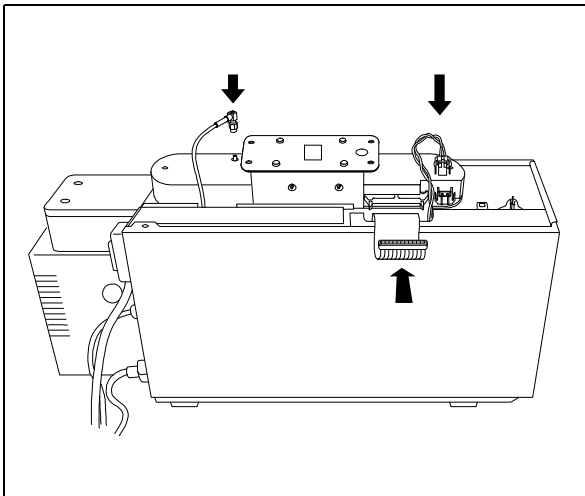
small (8650-0029)

Screwdriver, TORX T-15 (8710-1622)

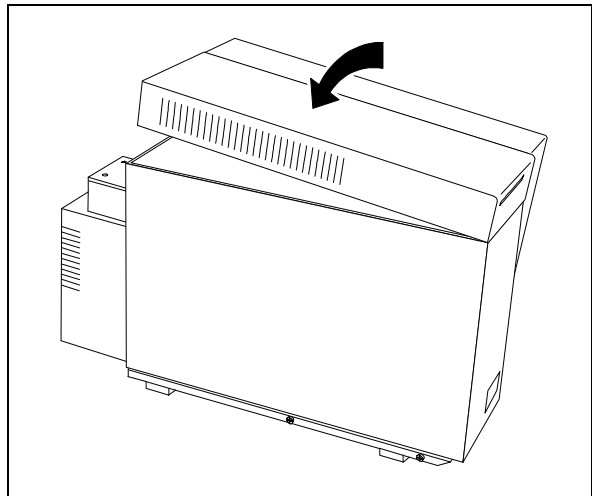
Wrench, open-end, 1/4-inch × 5/16-inch (8710-0510)



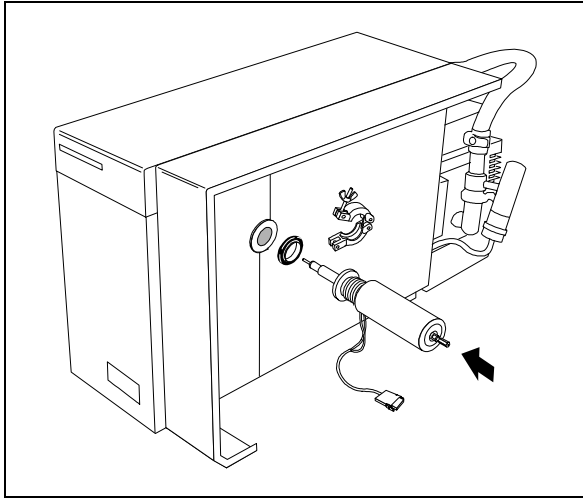
1 Lower the analyzer into position in the vacuum manifold.



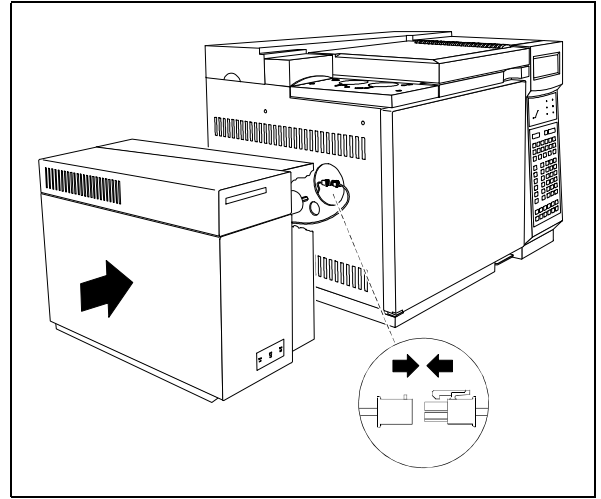
2 Reconnect the ribbon cable, filament cable, and signal cable.



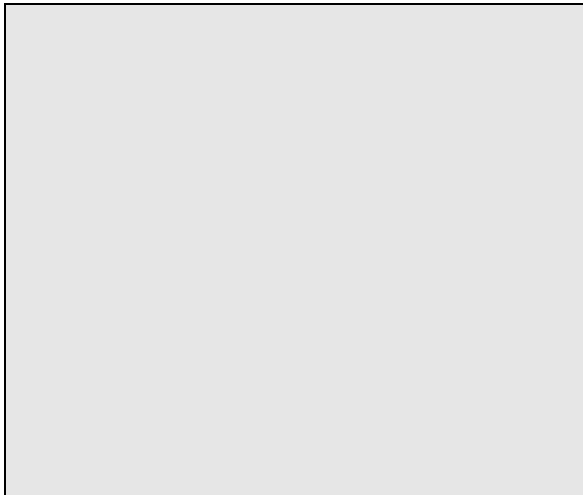
3 Reinstall the upper cover on the MSD.



4 Reinstall the GC interface. Replace the coseal if it is worn or damaged.



5 Reconnect the GC interface cable to the GC. Move the MSD to its normal location.

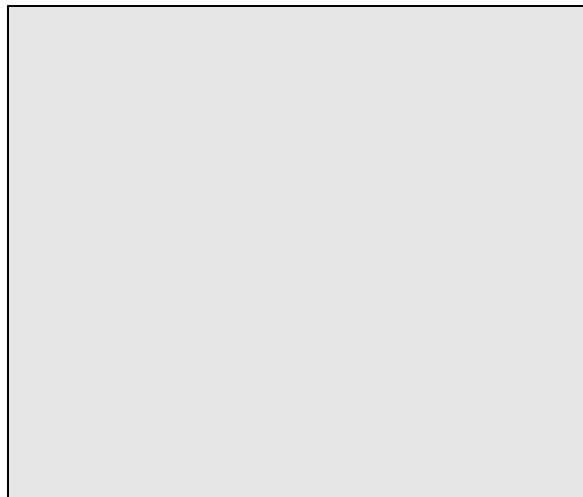


6 Reinstall the GC column. Start up and pump down the MSD (page 40).

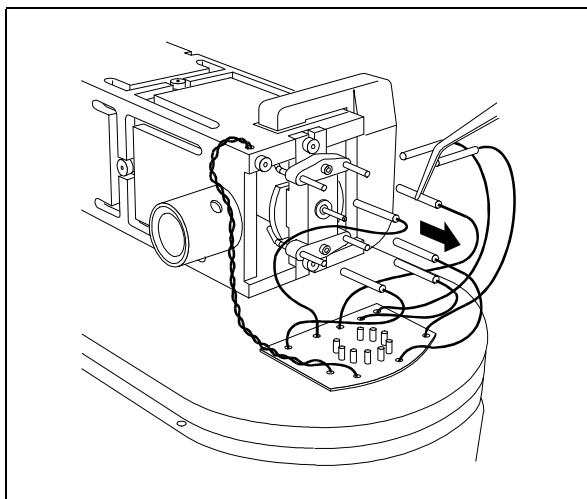
To remove the ion source

Materials needed:

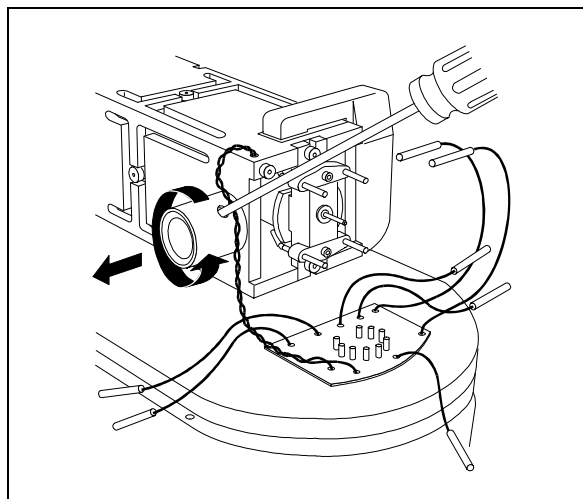
Gloves, clean, lint-free
 large (8650-0030)
 small (8650-0029)
Hex ball driver, 1.5-mm (8710-1570)
Pliers, long-nose (8710-1094)



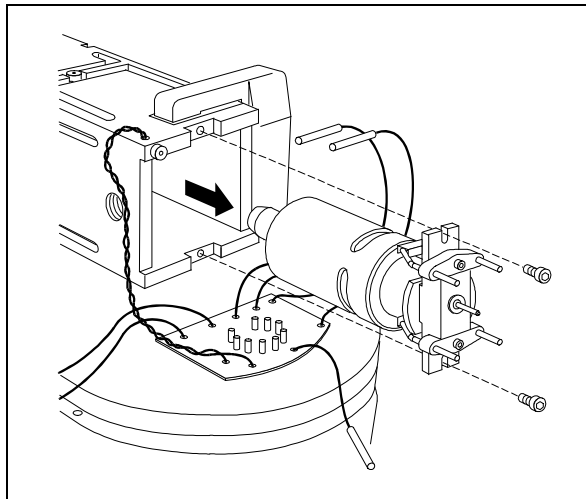
1 Remove the analyzer (page 204).



2 Disconnect the seven electrical leads from the ion source. Pull on the connectors, not on the wires.



3 Unscrew and remove the GC interface socket.

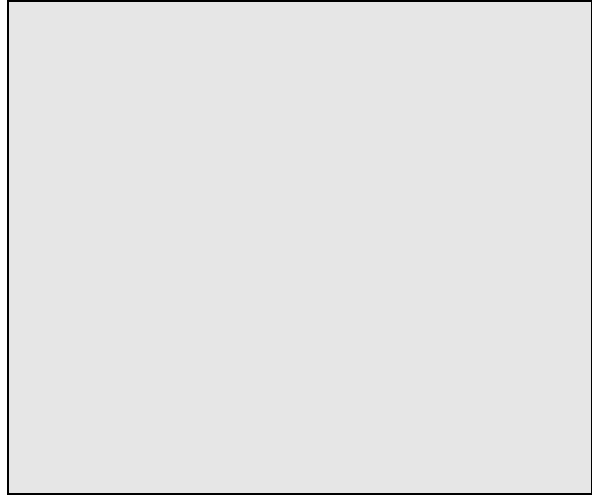


- 4 Remove the two screws that hold the ion source in place. Remove the ion source.

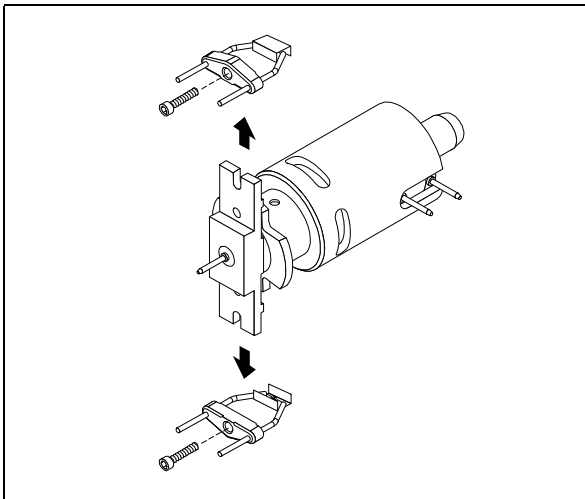
To disassemble the ion source

Materials needed:

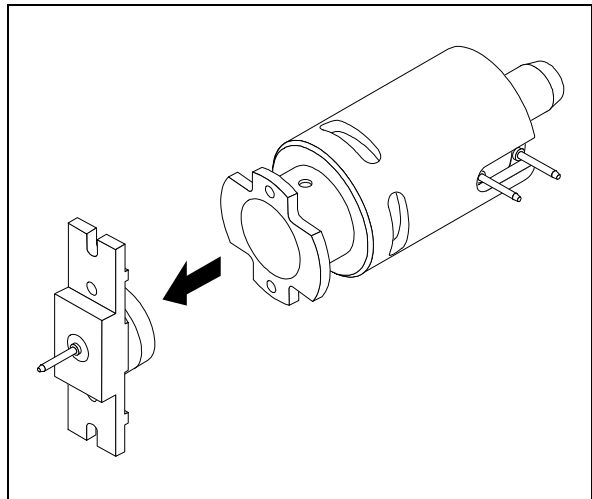
Gloves, clean, lint-free
 large (8650-0030)
 small (8650-0029)
Hex ball driver, 1.5-mm (8710-1570)



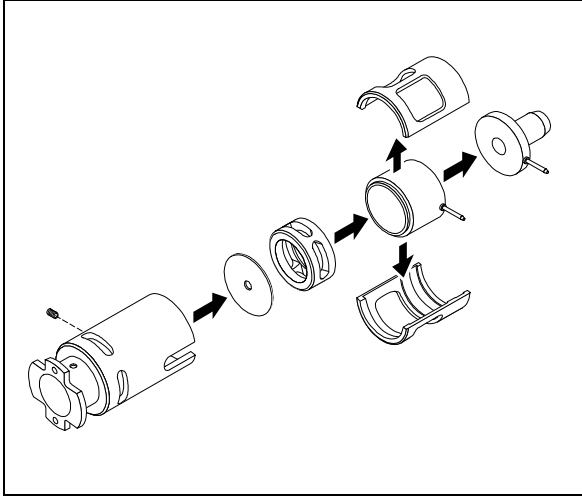
1 Remove the ion source (page 208).



2 Remove the filament retaining screws. Remove the filaments.



3 Pull the repeller assembly out of the source body.

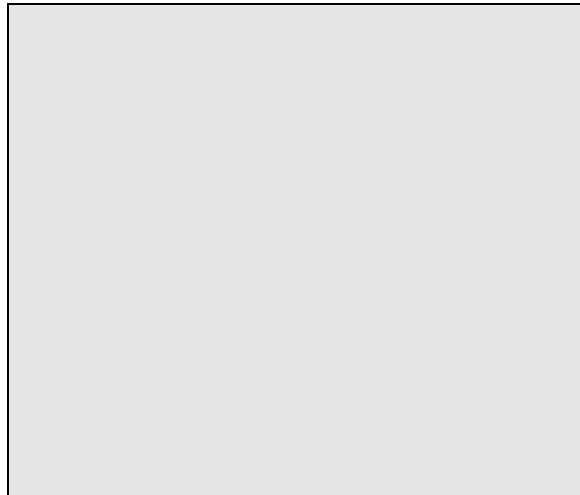


- 4** Remove the set screw. Push out the remaining ion source components.

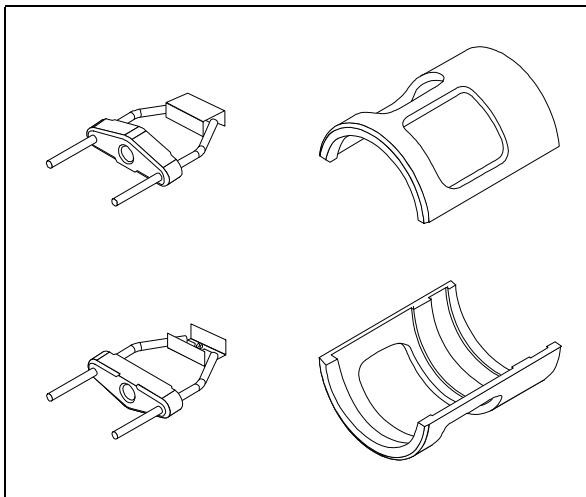
To clean the ion source

Materials needed:

Abrasive paper (5061-5896)
Alumina abrasive powder (8660-0791)
Aluminum foil, clean
Cloths, clean (05980-60051)
Cotton swabs (5080-5400)
Glass beakers, 50 and 500 ml
Gloves, clean, lint-free
 large (8650-0030)
 small (8650-0029)
Solvents
 acetone, reagent-grade
 methanol, reagent-grade
 methylene chloride, reagent grade
Ultrasonic bath



1 Disassemble the ion source (page 210).



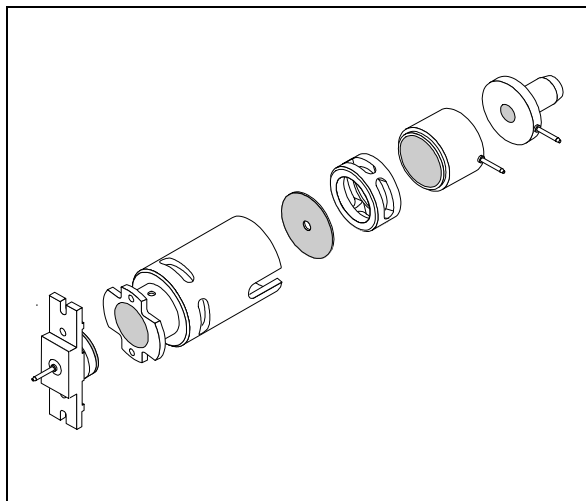
Do not clean the filament assemblies. If the lens insulators are dirty, clean them with a cotton swab dampened with reagent-grade methanol. If that does not clean the insulators, replace them. Do not abrasively or ultrasonically clean the lens insulators.

CAUTION

The following steps do not apply to the filament assemblies or lens insulators.

2 Separate the filament assemblies and the lens insulators from the other parts.

To clean the ion source



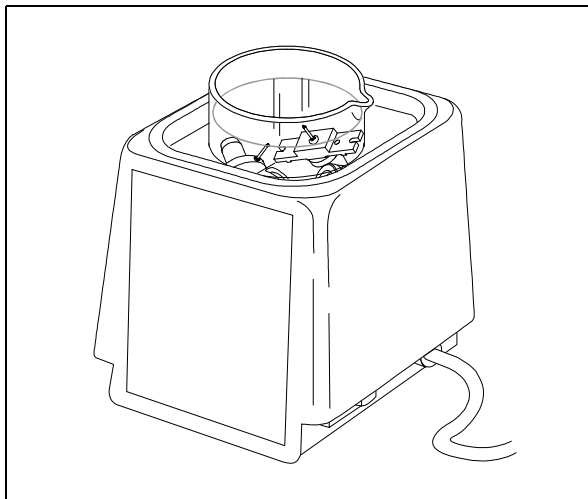
- 3** Abrasively clean discolored surfaces that contact the sample or ion beam.

Use abrasive paper or an abrasive slurry of alumina powder and reagent-grade methanol on a cotton swab. The slurry is preferred because it is less abrasive. Use only enough force to remove the discolorations. It is not necessary to polish the parts.

- 4** Rinse away all abrasive residue with reagent-grade methanol **before** ultrasonic cleaning.

- 5** Separate the parts that were abrasively cleaned from the parts that were not abrasively cleaned.

4 Maintaining the MSD
To clean the ion source

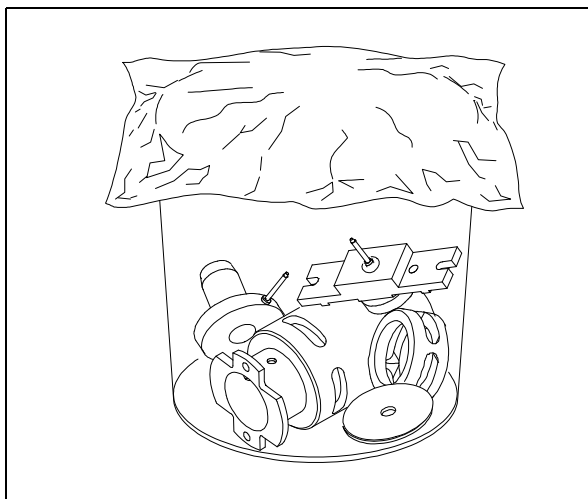


Clean the parts for 15 minutes in each of the following solvents:

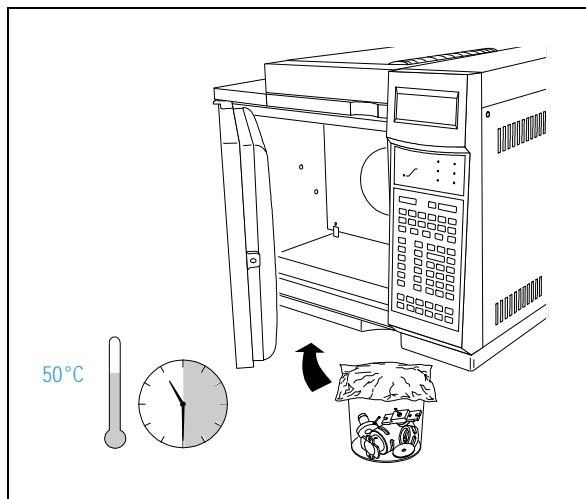
- Methylene chloride (reagent-grade)
- Acetone (reagent-grade)
- Methanol (reagent-grade)

WARNING All of these solvents are hazardous. Work in a fume hood and take appropriate precautions.

6 Ultrasonically clean each group of parts separately.



7 Place the parts in a clean beaker. **Loosely** cover the beaker with clean aluminum foil.



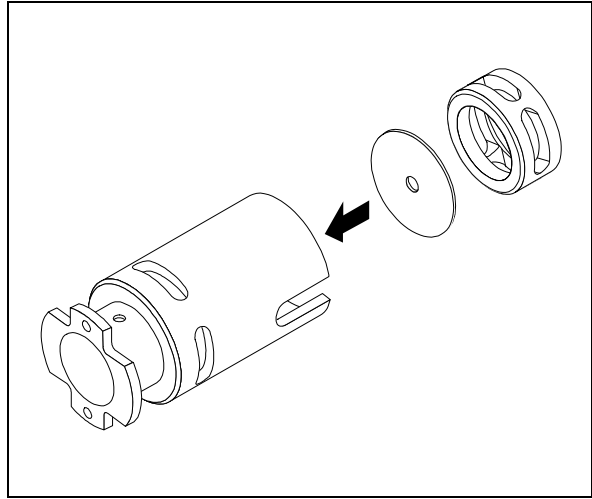
8 Dry the cleaned parts in an oven at 50°C for 30 minutes.

Take care to avoid recontaminating cleaned and dried parts. Put on a new, clean pair of gloves before handling the parts.

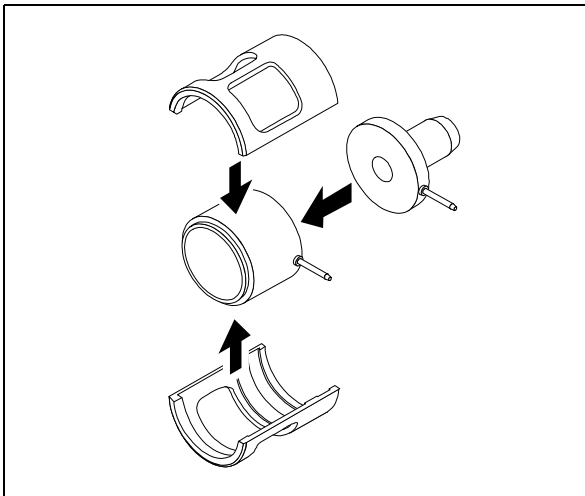
To reassemble the ion source

Materials needed:

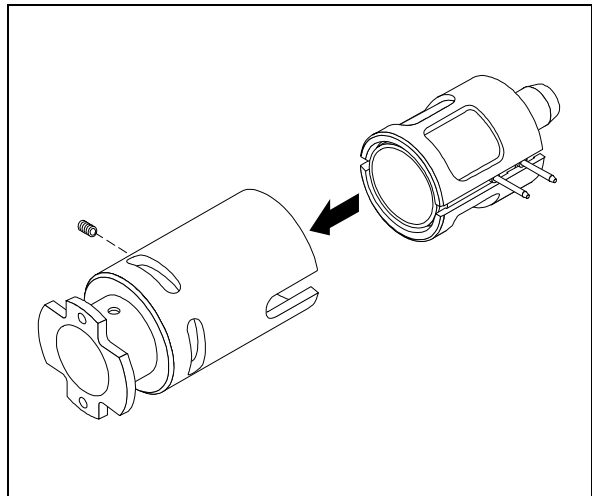
Gloves, clean, lint-free
large (8650-0030)
small (8650-0029)
Hex ball driver, 1.5-mm (8710-1570)



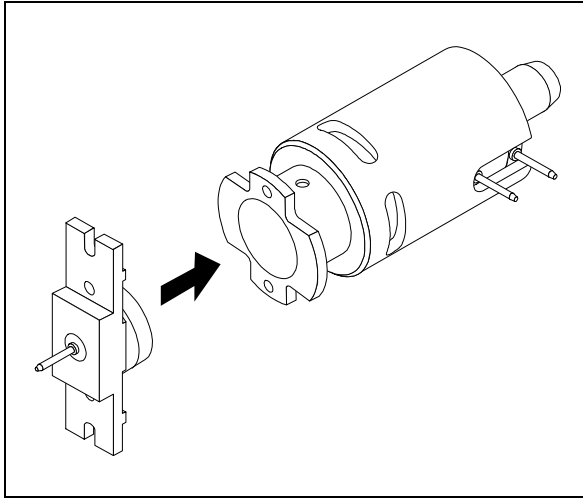
1 Slide the drawout plate and the drawout cylinder into the source body.



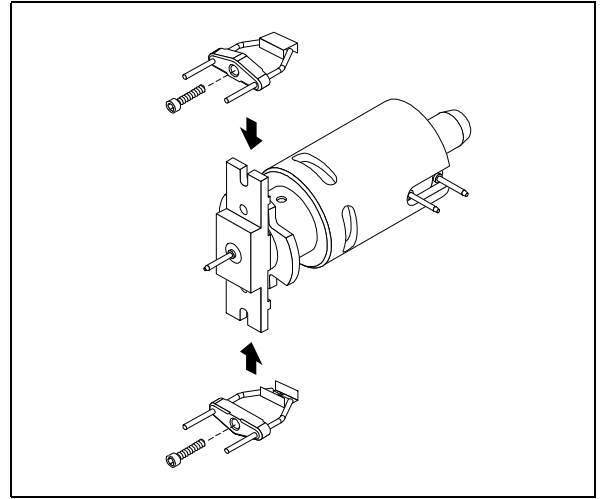
2 Assemble the ion focus lens, entrance lens, and lens insulators.



3 Slide the assembled components into the source body. Reinstall the set screw.



4 Reinstall the repeller assembly.



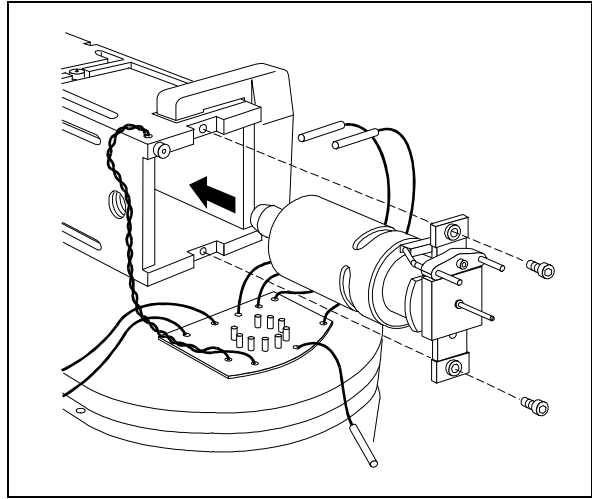
5 Slide the filament assemblies onto the repeller assembly. Reinstall the screws.

