CLARUS SQ 8 MS

Hardware Guide

PerkinElmer®

Clarus SQ 8 MS Hardware Guide

Release History

Part Number	Release	Publication Date
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Any comments about the documentation for this product should be addressed to:

User Assistance
PerkinElmer, Inc.
710 Bridgeport Avenue
Shelton, Connecticut 06484-4794
U.S.A.

Or emailed to: info@perkinelmer.com

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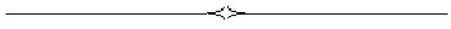


Conventions Used in this Manual

Terminology

Throughout the manual, the term ‘mass spectrometer’ or MS specifically refers to the Clarus SQ 8 series, while for ‘GC’ Clarus 580/680 is implied.

Normal text is used to provide information and instructions.

Bold text refers to text that is displayed on the touch screen.

All eight digit numbers are PerkinElmer part numbers unless stated otherwise.

Notes, warnings and cautions

Three terms, in the following standard formats, are also used to highlight special circumstances and warnings.

NOTE: *A note indicates additional, significant information that is provided with some procedures.*

WARNING

We use the term WARNING to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.

D

Warning (Warnung)

Bedeutet, daß es bei Nichtbeachten der genannten Anweisung zu einer **Verletzung** des Benutzers kommen kann.

DK

Warning (Advarsel)

Betyder, at brugeren kan blive **kvæstet**, hvis anvisningen ikke overholdes.

E

Warning (Peligro)

Utilizamos el término **WARNING** (PELIGRO) para informarle sobre situaciones que pueden provocar **daños personales** a usted o a otras personas. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.

F

Warning (Danger)

Nous utilisons la formule **WARNING** (DANGER) pour avertir des situations pouvant occasionner des **dommages corporels** à l'utilisateur ou à d'autres personnes. Les détails sur ces circonstances sont données dans un encadré semblable à celui-ci.

I

Warning (Pericolo)

Con il termine **WARNING** (PERICOLO) vengono segnalate situazioni che potrebbero provocare **incidenti alle persone**. Troverete informazioni su tali circostanze in un riquadro come questo.

NL

Warning (Waarschuwing)

Betekent dat, wanneer de genoemde aanwijzing niet in acht wordt genomen, dit kan leiden tot **verwondingen** van de gebruiker.

P

Warning (Aviso)

Significa que a não observância da instrução referida poderá causar um **ferimento** *ao usuário.*

CAUTION	We use the term CAUTION to inform you about situations that could result in **serious damage to the instrument**or other equipment. Details about these circumstances are in a box like this one.
D	Caution (Achtung) Bedeutet, daß die genannte Anleitung genau befolgt werden muß, um einen **Geräteschaden** zu vermeiden.
DK	Caution (Bemærk) Dette betyder, at den nævnte vejledning skal overholdes nøje for at undgå en **beskadigelse af apparatet**.
E	Caution (Advertencia) Utilizamos el término **CAUTION** (ADVERTENCIA) para advertir sobre situaciones que pueden provocar **averías graves en este equipo** o en otros. En recuadros éste se proporciona información sobre este tipo de circunstancias.
F	Caution (Attention) Nous utilisons le terme **CAUTION** (ATTENTION) pour signaler les situations susceptibles de provoquer de **graves détériorations de l'instrument** ou d'autre matériel. Les détails sur ces circonstances figurent dans un encadré semblable à celui-ci.
I	Caution (Attenzione) Con il termine **CAUTION** (ATTENZIONE) vengono segnalate situazioni che potrebbero arrecare **gravi danni allo strumento** o ad altra apparecchiatura. Troverete informazioni su tali circostanze in un riquadro come questo.
NL	Caution (Opgelet) Betekent dat de genoemde handleiding nauwkeurig moet worden opgevolgd, om **beschadiging van het instrument**te voorkomen.
P	Caution (Atenção) Significa que a instrução referida tem de ser respeitada para evitar a **danificação do aparelho**.

Customer Service

Company Name and Address:

PerkinElmer
710 Bridgeport Avenue
Shelton, Connecticut 06484-4794 USA

Tel: (800) 762-4000 or (203) 762-4000

Electromagnetic Compatibility (EMC)

Regulatory Information

United States (FCC)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which user will be required to correct the interference at their own expense.

NOTE: *Changes or modifications not expressly approved by PerkinElmer could cause the instrument to violate FCC (U.S. Federal Communications Commission) emission regulations, and because of this violation could void the user's authority to operate this equipment.*

Europe

All information concerning EMC standards is in the Declaration of Conformity, and these standards may change as the European Union adds new requirements.

CAUTION *The Clarus SQ 8 contains protective circuitry. Contact PerkinElmer Service before performing any AC line tests.*

Electrical Symbols Used on Clarus SQ 8 MS Series


Alternating current.


Protective conductor terminal. Ground


Off position of the main power switch.


On position of the main power switch.


Warning: Risk of electric shock.


Warning: Hot surface.


Warning: Refer to accompanying documents.


Vacuum

Label Location and Content

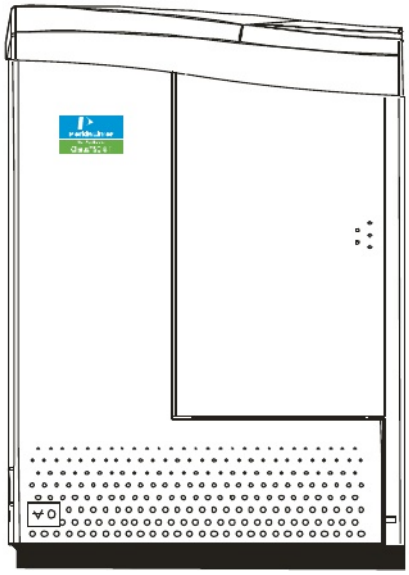


Figure 1 Front View of Clarus SQ 8 T.

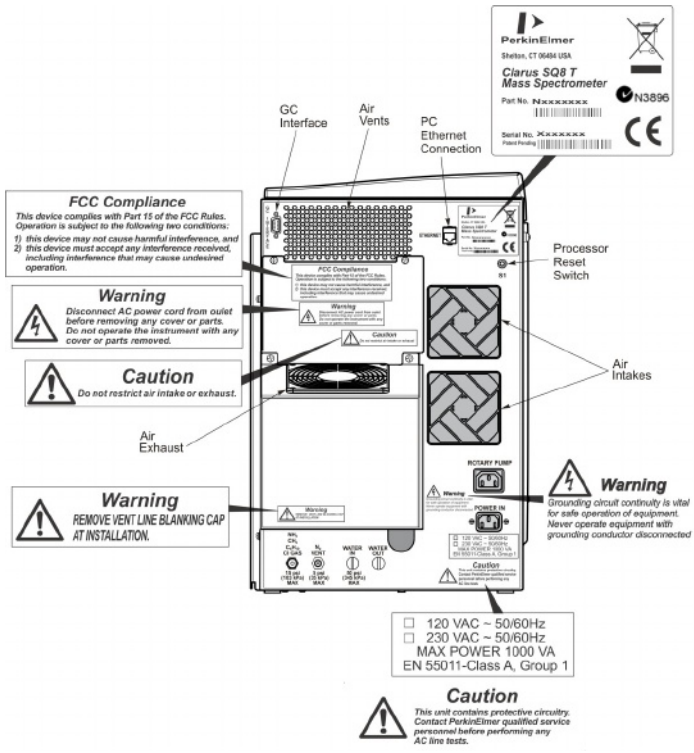


Figure 2 Rear View of the Clarus SQ 8 T.

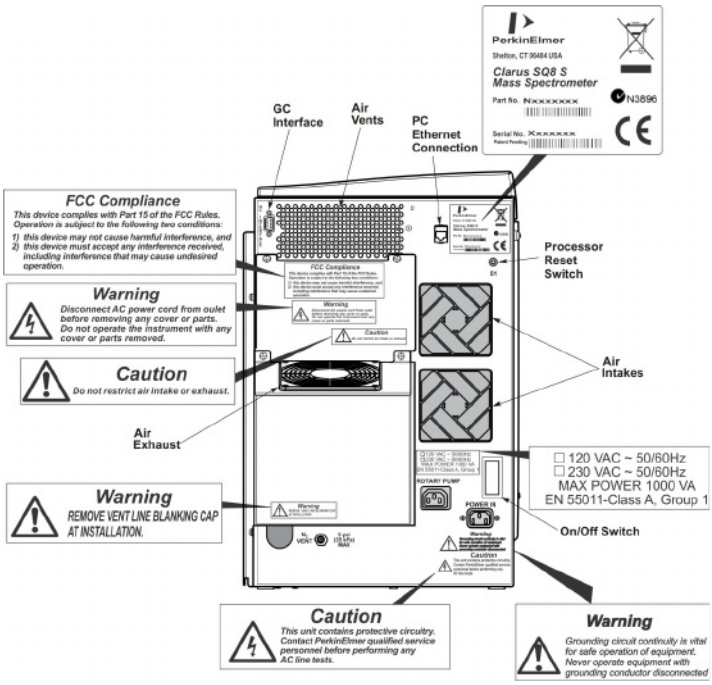


Figure 3 Rear View of the Clarus SQ 8 S compatible with the Clarus 580 GC and Clarus 680 GC.

Clarus MS Safety Practices

NOTE: *This equipment requires no specified inspection or preventive maintenance to ensure the continuous functioning of its safety features.*

The Clarus SQ 8 Mass Spectrometer should be used in accordance with the instructions provided in the hardware and software user's guides and tutorial supplied with the instrument. If used otherwise, the protection provided by the instrument may be impaired.