4 Maintaining the MSD
To reinstall the ion source

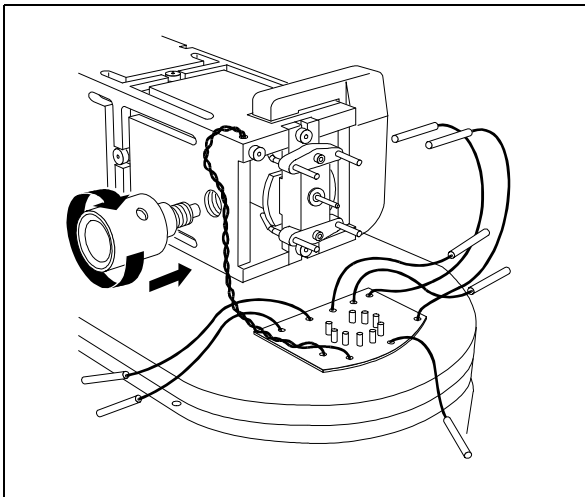
To reinstall the ion source

Materials needed:

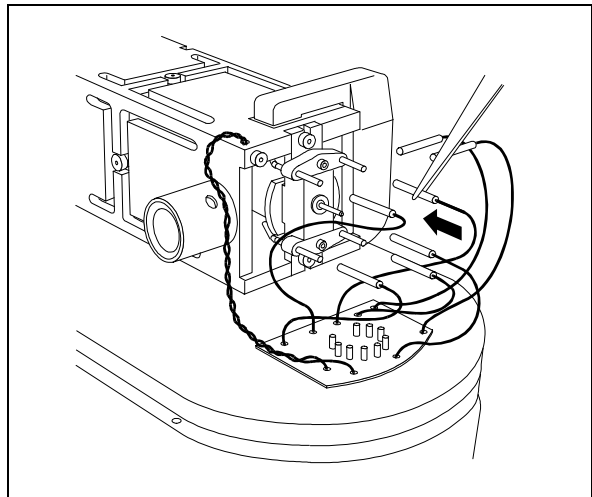
Gloves, clean, lint-free
large (8650-0030)
small (8650-0029)
Hex ball driver, 1.5-mm (8710-1570)
Pliers, long-nose (8710-1094)



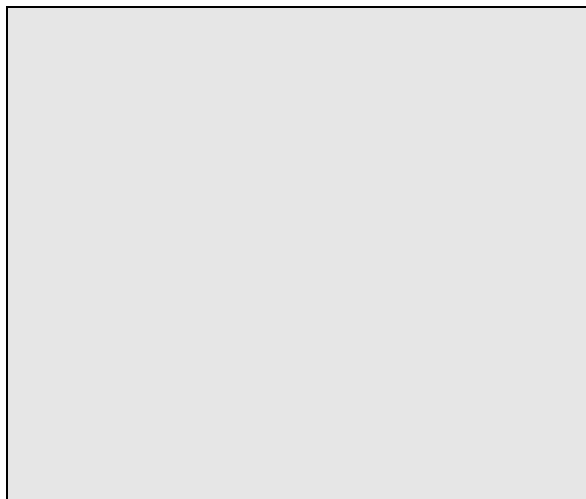
1 Slide the ion source into the radiator. Reinstall the two retaining screws.



2 Reinstall the GC interface socket. Tighten it.



3 Reconnect the electrical leads to the ion source.



4 Reinstall the analyzer (page 206).

To remove a filament

Materials needed:

Gloves, clean, lint-free

large (8650-0030)

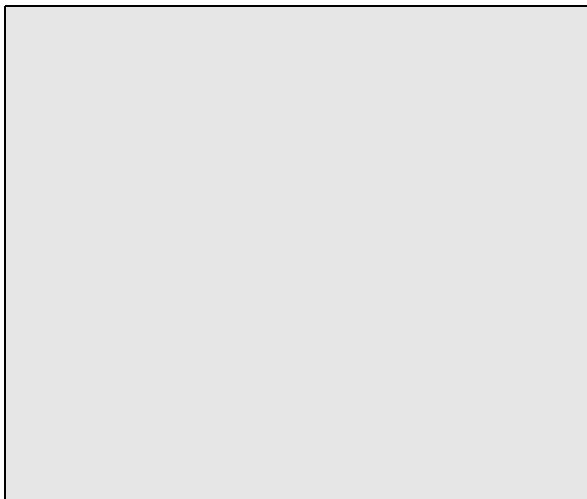
small (8650-0029)

Hex ball driver, 1.5-mm (8710-1570)

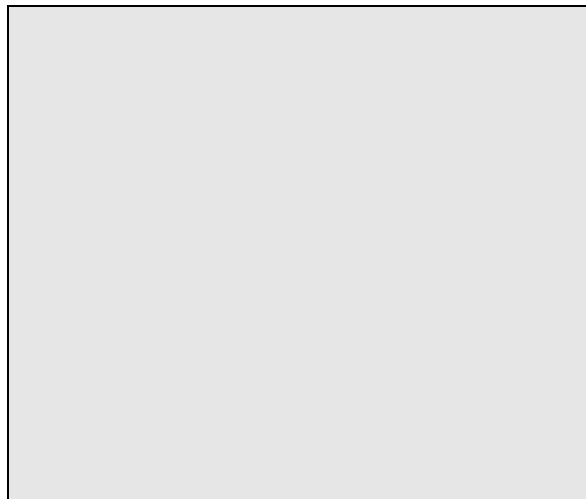
Screwdriver, TORX T-15 (8710-1622)



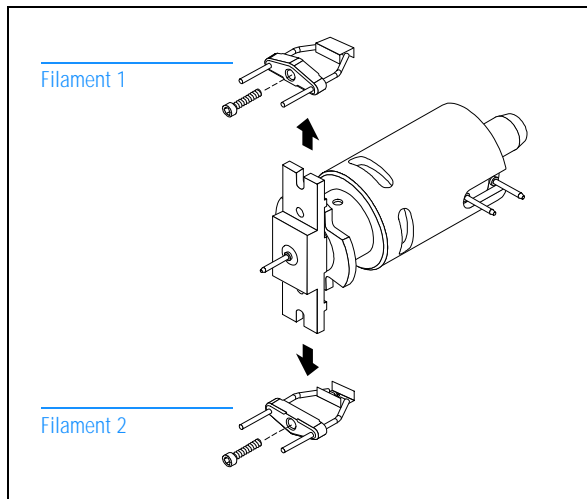
1 Vent and switch off the MSD (page 58).



2 Remove the analyzer (page 204).



3 Remove the ion source (page 208).



4 Remove the filament to be replaced.

To reinstall a filament

Materials needed:

Filament assembly (05972-60053)

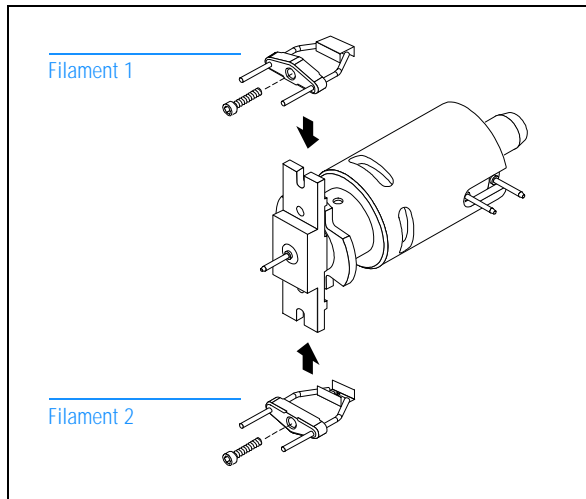
Gloves, clean, lint-free

large (8650-0030)

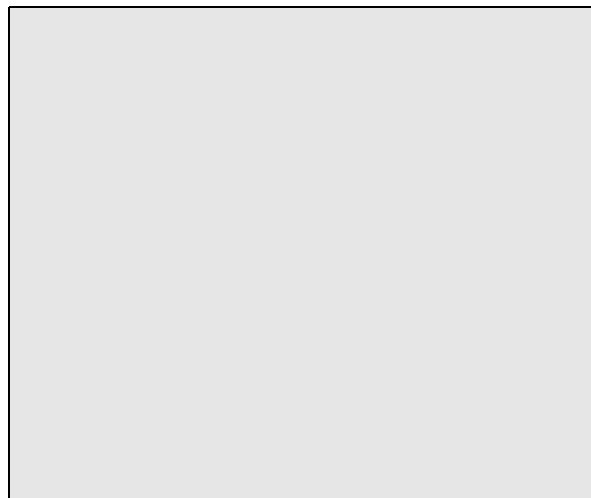
small (8650-0029)

Hex ball driver, 1.5-mm (8710-1570)

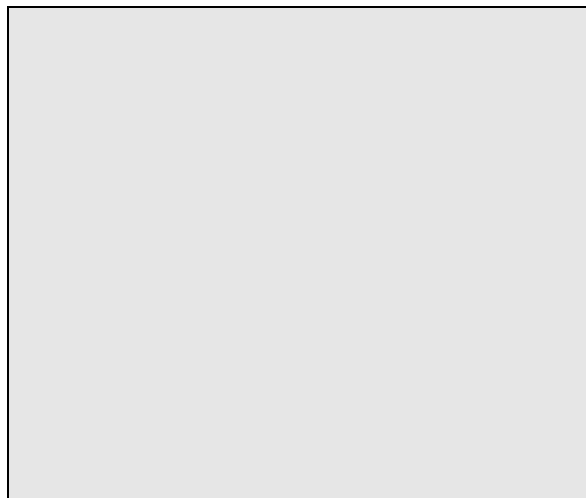
Screwdriver, TORX T-15 (8710-1622)



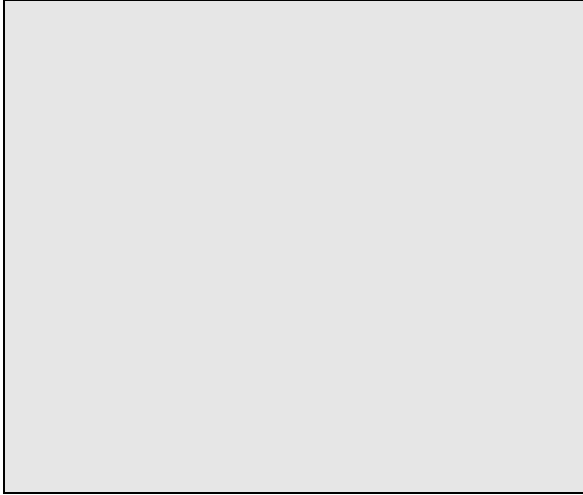
1 Install a new filament assembly. Reinstall the retaining screw.



2 Reinstall the ion source (page 218).



3 Reinstall the analyzer (page 206).

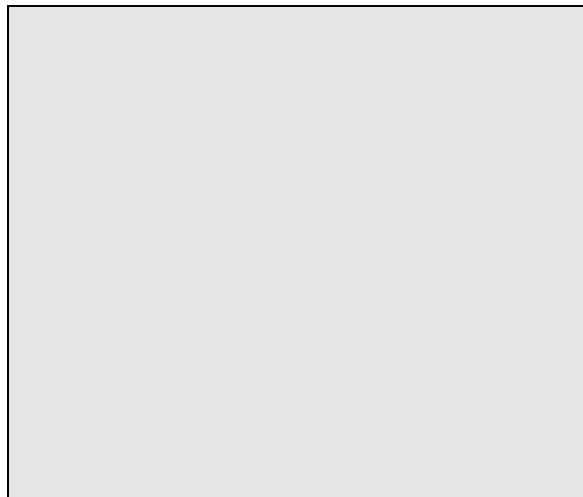


- 4 Autotune the MSD. Use the filament that gives the best results.

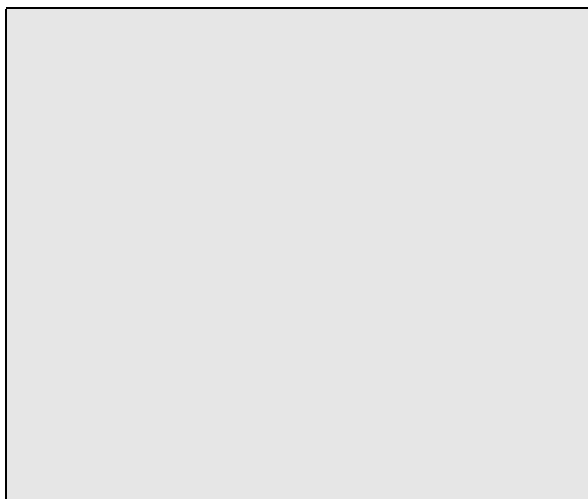
To remove the electron multiplier horn

Materials needed:

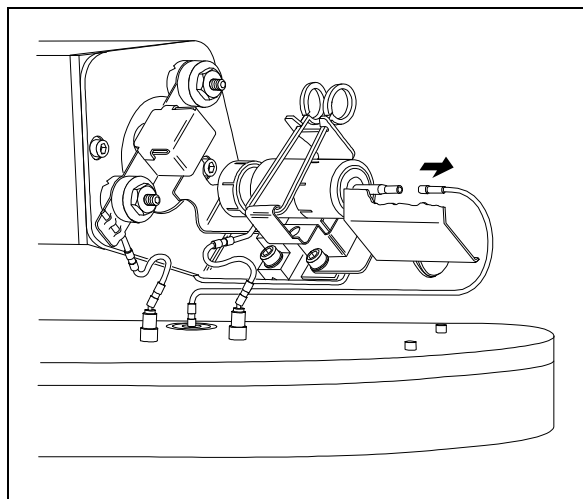
Gloves, clean, lint-free
large (8650-0030)
small (8650-0029)



1 Vent and switch off the MSD (page 58).

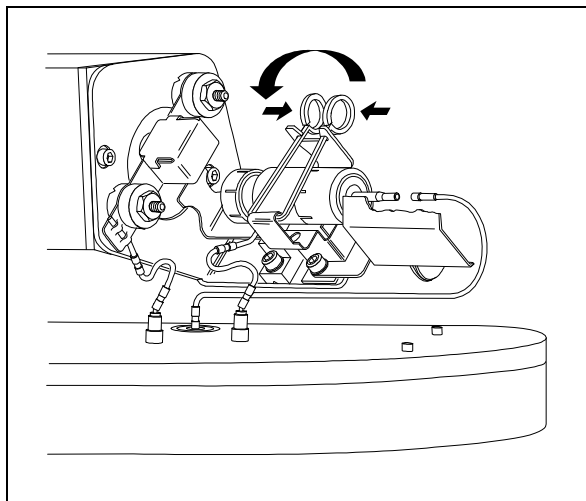


2 Remove the analyzer (page 204).

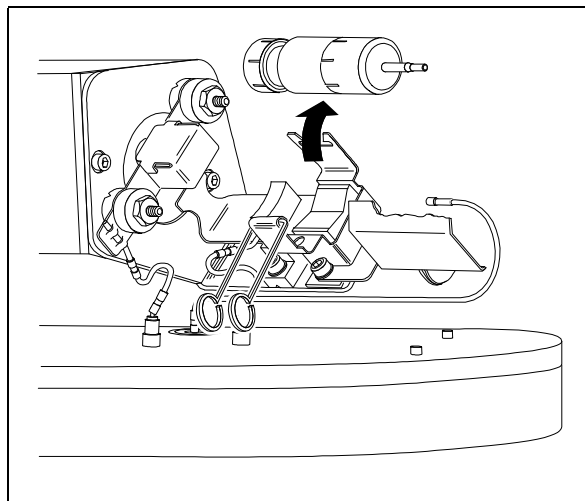


3 Disconnect the signal lead from the electron multiplier.

To remove the electron multiplier horn



4 Open the retaining clip.



5 Remove the electron multiplier horn.

To reinstall the electron multiplier horn

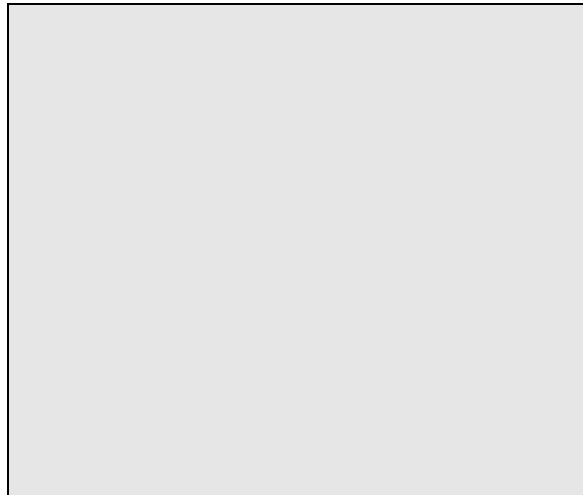
Materials needed:

Electron multiplier horn (05971-80103)

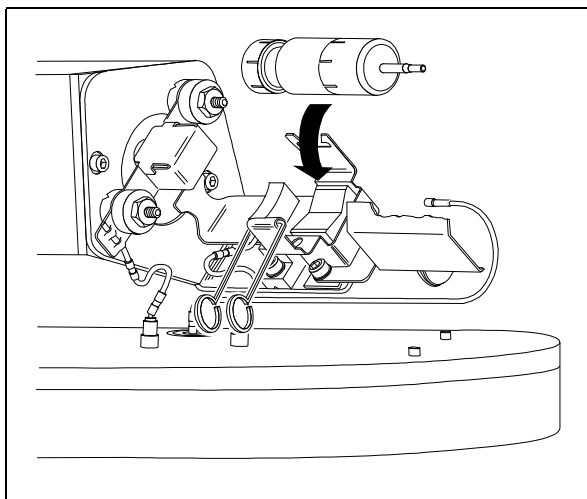
Gloves, clean, lint-free

large (8650-0030)

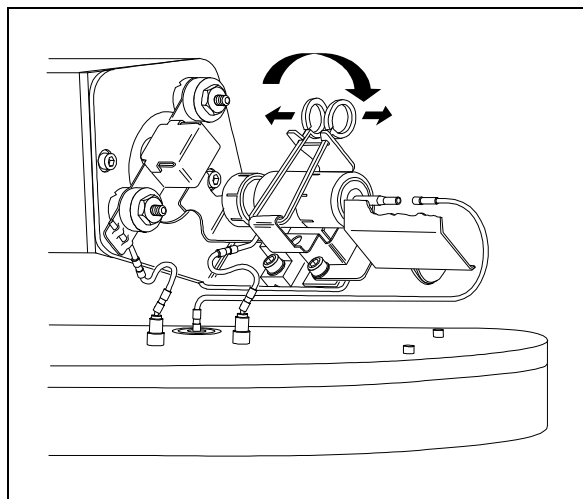
small (8650-0029)



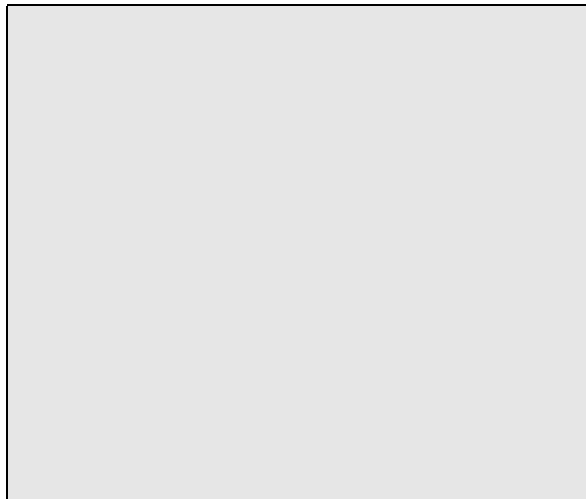
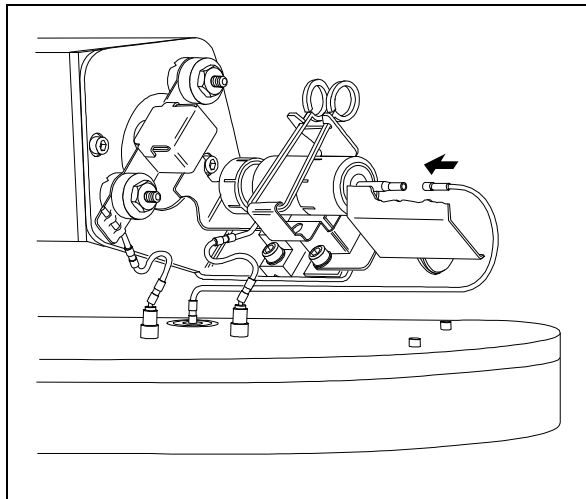
1 Remove the old electron multiplier horn (page 224).



2 Install a new electron multiplier horn.



3 Close the retaining clip.



4 Reconnect the signal lead to the electron multiplier horn.

5 Reinstall the analyzer (page 206).

Maintaining the GC interface

The GC interface requires no periodic maintenance

Rarely, the heater cartridge in the GC interface fails. In those cases, it is necessary to replace the heater/sensor assembly. This section contains procedures for removing the heater/sensor assembly and installing a new one.

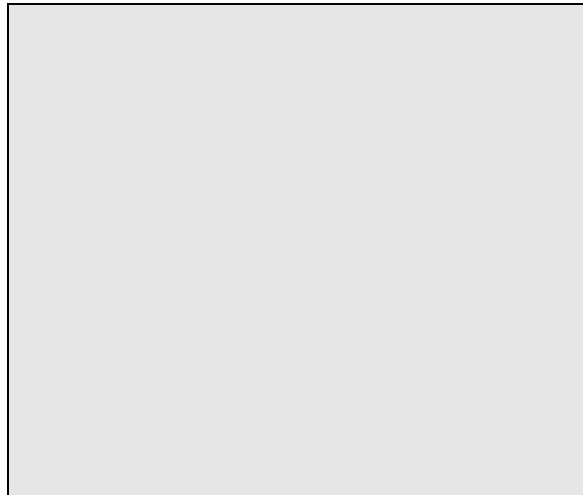
More information is available

If you need more information about the locations or functions of GC interface components, refer to Chapter 6, *GC Interface*, on page 271.

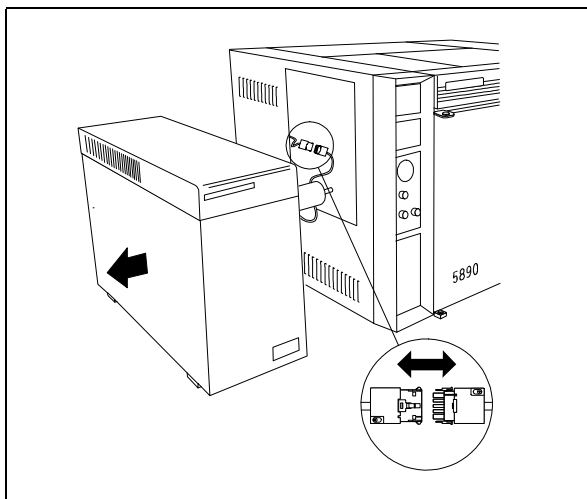
To remove the heater/sensor assembly (HP 5972A)

Materials needed:

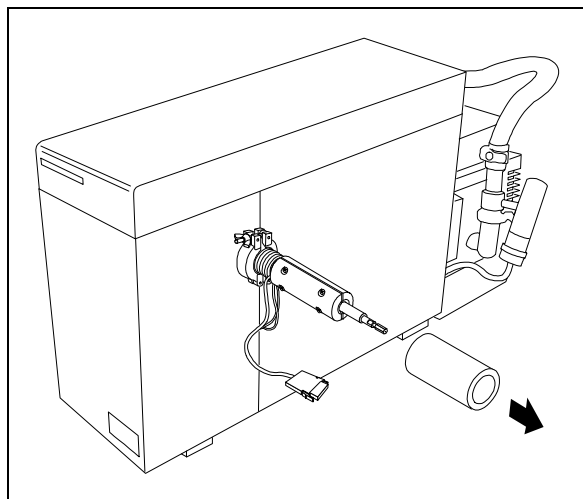
Screwdriver, Pozidriv #1 (8710-0899)



1 Vent and switch off the MSD (page 58).

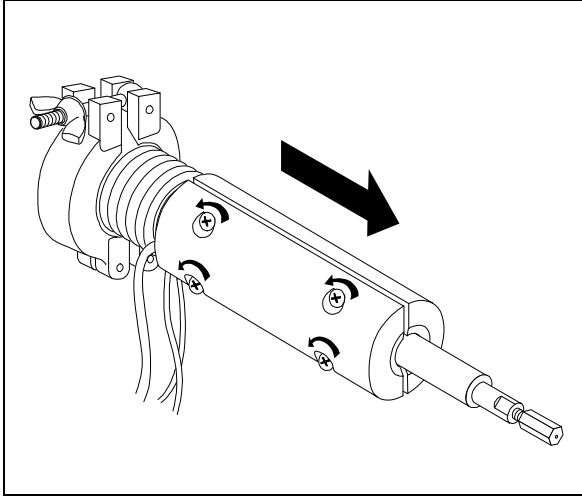


2 Slide the MSD away from the GC. Switch off the GC and then disconnect the GC interface cable.

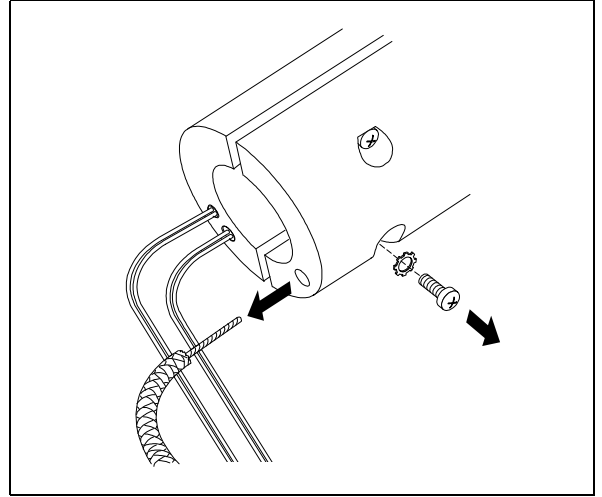


3 Slide the insulation off the GC interface.

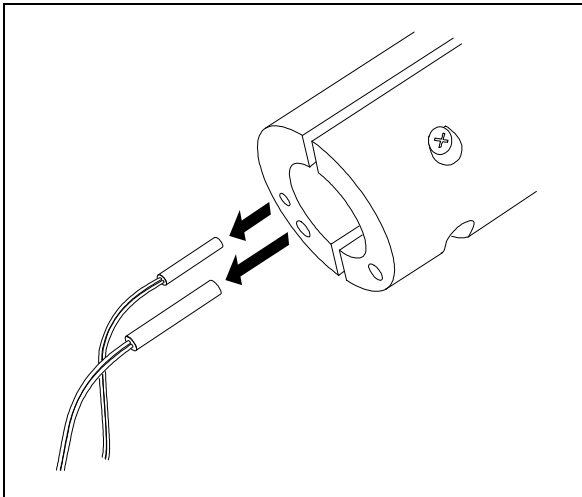
To remove the heater/sensor assembly (HP 5972A)



- 4** Loosen the four heater sleeve screws. Slide the heater sleeve off the GC interface.