Generic Warnings

Before installing or operating a Clarus SQ 8 MS, read the following topics concerning hazards and potential hazards. Ensure that anyone involved with installation and/or operation of a Clarus SQ 8 MS is knowledgeable in both general safety practices for the laboratory and safety practices for the mass spectrometer. Get advice from your safety engineer, industrial hygienist, environmental engineer, or safety manager before you install or use this instrument.

Moving the Clarus SQ 8 MS

WARNING

The Clarus SQ 8 MS is 48 kg (105 lb) in weight.

The mass spectrometer requires two people to safely lift it and should be lifted from the bottom. Use the following lifting posture to avoid back injury: With knees bent, simultaneously lift the instrument out of the carton as you end up in a standing position.

Electrical High Voltage

WARNING

High voltage. *The Clarus SQ 8 MS contains high voltages. To prevent the risk of shock, unplug the line cord from the AC outlet and wait at least one minute before opening or removing any instrument panel.*

WARNING

Lethal voltages are present at certain areas within the instrument. Internal maintenance of the instrument should only be performed by a PerkinElmer service engineer or similarly authorized and trained person. ***When the instrument is connected to line power, opening the instrument covers is likely to expose live parts. Even when the power switch is off, high voltages can still be present. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from all voltage sources.***

WARNING

Connect the Clarus SQ 8 MS to an AC line power outlet that has a protective ground connection. To ensure satisfactory and safe operation of the mass spectrometer, it is essential that the protective ground conductor (the green/yellow lead) of the line power cord is connected to a true electrical ground. Any interruption of the protective ground conductor, inside or outside the mass spectrometer, or disconnection of the protective ground terminal may impair the protection provided by the mass spectrometer.

WARNING

Customers should ***never*** *operate the Clarus SQ 8 MS with any covers or parts removed. Only a trained PerkinElmer Service Engineer or similarly trained and authorized person may need to operate the Clarus SQ 8 MS with covers or parts removed as they service it.*

WARNING

Do not *make adjustments, replacements or repairs to the Clarus SQ 8 MS except as described in the supplied user manuals. Only a PerkinElmer Service Engineer or similarly trained and authorized person should be permitted to service the Clarus SQ 8 MS.*

WARNING *For protection against fire hazard, only replace a fuse with a fuse with the same type and rating. For example, a 10 amp fuse for 120 V and a 5 amp fuse for 240 V.*

Ensure that the power cord is correctly wired and that the ground leads of all electrical units (for example, recorders, integrators) are connected together via the circuit ground to earth. Use only three-prong outlets with common earth ground connections. For details, refer to the descriptions in the *Clarus GC Installation Guide (P/N 09936590 or 09936779).*

- Servicing of electrical components within the mass spectrometer should be performed ***only*** by a PerkinElmer Service Representative.
- Servicing of the incoming AC power line components in your laboratory should be performed ***only*** by a licensed electrician.

WARNING *Electrical shock hazard.* ***To prevent electrical shock, disconnect the power cord from the AC outlet before servicing.***

Under no circumstances should circuit boards be removed or inserted unless the instrument is disconnected from line power.

Contamination

CAUTION *Never touch manifold components with your fingers. This will introduce contaminants into the system.*

CAUTION *To prevent Clarus SQ 8 MS contamination, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing, or replacing parts on or in the vacuum manifold assembly. These parts include the source, filament, pre-quads, analytical quads, and electron multiplier. Always hold the EI or CI source by its handle. Never touch these parts with ungloved (bare) fingers since this will introduce contaminants into the system.*

Decontamination

Before using any cleaning or decontamination methods except those specified by PerkinElmer, users should check with PerkinElmer that the proposed method will

not damage the equipment.
Customers wishing to return instrumentation and/or associated materials to PerkinElmer for repair, maintenance, warranty or trade-in purposes are advised that all returned goods must be certified as clean and free from contamination.

Follow the "Decontamination of Instrumentation and Associated Sub-assemblies" procedure and complete the "Certificate of Decontamination." The certificate is used to certify the decontamination process was completed before equipment can be returned to PerkinElmer. These documents are available on the PerkinElmer public website:

Procedure:

http://las.perkinelmer.com/Content/technicalinfo/dts_instrumentdeconprocedure.pdf

Certificate form:

http://las.perkinelmer.com/Content/technicalinfo/dts_perkinelmercertificationofdecontaminationform.pdf

If you do not have access to the internet and are located in the U.S., call toll free at 1-800-762-000 or (+1) 203-925-4602, 8:30 a.m. – 7 p.m. EST and speak to Customer Support.

In Canada, call toll free at 800-561-4646 and speak to Customer Support.

If you are located outside of the United States or Canada, please call your local PerkinElmer sales office for more information.

Compressed Gases

WARNING

Explosive hazard. *Cylinders (tanks) of compressed gases should be handled with extreme care. Gas cylinders can be hazardous if mishandled.*

Avoid banging the valves and ensure that the correct valves and gauges are installed. Gas cylinders should be stored (and placed) outside the laboratory and connected to the instrument through specially cleaned copper tubing. Use care to prevent kinking or stressing the gas tubing. For safety, cylinders should be firmly clamped in an upright position.

WARNING

Explosive hazard. *When using hydrogen, either as the combustion gas for a flame ionization detector or as a carrier gas, special care must be taken to avoid buildup of explosive hydrogen/air mixtures either in the GC oven or the Clarus SQ 8 vacuum manifold.*

Ensure that all hydrogen line couplings are leak-free and do not allow hydrogen to vent within the oven.

Ventilation

WARNING

Hazardous vapors. *When analyzing hazardous compounds, such as pesticides, it is necessary to arrange for venting of the mass spectrometer effluent from the fore pump exhaust into a fume hood or charcoal trap.*

In addition, adequate ventilation must be provided, particularly if a liquid nitrogen or carbon dioxide sub-ambient accessory is in constant use. The area underneath the bench (around the fore pump) should be well ventilated . An oil separation filter and charcoal trap should be installed at the outlet of the fore pump exhaust to prevent contamination if fume hood venting is unavailable.

To ensure adequate cooling of the instrument electronics, do not obstruct the gap at the base of the Clarus MS/Clarus GC, in the system (for example, the TurboMatrix ATD or and if practical, leave a minimum 6-inch clearance between each instrument Headspace). This does not include the Clarus MS/Clarus GC since they are connected.

Heated Zones

WARNING

Risk of burns. *Never touch a heated Clarus SQ 8 MS transfer line or a GC injector cap with bare (unprotected) fingers.*

Heated zones should be treated with caution. For example, the transfer line, injector caps, and detectors. In addition, the detector cover may get hot, especially if flame ionization detectors are operated at high temperatures. As a general rule, allow heated zones to cool before attempting to work in the GC oven, on the transfer line, on an injector, around the detector areas or inside the Clarus SQ 8 manifold. Proper cooling of the transfer line may take from 1/2 to 1 hour.

Using Hydrogen, Methane or Isobutane

WARNING

Explosive Hazard. *If the hydrogen is turned on without a column attached to the injector and/or detector fittings inside the oven, the gas could diffuse into the oven creating the possibility of an explosion.*

If the mass spectrometer is not under vacuum, hydrogen, methane, or isobutane can fill the vacuum chamber thereby creating an explosive hazard.
To avoid possible injury, do not turn on the hydrogen unless a column is attached, all joints have been leak-tested, and the mass spectrometer is under vacuum with the forepump exhaust properly vented to a fume hood.

Using Ammonia Gas

WARNING

Hazardous gas vapors. *When using ammonia gas while running in the chemical ionization (CI) mode, it is necessary to vent the mass spectrometer effluent from the forepump exhaust into a fume hood or charcoal trap.*

Hazardous Chemicals

WARNING

Hazardous chemicals. *Before using samples, thoroughly familiarize yourself with all hazards and safe handling practices. Observe the manufacturer's recommendations for use, storage and disposal. These recommendations are normally provided in the Material Safety Data Sheets (MSDS) supplied with the solvents, chemicals, and pump oils.*

Be aware that the chemicals that you use in conjunction with the Clarus SQ 8 may be hazardous. ***DO NOT*** store, handle, or work with any chemicals or hazardous materials unless you have received appropriate safety training and have read and understood all related Material Safety Data Sheets (MSDS). MSDSs give information on physical characteristics, precautions, first aid, spill clean up and disposal procedures. Familiarize yourself with the information and precautions contained in these documents before attempting to store, use or dispose of the reagents. Comply with all federal, state, and local laws related to chemical storage, handling, and disposal.

You must work under a suitable hood when handling and mixing certain chemicals. The room in which you work must have proper ventilation and a waste collection system. Always wear appropriate safety attire (full-length laboratory coat, protective glasses, gloves, etc.), as indicated on Material Safety Data Sheets.

WARNING

When using toxic samples, the mechanical pump oil is toxic waste.

WARNING

Some chemicals used with the Mass Spectrometer may be hazardous or may become hazardous after completion of an analysis.

The responsible person (for example, the Lab Manager) must take the necessary precautions to ensure that operators and people in the surrounding workplace are not exposed to hazardous levels of toxic substances (chemical or biological) as defined in the applicable Material Safety Data Sheets (MSDS) or OSHA, ACGIH, or COSHH documents. Venting for fumes and disposal of waste must be in accordance with all national, state and local health and safety regulations and laws.