- 5** Remove the ground screw. Remove the ground wire from the heater sleeve.

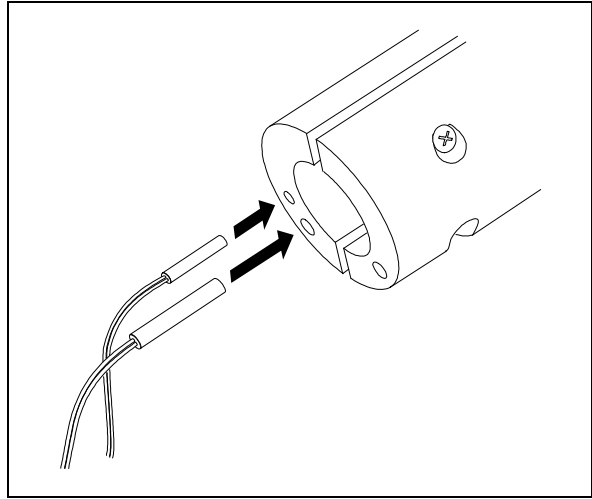


- 6** Remove the heater and sensor from the heater sleeve.

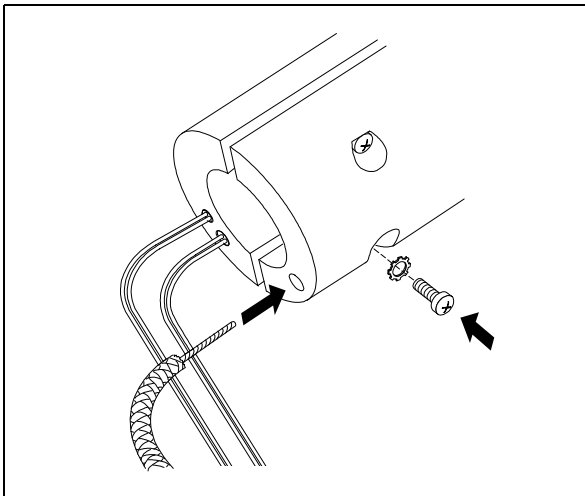
To reinstall the heater/sensor assembly (HP 5972A)

Materials needed:

Screwdriver, Pozidriv #1 (8710-0899)
Heater/sensor assembly (05971-60105)

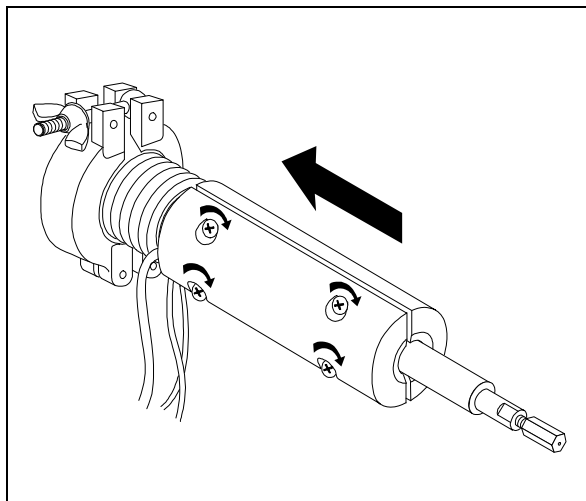


- 1** Slide the new heater and sensor into the heater sleeve.

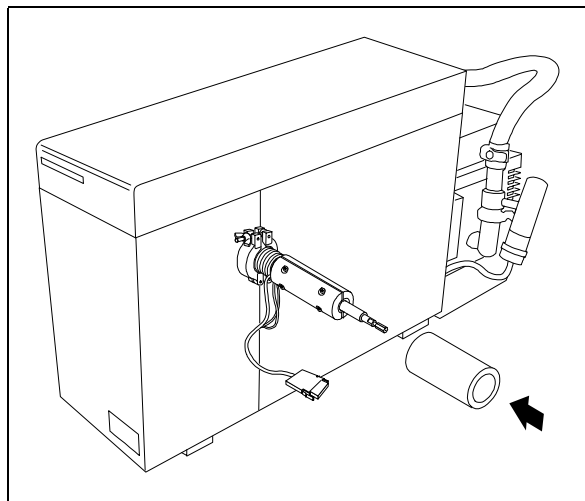


- 2** Insert the ground wire into the hole. Reinstall the ground screw and lockwasher.

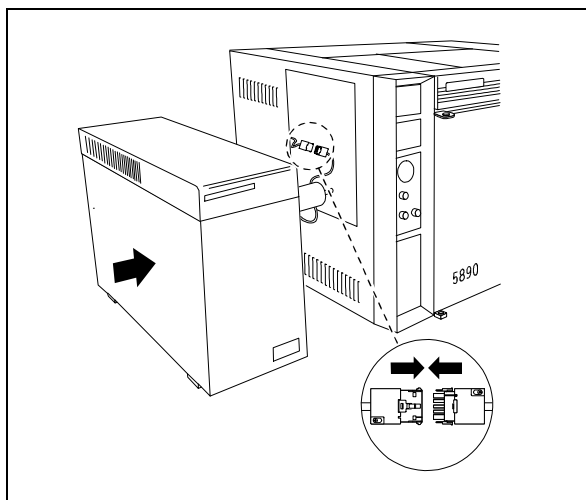
Either wrap the ground wire around the ground screw (inside the hole) or make sure the ground screw presses the ground wire against the heater sleeve. The ground wire must make good contact with the heater sleeve.



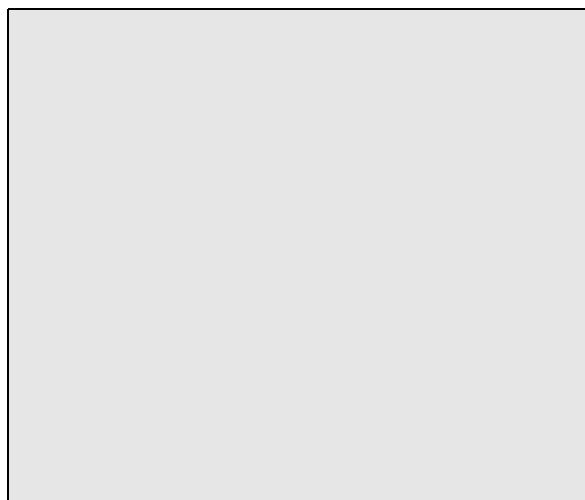
3 Slide the heater sleeve onto the GC interface. Tighten the screws evenly.



4 Slide the insulation onto the GC interface.



5 Reconnect the GC interface cable to the GC. Move the MSD back next to the GC.

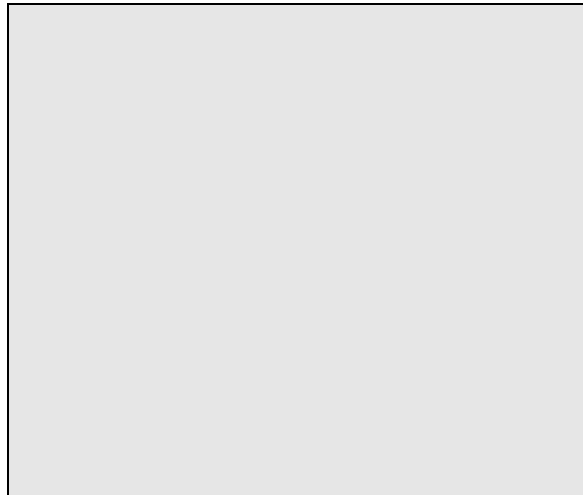


6 Reinstall the GC column. Start up and pump down the MSD (page 40).

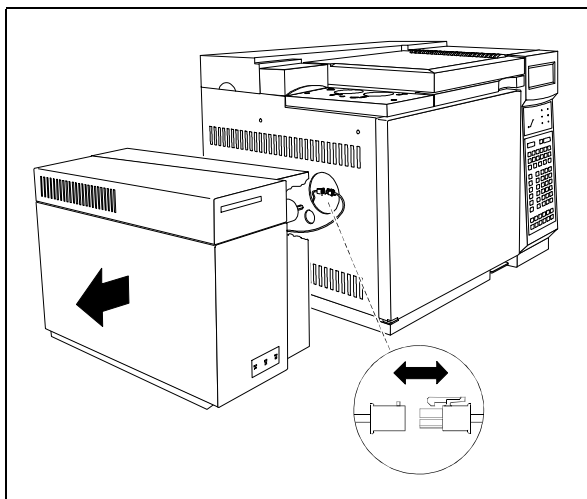
To remove the heater/sensor assembly (HP 6890 Series)

Materials needed:

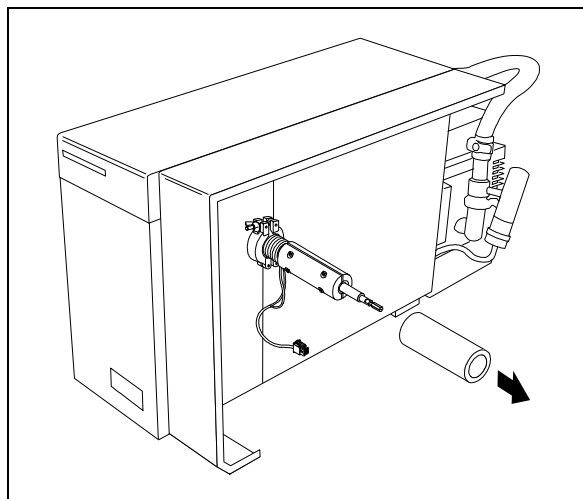
Screwdriver, Pozidriv #1 (8710-0899)



1 Vent and switch off the MSD (page 58).

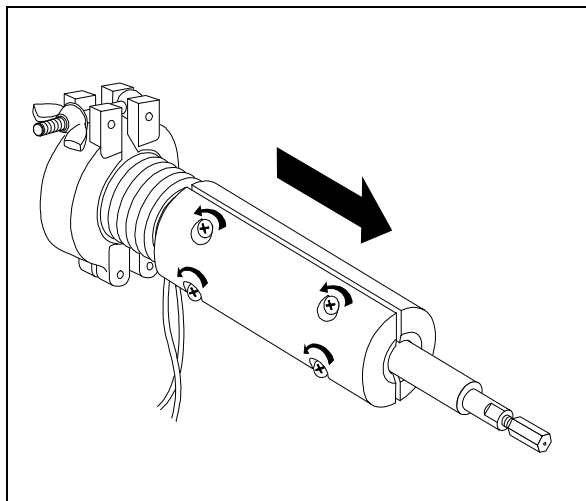


2 Slide the MSD away from the GC. Switch off the GC and then disconnect the GC interface cable.

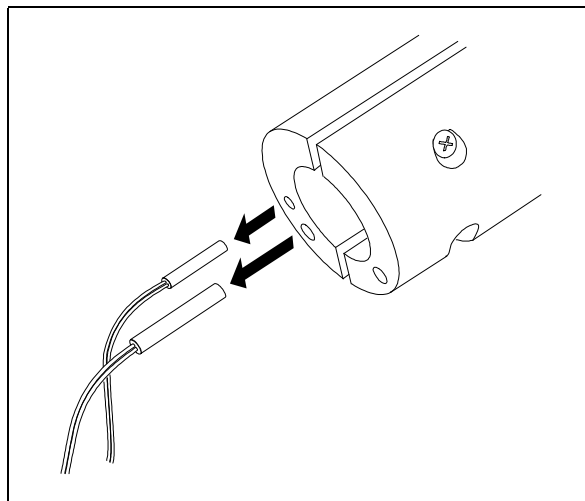


3 Slide the insulation off the GC interface.

To remove the heater/sensor assembly (HP 6890 Series)



- 4** Loosen the four heater sleeve screws. Slide the heater sleeve off the GC interface.

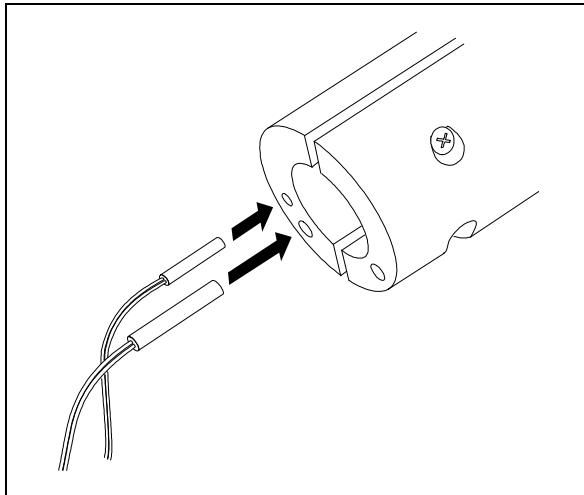


- 5** Remove the heater and sensor from the heater sleeve.

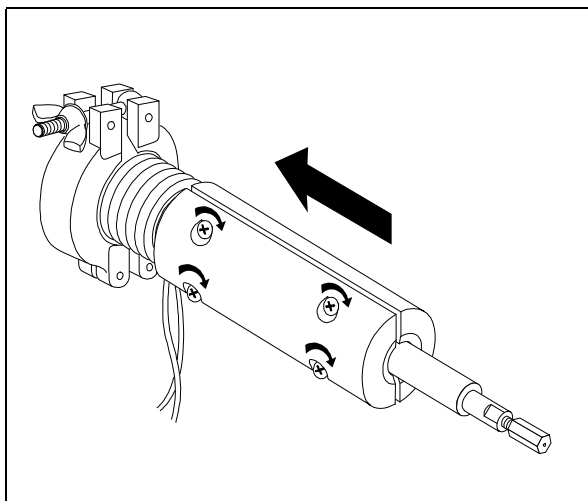
To reinstall the heater/sensor assembly (HP 6890 Series)

Materials needed:

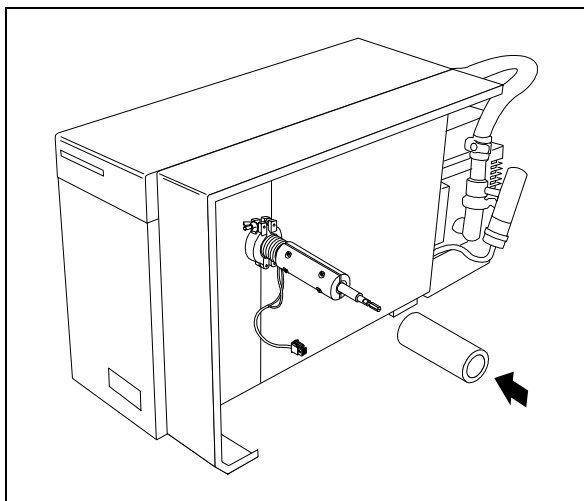
Screwdriver, Pozidriv #1 (8710-0899)
Heater/sensor assembly (05972-60106)



1 Slide the new heater and sensor into the heater sleeve.

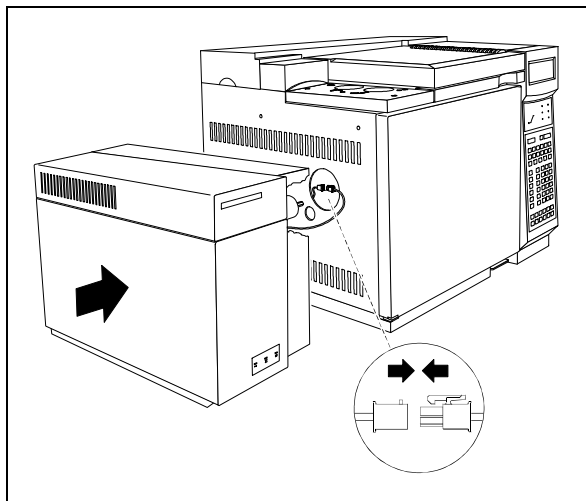


2 Slide the heater sleeve onto the GC interface.
Tighten the screws evenly.



3 Slide the insulation onto the GC interface.

To reinstall the heater/sensor assembly (HP 6890 Series)



4 Reconnect the GC interface cable to the GC. Slide the MSD back next to the GC.

5 Reinstall the GC column. Start up and pump down the MSD (page 40).

Maintaining the electronics

The MSD electronics do not require any scheduled maintenance

None of the electronic components of the MSD need to be replaced on a regular schedule. None of the electronic components in the MSD need to be adjusted or calibrated on a regular schedule. Avoid unnecessary handling of the MSD electronics.

On rare occasions, it may be necessary to replace a fuse or one of the printed circuit boards

The procedures in this section ***outline*** the steps required to replace some of the major electronic components of the MSD. These procedures are intended primarily for Hewlett-Packard service personnel. Do not attempt to use these procedures unless you have received previous training in the maintenance of the MSD electronics.

W A R N I N G

Improper use of these procedures could create a serious safety hazard. Improper use of these procedures could also result in serious damage to, or incorrect operation of, the MSD.

W A R N I N G

Vent the MSD and disconnect its power cord before performing any of these procedures except adjusting the RF coils.

If you experience problems with the electronics in your MSD, the best thing to do is contact your Hewlett-Packard Customer Engineer.

More information is available

If you need more information about the locations or functions of electronic components, refer to Chapter 8, *Electronics*, on page 289.

To replace the top board

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)

Screwdriver

TORX T-10 (8710-1623)

TORX T-15 (8710-1622)

Top board (05971-69001)

Special considerations

- Take full anti-static precautions.
- Be careful when disconnecting the 9-pin connector from the 9-pin feedthrough in the top plate. It is easy to damage the top board and the feedthrough pins.
- Make sure the pins of the 9-pin feedthrough in the top plate are straight before installing a new top board.
- You will have to adjust the RF coils after installing a new top board.

Steps

- 1** Vent the MSD.
- 2** Remove the upper MSD cover.
- 3** Reinstall and tighten the shipping clamps.
- 4** Disconnect the cables from the top board.
- 5** Remove the black safety covers from the top board.
- 6** Remove the 2 hex standoffs and 4 screws that hold the top board to the top plate.
- 7** Gently pry the 9-pin connector off the feedthrough in the top plate.
- 8** Lift off the top board.
- 9** Reverse steps 1 through 8 to install a new top board.
- 10** Adjust the RF coils.

To adjust the RF coils

Materials needed:

Tuning wand (8710-0933)

Special considerations

- Take full anti-static precautions.
- Use only the non-metallic tuning wand to adjust the RF coils.
- Adjust the coils alternately, keeping the screws at equal extensions from the coils.

Steps

- 1** Make sure the MSD is at thermal equilibrium.
- 2** Remove the upper MSD cover.
- 3** Call up the **Set RFPA** program in your data system.
- 4** Enter an amu value of 100 (if the instrument is far out of adjustment, you may have to begin at 10).
- 5** Adjust the RF coils to minimize the voltage displayed by the data system.
- 6** When the voltage is minimized, press the **STOP** key. The minimum voltage should be between 90 and 125 mV.
- 7** Repeat steps 3 through 6 for 650 amu. The minimum voltage should be between 500 and 800 mV.
- 8** Exit the Set RFPA program.
- 9** Reinstall the upper MSD cover.
- 10** Retune the MSD.

To replace the main board

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Screwdriver, TORX T-15 (8710-1622)
Main board (05971-60018)

Special considerations

- Take full anti-static precautions.

Steps

- 1** Vent the MSD and slide it away from the GC.
- 2** Remove the upper and lower MSD covers.
- 3** Remove the safety cover from over the main board.
- 4** Disconnect the cables from the main board (4 on the front of the board, 3 on the back).
- 5** Remove the 4 standoffs and 4 screws that hold the main board to the electronics panel.
- 6** Slide the main board to the right to disconnect it from the HP-IB/MS control card.
- 7** Remove the main board.
- 8** Reverse steps 1 through 7 to install a new main board.
- 9** Retune the MSD.

To replace the HP-IB/MS control card

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Screwdriver, TORX T-15 (8710-1622)
HP-IB/MS control card (05990-69406)

Special considerations

- Take full anti-static precautions.
- Make sure the address switch settings on the new HP-IB/MS control card match the address switch settings on the old card.

Steps

- 1** Vent the MSD.
- 2** Remove the upper and lower MSD covers.
- 3** Remove the safety covers from over the main board and HP-IB/MS control card.
- 4** Disconnect the cables from the HP-IB/MS control card.
- 5** Disconnect the accessory connector cable from the main board.
- 6** Remove the 6 screws and 1 standoff that hold the HP-IB/MS control card to the electronics panel.
- 7** Slide the HP-IB/MS control card to the left to disconnect it from the main board.
- 8** Remove the HP-IB/MS control card.
- 9** Reverse steps 1 through 8 to install a new HP-IB/MS control card.
- 10** Retune the MSD.

To remove the electronics panel

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Screwdriver, TORX T-15 (8710-1622)

Special considerations

- Take full anti-static precautions.

Steps

- 1** Vent the MSD and slide it away from the GC.
- 2** Remove the upper and lower MSD covers.
- 3** Disconnect the ribbon, filament, and signal cables from the main board.
- 4** Disconnect the ground wire that connects the ground terminal on the electronics panel to the base of the instrument.
- 5** Disconnect the calibration valve cable from the back of the main board (near the triode gauge).
- 6** Remove the three standoffs that hold the electronics panel to the instrument frame.
- 7** Tilt the top of the electronics panel toward you.
- 8** Reach behind the electronics panel and disconnect the diffusion pump, fan, and foreline vacuum gauge cables from the power distribution board.
- 9** Lift the electronics panel out of the MSD.

To reinstall the electronics panel

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Screwdriver, TORX T-15 (8710-1622)

Special considerations

- Take full anti-static precautions.

Steps

- 1** Place the electronics panel a few inches from its proper position.
- 2** Reconnect the diffusion pump, fan, and foreline vacuum gauge cables to the power distribution board.
- 3** Put the tabs on the bottom of the electronics panel into the slots in the base of the instrument.
- 4** Tilt the electronics panel up until the rear grommet seats on the vacuum manifold.
- 5** Reinstall the rear (left) standoff.
- 6** Reinstall the middle standoff.
- 7** Reinstall the front (right) standoff.
- 8** Reconnect the ground wire to ground terminal on the base of the instrument.
- 9** Reconnect the ribbon, filament, and signal cables to the main board.
- 10** Reconnect the calibration valve cable to the back of the main board.
- 11** Reinstall the upper and lower MSD covers.
- 12** Start up and pump down the MSD.

To replace the power distribution board

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Power distribution board (05971-60003)
Screwdriver, TORX T-15 (8710-1622)

Special considerations

- Take full anti-static precautions.
- If your instrument operates on 220/240 V ac power, you must replace the two standard 4-amp diffusion pump fuses with 2-amp fuses (2110-0002).

Steps

- 1** Vent the MSD.
- 2** Remove the upper and lower MSD covers.
- 3** Remove the electronics panel from the MSD.
- 4** Remove the safety cover from over the HP-IB/MS control card
- 5** Disconnect the white 5-pin connector located just below the two round diffusion pump fuse holders.
- 6** Disconnect the 5-pin and 12-pin connectors from the power distribution board.
- 7** Remove the 5 screws that hold the power distribution board to the electronics panel. Save the screws.
- 8** Remove the power distribution board.
- 9** Check the diffusion pump fuses in the new power distribution board. Make sure they are appropriate for the voltage range of your MSD.
- 10** Reverse steps 1 through 8 to install a new power distribution board.

To replace the power supply fuse

The fuse on the power supply is not replaceable. If this fuse fails, it indicates an event or power supply condition so serious that the entire power supply should be replaced.

To replace the power supply

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Screwdriver
Pozidriv #2 (8710-0900)
TORX T-15 (8710-1622)
Power supply board (0950-2552)

Special considerations

- Take full anti-static precautions.
- The power supply works for both 110/120 and 220/240 V ac power.

Steps

- 1** Vent the MSD.
- 2** Remove the upper and lower MSD covers and safety covers from over the HP-IB/MS control card and the main board.
- 3** Remove the electronics panel from the MSD.
- 4** Remove the main board.
- 5** Remove the HP-IB/MS control card.
- 6** Disconnect the power distribution board cable (3 wires) from the power supply.
- 7** Disconnect the main board cable (9 wires) from the power supply.
- 8** Remove the power supply (the 4 screws are on the main-board side of the electronics panel).
- 9** Reverse steps 1 through 8 to install the new power supply.

To replace the diffusion pump fuses

Materials needed:

Fuse
2-amp (2110-0002)
4-amp (2110-0055)
Hex nut driver, 1/4-inch (8720-0002)
Screwdriver
flat-bladed (8710-1029)
TORX T-15 (8710-1622)

Special considerations

- Take full anti-static precautions.
- Make sure to use fuses of proper rating for the voltage on which your MSD is operating.

110/120 V ac, 4-amp (2110-0055)
220/240 V ac, 2-amp (2110-0002)

Steps

- 1 Vent the MSD.
- 2 Remove the upper and lower MSD covers.
- 3 Remove the safety cover from over the HP-IB/MS control card.
- 4 Locate the round diffusion pump fuse holders to the left of the HP-IB/MS control card.
- 5 Remove the fuses and inspect them. If necessary replace the fuses.
- 6 Reinstall the safety cover.
- 7 Reinstall the upper and lower MSD covers.
- 8 Start up and pump down the MSD.

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Foreline pump and trap, 256
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Vacuum System

This chapter describes components of the vacuum system in the MSD

Vacuum System

The vacuum system is essential to MSD operation

The vacuum system creates the high vacuum (low pressure) required for the MSD to operate. Without this vacuum, the molecular mean free path is too short. Ions cannot travel from the ion source through the mass filter to the electron multiplier (detector) without colliding with other molecules.