Definitions in Warning for Hazardous Chemicals

Responsible body. "Individual or group responsible for the use and maintenance of equipment, and for ensuring that operators are adequately trained." [per EN/IEC 61010-1].

Operator. "Person operating equipment for its intended purpose." [per EM/IEC 61010-1].

OSHA: Occupational Safety and Health Administration (United States)

ACGIH: American Conference of Governmental Industrial Hygienists

COSHH: Control of Substances Hazardous to Health (United Kingdom)

Temperature, Humidity, and Environment

Operating Conditions

CAUTION The Clarus SQ 8 MS is designed for indoor use only.

CAUTION *Do not operate the mass spectrometer in a Cold Room or a refrigerated area. Clarus SQ 8 MS operates under the following conditions:*

Ambient temperature is 10 °C to 35 °C (50 °F and 95 °F) with a variability of less than ± 4 °C (± 7 °F).

The Clarus SQ 8 MS will operate safely between 5°C and 40 °C (41 °F and 104 °F).

If operating at ambient temperatures 10°C and 35 °C, you will need the water-cooling option for the turbopump.

Ambient relative humidity is 20 % to 80 % non-condensing.

Operating altitude is in the range of -400 to 2000 m (-1,312 to 6,562 feet).

WARNING *The mass spectrometer is not designed for operation in an explosive environment. The laboratory should be free of flammable, explosive, toxic, caustic, or corrosive vapors or gases and should be relatively free of dust.*

Pollution Degree

Clarus SQ 8 MS will operate safely in environments that contain non-conductive foreign matter up to Pollution Degree 2 in EN/IEC 61010-1.

Storage Conditions

The mass spectrometer may be stored under the following conditions:

- ambient temperature is -20 °C to +60 °C (-4 to 140 °F)

- ambient relative humidity is 20 to 80%, non-condensing
- altitude in the range of -400 to 12,000 m (-1,312 to 39,370 feet).

General Laboratory Safety

Your laboratory should have all equipment ordinarily required for the safety of individuals working with chemicals (fire extinguishers, first-aid equipment, safety shower and eyewash fountain, spill cleanup equipment, etc.).

Cleaning Requirements

Exterior surfaces of the MS may be cleaned with a soft cloth, dampened with a mild detergent and water solution. Do **not** use abrasive cleaners or solvents.

Before using any cleaning or decontamination methods except those specified by PerkinElmer, users should check with PerkinElmer that the proposed method will not damage the instrument.

WEEE Instructions for PerkinElmer Products

or

A label with a crossed-out wheeled bin symbol and a rectangular bar indicates that the product is covered by the Waste Electrical and Electronic Equipment (WEEE) Directive and is not to be disposed of as unsorted municipal waste. Any products marked with this symbol must be collected separately, according to the regulatory guidelines in your area.

The objectives of this program are to preserve, protect and improve the quality of the environment, protect human health, and utilize natural resources prudently and rationally. Specific treatment of WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or waste stream. Such treatment is the most effective means of protecting the customer's environment.

Requirements for waste collection, reuse, recycling, and recovery programs vary by regulatory authority at your location. Contact your local responsible body (e.g., your laboratory manager) or authorized representative for information regarding applicable disposal regulations. Contact PerkinElmer at the web site listed below for information specific to PerkinElmer products.

Web address:

http://las.perkinelmer.com/OneSource/Environmental-directives.htm

For Customer Care telephone numbers select "Contact us" on the web page.

Products from other manufacturers may also form a part of your PerkinElmer system. These other producers are directly responsible for the collection and processing of their own waste products under the terms of the WEEE Directive. Please contact these producers directly before discarding any of their products.

Consult the PerkinElmer web site (above) for producer names and web addresses.

Pre-Installation Requirements

Laboratory Space Requirements

	Size	Weight
Clarus SQ 8 T, C, and S MS	32 cm (13 in.) wide x 50 cm (20 in.) high x 77 cm (30 in.) deep	46.8 kg (102 lb)
Clarus 580 GC	32 cm (13 in.) wide x 46 cm (18 in.) high x 77 cm (30 in.) deep	48 kg (105 lb)
Forepump	30.5 cm (12 in.) wide x 44 cm (17.3 in.) high x 72 cm (28.4 in.) deep.	25.9 kg (57 lb)
Clarus 680 GC	99 cm (39 in.) wide x 53 cm (21 in.) high x 82 cm (32 in.) deep	49 kg (108 lb)
Autosampler Tower	13 cm (5 in.) wide x 36 cm (14 in.) high x 24 cm (9.5 in.) deep	4.5 kg (10 lb)
Physical Configuration	Single unit for use on standard laboratory bench that can be interfaced to a computer and printer.	
Peripherals, Printers etc.	Allow at least 94 cm (36 in.) on either side of the GC/MS to accommodate additional equipment (for example, the computer).	

Bench Space	The laboratory bench should be sturdy enough to support the full weight of the GC/MS as well as additional equipment (for example, computer and/or printer). Expect the total weight of the GC/MS and accessory equipment to weigh at least 159 kg (350 lb). Allow a minimum clearance of 15 cm (6 in.) on each side, 22.9 cm (9 in.) at the rear, and 137.2 cm (54 in.) at the top of the GC/MS. If this is not possible, install the GC/MS on a bench that has wheels. The bench requires an area underneath for the forepump. Do not position the Clarus SQ 8 T and C so that it is difficult to operate the AC power on/off switch on the lower left side of the instrument in case of a malfunction of the instrument. For the Clarus SQ 8 S the AC power on/off switch is on the back of the instrument.

Environmental Requirements

Pollution Degree	This instrument will operate safely in environments that contain non-conductive foreign matter up to Pollution Degree 2 as defined in EN/IEC 61010-1.
Laboratory Environment	Install the GC/MS in an indoor laboratory environment that is clean and free of drafts and direct sunlight. The laboratory should be free of flammable, explosive, toxic, caustic or corrosive vapors or gases, and should be relatively free of dust. The ambient laboratory temperature should be between 10 °C and 30 °C (50 °F and 86 °F) for Clarus SQ 8 C, SQ 8 T, and SQ 8 S systems unless the turbomolecular pump is water cooled, and between 10 °C and 35 °C (50 °F and 95 °F) for Clarus SQ 8 C, SQ 8 T, and SQ 8 S systems with water cooling.

Power Requirements

Power Consumption	Clarus MS: 1000 VA (volt-amps) Clarus GC: 2400 VA (volt-amps) Add 100 VA for the computer and 108 VA for a printer.
Power Consumption (with optional oven heater)	See below listing for the Clarus 580/680. Add 100 VA for the computer and 108 VA for the printer.
Power Specification	All electrical supplies must be smooth, clean, and free of line transients greater than 40 V peak to peak, and must meet and remain within the following tolerances: Clarus MS: 120 VAC ±10 % @ 50/60 Hz ±1 % 1000 VA maximum 230 VAC ±10 % @ 50/60 Hz ±1 % 1000 VA maximum Clarus GC: For GC with slow heating rate as standard; 120 VAC ± 10% @ 50/60 Hz ± 1% @ 20 Amps, 2400 VA maximum 230 VAC ± 10% @ 50/60 Hz ± 1% @ 10 Amps, 2400 VA maximum For GC with optional oven heater for fast heating rate; 220 VAC ± 5% @ 50/60 Hz ± 1% @ 15 Amps, 3120 VA maximum 230 VAC ± 5% @ 50/60 Hz ± 1% @ 16 Amps, 3120 VA maximum 240 VAC ± 5% @ 50/60 Hz ± 1% @ 13 or 16 Amps, 3120 VA max Instruments and peripherals should not be connected to circuits with large inductive or large and frequent loads (for example, large motors, discharge lamps, photocopy systems, radio transmitters, etc.).

Power Outlets	Clarus MS: A minimum requirement of a power line separate from the GC at 15 amps or greater. Clarus GC: A minimum of one dedicated 120 VAC outlet at 20 A or one 230 VAC outlet at 10 A (minimum) is required for the Standard GC. When the optional oven heater is ordered, the outlets will be as indicated above. Additional equipments, such as computers and printers, should be connected per their specifications.

Gas Requirements

Carrier gases used with the mass spectrometer require a minimum purity of 99.999 %. Gas cylinders should be located outside of the laboratory whenever possible, and should always be stored and operated in the vertical position.

CAUTION	*For all gases delivered to the mass spectrometer, always use copper tubing that is free of grease, oil, and organic material. If in doubt about the condition of your tubing, clean it before use.*

Carrier Gases

GC/MS Carrier Gases:	Minimum purity of 99.999% for methane, minimum purity of 99.98% for isobutane, minimum purity of 99.998% for ammonia. Carrier gas tubing should be ultra-clean.
Helium	A number 1A (200 ft^3) gas cylinder should be used for all carrier gases with a high-purity, stainless-steel diaphram, two-stage regulator. Filter through a moisture filter and/or hydrocarbon trap and de-oxo filter designed for MS. Gas delivery pressure to the GC should be 70 – 100 psi (483 – 689 kPa). Do not exceed 100 psi (689 kPa) on the carrier gas inlet.
Reagent Gases:	Minimum purity of 99.95%.

	The gas delivery pressure required is 15 psi (103 kPa) to the bulkhead fitting (1/8 in. Swagelok) on the mass spectrometer.
Ammonia Methane Isobutane	If ammonia is used for chemical ionization, all fittings and tubing must be stainless steel to avoid corrosion. A single-stage regulator is required for ammonia, rated for corrosive service. Also, the forepump must be vented to a fume hood or trap. A high-purity, stainless-steel diaphragm, two-stage regulator is required for methane and isobutane with a final delivery pressure of 15 psi (103 kPa). Clean tubing must be used. It must be solvent-washed and nitrogen-dried. The bulkhead connector at the rear of the instrument is a 1/8 in. Swagelok fitting. The use of commercial gas purifiers for reagent gas is recommended.

Safety Requirements

Gas Delivery Lines	Copper tubing that is free of grease, oil and organic material must always be used with the Clarus MS on all gas lines, except ammonia reagent gas. Ammonia reagent gas requires stainless steel. Solvent-washed copper tubing must be used to avoid contamination of the Gas Chromatograph. Suitable solvents are acetone or dichloromethane (do not use if negative chemical ionization is planned) followed by methanol. Clean helium or nitrogen should be used to blow any residual solvent from the tubing. Cap all unused tubing. Care must be taken not to kink or overstress the gas delivery lines. Strain relief consisting of two one inch coils of tubing should be installed at every gas line connection.
Gas Cylinders	All gas cylinders should be firmly clamped to a suitable surface. Gas cylinders should be located outside of the laboratory whenever possible, and should always be stored and operated in a vertical position.

Hydrogen	Ensure that all hydrogen lines and connections are leak-free. When using a hydrogen tank, install an in-line hydrogen snubber (part number 00090038) between the tank regulator and the delivery tubing.
Ventilation	Always provide adequate ventilation. When analyzing hazardous compounds such as pesticides, it may be necessary to arrange to vent the mass spectrometer effluent from the forepump into a fume hood. To prevent contamination if a fume hood is unavailable, an oil separation filter should be installed at the outlet of the forepump vented to a fume hood or an oil mist separator (Alcatel 68316) with a charcoal trap (Koby KA1). An acceptable alternative is to attach a ½ inch Tygon tube and vent to a hood. Pump oil vapor is considered toxic and must be vented properly.

Computer and System Software Requirements

To ensure that your system performs at the expected high level, your computer must be configured to the minimum capabilities indicated below.

These requirements may be updated as the requirements for TurboMass software and/or Microsoft Windows 7 are changed. Consult the latest Product Description List for current requirements.

NOTE: *This guide does not cover the installation and configuration of your computer. If you have purchased a complete system from PerkinElmer, the computer will already have been configured.*

PC Requirements

The TurboMass software is installed at PerkinElmer prior to shipment and tested using the following minimum PC system specifications. If you need to reinstall the software, verify that the PC meets the following minimum requirements:

- Lenovo ThinkCentre® M58p
- 3.0 GHz Intel® Core 2 Duo Processor
- 4 GB of Random Access Memory (RAM)

- Integrated video, Intel® GMA4500
- Hard disk with 2.0 GB free space
- 1 RS-232 port
- 2 RJ-45 10/100Base-T ports
- Lenovo USB Keyboard and Lenovo USB optical mouse with scroll

Operating System

Windows 7 Professional

Software

TurboMass Software.

Instrument Firmware Versions

Internal dotLINK

Printer

HP LaserJet P4014 Printer Series (CB506A)

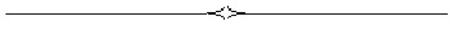
NOTE: *Using any printers other than the one recommended above may not correctly display the Communiqué reports.*

Pre-Installation Checklist

MODEL: _____ DATE: _____
CUSTOMER: _____
SPO#: _____

Requirements	OK	Needs Prior To Installation
Customer Responsibility		
Lab Space Requirements		
Power Requirements		
Gas Requirements		
Environmental Requirements		
Safety Requirements		
Preparation of Samples (Customer Responsibility)		
Computer Configuration		
Customer Experience		

2 Introduction



Preface

The Clarus MS is a benchtop mass spectrometer designed with the user in mind. The small profile of combination Gas Chromatograph and Mass Spectrometer (GC/MS) allows it to fit on a standard six foot long laboratory bench. Sophisticated software controls the GC/MS from a Windows 7 computer.

System Overview

The system consists of:

- Clarus GC
- Clarus MS
- Computer
- TurboMass Software
- Foreline Pump

Summary of this Guide

Thoroughly read and understand the Safety and Regulatory Information chapter before using the mass spectrometer.

Chapter 1:	*Warnings and Safety Information* Contains all of the safety information and topics to comply with EN/IEC 61010.
Chapter 2:	*Introduction* Provides an instrument overview and the references to related documentation.
Chapter 3:	*About the Clarus SQ 8 MS System* Describes each of the components in the system and includes a list of items to check before using the instrument.
Chapter 4:	*Maintenance* Contains preventive and routine maintenance procedures that typical users can perform.
Chapter 5:	*Troubleshooting* Provides helpful troubleshooting tips and a table to help you identify and solve typical problems.

Related Documentation

The Clarus ST8 family of manuals includes the following:

- *Clarus GC/MS Tutorial* (part number 09931018): The tutorial provides a step-by-step guide to performing a number of tasks using the instruments and software.
- *TurboMass Software User's Guide* (part number 09931016): A comprehensive manual describing the functionality of each part of the TurboMass software. It describes the keys and fields on each screen.

- *Clarus SQ 8 MS Hardware Manual* (part number 09931017): Contains the required safety and regulatory information required for EN/IEC 61010. It contains an overview of mass spectrometry and of each component in this system; a pre-operational checklist, typical user maintenance and a troubleshooting guide.

- *Service Manual (not included)*: Contains information for trained service engineers to completely service the Clarus.

Supplies, Accessories and Replacement Parts

Supplies, accessories, and replacement parts can be ordered directly from PerkinElmer using the eight-digit part numbers provided in this manual. To place an order for supplies and many replacement parts, request a free catalog, or ask for information visit our website.

www.perkinelmer.com/supplies

The most up-to-date information on part numbers, product brochures, spare parts and application notes are located in the PerkinElmer website.

- If you are located *within* the U.S., call toll-free: (800) 762-4000, Monday - Friday, 8:30 a.m. to 7 p.m. EST. Your order will be shipped promptly, usually within 24 hours.

- If you are located *outside the U.S.*, call your PerkinElmer sales office.

3 About the Clarus GC/MS System

About the Clarus SQ 8 MS System

The Clarus SQ 8 mass spectrometers (MS) are compact benchtop instruments that produce positive identification and quantitation of compounds separated by the Clarus 580 and 680 series gas chromatographs, respectively. Even if the compounds coelute, the mass spectrometer can still positively identify and quantitate each compound based on spectral data. Clarus SQ 8 C MS is designed to include both Electron Impact (EI) ionization as well as chemical ionization (CI). The Clarus SQ 8 S and SQ 8 T MS are electron impact (EI) only.

Figure 4 Clarus SQ 8 MS with Clarus 680 GC.

The Clarus MS system is controlled by a PC using TurboMass Software. The application runs in a Microsoft Windows 7 Professional operating environment. The software user interface contains color graphics and provides full user interaction with either the keyboard or the mouse. TurboMass completely controls the GC/MS system from tuning and data acquisition (scanning or selected ion recording mode), through quantifying your results. Complete operating instructions of all TurboMass controls are in the *TurboMass Software Guide* (part number 09931016), supplied with the system.

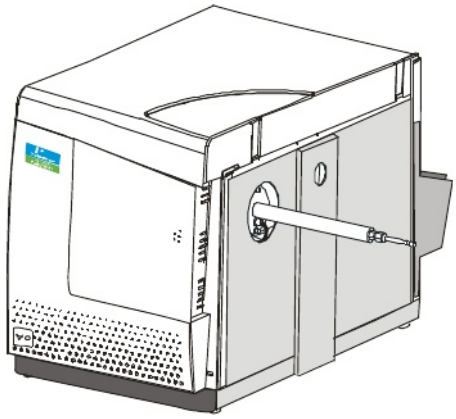


Figure 5 Clarus SQ 8 Mass Spectrometer.

A high-performance, research-grade analytical quadrupole mass analyzer with a quadrupole prefilter assembly transmits only those ions having your selected mass-to-charge ratio. The prefilter rod set improves sensitivity and protects the analytical quadrupole rods from contaminating ion deposits. Ions emerging from the quadrupole mass analyzer are detected by the electron multiplier detector system.

Clarus 580/680 Series GC

The Clarus 580/680 Series Gas Chromatograph is a dual-channel, temperature-programmable gas chromatograph (GC). It is available in many configurations, such as with or without, an autosampler, programmable pneumatic control (PPC), and a variety of injector/detector combinations to provide you with total GC flexibility. The Clarus GC is microprocessor controlled, where you enter the operating parameters and view the prompting text and monitor instrument functions on a large full-color touch screen display.

Figure 6 Clarus 680 GC.

The Programmed Pneumatic Control (PPC) Version of the Clarus 580/680 Series GC is used where the carrier gas and detector gases are monitored and controlled by the microprocessor, thereby producing a fully automated system that is capable of managing all pneumatic functions within the gas chromatograph.

The Clarus 500/600 Series GC can store up to five GC methods. Methods can be generated, copied, deleted, edited, set up, and printed. These methods are normally developed and stored on the TurboMass data system. The automatic liquid

autosampler can run up to 15 injections per vial from as many as 108 vials and one priority vial using one or two autosampler programs (if not under TurboMass control). In the latter case, a different GC method can be used by each program if desired.

PPC provides real-time digital readouts to simplify setting carrier gas pressures and flows.