Many components make up the vacuum system

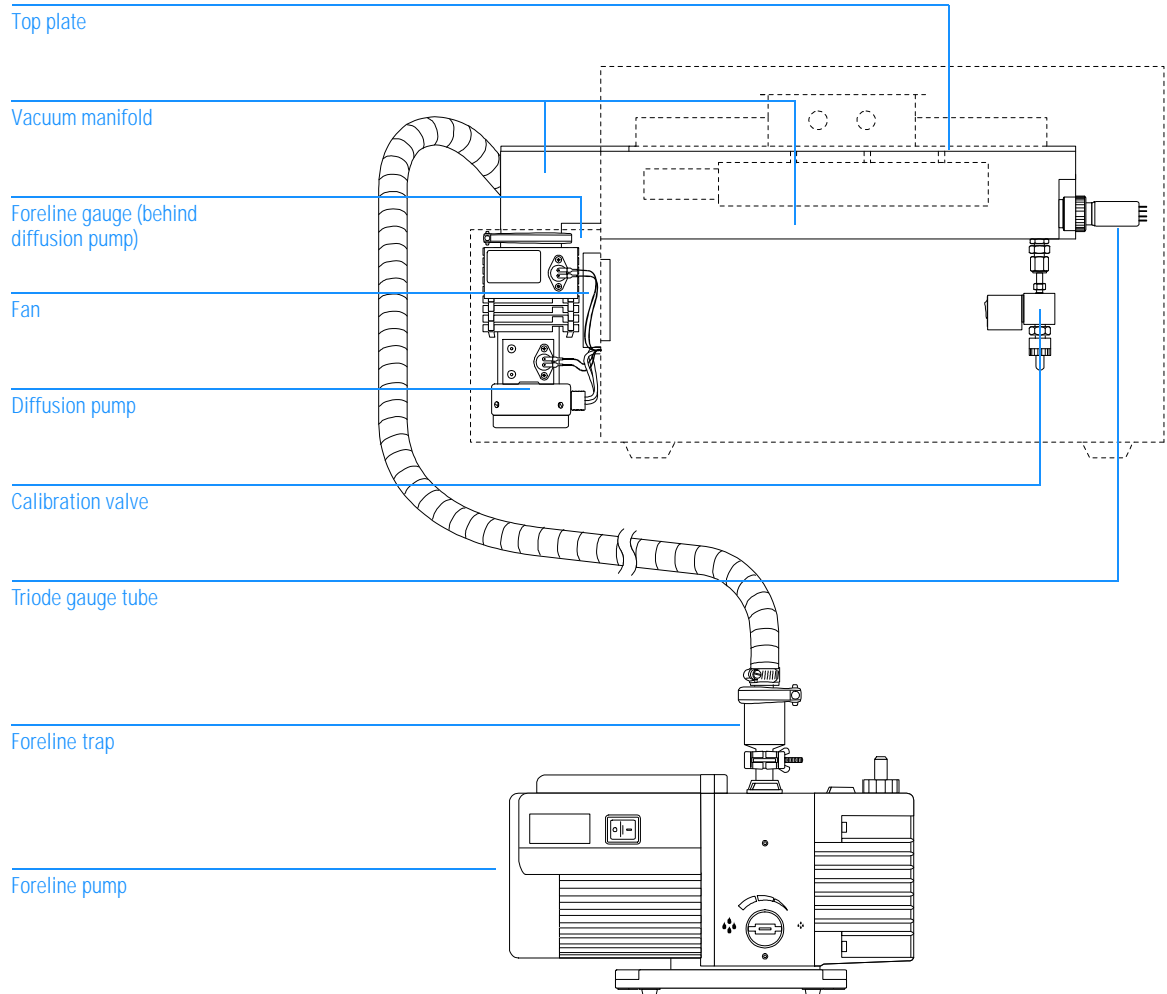
The major components of the vacuum system are:

- Vacuum manifold
- Vacuum seals
- Top plate
- Foreline pump and trap
- Foreline gauge
- Diffusion pump and fan
- Calibration valve
- Triode gauge tube
- Gauge controller (optional)

Each of these is discussed in more detail in the following material.

Vacuum system control is mostly automated

Most vacuum system operation is automated and done through the data system. Monitoring of the vacuum system is done through the data system or the optional gauge controller.

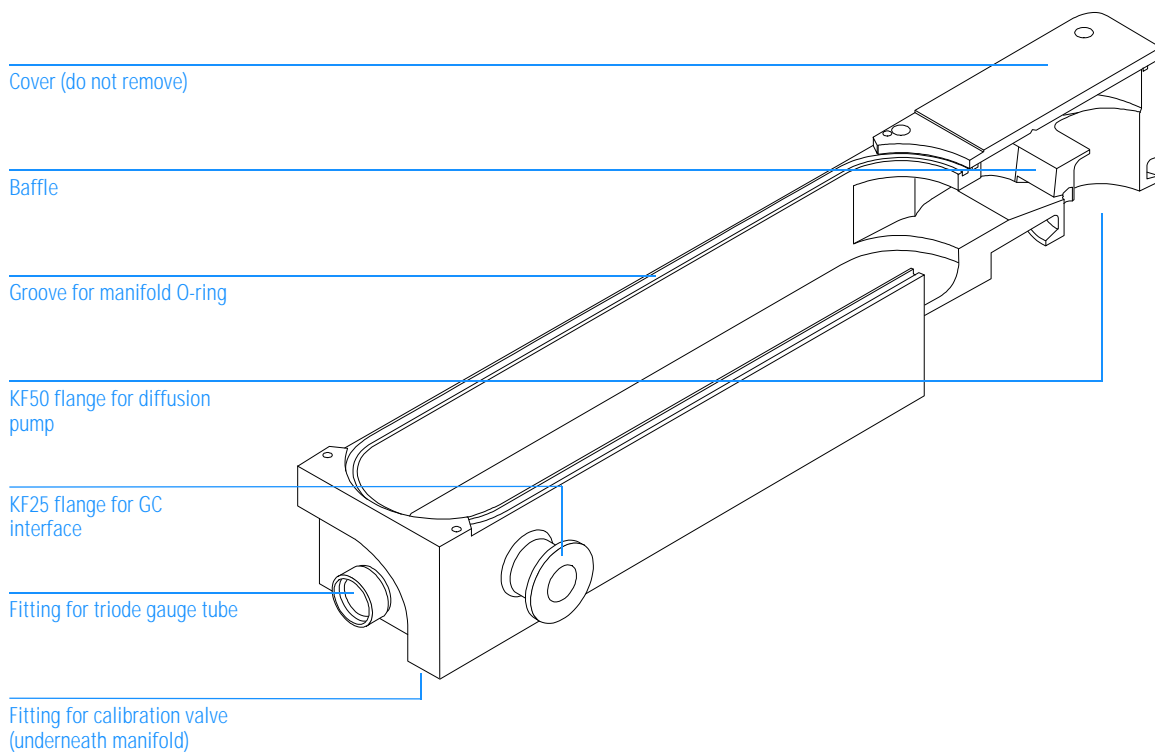


Vacuum manifold

The vacuum manifold is the housing for the analyzer which must operate in a vacuum. The vacuum manifold is machined from a solid block of aluminum alloy. The large opening in the top of the vacuum manifold is covered by the top plate. An O-ring provides a seal between the manifold and the top plate.

Fittings on the vacuum manifold provide attachment points for the triode gauge tube, calibration valve, GC interface, and diffusion pump.

The diffusion pump attaches to a large flange on the vacuum manifold. Above the diffusion pump flange is an internal baffle which helps prevent pump-fluid vapor from migrating toward the sensitive analyzer elements. A return path is provided for any fluid that condenses on the baffle.

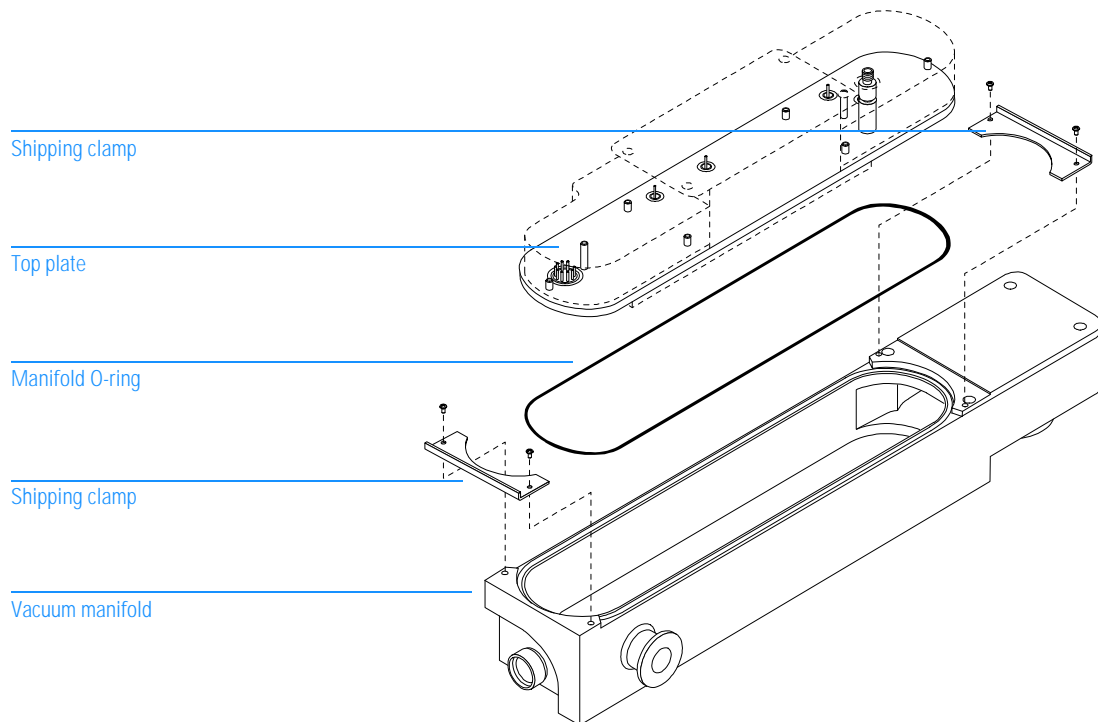


Top plate

The top plate is a flat, stainless steel plate. It covers the large opening in the top of the vacuum manifold. The analyzer assembly is suspended from the top plate inside the vacuum manifold. Several electrical feedthroughs are built into the top plate. Wires connect the feedthroughs to analyzer components. The top board is mounted on the atmospheric side of the top plate. The proximity of the top board to the analyzer provides cleaner signals. Shipping clamps are located on the vacuum manifold at each end of the top plate.

CAUTION

Tighten the shipping clamps only for shipping or storage. If the shipping clamps are tight during normal operation it can cause air leaks.



Vacuum seals

Several types of seals are used to prevent air leaks into the vacuum manifold.

Manifold O-ring

The manifold O-ring is an elastomer O-ring. It sits in a groove around the opening on top of the vacuum manifold. The top plate rests on the manifold O-ring. Keep the manifold O-ring free of dust and particles. Avoid nicking or scratching it. Avoid nicking or scratching the vacuum manifold and top plate surfaces that contact the O-ring. The manifold O-ring can be replaced.

KF seals

The seals for the diffusion pump, GC interface, foreline vacuum gauge assembly, and foreline trap are known as KF seals. There are two types of KF seals. One type, the O-ring assembly, consists of an elastomer O-ring and a metal or plastic centering (positioning) ring inside the O-ring. The other type, called a coseal, has a seal that is almost square in cross-section and a centering ring around the outside of the seal. Most KF seals are vented to prevent air from being trapped between the seal and the centering ring.

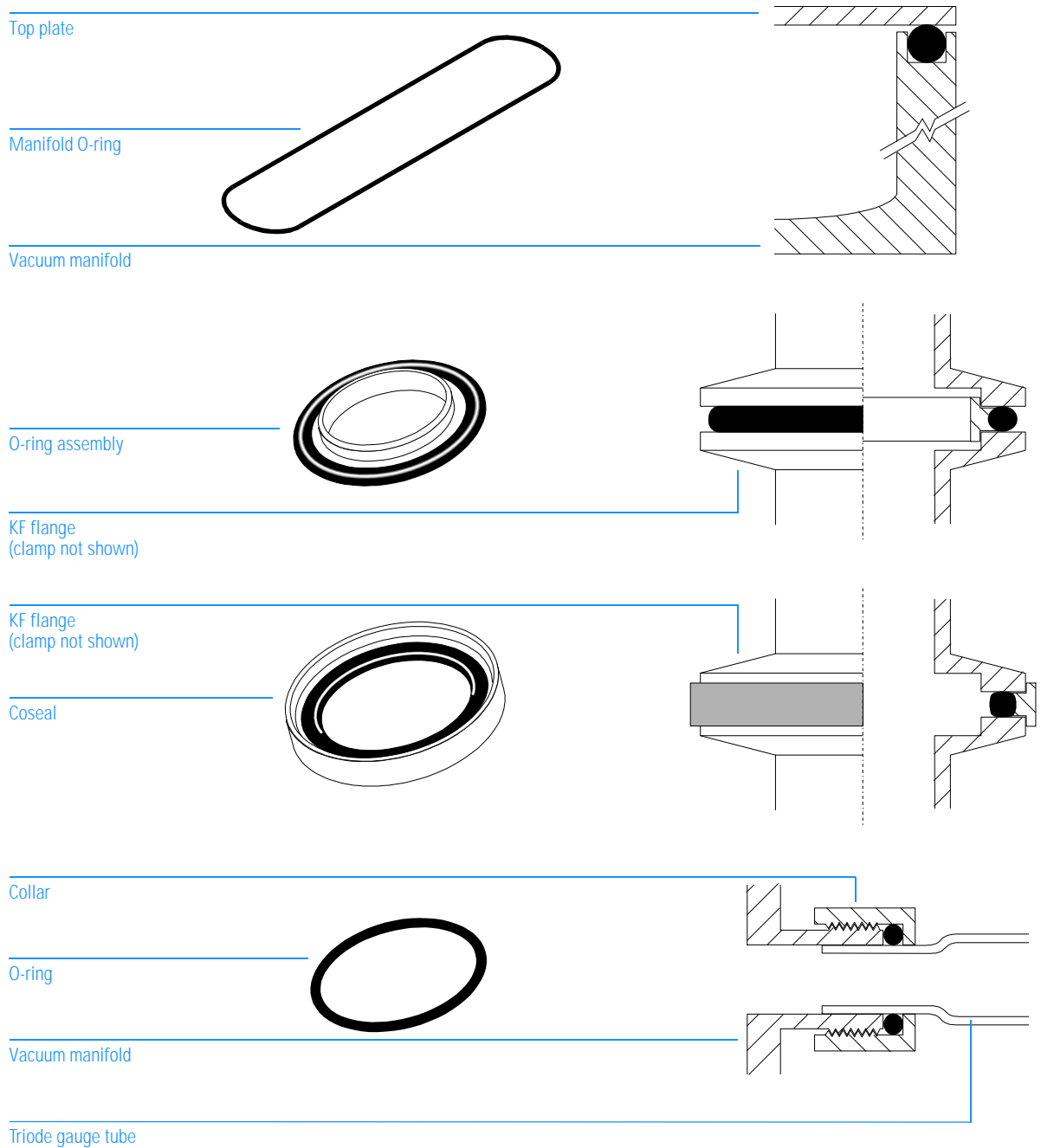
When KF flanges are clamped together, the seal is compressed between the flange surfaces. KF clamps require no tools for assembly or disassembly.

Calibration valve O-rings

The calibration valve assembly threads onto a fitting which threads into the vacuum manifold. Small O-rings on each end of the fitting provide vacuum seals.

Triode gauge seal

The vacuum seal for the triode gauge tube consists of a threaded fitting on the vacuum manifold, a threaded collar, and an O-ring. The O-ring is located inside the collar. The stem of the triode gauge tube fits inside the collar. When the collar is tightened, the O-ring is compressed and seals around the stem of the tube.



Foreline pump and trap

The foreline pump lowers the pressure in the vacuum manifold so the diffusion pump can be switched on. Once the diffusion pump is on, the foreline pump continues to pump away the material exiting the diffusion pump.

The foreline pump is a mechanical, rotary-vane pump. It has a built-in anti-suckback valve. The inlet of the foreline pump is equipped with a trap. The trap is filled with adsorbent pellets (molecular sieve). The trap helps prevent vapor from the foreline pump fluid from being drawn up into the foreline gauge, diffusion pump, and vacuum manifold.

The foreline pump can be located anywhere near the MSD, within reach of the hose that connects the pump to the MSD. Typically, the foreline pump sits on the bench behind the MSD or on the floor below the MSD.

CAUTION

Do not place the foreline pump near any equipment that is sensitive to vibration.

The exhaust from the foreline pump may contain traces of solvents and samples. Some of these may be toxic. The exhaust must be vented outside or to a fume hood.

WARNING

The exhaust from the foreline pump may contain traces of toxic chemicals from your analyses. Always vent the pump exhaust outside or to a fume hood.

The ballast control on top of the pump controls the amount of air (ballast) allowed into the pump. Increasing the ballast increases the volume of material the pump can transport but decreases the ultimate vacuum the pump can achieve. For use with the MSD, ultimate vacuum is more important than pumping volume. The ballast control should always be set to the 0 position.

The mode switch on the side of the pump controls the amount of pump fluid sent to the high-vacuum stage of the pump. Increasing the pump fluid to this stage increases the volume of material the pump can transport but decreases the ultimate vacuum the pump can achieve. For use with the MSD, ultimate vacuum is more important than pumping volume. The mode control should always be turned fully clockwise (to the position with the small droplets).

Foreline hose
(from diffusion pump outlet)

Foreline trap

Ballast control

Power (on/off) switch

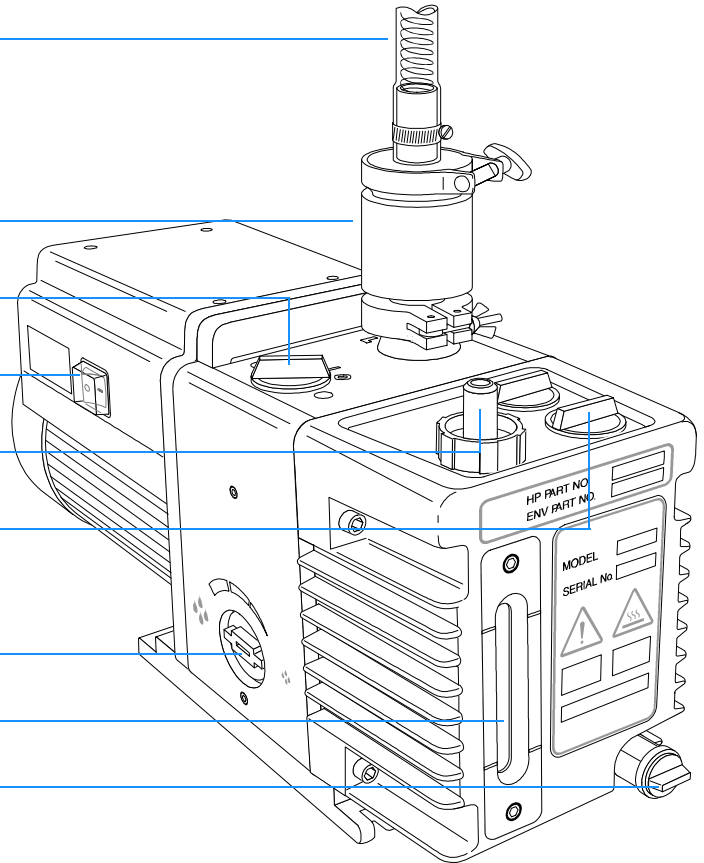
Exhaust outlet (route exhaust outside of laboratory)

Fill cap

Mode switch

Fluid level window

Drain plug



A window in the front of the foreline pump shows the level of the foreline pump fluid. There are two sets of marks next to the window. The level of the pump fluid should never be above the upper marks or below the lower marks. If the level of pump fluid is near the lower marks, add foreline pump fluid.

See Also

To check and add foreline pump fluid, page 168

Foreline gauge

The foreline gauge monitors the pressure (vacuum) at the exit of the diffusion pump. The primary function of the foreline gauge is diffusion pump control. When the foreline pump has reduced the pressure in the vacuum manifold to below 300 mTorr (0.3 Torr), the diffusion pump is automatically switched on. If the foreline pressure rises above 400 mTorr (0.4 Torr), the power distribution board switches off the diffusion pump heater and the analyzer electronics.

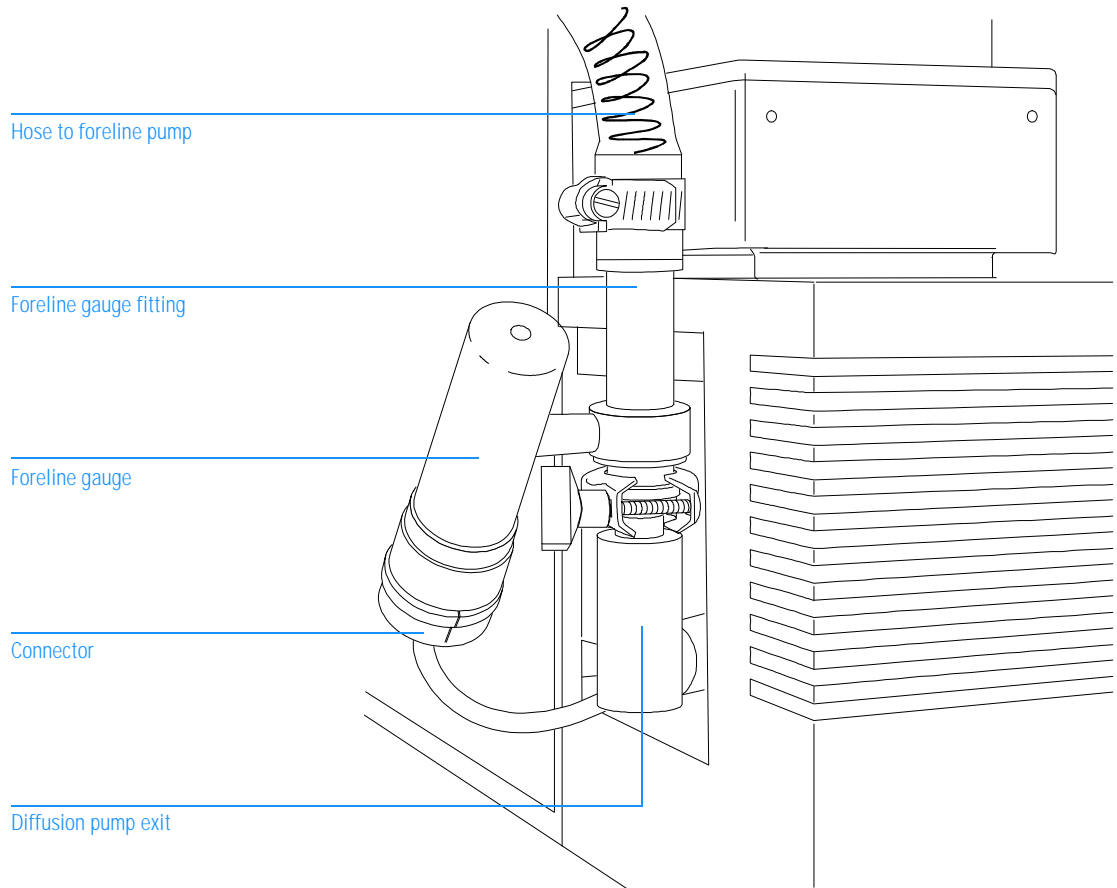
The foreline pressure can be monitored from your data system.

The MSD also includes a triode gauge tube. With the optional gauge controller, the triode gauge can measure the high vacuum in the vacuum manifold.

See Also

To monitor the foreline pressure, page 42

Gauge controller, page 268



Diffusion pump and fan

The diffusion pump creates the low pressure (high vacuum) required for correct analyzer operation. The diffusion pump in the MSD is an air-cooled vapor diffusion pump. It is clamped to the large KF50 flange at the rear of the vacuum manifold.

The diffusion pump has a cylindrical body surrounded by fins to help dissipate heat. Its inlet is open to the interior of the vacuum manifold. A structure called the stack is located at the center of the pump body. An electric heater is located at the bottom of the stack.

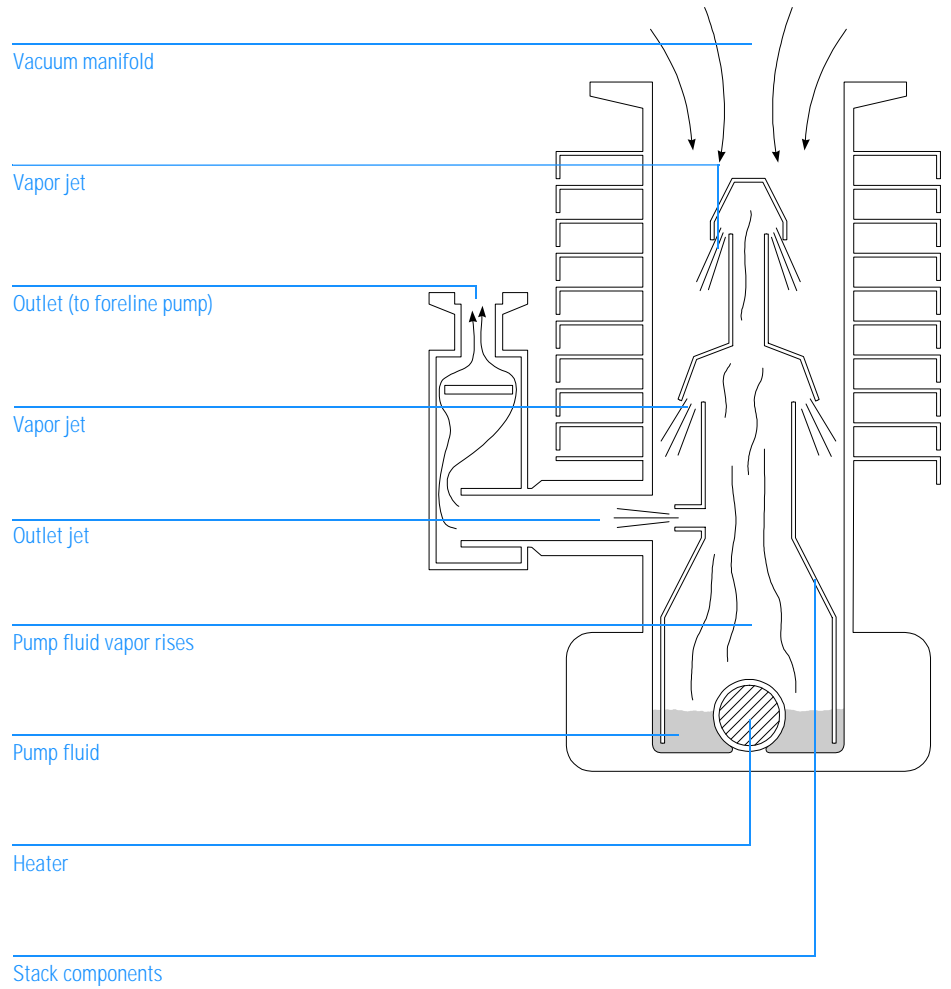
The diffusion pump transports gas by momentum transfer. The heater boils a special fluid (a synthetic oil) inside the stack. As the vapor pressure increases, the fluid vapor is forced out through jets in the stack. These jets are angled downward. The vapor forced out of these jets strikes the gas molecules that are present. This forces the gas molecules down toward the outlet near the bottom of the pump. Another jet in the stack points directly at the outlet and forces the gas molecules out. The fluid falls back to the bottom of the pump. Some fluid also condenses on the sides of the pump and runs down to the bottom. The fluid is boiled again and is thus reused continuously.