GC Interface (Transfer Line)

The detector end of a capillary GC column in the Clarus GC oven is inserted through a temperature-controlled transfer line and optimally positioned so that the column end is flush with the inner wall of the EI or CI ion source. The transfer line is temperature controlled by Clarus MS and has a 350 °C upper limit. If the Clarus GC detects improper operation (for example, no carrier gas) and goes into an alarm condition, it will turn off the temperature to the transfer line.

Figure 7 The transfer line.

Reference Gas Inlet

The MS reference gas inlet system consists of a glass bulb filled with heptacosa (FC43) connected to tubing which directs it to the ion source. You can switch the reference gas solenoid valve on and off and also purge the reference gas lines from the Tune screen. The reference gas vial is located toward the front of the instrument underneath the top cover and **not** visible on the front panel.

Ion Optics Path

Ion Source

The Clarus MS ion source consists of a removable ion source. The Clarus SQ 8 C also supports a CI source. In the EI source, molecules exit the column where they are bombarded by electrons from the filament and ionized into positive and negative ions as well as neutral species. The positive electron trap attracts the negative ions and electrons to the repeller that directs the positive ions out of the inner source through focusing lens to the mass analyzer. Those remaining molecules and neutral fragments are pumped away by the vacuum. Heaters in the outer source raise the source temperature high enough to prevent sample molecules from condensing in the source and minimize any contamination.

Mass Analyzer

The mass analyzer element of this high performance quadrupole mass spectrometer is a finely machined assembly that has been precisely aligned using specialized equipment. ***Under no circumstances*** should the main analyzer rod set assembly ever be dismantled.

The mass spectrometer is fitted with a quadrupole prefilter assembly that is designed to protect the main analyzer by intercepting the majority of any contamination. As a consequence, the main analyzer should never require cleaning.

On occasion, it may be necessary to remove the prefilter rods for cleaning. The need to clean these rods is usually indicated by poor peak shape or loss of resolution, although other more likely causes, such as source contamination, should be eliminated first. It is necessary to remove the inner and outer ion source assembly before the prefilter assembly can be removed.

Detector

The detector consists of a series of focusing lenses, a 270 ° turn and a high voltage conversion dynode. The ions hit the high voltage conversion dynode and are converted to electrons. The electrons are directed into a series of diecrete dynodes with amplify the signal. Finally the signal is collected and transferred to the Data system.

Electronics

The Clarus MS electronics consist of an Ethernet port in the PC, an embedded processor & digital I/O board, analog board (GC/MS), backplane board, head amplifier, and high voltage and low voltage power supply boards. The embedded processor controls all aspects of instrument and data acquisition.

Vacuum System

The source, ion optics, analyzer, and detector are fitted inside a cast aluminum chamber. Vacuum is applied to the chamber using a rotary pump and a turbomolecular pump. The vacuum is monitored through a wide range gauge. The rotary pump sits on the floor and a turbomolecular high vacuum pump is inside the instrument.

Rotary Pump

The Clarus MS has a 3 m^3/hr computer controlled mechanical pump. The turbomolecular pump is backed by this direct drive rotary pump. The rotary vane pump rests on the lab floor and may be positioned beneath the instrument. Care should be taken to avoid mechanically coupling vibrations from this pump to the mass spectrometer. Operation and maintenance details about these pumps can be found in the manuals provided with the pump.

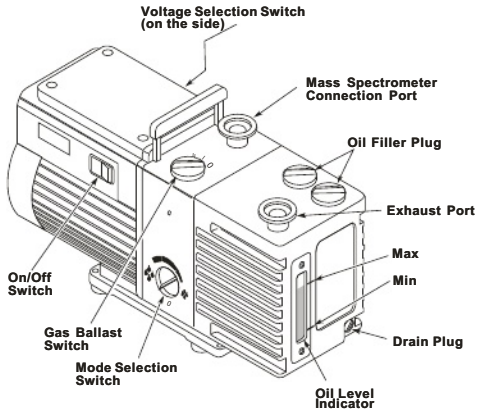


Figure 8 The rotary (fore) pump.

The rotary vane pump (also called the forepump) provides the first level of vacuum to approximately 2 x 10^{-3} Torr. The pump has a switchable dual voltage.

Connect the rotary pump exhaust to a line vented to the atmosphere outside the laboratory or use an appropriate exhaust line filter.

CAUTION	*The AC line cord for the rotary vane pump must be plugged into the designated receptacle on the back of the Clarus MS. The pump is controlled by the TurboMass software.* *Connecting the vacuum hose to the exhaust connection of the rotary pump will severely contaminate the Clarus MS.*

Vacuum Pump Options

The Clarus SQ 8 MS offers two different vacuum pump capacities.

Turbomolecular pumps are high-speed turbines which transport the sample and carrier gas molecules away from the mass spectrometer.

- Clarus SQ 8 S - The 75 L/sec turbomolecular pump supports Electron Ionization operation (EI) and has optional water cooling.
- Clarus SQ 8 T – All of the functions and options of the SQ 8 S with a 255 L/sec turbomolecular pump for higher column flow rates, pump-down time under three minutes, and lower detection limits
- Clarus SQ 8 C - All of the functions and options of the SQ 8 T with positive and negative Chemical Ionization (CI) operation.

Pumping Down a Turbomolecular Pump Vacuum System

➢ Select **Pump/Vacuum System On** from the **Options** menu on the Tune page.

The menu name will change from **Pump/Vacuum System On** to **Vent/Vacuum System Off**, and the system will begin its pump-down sequence. Once **OPERATE** is enabled, it remains enabled unless the **Vent/Vacuum System Off** command is given.

Venting the Turbomolecular Pump Vacuum System

1. Cool the source and inlet to below 100 °C.
2. Select **Vent/Vacuum System Off** from the **Options** menu on the Tune page, and confirm that you want to vent the system.

Vacuum Gauge

The single wide range vacuum gauge monitors the system pressure from atmosphere down to 10^{-9} Torr using a combined Pirani/Inverted Magnetron ionization sensor.

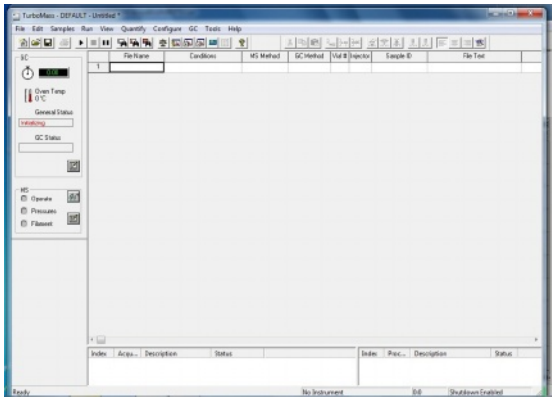
Normal operating pressure with 1 mL/min helium for the 255 L/sec turbomolecular pump is between $9x10^{-6}$ Torr and $2x10^{-5}$ Torr after pump-down and ion source bake-out. The 75 L/sec turbomolecular pump will operate at somewhat higher pressures, typically below $4x10^{-5}$ Torr.

TurboMass Software

TurboMass software is the user interface of the Clarus system. The following screens show some examples of how you can control Clarus. Interaction is via the mouse and keyboard using menu-driven commands. Printing, file management and other routine procedures are performed using the appropriate Microsoft Windows modules.

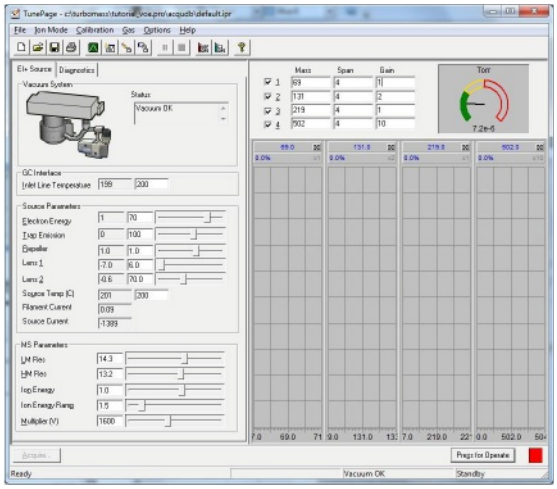
Top Level Screen

This screen contains the GC/MS status, sample list, sequence queue, and provides you with access to all other functions.



Tune Page

The Tune Page allows you to tune the mass spectrometer, control the gases, set the GC interface temperature, and monitor the instrument vacuum pressure.



Analytical Column

The analytical column inside the Clarus GC oven provides the sample separation. Make sure you select the proper column for your analysis. PerkinElmer offers a wide range of columns in the *Gas Chromatography Column Catalog*. The TurboMass Tutorial provides additional column selection tips.

There are several things to consider when choosing an analytical capillary column:

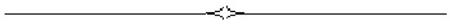
1. Know the types of samples you will be analyzing. Are they volatile, semi-volatile, pesticides, solvents, etc?
2. Select a stationary phase based on polarity of the sample. A very general rule in column selection is that like dissolves like. Column polarity has the greatest effect on how the column separates the compounds of interest as the sample interacts with the stationary phase. There are different degrees of polarity from non-polar to very polar. When compounds are separated primarily on their boiling points the phase is considered to be non-polar. Polar phases typically separate compounds based on the chemical interactions between the sample components and the stationary phase.
3. The inside diameter of the capillary column has an effect on the column's resolving power and its capacity or concentration range. In general, the larger the inside diameter of the column, the larger the sample capacity. However, the larger the inside diameter, the higher the flow necessary to achieve good performance.
4. The next parameter is the phase or film thickness. Film thickness will primarily affect the retentive character and the capacity of the column. Increasing the film thickness will cause an increase in the retention of the compounds being analyzed. Thick film columns are primarily used for extremely volatile compounds. The thicker phases will retain components longer, allowing them to interact longer with the stationary phase, thereby increasing the separation of closely eluting compounds.
5. The last variable to consider is column length. The effect of column length on a separation becomes less important as column length increases. Resolution is a function of the square root of the column length. An example of this relationship is that, if you want to double the separation between two peaks without changing the stationary phase, inside diameter, film thickness, or GC conditions, it would take a four-fold increase in the column length. A 30 meter column is the most common length and is usually sufficient for analyzing most samples. Typically, users doing environmental EPA type analysis will use a 30 meter column for semi-volatile compounds and 60 to 105 meter columns for volatile compounds.

Pre-Operational Checklist

This checklist provides you with a list of items to check to make sure everything is in working order before you begin to use Clarus.

Item	OK
Are the gases connected to the GC?	
Is the proper column connected?	
Is the proper liner installed in the injector?	
Are your samples prepared?	
Is there a GC method?	
Is the GC split vent open?	
Is the proper mass spectrometer vacuum achieved?	
Is the system leak-free?	
Is there a mass spectrometer method?	
Are the autosampler wash vials filled with solvent?	
Are you using the proper column flow or pressure?	
Did you check the air/water spectrum on the TurboMass Tune screen?	
Is the injector hot and set to the proper temperature?	
Is the transfer line hot and set to the proper temperature?	
Is the source hot and set to the proper temperature?	

Maintenance 4



Overview

WARNING

High electrical voltage is present inside the mass spectrometer. *To prevent the risk of electrical shock or injury from high voltage, unplug the AC line cord from the AC outlet and wait at least one minute before opening or removing an instrument panel.*

WARNING

Disconnect AC power cord from outlet before removing any cover or parts. Do ***not*** *operate the instrument with any covers or parts removed.*

WARNING

Do ***not*** *attempt to make adjustments, replacements or repairs to this instrument except as described in the accompanying user documentation.*

NOTE: *This equipment requires no specified inspection or preventive maintenance to ensure the continuous functioning of its safety features.*

Cleanliness and care are of critical importance whenever internal assemblies are removed from the instrument.

- Always prepare a clear, clean work area.
- Make sure that any required tools or spare parts are close at hand.
- Obtain small containers to store screws, washers, spacers etc.
- Never touch any internal source parts with your bare fingers.

- Use tweezers and pliers whenever possible.
- If nylon or cotton gloves are used, prevent leaving fibers in sensitive areas. **NEVER** use rubber gloves.
- Before reassembling and replacing dismantled components, inspect O-rings and other vacuum seals for damage. If you in doubt, replace the O-rings and vacuum seals with new ones.

If a fault occurs soon after repairing or disturbing a particular part of the system, ensure that this part has been correctly refitted and/or adjusted and that any adjacent components have not been inadvertently disturbed.

WARNING

Many of the procedures described in this chapter involve removing potentially toxic contamination deposits using flammable or caustic agents. Anyone performing these operations should be aware of the inherent risks and should take the necessary precautions.

Typical Overall Maintenance Schedule

Performing maintenance tasks on a routine basis can reduce the overall costs of operation. If a fault occurs, you can correct it with minimum difficulty.

Advanced maintenance should be performed by a skilled person capable of removing complicated mechanical assemblies. For example, an untrained individual should not attempt to remove the manifold but may be able to perform basic maintenance such as draining and filling the forepump.

Exterior surfaces may be cleaned with a soft cloth dampened with a mild detergent and water solution. Do not use abrasive cleaners or solvents.

Factory trained service personnel can assist in any advanced training needs. All tasks should be logged into a logbook to keep a record of any problems or trends.

Daily

- Make sure all system components are in working order.
- Check and ensure that there are gas supplies to the GC and to the mass spectrometer.
- Check the air/water spectrum. Perform leak checking if necessary.
- Enter information into a logbook.

Weekly

- Check the tune and mass calibration. Tune if necessary.
- Check the forepump oil level and color. Replace if necessary.
- If equipped with a water chiller, check the water level and temperature.
- If using CI, at the end of the day gas ballast the forepump lightly for 20 minutes.

Monthly

- Clean the fan filters on the rear of Clarus MS.
- Check the reference gas vial. Refill if necessary.

Every Six Months

- Replace the forepump oil.
- Check the analyzer prequadrupole. Clean if necessary.

Yearly

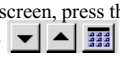
- Check lens 1, lens 2, and analyzer prequadrupole. Clean if dirty.
- Check and clean the forepump inlet filter, gas ballast control, and the motor fan cover and enclosure.

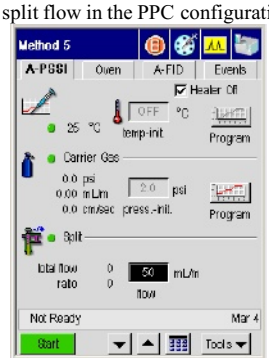
Leak Checking

Checking for leaks is actually checking the integrity of the vacuum system. You observe masses 4 (helium), 18 (water), 28 (nitrogen), and 32 (oxygen).

To leak-check the system, follow this procedure:

1. Ensure that all connections are made to the mass spectrometer.

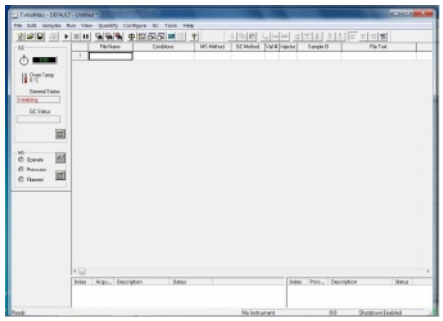
2. Set the GC split flow to 50 mL/min by pressing the PSSI injector icon on the Clarus GC touch screen. On the next screen, press the split flow setpoint and use the up and down arrow or keypad  buttons to set the split flow to 50mL. For example, if the capillary injector is in position 1 and you selected split flow in the PPC configuration software, the following screen is displayed.



The total flow (split vent + septum purge + column) is displayed in the lower left of the screen. The split vent flow setpoint is displayed in the setpoint box in the lower right.

3. Start the TurboMass software by clicking on the Windows **Start** button at the bottom left of the screen and select **TurboMass** under the *Programs/TurboMass/TurboMass* path, or double-click on the TurboMass icon if it is on your Windows desktop.

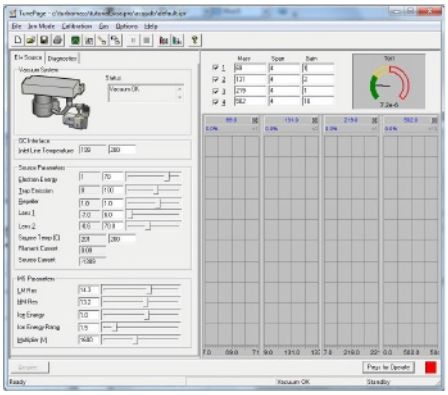
The initial TurboMass window is displayed.



4. Display the TunePage dialog by clicking  .
   The TunePage dialog is displayed.

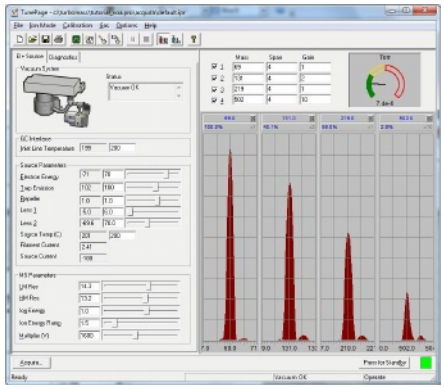
5. Make sure the Tune parameters are similar to the values displayed.

NOTE: *The inlet and source temperatures should be less than 100°C* ***only*** *when venting the system.*



6. Click **Press for Operate** next to the red indicator box.

The indicator box color changes to green and the name of the button changes to Press for Standby.



7. Select **Pump** from the **Options** menu.

   This starts the forepump and the turbomolecular pump. Watch the vacuum gauge readout and allow time for the gauge to achieve 4 x 10-5 Torr.

8. Observe the displayed masses.

   Mass 4 (helium) should be much larger than mass 18 (water), which should be larger than mass 28 (nitrogen), which should be about 4 times larger than mass 32 (oxygen).

9. If the nitrogen and oxygen are larger it indicates an air leak, which could damage the filament. Immediately click **Press for Standby** to turn off the filament.

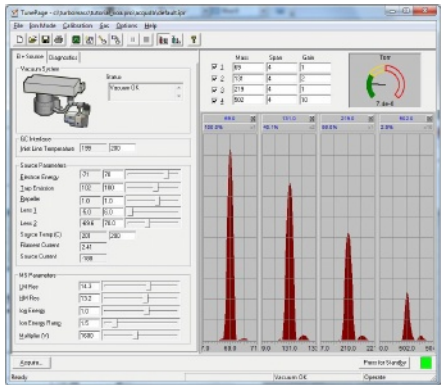
10. If a leak exists, locate and fix it.

    Typical areas to check for leaks are around fittings and areas under vacuum.

Tuning the Clarus MS

After determining that no leaks exist and before acquiring data, you may need to check the mass spectrometer tuning conditions and, if necessary, modify one or more of the tuning parameters. Clarus MS can be tuned either manually or automatically from the Tune window.