The foreline pump is connected by a hose to the outlet of the diffusion pump. It removes the gas molecules that reach the outlet.

The diffusion pump is turned on automatically as soon as the foreline pump lowers the pressure in the vacuum manifold below approximately 300 mTorr (0.3 Torr). The diffusion pump typically maintains an indicated pressure below 1.4×10^{-4} Torr for GC carrier gas flows up to 2 ml/minute. High vacuum (manifold) pressure can only be measured if your MSD is equipped with the optional gauge controller.

See Also

Gauge controller, page 268



Diffusion pump and fan

The small size of the diffusion pump allows it to heat up and cool down quickly. This simplifies pumpdown and venting. From initial power-on, the system can pump down to operating pressure in approximately 15 minutes. If the power fails, the diffusion pump fluid stops boiling before the vacuum manifold pressure begins to rise significantly. This helps prevent backstreaming of diffusion pump fluid into the vacuum manifold. Your data system has pumpdown and venting programs to guide you through these procedures. Follow their instructions carefully.

See Also

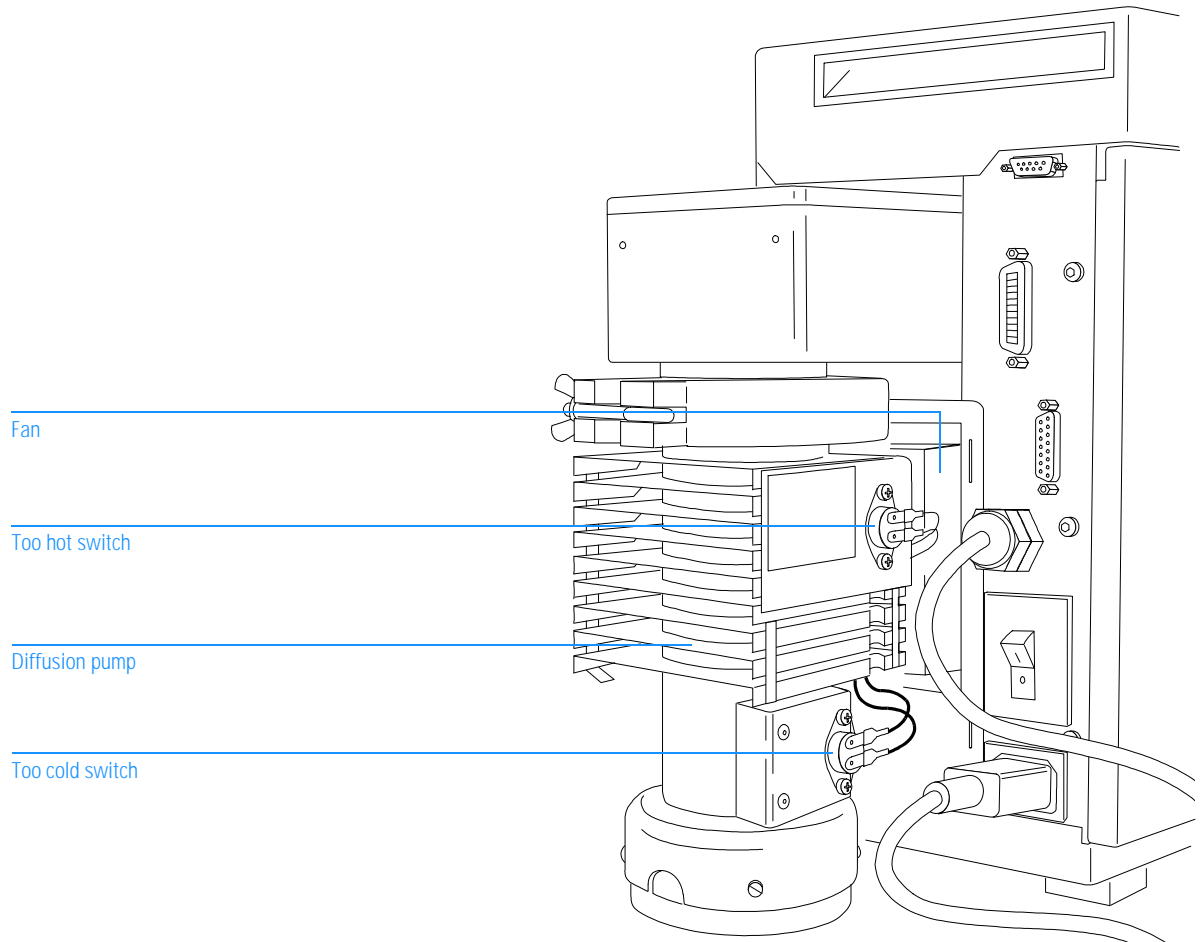
To pump down the MSD, page 40

To vent the MSD, page 58

A fan is located between the diffusion pump and the back panel of the MSD. The fan draws air through the MSD and blows it over the pump.

There are two thermal switches on the diffusion pump. The too hot switch is located on the cooling fins of the pump. If the pump is too hot, the diffusion pump and analyzer electronics are automatically switched off. They will not switch on again until you switch the power switch off and then on.

The too cold switch is located below the cooling fins on the diffusion pump. This switch keeps the analyzer off until the diffusion pump reaches its normal operating temperature.

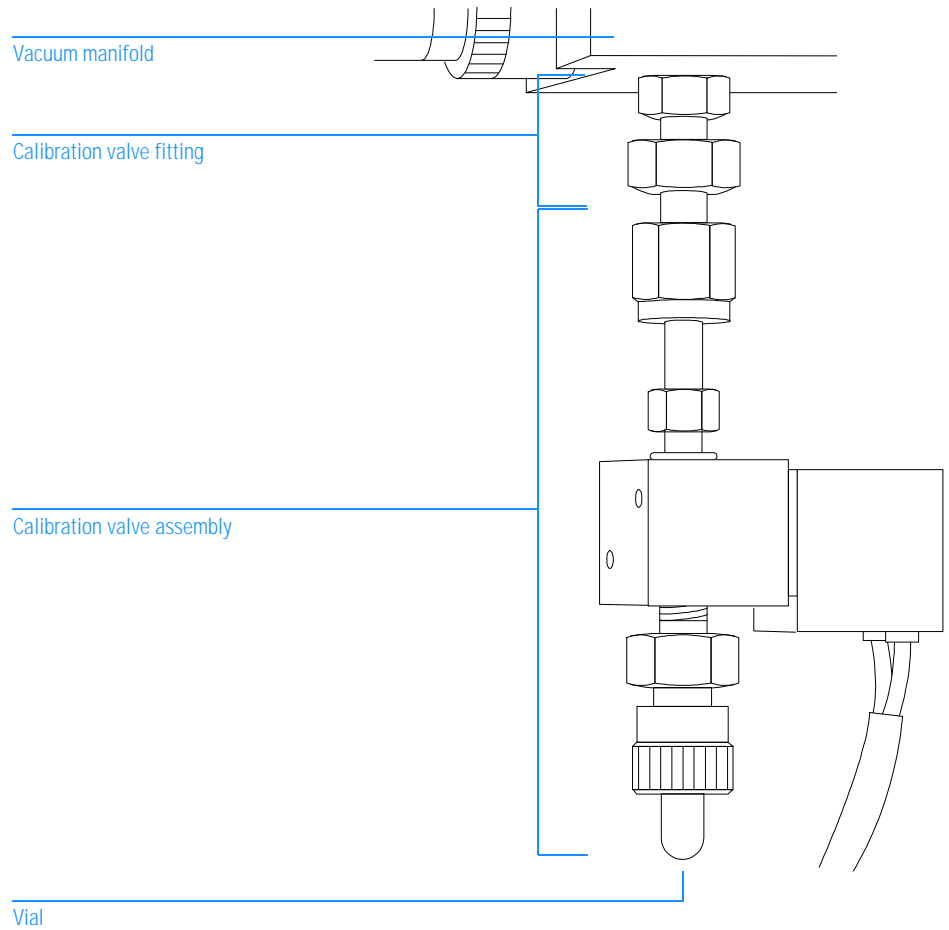


Calibration valve

The calibration valve is an electromechanical valve with a vial for tuning compounds. The calibration valve is threaded into a hole in the bottom of the vacuum manifold. It is controlled from the data system.

When the calibration valve is opened, tuning compound in the vial diffuses into the vacuum manifold. The valve has a restrictor that controls the entry of the tuning compound into the vacuum manifold.

Perfluorotributylamine (PFTBA) is the most commonly used tuning compound. It is required for automatic tuning of the MSD. Other compounds can be used for manual tuning. The tuning compound is usually a liquid but can be a volatile or semi-volatile solid.



Triode gauge tube

A triode gauge tube is connected to the vacuum manifold. If your MSD is equipped with the optional HP 59864A Gauge Controller, the triode gauge can be used to measure the pressure (high vacuum) in the vacuum manifold. The triode gauge will not operate at pressures above 8×10^{-3} Torr. The triode gauge cannot be used without the gauge controller.

W A R N I N G

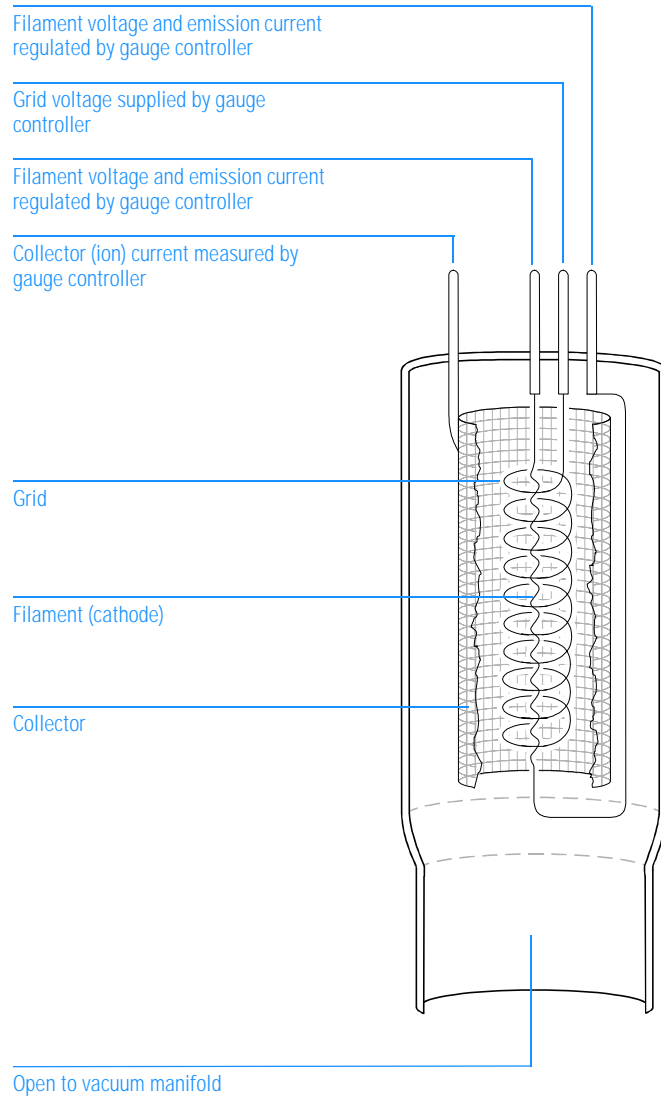
Parts of the triode gauge tube operate at approximately 180 V dc. Turn off the triode gauge before working near it.

The triode gauge relies on the ionization of gas molecules to establish a pressure-dependent current flow. In the triode gauge, electrical current is passed through a filament called the cathode. This heats the filament causing it to emit electrons. The gauge controller regulates the current to maintain a constant rate of electron emission. The electrons accelerate from the filament toward a surrounding grid which is held at a higher potential (+150 V dc).

The emitted electrons collide with gas molecules in the tube. These collisions knock electrons off of the gas molecules, forming positive ions. The positive ions are driven to a wire mesh collector which is at ground potential. At the collector, the positive ions reacquire missing electrons and become neutral again. This generates a current in the collector. The current is measured by the gauge controller.

The number of ions formed is a function of the number of gas molecules present. Pressure is also a function of the number of gas molecules present. Therefore, pressure can be calculated based on the current applied to the filament (cathode) and the current measured in the collector. Since one end of the triode gauge tube is open to the vacuum manifold, the pressure in the triode gauge is essentially the same as the pressure in the vacuum manifold.

Unlike some other pressure gauges that work by ionization, the triode gauge does not require degassing to remove accumulated ions from the surfaces in the gauge.



Gauge controller

Each MSD is equipped with a triode gauge tube. The optional HP 59864A Gauge Controller allows you to use the triode gauge to monitor the pressure in the MSD vacuum manifold. This can aid in everyday operation and in troubleshooting.

Ion gauge tube

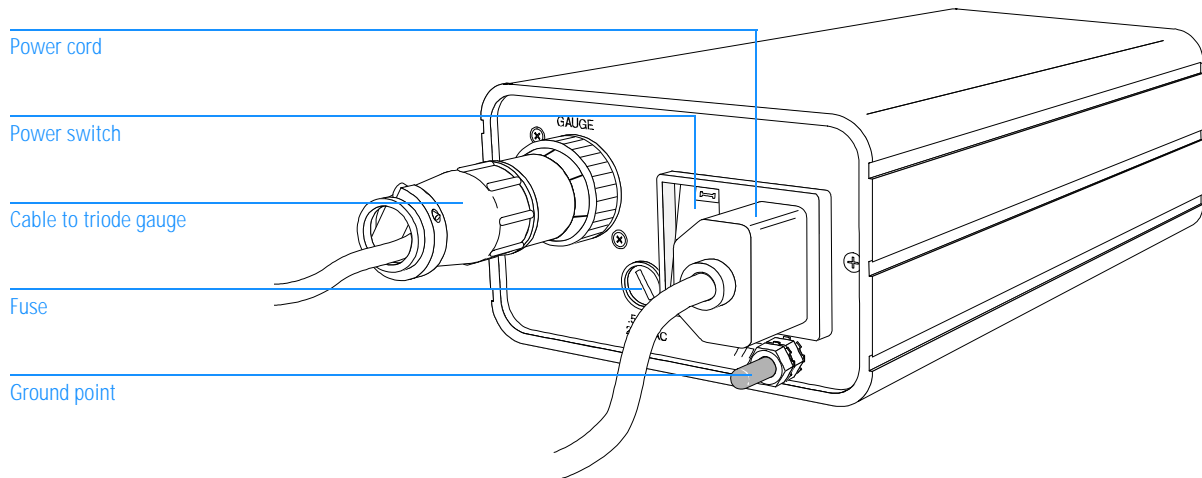
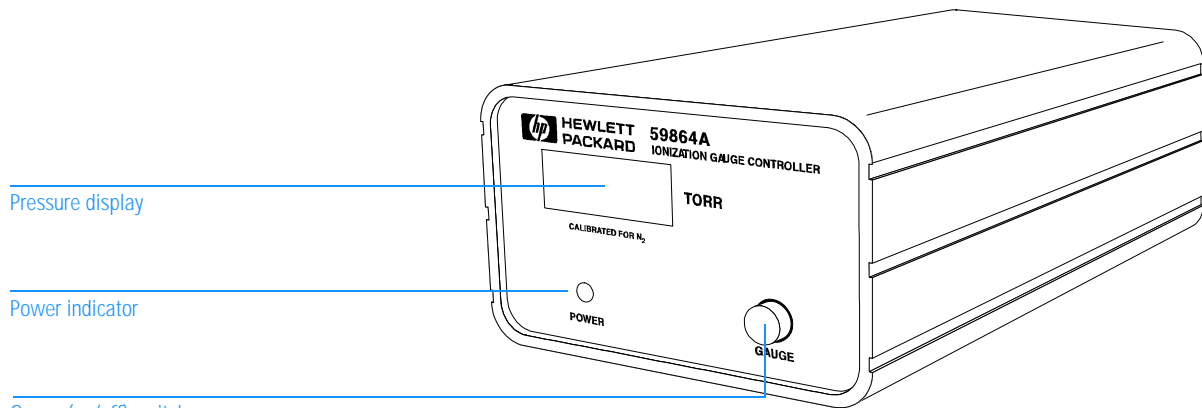
HP 5972A MSDs with serial numbers below 3501A00000 were equipped with an ion gauge tube. An ion gauge tube is functionally similar to, but physically different from, a triode gauge tube. The HP 59864A Gauge Controller cannot be used with an ion gauge tube. If your MSD is equipped with an ion gauge tube, use an HP 59822B Gauge Controller or replace the ion gauge tube with a triode gauge tube.

The HP 59864A Gauge Controller includes the gauge controller, a 2-meter power cord, and a cable for connecting the gauge controller to the triode gauge. The power cord is supplied with a connector appropriate for the country from which the order was placed. The gauge controller can operate on all voltages between 100 and 240 V ac (nominal). It can operate at ac frequencies of 50 to 60 hertz. The fuse in the gauge controller is appropriate for all allowed voltages.

The gauge controller regulates the current to the filament of the triode gauge tube, ensuring a constant emission of electrons from the filament. It also measures the ion current in the collector. From these data, the gauge controller calculates and displays the pressure present in the vacuum manifold. The vacuum manifold pressure (in Torr) is displayed on the front panel of the controller.

The gauge controller has no degas circuit because the triode gauge tube does not require degassing.

The gauge controller is calibrated for nitrogen (N_2). The dominant gas in the MSD is the carrier gas (usually helium). In these cases, the pressure reading on the gauge controller will not be absolutely accurate. It is an *indicated* pressure, not an *absolute* pressure. If the gauge controller is calibrated for nitrogen, and is measuring helium, the indicated pressure will be approximately a factor of 6 lower than the absolute pressure (for example, an indicated pressure of 2.0×10^{-5} versus an absolute pressure of 1.2×10^{-4}). The distinction between indicated and absolute pressure is generally not important for day-to-day operation of the MSD. Of greater concern are changes in pressure from hour to hour or day to day. These changes can indicate impending problems and the need for maintenance.



All the pressures listed in this manual are indicated pressures for helium carrier gas. The gauge controller setpoints are also indicated pressures.

See Also

To monitor vacuum manifold pressure, page 46

GC interface, 272

GC Interface

This chapter describes the function of the GC interface

GC interface

The GC interface provides a heated sample path from the GC oven to the ion source in the MSD. It is mounted on the KF25 flange on the right side of the vacuum manifold. One end of the GC interface passes through the side of the gas chromatograph and protrudes into the GC oven. The other end of the GC interface fits into a socket on the ion source.

The GC interface is heated by an electric cartridge heater. On the HP 5972A MSD, the heater is powered by 110 V ac electricity from either the detector B (Det B) heated zone or the auxiliary (Aux) heated zone of an HP 5890 GC. On the HP 6890 Series MSD, the heater is powered by 40 V dc electricity from auxiliary heated zone 2 (Aux 2) of the HP 6890 Series GC.

The GC interface temperature can be set from the data system. It can also be set from the keypad of the gas chromatograph. A sensor (thermocouple) in the GC interface monitors the temperature. The bellows on the interface provides a high-thermal-impedance path, so that the vacuum manifold and manifold O-ring stay relatively cool.

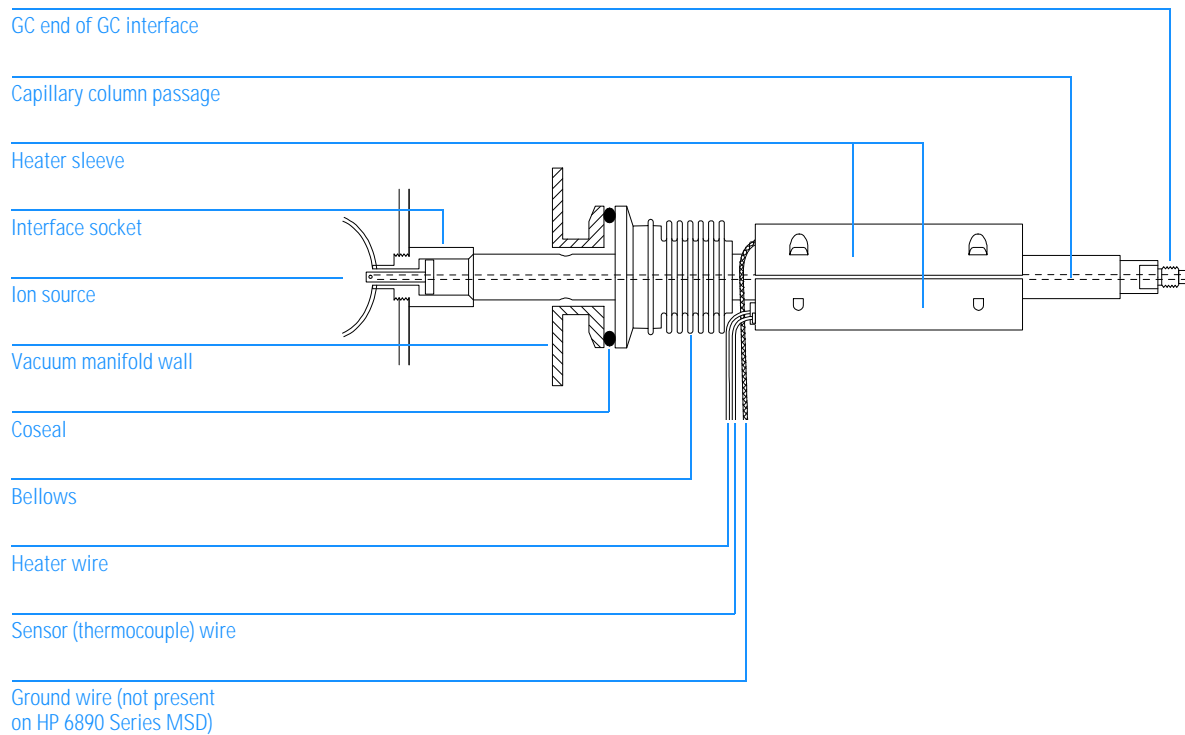
The GC interface should be operated in the 250° – 320°C range. Subject to that restriction, the GC interface temperature should be slightly higher than the maximum GC oven temperature.

A fused-silica transfer line runs through the center of the GC interface. The GC eluent flows through the transfer line. If the GC column is a narrow-bore (0.20 mm id) or wide-bore (0.32 mm id) capillary column, the last 20 cm of the column can be inserted directly into the GC interface to serve as the transfer line (subject to flow restrictions). If a megabore or packed column is installed in the GC, an effluent splitter or jet separator must be used to reduce the column flow into the MSD. A separate piece of capillary column is then installed as the transfer line.

See Also

Radiator on page 278 for more information about indirect heating of analyzer components by the GC interface.

Installing GC Columns on page 17



Radiator, 278
Ion source, 280
Mass filter, 284
Electron multiplier, 287

Analyzer

This chapter describes the analyzer

Analyzer

The analyzer is the heart of the MSD

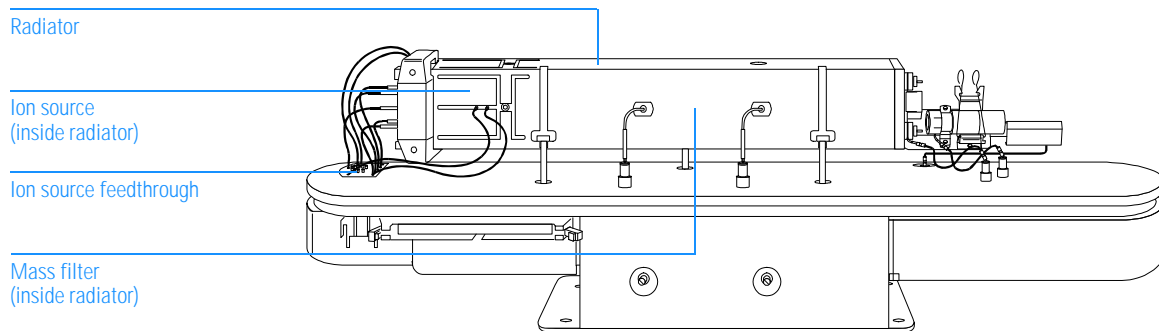
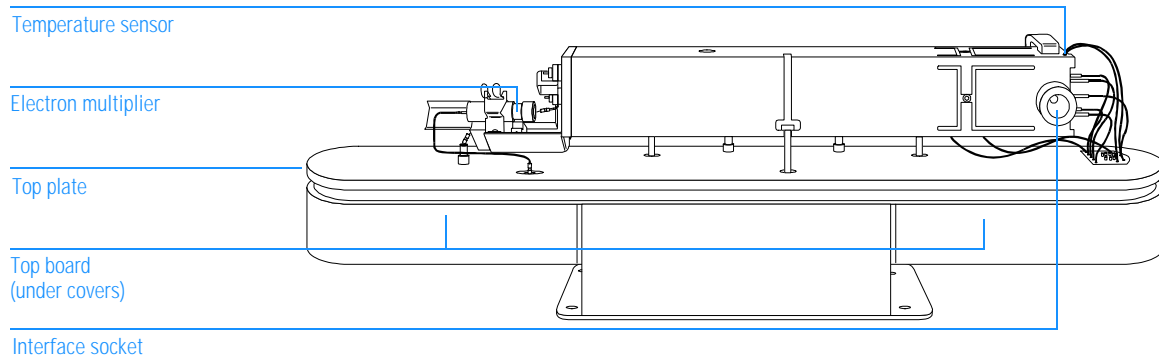
The analyzer ionizes the sample, filters the ions, and detects them. The sample components exiting the GC column flow into the ion source. In the ion source, the sample molecules are ionized and fragmented. The resulting ions are expelled from the ion source into the quadrupole mass filter. The mass filter allows selected ions to pass through the filter and strike the electron multiplier at the exit of the filter. The electron multiplier generates a signal proportional to the number of ions striking it. The analyzer is suspended from the top plate inside the vacuum manifold.

The analyzer has four basic components

The analyzer consists of the following components:

- Radiator
- Ion source
- Mass filter
- Electron multiplier

Each of these is discussed in the following material.



Radiator

The ion source and quadrupole mass filter are housed in a square aluminum tube called the radiator. The radiator is conductively heated by the GC interface. The radiator geometry determines the relative heating of the analyzer components. Because the analyzer is heated indirectly, it responds slowly to changes in the GC interface temperature. After pumpdown, it takes at least 4 hours for the analyzer to reach thermal equilibrium. Data acquired sooner may not be reproducible.