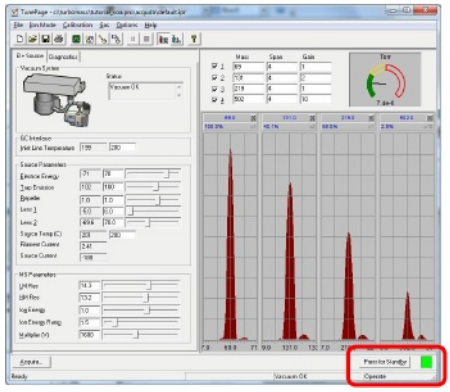
The left side of the page holds the tuning parameters for a selected region of the mass spectrometer. You can change the region by selecting an item from the Window menu, or by pressing one of the buttons on the bottom-left of the Tune page.



The panel displayed in the top right-center of the Tune page displays the tune peak information and instrument pressure information.

The tune peak display is located on the right side of the screen and allows you to view up to four masses. The corresponding check boxes located above the peaks allow you to control each peak display. Any one of the tune peaks can be zoomed so that it occupies the entire tune peak area. When a tune peak has been zoomed, the controls for the mass and span for that peak are displayed at the top of the display window. This enables you to display the pressure information while having control over the peak display.

To display the Tune page:

1. While displaying TurboMass sample list screen click  .
   The TunePage displays.
   

2. Turn on the filament and high voltages by clicking **Press for Operate** at the bottom right of the window.
   The indicator box turns green to indicate that it is on.

3. Select **UltraTune/Custom (AutoTune)** from the **Options** menu, then click **Start**.
   You will hear a click when the reference gas solenoid valve opens and AutoTune begins. Upon completion, the message **AutoTune completed successfully** is displayed.

4. Click **OK**.

5. Select **Reference Gas On** from the **Gas** menu to remove the check mark (✓), or click  to set it in the **up** position.

6. Save this new **Tune** of the instrument by selecting **Save As** from the File menu and entering a name for this tune in the **File name** field.

   A way to keep track of the tunes is to use dates for the file names.

7. Click **Save**.

   Your mass spectrometer is now Tuned. To ensure proper operation, check the mass calibration.

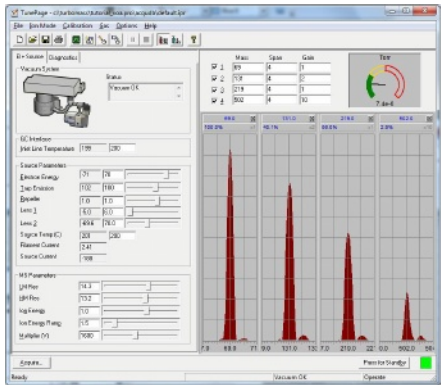
Preparing Clarus MS for Hardware Maintenance

To prepare Clarus MS for hardware maintenance, there are several steps that are common and precursory to all maintenance procedures. They are as follows:

Turn off the Operate Mode

1. Display the **Tune** window.

2. If the **Press for Standby** button is green (indicating an operating instrument), switch it off by clicking on it.



Cool the Transfer Line, GC Column Oven, and the Source

WARNING

*The transfer line, GC oven, and source are **HOT**. Touching them can cause serious burns. To prevent personal injury, wait until the oven and transfer line reach the lower setpoint temperature before touching them. Only grab and hold the source by its handle.*

1. On the left side of the Tune page enter **20** in the **Inlet Line Temperature** to cool the GC Interface (transfer line).

CAUTION *If the Clarus GC is off, then the PPC control is off and no gas is flowing through the system.*

2. Open the GC oven door to cool the column oven.
3. On the **Tune** page, set the source temperature by entering **20** in the **Source Temp** field.
4. Allow the transfer line, column oven, and source to cool before touching them.

WARNING

Remember, the transfer line was heated and it may take at least 10 to 20 minutes to cool.

CAUTION

*Avoid venting to air whenever possible. This eliminates the introduction of oxygen and water vapor into the mass spectrometer. The Clarus MS should be vented with UHP nitrogen (99.9995%). Helium should **not** be used. To properly connect a source of dry nitrogen to the instrument order the manifold venting kit (Part No. N6470045).*

Vent the System

1. Once both the Inlet Line and Source temperatures have dropped below 100 °C, select **Vent/Vacuum System Off** from the **Options** menu.
2. The Vent Pump dialog appears. All pumps are turned off.
3. Click **OK**.
4. Observe the Vacuum Pressure Gauges status on the Tune window.
5. The gauge goes to **ZERO** after the turbopump reaches 50 % speed and the vent valve is opened.

NOTE: *Mass Spectrometer venting may take several minutes depending on the helium flow and/or vent gas flow into the manifold.*

6. The system is now vented to atmosphere (or optional dry gas).

Turn off the GC Carrier Gas

Set all temperatures to ambient. Once the GC column oven, source, and transfer line are cool you may then turn off the GC carrier gas.

Removing and Returning the Source

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing or replacing parts. Hold the source by its handle only. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

Removing the Source

To remove the source, follow this procedure:

1. Prepare the mass spectrometer for maintenance as described in Preparing the Clarus MS for Hardware Maintenance on page 68.
2. Open the GC oven door and locate the mass spectrometer transfer line.
3. Using a 9/16-inch wrench, loosen the ¼-inch nut on the transfer line.

WARNING ***Risk of burns.*** *Never touch a heated mass spectrometer transfer line or a GC injector cap with unprotected (bare) fingers.*

4. Pull the inner transfer line tube back 25 mm (1 inch).

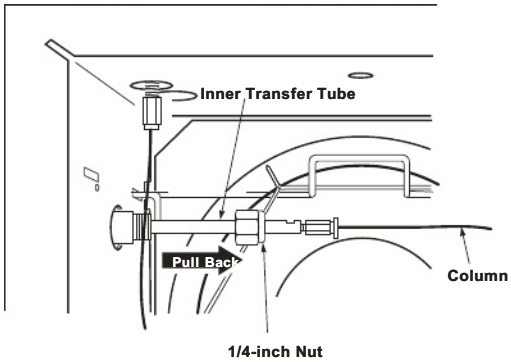


Figure 9 Pulling back the inner transfer tube.

5. Open the Clarus SQ 8 MS access door.
6. Hold the source by the edge and rotate it counter clockwise.

Figure 10 Rotating the source.

7. Carefully pull out the source.

Figure 11 Removing the source.

8. Place the source on a clean surface.
   Preferably place the handle end on a flat surface so that the source stands in an upright position.

Figure 12 The source placed in an upright position.

Returning the Source

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing or replacing parts. Hold the source by its handle only. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

1. Carefully hold the source by its edges.
2. Align the red dot on the source handle with the red dot on the instrument panel and rotate the source clockwise until it locks into position.

Figure 13 Lining up the red dots.

3. Push the inner transfer line tube back.
4. Using a 9/16-inch wrench, tighten the ¼-inch nut on the transfer line.
5. Close the Clarus SQ 8 MS access door.

Changing a Column

This procedure outlines the steps required to properly position the end of the column in the Source and connect the column to the MS Transfer Line tube fitting inside the GC oven.

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves when handling the part of the capillary column that will be inserted into the MS Transfer Line. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

Tools and Items Required:

NOTE: *Do **not** use a 100% Graphite ferrule to connect the column since it is a porous material that will allow air to diffuse into the MS system and prevent a high vacuum from being attained inside the system.*

- 9/16 inch wrench
- 1/4 inch wrench
- 5 mm wrench
- One 1/16 inch Column Nut
- One Graphite/Vespel ferrule appropriately sized for the capillary column i.d. that you will be using. (</= 0.25 mm i.d. columns require a 0.4 mm i.d. ferrule and >/= 0.32 mm i.d columns require a 0.5 mm i.d. ferrule.)
- Optional Plug Handle and Sight (P/N N6480380)

NOTE: *Please read the following guidelines in entirety prior to attempting the procedure for the first time. Following these guidelines at all times when performing this procedure will ensure that contaminants entering your MS system will be minimized, vacuum leaks will be minimized and detector response (sensitivity) will be maximized.*

NOTE: *The placement of the outlet end of the column relative to its position inside the source is a critical parameter for maximizing peak responses in your application. Follow this procedure closely to ensure that you achieve the correct column placement inside the source. Failure to do so may result in less than optimal detector response of target compounds in your analysis.*

CAUTION	*Prior to removing the source from the Clarus SQ 8 MS instrument (for example, to change a filament or clean the source), the column must be pulled back from its placement inside the source. This is conveniently achieved by loosening the large nut on the Transfer Line tube assembly so that the entire Transfer Line tube assembly can be pulled back from the source. It is not necessary to loosen the column nut as this may disrupt its proper positioning inside the source after the source is reinstalled. The source will not be able to be removed or reinstalled if the Transfer Line tube assembly is not pulled back first.*

There are three different recommended techniques that may be used to position and connect the capillary column. Each of the three techniques is outlined in the following procedure. Use the technique that you are most comfortable with.

The three different techniques are:

1. Physical measurement outside the SQ 8MS
2. Alignment using the 10 mm gauge tool (supplied with the SQ 8 MS instrument)
3. Optical Column Alignment Using the Optional Plug Handle and Sight (P/N N6480380)

Physical Measurement Outside the SQ 8MS

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves when handling the part of the capillary column that will be inserted into the MS Transfer Line. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

1. Slide an injector septum over the outlet end of the capillary column to use it as a positioning indicator aid.

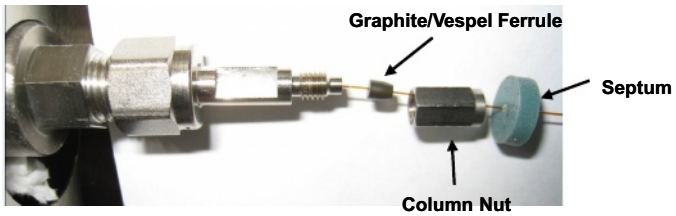


Figure 14 Location of septum on capillary column.