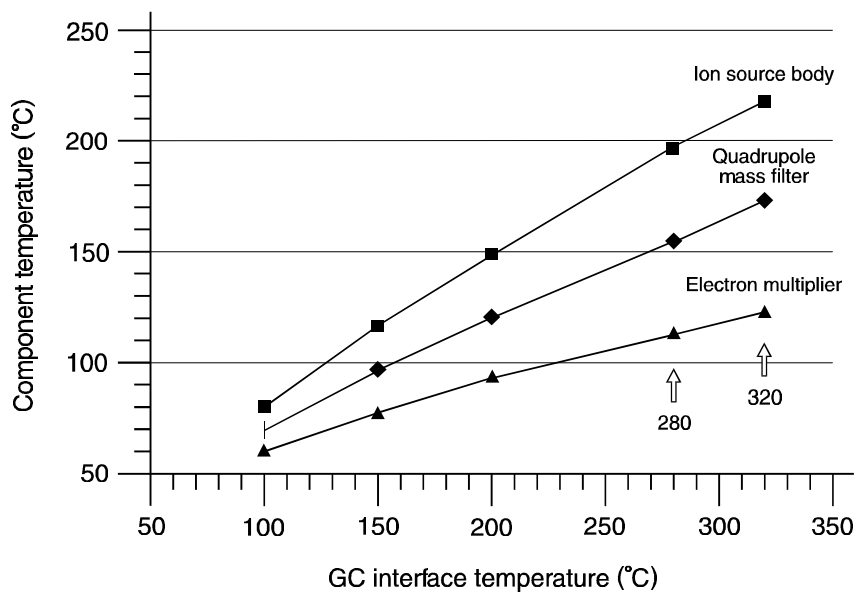
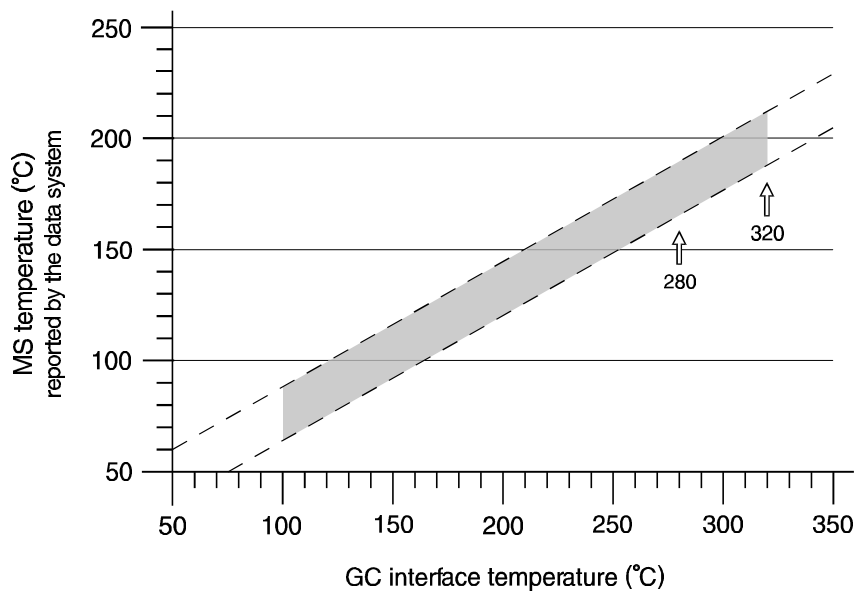
To establish proper analyzer temperature, the GC interface assembly should be operated in the 250° to 320°C range. A typical GC interface temperature is 280°C. Corresponding temperatures for the various parts of the analyzer are approximately:

- Radiator near the ion source (MS temperature) 175°C
- Ion source 195°C
- Mass filter 155°C
- Electron multiplier 110°C

The MSD has two temperature sensors. One sensor is in the GC interface. Its temperature can be read from the data system or from the GC. If you are using an HP 5890 GC, the GC interface temperature will be called the Det B temperature or the Aux temperature depending on which heated zone controls the GC interface. If you are using an HP 6890 Series GC, the GC interface temperature will be called the Auxiliary 2 (thermal aux 2) temperature. The other sensor is in the radiator near the ion source. Its temperature can be read only from the data system. In the MS ChemStation software it is called the MS temperature.

The top figure on the opposite page is a graph of MS temperature as a function of GC interface temperature. The relationship is shown as a band rather than a line because MS temperature can vary slightly from instrument to instrument.

The bottom figure on the opposite page is a graph of ion source temperature, quadrupole mass filter temperature, and electron multiplier temperature as a function of GC interface temperature. All temperature curves shown are approximations that can vary slightly from instrument to instrument.



Ion source

The ion source is an electron-ionization ion source. It has a cylindrical geometry, which ensures proper concentric alignment of the ion source elements. The sample enters the ion source from the GC interface. Electrons emitted by one of the filaments enter the ion source volume, which is at ground potential. A small permanent magnet focuses the electron beam. The electrons ionize and fragment the sample molecules. Positive and negative ions are generated. Positive ions are repelled from the ion source volume. They pass through several electrostatic lenses. These lenses concentrate the ions into a tight beam.

Ion source body

The ion source body is a cylinder. It holds the other parts of the ion source. With the repeller and the drawout plate, it forms the ion source volume. The ion source volume is the space where the ions are formed. The source body is slotted. This makes it easier for the vacuum system to pump away carrier gas and un-ionized sample molecules or fragments.

Filaments

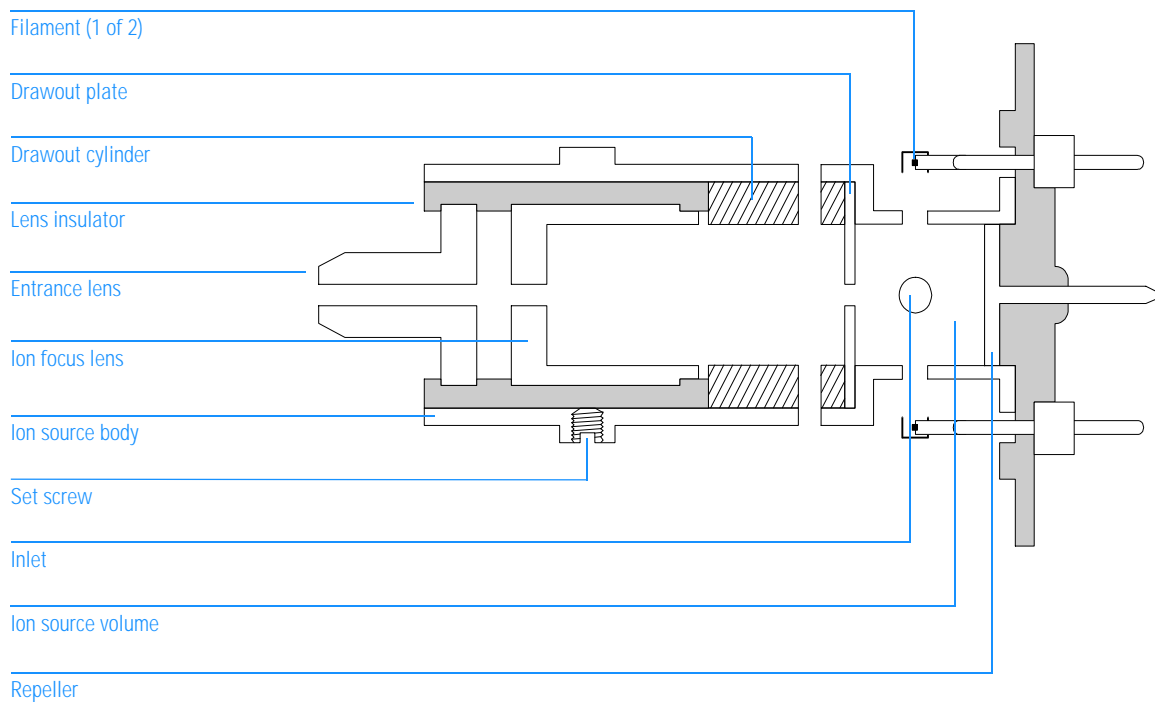
Two filaments are located on opposite sides of the outside of the ion source. The filaments emit electrons that ionize the sample molecules. In addition to the ac power that heats them, each filament carries a -70 V dc bias voltage.

Only one filament can be active at a time. The active filament can be chosen through the data system. Turning the active filament off when it is not in use prolongs filament life. Turning the active filament off for large solvent peaks can also prevent filament damage. The filament is shut off automatically if there is a general instrument shutdown.

There are two parameters that affect the filaments: filament emission and filament selection.

Filament emission

The filament emission current is variable but typically set at 50 μA . The filament emission parameter allows you to specify the emission current.



Filament selection

The filament selection parameter allows you to select which filament in the ion source is active.

- Filament 1 is also referred to as filament B, and the up filament.
- Filament 2 is also referred to as filament A, and the down filament.

Frequently, one filament will give better performance than the other. The better of the two filaments is noted on the final-test sheet accompanying your MSD. No MSD is shipped until it passes all tests using each filament.

After replacing a filament, you must determine which filament gives better performance. To do this, run two autotunes, one with each filament. Use the filament that gives the best results.

Repeller

The repeller forms one wall of the ion source volume. A positive charge on the repeller pushes positively-charged fragments and parent ions out of the source through a series of lenses. The repeller voltage is also known as the ion energy, although the ions only receive a fraction of the repeller energy.

The repeller voltage can be varied from 0 to +42.8 V dc. Some tune programs use a fixed repeller voltage. Others ramp the repeller voltage to find the optimum setting.

- A too low repeller voltage results in poor sensitivity and poor high mass response
- A too high repeller voltage results in a precursor (poor mass filtering) and poor low mass resolution

Drawout plate and cylinder

The drawout plate forms another wall of the ion source volume. The drawout cylinder is slotted. The slots correspond to slots in the source body. These allow carrier gas and un-ionized sample molecules or fragments to be pulled away by the vacuum system. The drawout plate and drawout cylinder are both at ground potential. The ion beam passes through the hole in the drawout plate.

Ion focus

The voltage on the ion focus lens can be varied from 0 to -127 V dc. A typical voltage is between -60 and -100 V dc. In general:

- Increasing the ion focus voltage improves sensitivity at lower masses.
- Decreasing the ion focus voltage improves sensitivity at higher masses.
- Poor ion focus adjustment results in poor high mass response.

Entrance lens

The entrance lens is located at the entrance to the quadrupole mass filter. This lens minimizes the fringing fields of the quadrupole which discriminate against high-mass ions. Two voltages are applied to the entrance lens. One voltage is fixed. The other voltage varies according to the ion mass currently being passed through the mass filter. In addition, +4.4 V dc is permanently applied to the entrance lens.

Entrance lens gain

Entrance lens gain controls the variable voltage applied to the entrance lens. It determines how many volts are applied for each amu. It can be varied from 0 to -128 mV/amu. A typical range is -30 to -60 mV/amu.

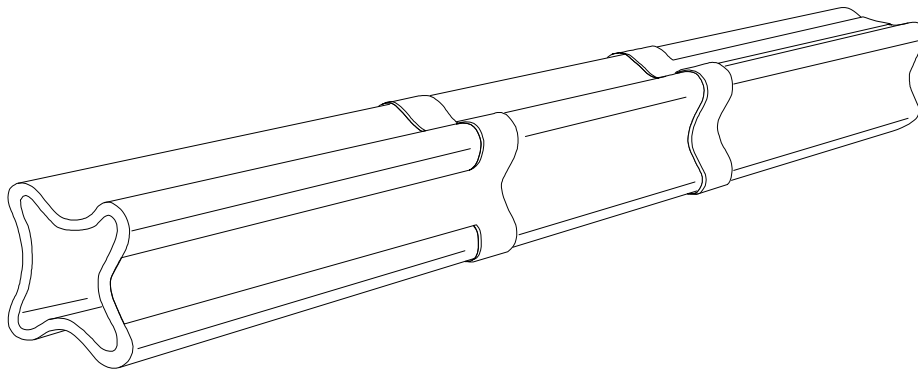
Entrance lens offset

The entrance lens offset controls the fixed voltage applied to the entrance lens. It can be varied from 0 to -64 V dc. Increasing the entrance lens offset generally increases the abundance of ions at low masses without substantially decreasing the abundance of high mass ions.

Mass filter

The mass filter separates ions according to their mass-to-charge ratio (m/z). At a given time, it only ions of a selected mass-to-charge ratio can pass through the filter to the detector.

The mass filter is a fused-silica tube with a hyperbolic geometry. The four hyperbolic segments are coated on the inside with a conductive material. Opposing segments are connected together.



A combined direct current (dc) and radio frequency (RF) signal is applied to the two pairs of segments. The magnitude of the RF voltage determines the mass-to-charge ratio of the ions that pass through the mass filter and reach the detector. The ratio of dc-to-RF voltage determines the resolution (widths of the mass peaks). There are several parameters that control the dc and RF voltages:

- Dc polarity
- Amu gain
- Amu offset
- 219 width

Dc polarity

The dc polarity parameter selects the orientation of the direct current applied to the quadrupole mass filter. The value can be positive or negative. The dc polarity that works best for your MSD is determined at the factory. It is listed on the final test sheet accompanying your MSD. It is also listed on a label on the cover over the RF coils. This cover can be viewed by removing the upper MSD cover.

AMU gain

AMU gain affects the ratio of dc voltage to RF frequency on the mass filter. This controls the widths of the mass peaks.

- A higher gain yields narrower peaks.
- Amu gain affects peaks at high masses more than peaks at low masses.

AMU offset

AMU offset also affects the ratio of dc voltage to RF frequency on the mass filter.

- A higher offset yields narrower peaks.
- Amu offset generally affects peak widths equally at all masses

219 width

m/z 219 is a prominent mass in PFTBA. This parameter makes small corrections to the m/z 219 peak width. The correction is electronic; it does not alter the voltages applied to the mass filter. Amu gain and amu offset must be readjusted after the 219 width is changed. If you are tuning with a compound other than PFTBA, there may not be an ion at m/z 219. In that case, set the 219 width to the last value found for it by autotune or set it to 0.

Mass filter

The mass filter fits accurately over the end of the entrance lens, so that the entrance lens centers the quadrupole. The exit end of the quadrupole is held in place by a ceramic insulator.

The mass filter requires no periodic maintenance. If maintenance is performed around the mass filter, care should be taken; the mass filter can be damaged by water or solvents with free chloride. Acetone, hexane, and freon can be used safely around the mass filter.

CAUTION

Never use water or solvents with free chloride anywhere near the mass filter. These can ruin the mass filter.

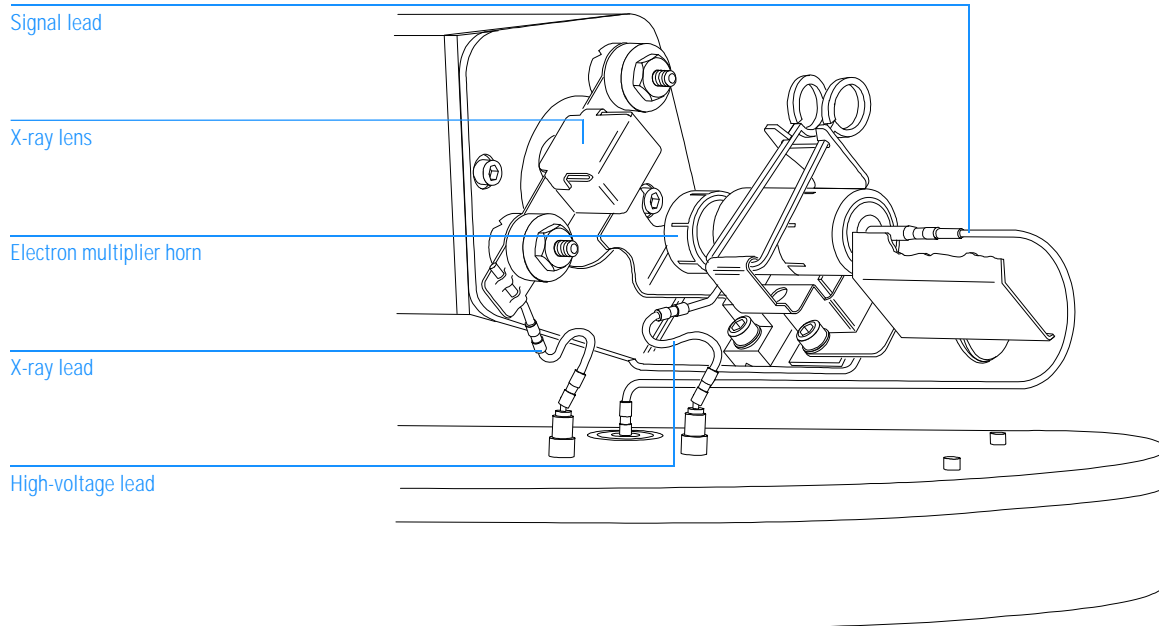
CAUTION

Never change the physical orientation of the quadrupole mass filter.

Electron multiplier

The electron multiplier is located at the exit end of the quadrupole mass filter. It receives the ions that have passed through the mass filter. The electron multiplier generates an electronic signal proportional to the number of ions striking it. The electron multiplier has two main components:

- X-ray lens
- Electron multiplier horn



Electron multiplier**X-ray lens**

The x-ray lens directs ions into the electron multiplier horn. The horn is located off-axis from the center of the quadrupole mass filter to minimize signals due to photons, hot neutrals, and electrons coming from the ion source. The optimum x-ray voltage is affected by the electron multiplier voltage. For that reason, the electron multiplier voltage is usually set first. Then, the x-ray voltage is ramped to determine the setting that provides the greatest abundance.

Electron multiplier horn

The electron multiplier horn usually carries a high negative potential (voltage) which attracts the positive sample ions. Ions strike the interior of the horn and liberate secondary electrons. These cascade through the horn, liberating more electrons as they go. A shielded cable carries the electron multiplier output to a logarithmic amplifier on the main board. The overall gain of the system is adjusted to about 10^5 .

The voltage applied to the electron multiplier horn determines the gain. The voltage is adjustable from 0 to -3000 V dc. The electron multiplier voltage found in autotune should be used as a baseline for the electron multiplier voltage setting.

- To increase sensitivity, increase the electron multiplier voltage.
- For concentrated samples where less sensitivity is needed, decrease the electron multiplier voltage.

The voltage required by the electron multiplier generally increases over time. If the electron multiplier voltage must always be set at or near -3000 V dc to achieve adequate sensitivity, it may need to be replaced.

See Also

Troubleshooting the MSD on page 63 for more information about symptoms that may indicate electron multiplier problems.

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Electronics

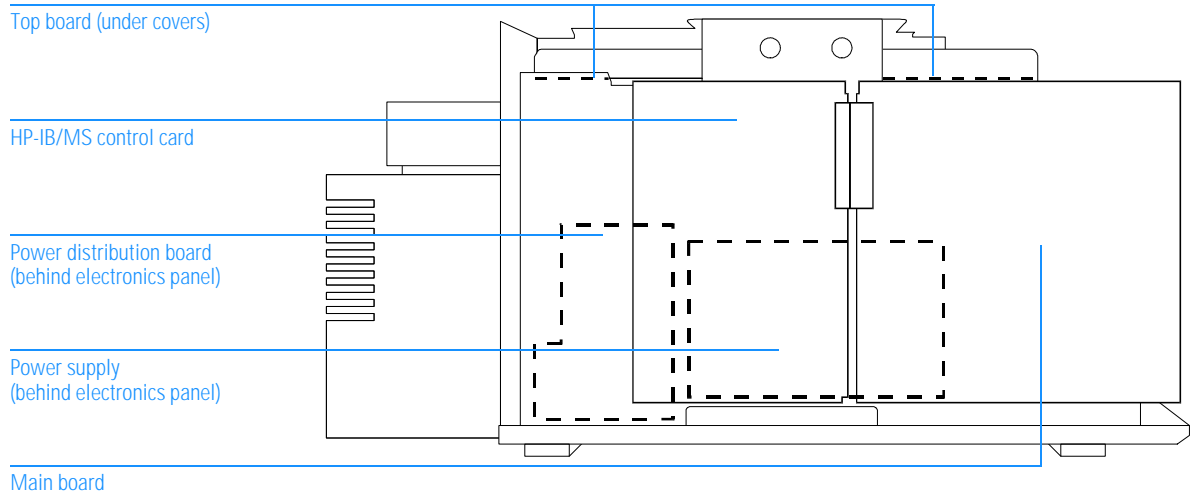
This chapter describes how the MSD electronics work

Electronics

The following assemblies make up the MSD electronics:

- Top board
- Main board
- HP-IB/MS control card
- Power distribution board
- Power supply
- Connectors and controls
- Status display
- Parallel/remote board

Each is discussed in this chapter. Except for the *Connectors and controls* and *Status display* sections, most of this material is not essential for day-to-day operation of the MSD. It may be of interest to persons responsible for servicing the MSD. Some of the material in the *Main board* and *HP-IB/MS control card* sections may be of interest to advanced users who need to interface the MSD to external devices.



Top board

The top board is mounted on the top plate. It performs the following functions:

- Generates the RF component of the voltage applied to the quadrupole mass filter according to a signal from the main board
- Generates the dc component of the voltage applied to the quadrupole mass filter – the magnitude of this voltage is proportional to the RF voltage
- Generates the 0 to -3000 V dc that is applied to the horn of the electron multiplier
- Amplifies the signal from the thermocouple near the ion source and sends the signal to the main board
- Passes voltages generated on the main board to elements in the ion source and the electron multiplier
- Switches the filament power from one filament to the other when commanded by the data system

The top board contains the following functional elements:

- RF amplifier
- DC amplifiers
- High voltage supply
- Thermocouple amplifier
- Alternate filament relay
- Feedthrough connections

RF amplifier

The RF amplifier supplies the RF component of the voltage to the quadrupole mass filter. The magnitude of this RF voltage determines the mass-to-charge ratio of the ions that will be transmitted through the mass filter. The RF voltage magnitude is controlled by a 0 to -10 V signal on the mass axis line from the main board. The RF amplifier has three main parts:

- RF modulator
- RF transformer
- RF detector

RF modulator

The RF modulator generates a 1 MHz square wave. Its amplitude is proportional to the voltage on the mass axis line. The square wave varies from 0 to +11 V as the mass axis signal varies from 0 to -7.9 V. The output of the RF modulator is disabled if the shutdown line is active.

RF transformer

The output of the RF modulator drives the primary winding of the RF transformer (a transformer-coupled tuned amplifier). The secondary winding consists of two adjustable coils. These coils, together with the quadrupole capacitance, form a circuit that is resonant at 1 MHz. The resonant condition can be detected by measuring the voltage at the DIP test point, or by using the data system to monitor the voltage on the coil dip line to the main board.

The coils can be adjusted with a small nonmetallic tuning wand. As the circuit is tuned through resonance, the voltage dips. For that reason, the adjustment procedure is called “dipping the coils”. The coils do not need to be adjusted during normal operation. If either the quadrupole mass filter or the top board is replaced, the coils will need to be adjusted.

The mass of the transmitted ions ranges from 1.2 to 700 amu, as the output of the RF transformer ranges from approximately 1.2 to 700 V rms.

Top board***RF detector***

The RF detector samples the 1 MHz RF voltage across the quadrupole. Through full-wave rectification and filtering, the detector produces a dc voltage proportional to the magnitude of the RF voltage. This voltage can be measured at the RF DET test point.

The RF modulator, RF transformer (tuned amplifier), and RF detector are arranged in a closed loop so that the RF output can be very accurately controlled. The RF detector output is equal in magnitude and opposite in polarity to the mass axis signal. The RF detector output is summed with the mass axis signal at the input of the RF modulator.

If the feedback loop is not completed, the operational amplifier at the input of the RF modulator will be driven to its positive limit. This activates the RF fault signal to the main board. When an RF fault occurs, a message is displayed by the data system. If the loop is incomplete for a reason other than an RF amplifier malfunction (as, for example, when another fault shuts down the RF amplifier), this message will not be displayed.

The gain of the RF detector is approximately 0.01 (10 V dc output for about 1000 V RF input). The exact ratio is fixed by a set of three parallel resistors. Two of these are factory selected during the board test process so that the RF detector gain, and hence the gain of the RF amplifier as a whole, will be accurate enough to assure proper mass selection by the quadrupole.

Dc amplifiers

The dc amplifiers supply the dc component of the voltage to the quadrupole mass filter. This dc voltage is proportional to the RF voltage (and hence proportional to the mass axis signal from the main board). The ratio of the dc voltage to RF voltage determines the resolution of the mass filter.

There are two dc amplifiers, U- and U+. The U- amplifier has the output of the RF detector as its input. Its gain is -19.159. This gain can be adjusted slightly by the ratio adjust signal from the main board. As the output of the RF detector varies from 0 to +7.9 V, the output of the U- amplifier varies from 0 to -154 V (-151 V plus the ratio adjust contribution). The U+ amplifier operates as an inverter. It has a gain of -1. The U- and U+ amplifier outputs can be measured at the U- and U+ test points, respectively.

The U+ and U- amplifier outputs are added to the RF voltage. RF filters keep the RF voltage from coupling back into the U+ and U- amplifiers.

The polarity of the dc voltage can be reversed. When the U+/U- polarity line from the main board is held low, the alternate polarity relay is activated. Generally, a particular quadrupole mass filter will operate better on one dc polarity or the other. The better polarity is selected at the factory. Polarity should generally not be change unless the quadrupole is replaced. The better polarity for the mass filter in your MSD is listed on the final-test sheet accompanying the instrument.

When the TTI (true total ion) line is active (low), the TTI relay is energized. This interrupts the RF input to the U- amplifier. This drives the U- and U+ outputs to zero, cutting off the dc voltage to the quadrupole. When there is no dc voltage on the quadrupole, it acts as a high-pass mass filter. The low-mass cutoff is proportional to the amplitude of the RF voltage. This is the true total ion mode of operation.

Top board**High voltage supply**

The high voltage supply is a non-inverting amplifier with a gain of about 486. It is driven by the HV drive signal from the main board. HV drive varies from 0 to -6.3 V. The high voltage supply generates a 0 to -3000 V output. This voltage is applied to the horn of the electron multiplier. If the high voltage supply is working properly, the HV test point will have the same value as HV drive.

If there is a malfunction in the high voltage amplifier, an HV fault signal is generated and sent to the main board. This causes the data system to display an error message. If the shutdown line is active, the high voltage supply shuts down. This also generates an HV fault signal. If the HV fault is caused by an active shutdown line, the data system may or may not display a high voltage error message. This depends on the software mode.

Thermocouple amplifier

A type K (red/yellow or chromel/alumel) thermocouple is attached to the radiator near the ion source. The signal from the thermocouple is the input to the thermocouple amplifier on the top board. The amplifier's output can be measured at the TEMP test point. The voltage at the test point should be 10 mV/°C. At room temperature this would be approximately 0.25 V. The temperature of this thermocouple is displayed by the data system. It is called the MS temperature.

Alternate filament relay

Filament power is supplied by the main board. This power can be routed to either of two filaments in the ion source. When the alternate filament signal is held low, the alternate filament relay on the top board is energized. This switches the filament power from filament 1 (B) to filament 2 (A). The active filament can be selected from the data system.

Feedthrough connections

Four other dc voltages are generated on the main board. These are the repeller, ion focus, and entrance lens voltages to the ion source, and the x-ray voltage to the electron multiplier. They are passed through the top board and through feedthroughs in the top plate to the ion source and electron multiplier.

Main board

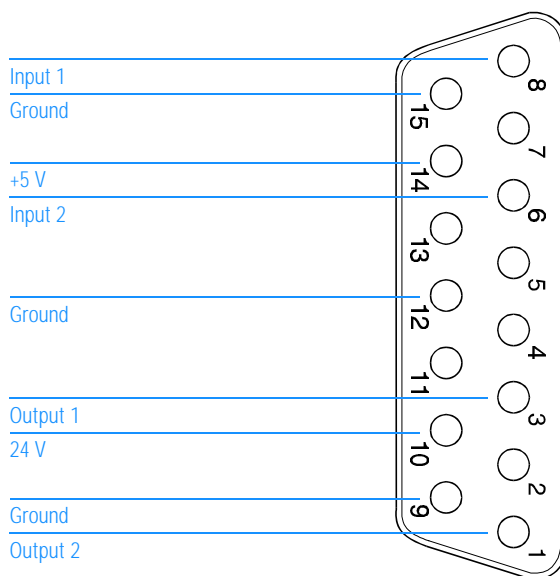
The main board is mounted on a vertical piece of sheet metal called the electronics panel. The main board performs the following functions:

- Receives and decodes digital information from the HP-IB/MS control card
- Sends digital information to the HP-IB/MS control card
- Generates voltages for the ion source filaments, repeller, ion focus lens, entrance lens, x-ray lens, electron multiplier high-voltage control, quadrupole RF voltage control, and dc/RF ratio adjustment
- Generates control signals for alternate filament selection, filament emission current, quadrupole dc polarity, and true total ion mode selection
- Performs logarithmic amplification for the electron multiplier output
- Performs analog-to-digital conversion for the logarithmic amplifier output, coil DIP signal, ion source temperature signal, and foreline pressure signal
- Monitors the too hot, too cold, and foreline pressure signals from the vacuum system and monitors the HV fault and RF fault signals from the top board; based on these signals, implements the safety interlocks
- Activates the shutdown line to the top board when the analyzer electronics should be disabled
- Controls the calibration valve
- Energizes the filaments (one at a time)
- Provides accessory control
- Generates a 1-MHz clock signal for the top board
- Generates ± 250 V dc (nominal) power for dc amplifiers and lens power supplies on the top board

Accessory control

An accessory control connector is located above the power cord on the back panel of the MSD. The connector is part of the accessory control cable which attaches to connector J5 on the main board. It extends the functions of J5 to a more accessible location.

The accessory control connector provides an interface through which external devices such as LEDs and solenoids can be powered and controlled. It also provides a path for inputs such as a remote start signal. The Analytical Products Group (APG) remote connector (labeled REM) at the top of the MSD back panel is normally used to receive remote start signals. The accessory connector can be used for special applications such as GC/IRD/MSD systems. It can also be used for coordination with instruments that cannot communicate on the APG bus.



Main board***Input lines***

Input lines 1 and 2 (pins 8 and 6, respectively) are connected to a 74LS244N logic chip. The logic chip is inactive when the voltage on the lines is above +2.0 V. Line voltages between +2.0 V and +0.7 V produce indeterminate logic states.

When there is no input to the input lines, the voltages on the lines are pulled toward +5 V by 1 kilohm resistors between the input lines and the +5-V power supply. Under these conditions, the logic chip is inactive.

If an input line voltage is pulled down to less than +0.7 V, that input line is active. The input driver must sink 4.3 mV below +0.7 V to ensure that the input signal is recognized. The logic chip does not latch inputs. As a result, an input line voltage must be low (the chip must be active) when the input is being read by the data system. Most software reads the input status several times in quick succession to avoid erroneous responses to a single noise transient.

The status of an input line can be read through the data system by using the XFER command. The response is a number that identifies the states of the two input lines.

*Command***XFER 20480**

Input 1	Input 2	Response
Inactive (high)	Inactive (high)	4095
Active (low)	Inactive (high)	4094
Inactive (high)	Active (low)	4093
Active (low)	Active (low)	4092

Output lines

The output driver is a 75462 dual peripheral, positive NAND driver integrated circuit. When the output lines are inactive, their voltages can range from 0 to 24 V depending on the circuit to which they are connected (passive high). A diode in each output circuit limits the lines to a maximum of 24 V. When the output lines are active, they are pulled down to below 0.4 V (active low).

The output lines can be activated or deactivated through the data system by using the XFER command. The state of the lines, active or inactive, is determined by a number, n, appended to the command. The number, n, can be 0-3.

Command

XFER 28416,n

n	Output 1	Output 2
0	Inactive (high)	Inactive (high)
1	Active (low)	Inactive (high)
2	Inactive (high)	Active (low)
3	Active (low)	Active (low)

Other lines

There are five other lines on the accessory connector: three ground lines, one +5-V dc line, and one +24-V dc line.

The three ground lines are tied directly to the main board ground. The main board ground is tied directly to the instrument ground.

The +24-V line allows the output lines to drive loads such as 24-V relays or solenoids. The +5-V line allows the output lines to drive loads such as LEDs or TTL logic devices. Either the +5-V or +24-V lines can be used to power small interface circuits, which might be useful in achieving hardware compatibility between the MSD and external accessories. Consult a Hewlett-Packard Customer Engineer before attempting to draw more than 100 mA for this purpose.

Make sure the voltage drops across resistances do not seriously affect the 0.7 – 2.0 V margin on the input lines. For example, if a ground wire is too small and there is a 0.8-V drop on the ground due to the external load, the input circuitry may not correctly read an active (low) input.

HP-IB/MS control card

The HP-IB/MS control card is located to the left of the main board on the electronics panel. The HP-IB/MS control card has two main functions:

- Providing a communication interface between the MSD and the data system
- Providing real-time control of the MSD, freeing the data system for other tasks

Functional areas of the HP-IB/MS control card include:

- Instrument controller
- Data processor
- Main processor
- Serial communication processor
- HP-IB controller
- Remote control processor

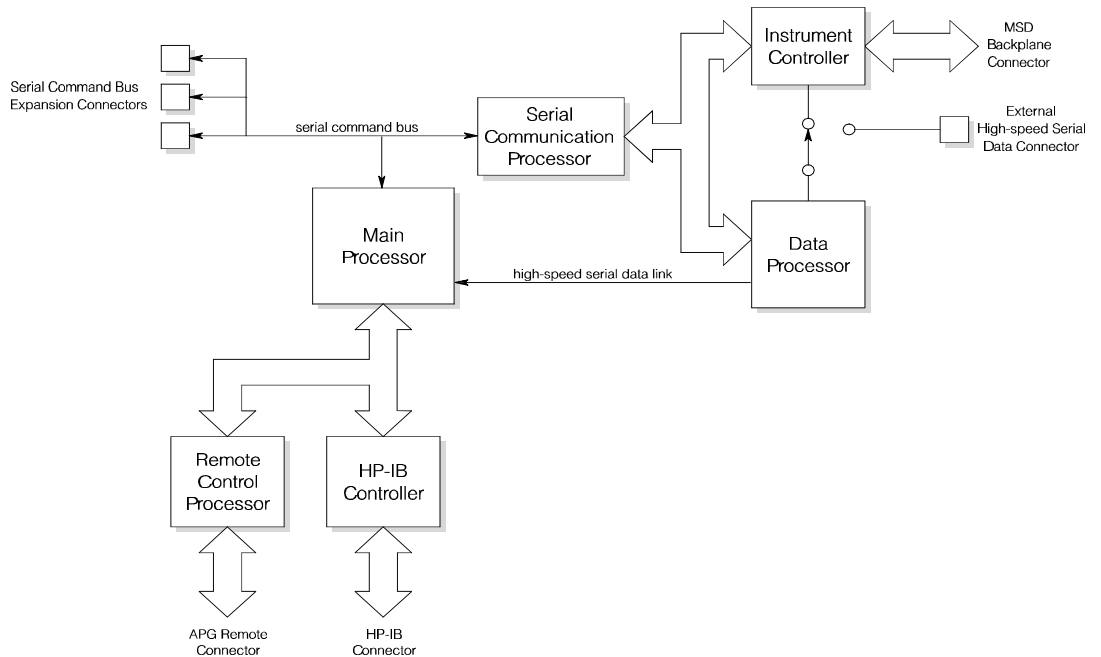
Each of these is described in the following material.

Instrument controller

The instrument controller controls scanning of the mass filter. It also collects signal data from the analog-to-digital converter and passes that data to the data processor. The instrument controller can also dynamically ramp the lens voltages.

Data processor

The data processor filters data collected by the instrument and packages it into a format the data system can accept. This data is passed to the main processor through a high-speed serial data link.



Main processor

The main processor receives data from the data processor. It stores the data until it is requested by the data system. The main processor also controls real-time events such as opening valves and changing scan or SIM parameters during data acquisition.

Serial communication processor

The serial communication processor controls communications between the main processor and the data processor and instrument controller. It communicates with the main processor through the serial bus. It communicates with the data processor and instrument controller through a parallel bus. The serial communications processor is also responsible for boot-up and control of the instrument controller and data processor.

HP-IB controller

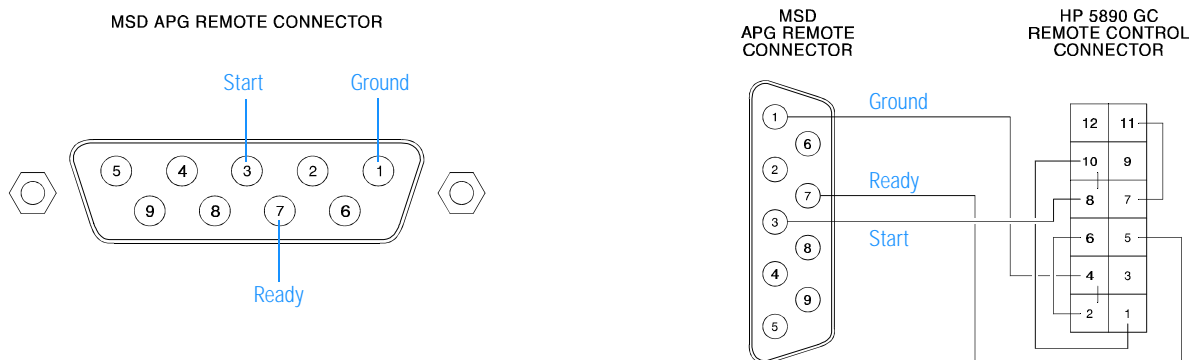
The HP-IB controller manages communication between the main processor and the data system.

Remote control processor

The remote control processor is the interface to the Analytical Products Group (APG) remote control bus. It synchronizes start-run signals with GCs, ALSs, and purge and traps. The functions of the remote control processor are extended by a cable to the APG remote connector on the back panel of the MSD.

MSDs and HP 6890 Series GCs have standard 9-pin, D-shaped, APG remote connectors. The connectors are located on the back panels of those instruments. HP 5890 GCs have a 12-pin, remote start connector that serves many of the same functions as the APG remote connector. It is located on the GC main board.

A special cable (35900-60700) is available to connect the APG remote connector on the MSD to the remote control connector on an HP 5890 GC.



An APG remote control cable (G1530-60930) is available to connect HP 6890 Series GCs and MSDs.

Interfacing to external devices

It is often necessary to communicate with external devices (for example, a purge-and-trap) during a run. Typically, these communications are:

- Requests to send a system ready signal
- Receive a start run signal from an external device
- Program the timing of events during a run

System ready

When interfacing to an external device, it is often desirable to send a system ready signal to the device. In the case of a multi-sample Tekmar purge-and-trap, each sample is purged onto a trap where it waits for a ready signal. On receipt of the ready signal, the desorb cycle begins. When a specific temperature has been reached, the purge-and-trap closes a contact to indicate the run has started.

The ready pin on the remote control connector on the GC is held low at all times except when the GC, MSD, and data system are all ready. On system ready, a logic high of 5 V dc is present between that pin and any ground. This same high can be detected between the ready and ground pins on the APG connector on the MSD.

Start run input

The best way to generate a start run signal is to use the remote control connector on the GC. Since remote cables are made for most common devices, this is often the simplest way. A general-purpose remote cable (05890-61080), which is also available, terminates in spade lugs. Care must be taken to ensure that the system is actually ready before the start run signal is sent.

If necessary, the APG remote connector on the back of the MSD can be used to send the start run signal. A contact closure between the start and ground pins will start the run if the system is ready.

Power supply

The power supply is mounted next to the power distribution board on the electronics panel below the vacuum chamber. It converts ac line power into the dc voltages used by the rest of the electronics. The power supply generates the following dc voltages:

- +24 V (nominal) with a maximum of 0.5 A
 - +15 V (nominal) with a maximum of 1.0 A
 - -15 V (nominal) with a maximum of 0.2 A
 - +5 V (nominal) with a maximum of 1.5 A
-

Power distribution board

The power distribution board is mounted on the opposite side of the electronics panel from the HP-IB/MS control card. The power distribution board performs the following functions:

- Distributes ac line power to the dc power supply and to the cooling fan
- Turns on the diffusion pump once the foreline pressure is low enough
- Regulates the ac power to the diffusion pump heater
- Disables the diffusion pump if the foreline pressure is too high or if the diffusion pump is too hot or too cold
- Passes the foreline pressure signal from the foreline gauge to the main board

The power regulator ensures that the diffusion pump heater receives constant power, even if there are fluctuations in the ac line voltage. It measures the voltage across the heater and the current through it, multiplies them together, and compares the result with a standard value. Any discrepancy is applied as an error signal to adjust the power.

If the power distribution board senses a malfunction in the diffusion pump power regulator, it shuts off power to the diffusion pump.

Connectors and controls

All connectors and controls are located on the back panel of the MSD. These include:

- APG remote control connector
- I/O (HP-IB) connector
- Accessory connector
- Ac power cord
- Power switch
- Foreline pump cord receptacle

The following material describes the functions of these connectors and controls.

APG remote connector

The Analytical Products Group (APG) remote connector is the external connector for the APG remote control circuitry on the HP-IB/MS control card. It receives remote start signals from the GC.

I/O connector

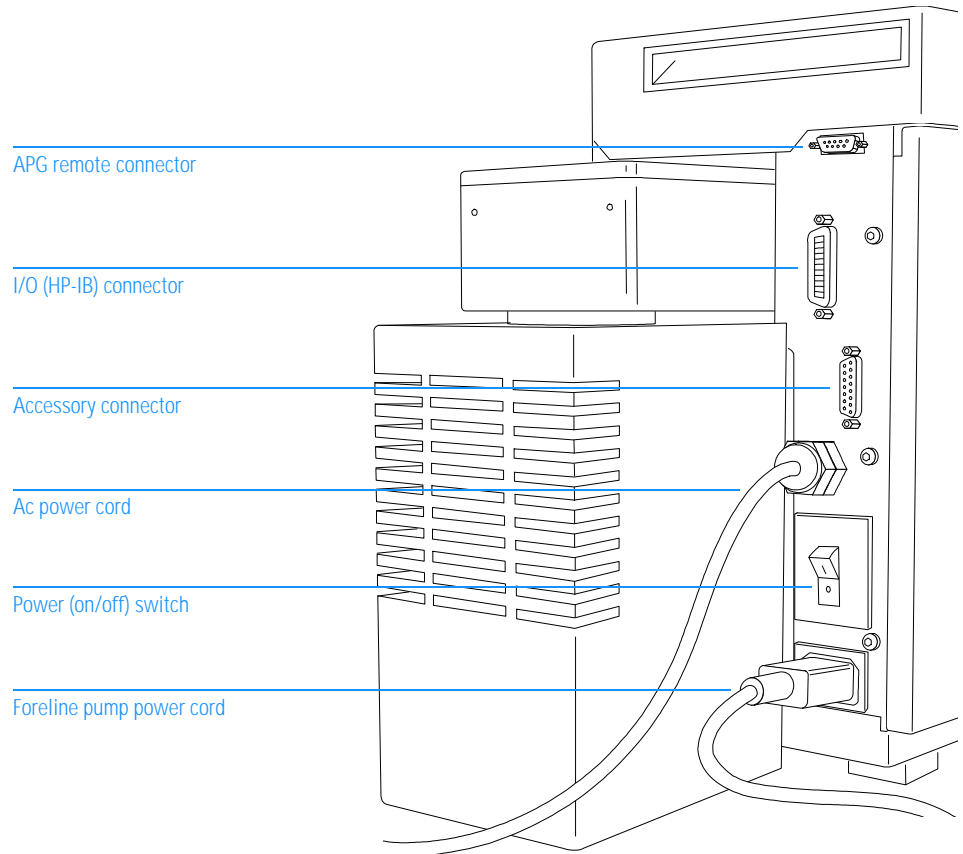
The HP-IB cable from the data system is connected to the I/O (HP-IB) connector.

Accessory connector

The accessory connector provides an interface through which external devices such as LEDs and solenoids can be powered and controlled. In addition, it provides a path for inputs such as a remote start signal from devices that cannot communicate on the APG bus.

Ac power cord

The ac power cord brings in all electrical power for the MSD.



Power switch

The power switch is a circuit breaker. It is used to switch the MSD on and off. It also functions as a circuit breaker in case of power surges.

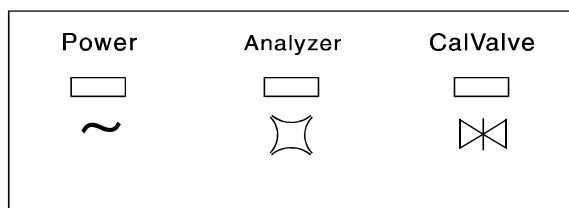
Foreline pump power cord receptacle

The foreline pump power cord receptacle provides ac power for the foreline pump. If the power switch is off, no power is supplied to the foreline pump.

Status display

The MSD has a status display along the lower front edge of the instrument. It includes three status LEDs:

- Power
- Analyzer
- Cal (calibration) Valve



Each LED provides information about the status of the MSD. In addition, if power to the MSD is interrupted, all three LEDs will blink until the data system reestablishes contact with the MSD and downloads the proper information to the HP-IB/MS control card.

Power status LED

The power status LED lights when the MSD is connected to a power source and the power switch is on.

Analyzer status LED

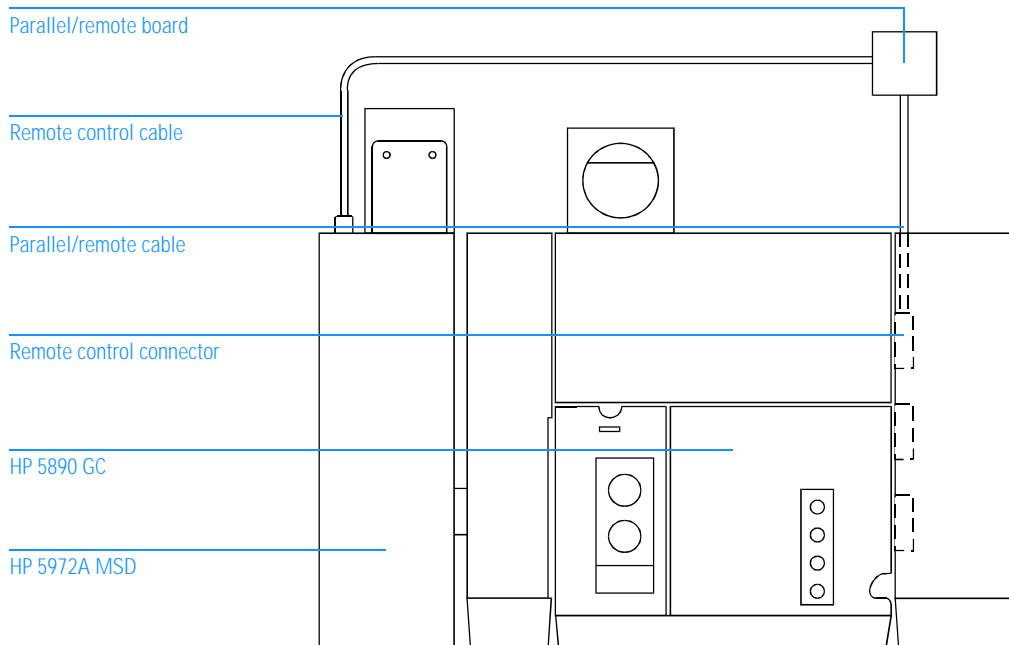
The analyzer (ion source, mass filter, and electron multiplier) is frequently off even though the MSD is powered up. This helps extend the life spans of the filaments and electron multiplier. The analyzer status LED lights when the MSD receives the MSON signal from the data system. The analyzer LED should always be on during data acquisition or tuning.

Cal valve status LED

The cal (calibration) valve status LED lights when the data system instructs the calibration valve to open.

Parallel/remote board & cable (HP 5890 GC only)

An HP 5890 GC has only one remote control connector. It is located on the GC main board. To allow more devices to be connected to the HP 5890 GC, the parallel/remote board and cable are supplied in the MSD shipping kit. The parallel/remote board is a small printed circuit board with several connectors. The parallel/remote cable connects the parallel/remote board to the remote control connector on the GC. The board and cable allow up to three devices (instead of 1) to be connected to the remote control connector.



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Parts

This chapter lists parts that can be ordered for your MSD

Parts

This chapter lists parts that can be ordered for use in maintaining your HP 5972A and HP 6890 Series MSDs. It includes most of the parts or assemblies in the MSDs. This chapter is organized so that related parts are grouped together.

To order parts

To order parts for your MSD, address the order or inquiry to your local Hewlett-Packard office. Supply them with the following information:

- Model and serial number of your MSD
- HP part number(s) of the part(s) needed
- Quantity of each part needed

Some parts are available as rebuilt assemblies

Rebuilt assemblies pass all the same tests and meet all the same specifications as new parts. Rebuilt assemblies can be identified by their part numbers. The first two digits of the last five digits of the part number are 69 or 89 (i.e., XXXXX-69XXX). Rebuilt assemblies are available on an exchange-only basis. You must return the equivalent part to Hewlett-Packard after you receive the rebuilt assembly or a price penalty will be assessed.

If you cannot find a part you need

If a part you need is not listed in this chapter, check the *Hewlett-Packard Analytical Supplies Catalog*. If you still can not find it, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Electronics

The printed circuit boards in the MSD are available only as complete assemblies. Individual electronic components are not available. This section contains the following parts: cables, fuses, printed circuit boards (electronic assemblies).

Table 10

Internal cables

Description	HP part number
Accessory connector cable (main board to accessory connector)	05972-60437
Analyzer cable kit (all wiring inside the vacuum manifold)	05972-60230
high voltage/x-ray wire	05972-60016
ion source cable (printed circuit board and wiring for ion source)	05972-60015
APG connector cable (HP-IB/MS control card to APG connector)	05972-60438
Coupler (for status display cables)	1252-5255
Diffusion pump control cable (power distribution board to main board)	G1800-60422
Diffusion pump extender cable (power distribution board to back panel)	05972-60423
Diffusion pump power cable (includes thermal switches)	05972-60401
Filament cable (top board to main board, twisted pair)	05971-60412
Foreline gauge cable	05971-60413
GC to GC interface (GC interface heater/sensor assembly)	
HP 5972A MSD	05971-60105
HP 6890 Series MSD	05972-60106
HP-IB connector cable (from HP-IB/MS control card to HP-IB connector)	05971-60417
Power supply cables	
ac input (power supply to power distribution board)	05972-60426
dc output (power supply to main board)	05972-60427
Ribbon cable (top board to main board)	05971-60411
Signal cable (top board to main board)	05971-60416
Status display cable	
long (coupler to HP-IB/MS control card)	05972-60435
short (status display to coupler)	05972-60436

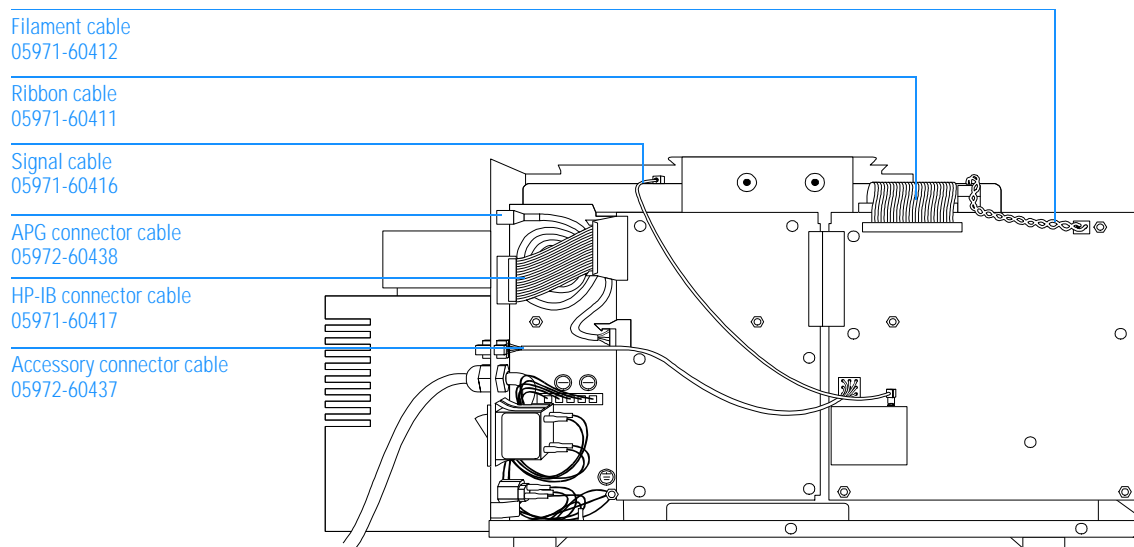


Table 11

External cables

Description	HP part number
Gauge controller cable (triode gauge tube to gauge controller)	8120-6573
HP-IB cable, 1-meter	8120-4654
IRD external accessory control cable (used in GC/IRD/MSD systems – HP 5890 GC only)	05971-60429
Parallel/remote cable (HP 5890 GC only)	05990-60019
Remote control cable	
HP 5972A MSD to HP 5890 GC	35900-60700
HP 6890 Series MSD to HP 6890 Series GC	G1530-60930
General purpose (one end without connector, HP 5890 GC to ?)	05890-61080

Table 12

Fuses and circuit breakers	
Description	HP part number
Circuit breaker (main power switch)	
110/120 V ac	3105-0172
220/240 V ac	3105-0173
Diffusion pump fuses	
2-amp (220/240 V ac)	2110-0002
4-amp (110/120 V ac)	2110-0055

Table 13

Printed circuit boards	
Description	HP part number
HP-IB/MS control card	05990-69406
Main board	05972-69020
Parallel/remote board (HP 5890 GC only – installed on the GC)	05990-60320
Power distribution board	05971-60003
Power supply	0950-2552
Status display (not shown)	05972-60030
Top board	05971-69001

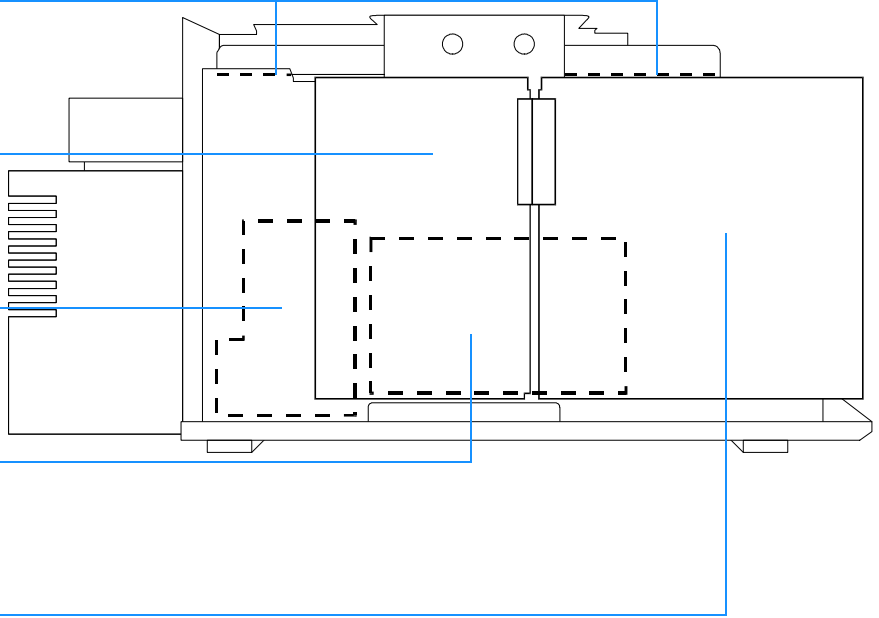
Top board (under covers)
05971-69001

HP-IB/MS control card
05990-69406

Power distribution board
(behind electronics panel)
05971-60003

Power supply
(behind electronics panel)
0950-2552

Main board
05972-69020



Vacuum system

This section lists replacement parts available for the vacuum system. It includes: clamps, O-rings and seals, and vacuum system components.

Table 14

Clamps

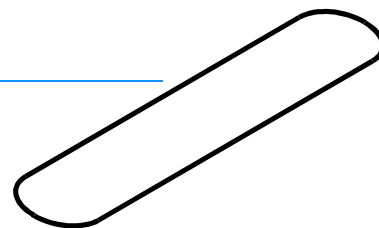
Description	HP part number
KF10/16 (for foreline hose fitting)	0100-1397
KF25 (hinged, for GC interface and bottom of foreline trap)	0100-1398
KF25 (stamped)	0100-0549
KF40 (for top of foreline trap)	0100-1426
KF50 (for diffusion pump)	0100-1395
Shipping clamps	05972-00200

Table 15

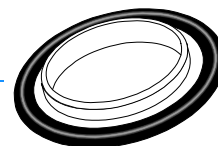
O-rings and seals

Description	HP part number
KF10 O-ring assembly (for foreline hose fitting)	0100-1183
KF25 blank flange	0100-1396
KF25 coseal (for GC interface)	0100-1597
KF25 O-ring assembly (for bottom of foreline trap – not compatible with inlet filter)	0100-1551
KF40 O-ring assembly (for top of foreline trap)	0100-1425
KF50 coseal (for diffusion pump)	0100-1804
Manifold O-ring	0905-1242
Triode gauge tube O-ring	0905-1070

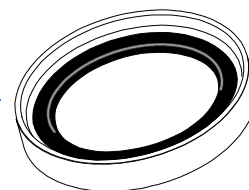
Manifold O-ring
0905-1242



O-ring assembly
KF10 0100-1183
KF25 0100-1551
KF40 0100-1425



Coseal
KF25 0100-1597
KF50 0100-1804



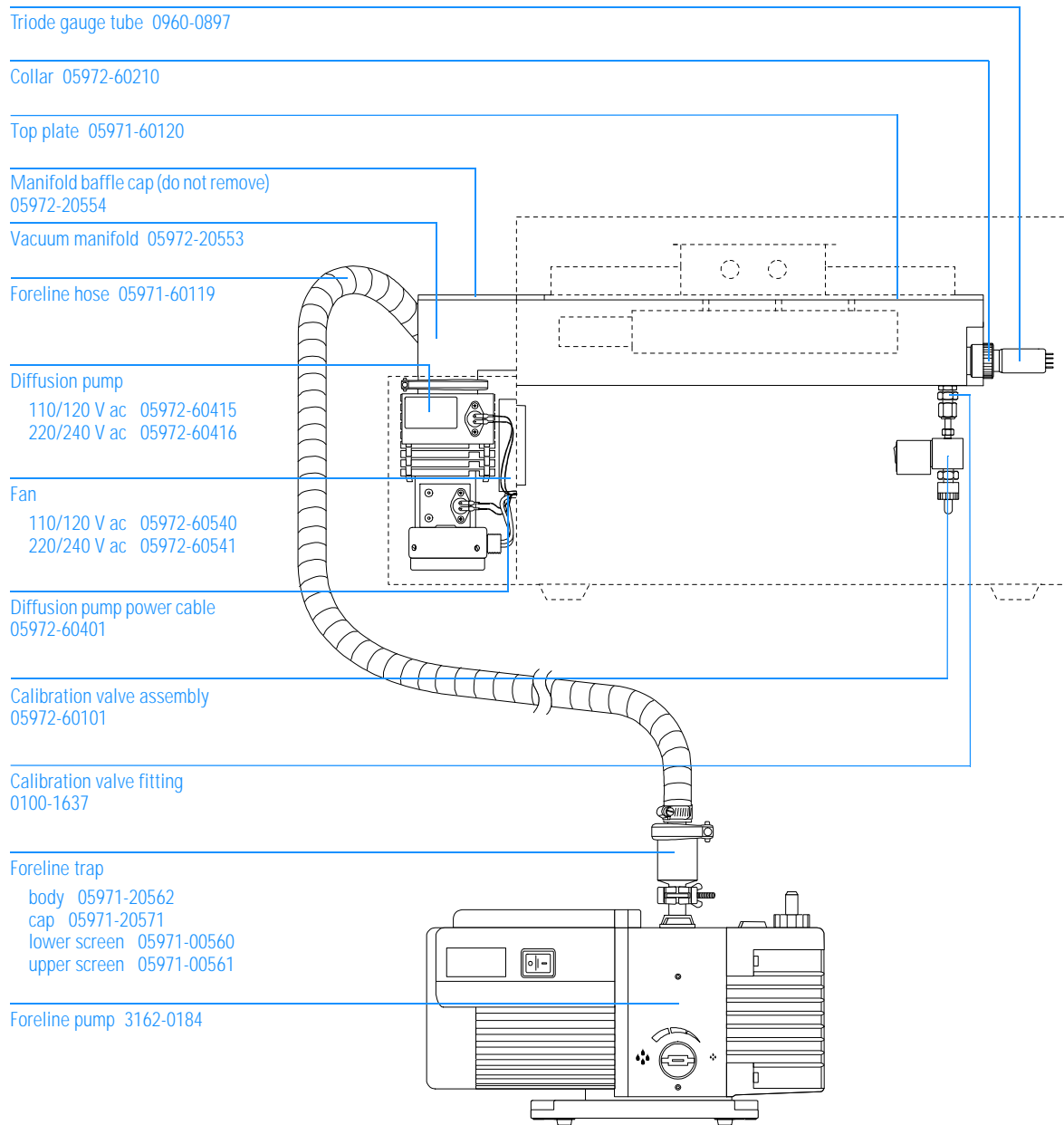
Triode gauge tube O-ring
0905-1070



Table 16

Vacuum system components

Description	HP part number
Baffle (inside stem of triode gauge tube)	05972-00015
Blank flange, KF25	0100-1396
Calibration valve assembly (includes vial)	05972-60101
O-ring	0905-1217
vial	05980-20018
Calibration valve fitting	0100-1637
Collar (for triode gauge tube)	05972-60210
Diffusion pump, complete	
110/120 V ac	05972-60415
220/240 V ac	05972-60416
Diffusion pump extender cable (power distribution board to back panel)	05972-60423
Diffusion pump power cable (includes thermal switches)	05972-60401
Fan	
110/120 V ac	05972-60540
220/240 V ac	05972-60541
Foreline hose	05971-60119
Foreline pump (for all voltage ranges)	3162-0184
power cord	8120-6476
Foreline trap	
body	05971-20562
cap	05971-20571
lower screen	05971-00560
upper screen	05971-00561
Foreline gauge assembly (not shown)	05972-60545
Manifold baffle cap	05972-20554
Manifold baffle cap O-ring	0905-1237
Screws, for manifold baffle cap	0515-1034
Top plate (includes feedthroughs)	05971-60120
Triode gauge tube	0960-0897
Vacuum manifold	05972-20553



Analyzer

This table lists the replacement parts for the analyzer. The individual ion source parts are listed the next table.

Table 17

Analyzer parts

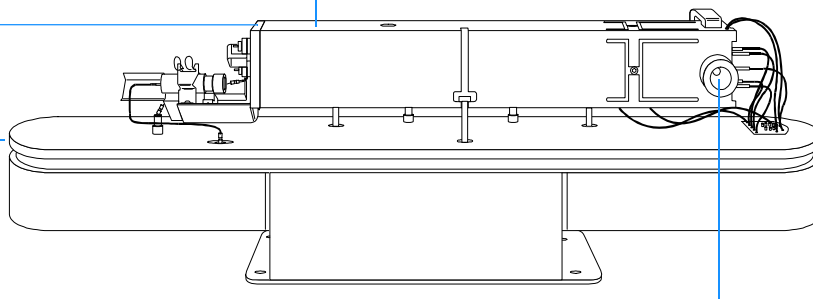
Description	HP part number
Analyzer (ion source, mass filter, and detector) with top plate and top board, tested	05972-69228
analyzer cable kit (wiring inside manifold)	05972-60230
electron multiplier (complete)	05971-80102
electron multiplier horn	05971-80103
interface (GC interface) socket	05971-20133
ion source, complete	05972-60226
magnet assembly	05971-60160
quadrupole contacts (1 pair)	05971-60142
quadrupole spring clip	05971-20182
quadrupole support, detector end	05971-20136
quadrupole support, source end	05971-20135
radiator	05971-20120
screws	
M2 x 5L, ion source mounting screw	0515-1077
M2 x 6L, detector mounting screw	0515-0221
M3 x 8L, analyzer mounting screw	0515-0319
top plate (includes feedthroughs)	05971-60120

Radiator
05971-20120

Quadrupole support
(detector end)
05971-20136

Top plate
05971-60120

Interface socket
05971-20133



Quadrupole contacts (1 pair)
05971-60142

Magnet assembly
05971-60160

Electron multiplier horn
05971-80103

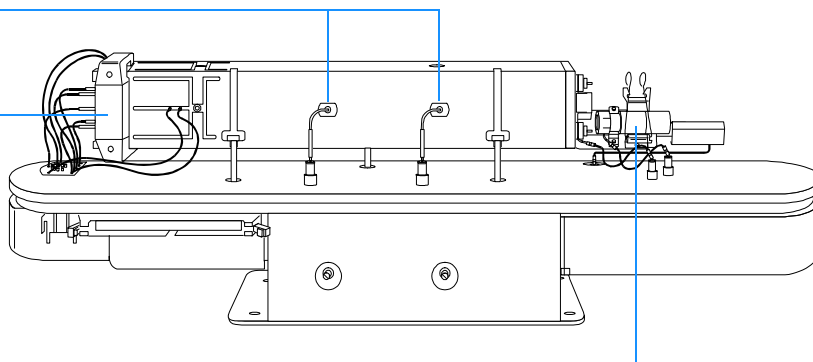


Table 18

Ion source parts

Description	HP part number
Ion source, complete	05972-60226
drawout cylinder	G1072-20008
drawout plate	05971-20134
entrance lens (with pin)	05971-20126
filament assembly	05972-60053
ion focus lens (with pin)	05971-20143
lens insulator (pair)	05971-20130
repeller assembly	05971-60170
screws	
M2 x 5L, ion source mounting screw	0515-1077
M2 x 8L, filament retaining screw	0515-1046
M3 x 2.4L, set screw	0515-1446
source body	05971-20128

Entrance lens (with pin)
05971-20126

Lens insulator (pair)
05971-20130

Ion focus lens (with pin)
05971-20143

Drawout cylinder
G1072-20008

Set screw, 3M x 2.4L
0515-1446

Filament assembly
05972-60053

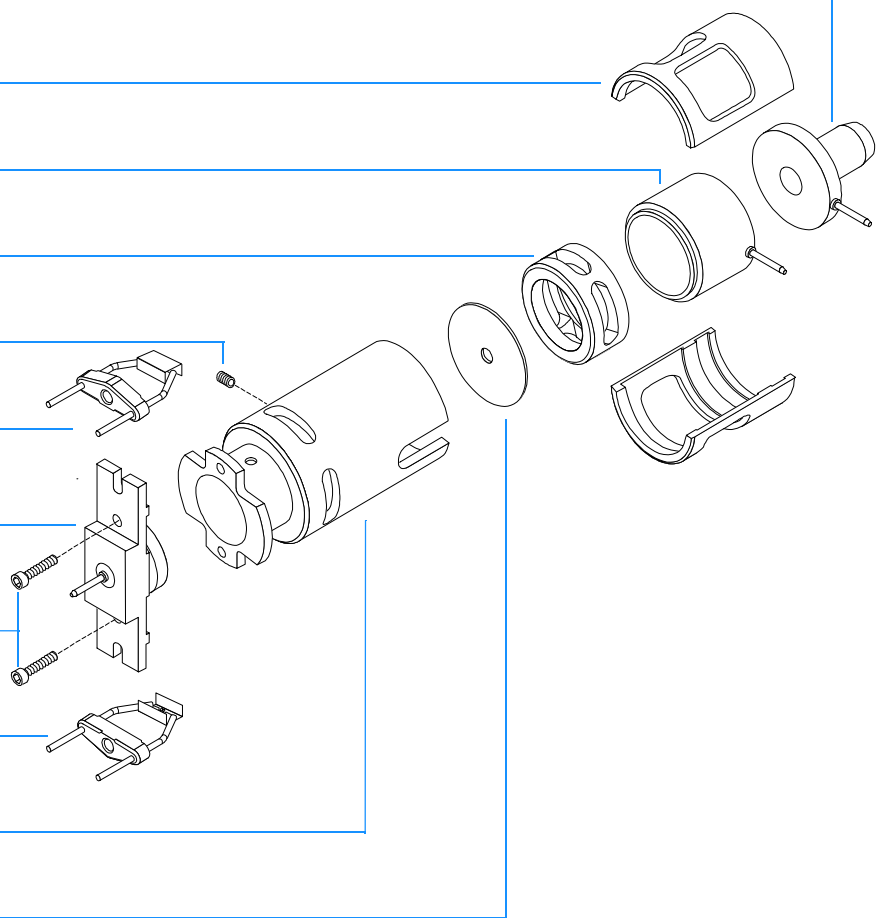
Repeller assembly
05971-60170

Screws, M2 x 8L
0515-1046

Filament assembly
05972-60053

Source body
05971-20128

Drawout plate
05971-20134



GC interface

This table lists the replacement parts related to the GC interface. Effluent splitter parts are listed in the next table.

Table 19

GC interface

Description	HP part number
GC interface (complete)	
HP 5972A MSD (100 V ac heater)	05972-60040
HP 6890 Series MSD (40 V dc heater)	05972-60021
GC interface parts	
column nut (not shown)	05988-20066
guide tube	05971-20307
heater sleeve	05988-20210
heater/sensor assembly (includes cable)	
HP 5972A MSD	05971-60105
HP 6890 Series MSD	05972-60106
insulation (not shown)	05971-20301
lockwashers, for screws for heater sleeve	2190-0586
screws, M4 x 16L, for heater sleeve	0515-0071
transfer tube	
tip (gold-plated)	05971-20305
welded assembly	05971-60302
Tape (for securing insulation)	0460-1300

Guide tube
05971-20307

Heater sleeve
05988-20210

Tip
05971-20305

Welded assembly
05971-60302

Heater/sensor assembly
HP 5972A MSD 05971-60105
HP 6890 Series MSD 05972-60106

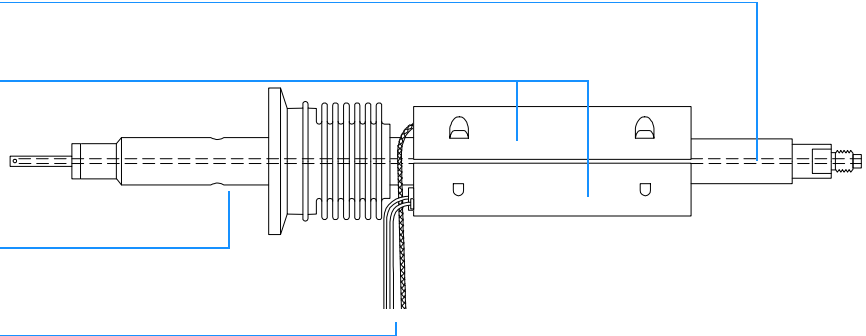
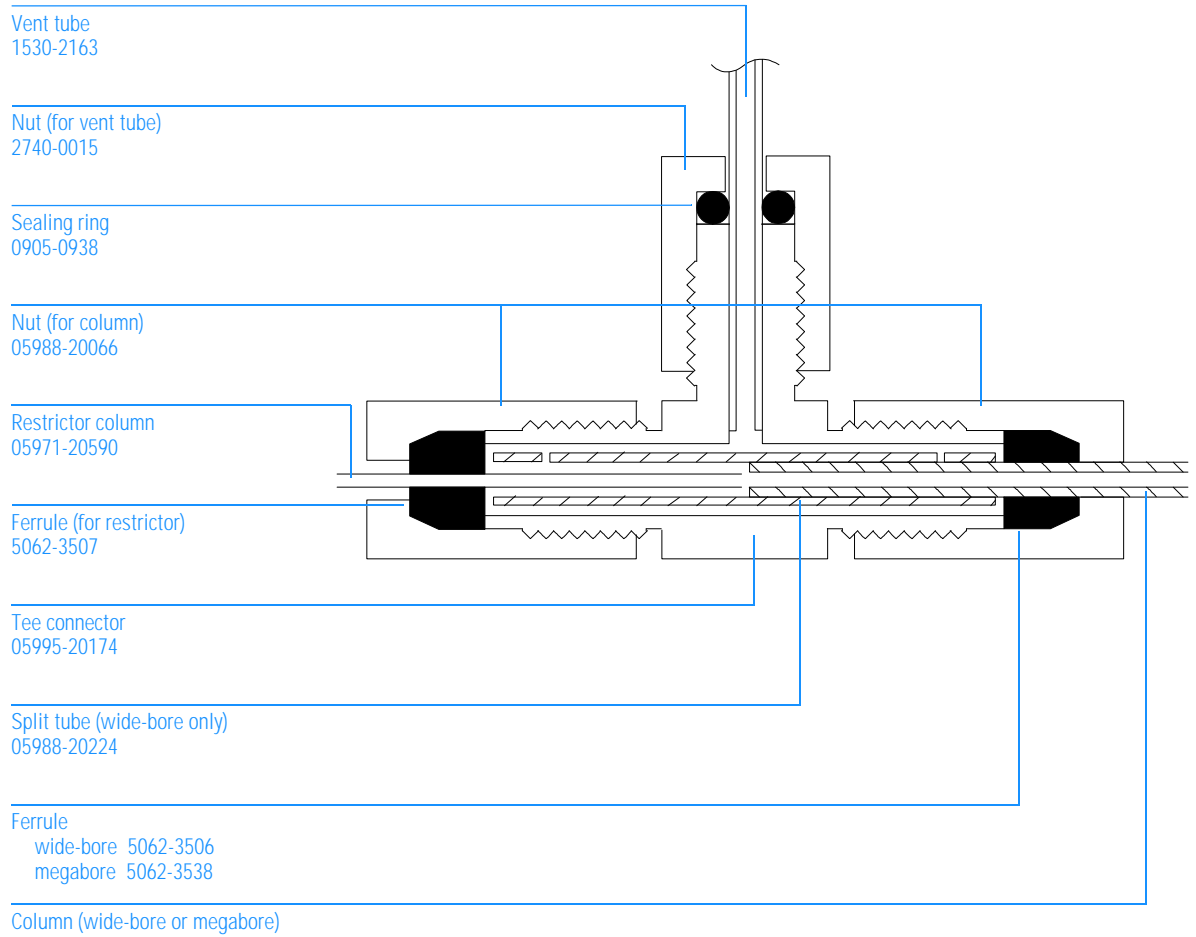


Table 20

Effluent splitter	
Description	HP part number
Ferrules	
for megabore (0.53-mm id) column	5062-3538
for restrictor column	5062-3507
for wide-bore (0.32-mm id) column	5062-3506
Mounting plate	
HP 5972A MSD	05988-00080
HP 6890 Series MSD	05972-00017
Nut	
for capillary columns	05988-20066
for vent tube	2740-0015
Restrictor column (0.115-mm)	05971-20590
Sealing ring, for vent tube	0905-0938
Split tube (used only for wide-bore columns)	05988-20224
Tee connector	05995-20174
Vent tube	1530-2163



Consumables and maintenance supplies

This chapter lists parts available for cleaning and maintaining your MSD. These include cleaning and maintenance supplies, ferrules, fuses, parts and samples, and O-rings and seals.

Table 21

Maintenance supplies

Description	HP part number
Abrasive paper, 30 μm	5061-5896
Alumina powder	8660-0791
Cloths, clean	05980-60051
Cotton swabs (package of 100)	5080-5400
Gloves, clean	
large	8650-0030
small	8650-0029
Paint, touch-up, Glacier Gray – for HP 6890 Series MSD only	6010-1497
Tool kit	05972-60566
Video tape (cleaning the ion source)	
VHS-NTSC format	05972-90011
VHS-PAL format	05972-90012

Table 22

Ferrules	
Description	HP part number
Blank, graphite-vespel	0100-0691
GC interface and splitter	
0.3-mm id, 85% Vespel 15% graphite, for 0.1-mm id columns	5062-3507
0.4-mm id, 85% Vespel 15% graphite, for 0.2-mm id and 0.25-mm id columns	5062-3508
0.5-mm id, 85% Vespel 15% graphite, for 0.32-mm id columns	5062-3506
0.8-mm id, 85% Vespel 15% graphite, for 0.53-mm id columns	5062-3538
Injection port	
0.27-mm id, 90% Vespel 10% graphite, for 0.1-mm id columns	5062-3518
0.37-mm id, 90% Vespel 10% graphite, for 0.2-mm id columns	5062-3516
0.40-mm id, 90% Vespel 10% graphite, for 0.25-mm id columns	5181-3323
0.47-mm id, 90% Vespel 10% graphite, for 0.32-mm id columns	5062-3514
0.74-mm id, 90% Vespel 10% graphite, for 0.53-mm id columns	5062-3512

Table 23

Miscellaneous parts and samples

Description	HP part number
Cable ties	1400-0482
Cover (cardboard, for protecting the MSD during shipping)	05972-80005
Diffusion pump fluid (20 ml)	6040-0809
Electron multiplier horn	05971-80103
Filament assembly	05972-60053
Foreline pump fluid (1 liter)	6040-0834
Foreline trap pellets (molecular sieve)	9301-1104
Grommet, 0.875-inch id (for cutouts in sheet metal to mount the vacuum manifold)	0400-0268
HCB performance evaluation sample (checkout sample)	8500-5808
Hydrocarbon sample kit	05970-60045
PFTBA sample kit	05971-60571
Shipping bracket (for use with shipping crate)	
HP 5972A MSD	05972-00005
HP 6890 Series MSD	05972-00006
Shipping crate	05972-80020
Shipping kit	
HP 5890 GC (Option #201)	05890-61455
HP 6890 Series GC	G1530-60860
MSD	05972-60565
Vacuum gauges	
foreline gauge assembly	05972-60545
triode gauge tube	0960-0897

Table 24

O-rings and seals

Description	HP part number
KF10 O-ring assembly (foreline hose fitting)	0100-1183
KF25 O-ring assembly (bottom of foreline trap – not compatible with inlet filter)	0100-1551
KF25 coseal (GC interface)	0100-1597
KF40 O-ring assembly (top of foreline trap)	0100-1425
KF50 coseal (diffusion pump)	0100-1804
Manifold O-ring	0905-1242
Triode gauge tube O-ring	0905-1070

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Warranty

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If Buyer schedules or delays installation more than 30 days after delivery, then warranty period starts on 31st day from the date of shipment. For international orders, the grace period is 60 days and the warranty period starts on the 61st day from the date of shipment.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in materials and workmanship. If HP receives notice of such defects during the warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

Within HP service travel areas, warranty and installation services for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge. For installation and warranty services outside of HP's service travel area, HP will provide a quotation for the applicable additional services.

The foregoing warranty shall not apply to defects resulting from:

1. Improper or inadequate maintenance, adjustment, calibration or operation by Buyer.
2. Buyer-supplied software, hardware, interfacing or consumables.
3. Unauthorized modifications or misuse.
4. Operation outside of the environmental and electrical specifications for the product.
5. Improper site preparation and maintenance.
6. Customer-induced contamination or leaks.

This warranty may be modified in accordance with the laws of your country. Please consult your local HP office for the period of the warranty, for shipping instructions and for the applicable wording of the local warranty.

Warranty Claims

If physical damage is found, or if operation is not as specified when the instrument is first received, notify the carrier and the nearest Hewlett-Packard office immediately. The HP office will arrange for repair or replacement of the instrument without waiting for settlement of a claim with the carrier. For other than initial inspection warranty claims, contact your local HP office.

Service Agreements

Several service agreements are available, each designed to meet a specific need. In addition to a preventive maintenance agreement, others cover specific repair/maintenance services for the HP 5972A or HP 6890 Series Mass Selective Detector, and can provide for the extension of warranty beyond the initial warranty period.

Details of these agreements, together with prices applicable to the particular installation, can be obtained from your local Hewlett-Packard office.