2. Slide a 1/16 inch column nut over the outlet end of the column.

3. With the tapered end facing towards the column nut, slide a graphite/vespel ferrule over the outlet end of the column.

4. Using the edge of a wafer scribe, score the outside surface of the column perpendicular to its length approximately 2 inches from the end and carefully break it off and discard the cut off piece of column. Jagged or angled cuts should be avoided. See Figure 15 for examples of good cuts and bad cuts.

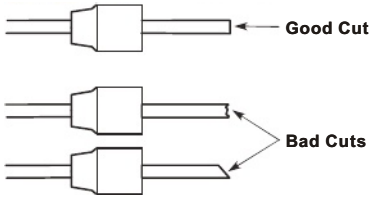


Figure 15 Good cuts and bad cuts

5. Use a lint-free wipe pre-soaked with a small amount of methanol to wipe the outside of the column a few times to remove surface contamination.

6. Place the column onto a clean, lint-free surface on the bench top. Measure exactly **34.4** cm from the outlet end of the column to the front side of the septum.

7. Confirm that the Source is fully installed in the instrument. If it is not, install the source into the instrument. See *Removing and Returning the Source* on page 71.

8. Insert the column into the MS Transfer Line tube and carefully slide it *partially* toward the source. Be careful not to move the septum.

9. With the column *partially* inserted, engage the threaded column nut onto the Transfer Line tube fitting until it is just finger-tight.

10. Slide the column into the Transfer Line tube until the septum is aligned at a distance exactly 10 mm away from the end of the column nut. See Figure 16.

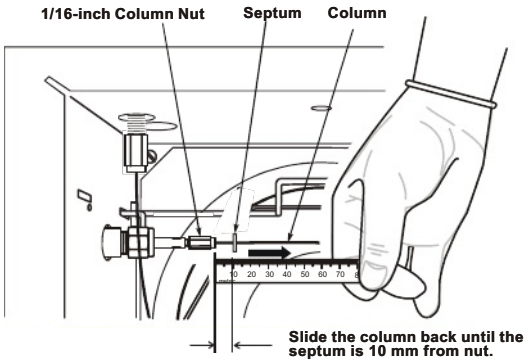


Figure 16 Measuring from the outlet of the column to the front of the septum.

11. Using the 5 mm and 1/4 inch crescent wrenches, tighten the column nut until the ferrule is crimped onto the column. See Figure 17.

Figure 17 Tightening the column nut.

12. The column is now installed the MS may be pumped down. Confirm that the proper vacuum level is reached (on the TurboMass software Tune Page).

13. After initially heating the GC oven through one or two analysis cycles, the column nut may loosen. Re-tighten the column nut. After re-tightening, the column nut should not loosen any more.

Alignment Using the 10 mm Positioning Gauge Tool

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves when handling the part of the capillary column that will be inserted into the MS Transfer Line. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

NOTE: *The 10 mm positioning gauge tool is supplied with the instrument.*

1. Slide an injector septum over the outlet end of the capillary column to use it as a positioning indicator aid. Slide the septum approximately 40 mm up the column.

2. Slide a 1/16 inch column nut over the outlet end of the column.

3. With the tapered end facing towards the column nut, slide a graphite/vespel ferrule over the outlet end of the column. See Figure 14.

4. Using the edge of a wafer scribe, score the outside surface of the column perpendicular to its length approximately 2 inches from the end and carefully break it off and discard the cut off piece of column. Jagged or angled cuts should be avoided. See Figure 15 for examples of good cuts and bad cuts.

5. Use a lint-free wipe pre-soaked with a small amount of methanol to wipe the outside of the column a few times to remove surface contamination.

6. Confirm that the Source is fully installed in the instrument. If it is not, install the source into the instrument. See *Removing and Returning the Source* on page 71.

7. Insert the column into the MS Transfer Line tube and carefully slide it toward the source.

8. With the column partially inserted, engage the threaded column nut onto the Transfer Line tube fitting until it is finger-tight.

9. Carefully continue inserting the column into the Transfer Line tube until it hits the far side of the source. Be careful to avoid forcefully jamming the column into the side of the source. Doing so may damage the cleanly cut end of the column resulting in poor chromatography.

10. With the column positioned as described in Step 9, slide the septum toward the column nut until it touches the nut.

11. Pull the column back 10 mm. Then use the 10 mm positioning tool (Gauge) to set the column nut at this position by placing the slot in the 10 mm Gauge over the column between the nut and the septum. At this point be careful to avoid moving the septum from its position on the column. See Figure 18.

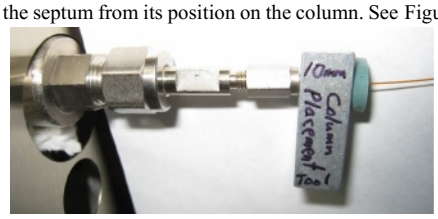


Figure 18 The 10 mm positioning tool (Gauge) in place.

12. Using the 5 mm and 1/4 inch crescent wrenches, tighten the column nut until the ferrule is crimped onto the column making sure that the 10 mm spacing is retained between the end of the column nut and the septum.

13. Remove the 10 mm Gauge.

    The column is now installed and the MS may be pumped down. Confirm that the proper vacuum level is reached (on the TurboMass software Tune Page).

14. After initially heating the GC oven through one or two analysis cycles, the column nut may loosen. Re-tighten the column nut. After re-tightening, the column nut should not loosen any more.

Optical Column Alignment Using the Optional Plug Handle and Sight

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves when handling the part of the capillary column that will be inserted into the MS Transfer Line. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

1. Loosen the large nut on the Transfer Line tube assembly using the 9/16 inch wrench and pull back the Transfer Line tube approximately 1 to 2 inches.
2. Remove the source from the Clarus SQ 8 MS instrument. See *Removing and Returning the Source* on page 71.
3. Insert the optional Plug Handle and Sight (Part No N6480380). Make sure to line up the red dots on the plug and instrument.
4. Turn the plug clockwise until the line on the plug and the lock symbol line up.

Figure 19 Inserting the Plug Handle and Sight.

5. Re-insert the Transfer Line tube assembly and tighten the large nut.
6. Slide a 1/16 inch column nut over the outlet end of the column.
7. With the tapered end facing towards the column nut, slide a graphite/vespel ferrule over the outlet end of the column. See Figure 14.
8. Using a wafer scribe, score the outside surface of the column approximately 2 inches from the end and carefully break it off and discard the cut off piece of column.
9. Use a lint-free wipe pre-soaked with a small amount of methanol to wipe the outside of the column a few times to remove surface contamination.
10. Insert the column into the MS Transfer Line tube and carefully slide it toward the source.

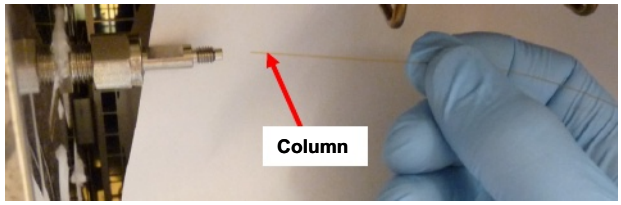


Figure 20 Inserting the transfer line.

11. With the column partially inserted, engage the threaded column nut onto the Transfer Line tube fitting until it is finger-tight.

12. Carefully continue inserting the column into the Transfer Line tube until it becomes visible inside the Plug Handle and Sight. Be careful to avoid inserting the column so far that it hits the far side of the MS vacuum chamber.

13. Position the outlet end of the column so it aligns with the edge of the engraved circle on the tip of the Plug Handle and Sight.

    The correct position of the column is reached when it is aligned with the edge of the circle (in other words, at the "3 o'clock" position).

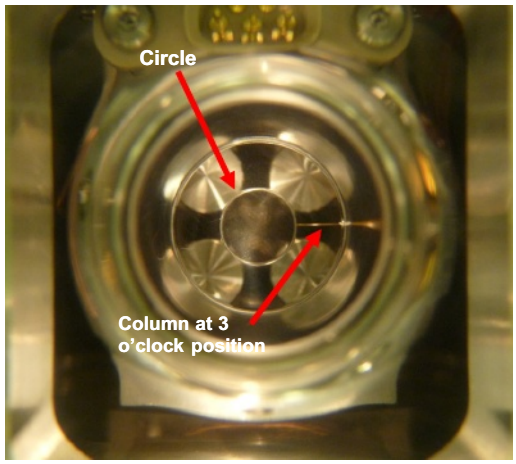


Figure 21 Viewing the Column through the Plug Handle and Sight.

14. Using the 5 mm and 1/4 inch crescent wrenches, tighten the column nut until the ferrule is crimped onto the column. Be careful to avoid moving the column from the set position. Confirm by gently tugging back the column. It should not move from the set position. Verify that the column placement is correct by visually inspecting its position on the circle inside the Plug Handle and Sight.

15. Loosen the large ¼ inch nut on the Transfer Line tube assembly using the 9/16 inch wrench and pull back the Transfer Line tube approximately 1 to 2 inches. See Figure 9.

16. Turn the Plug Handle and Sight counterclockwise to the unlock symbol on the instrument and remove it from the Clarus SQ 8 MS instrument.

17. Insert the source. See *Removing and Returning the Source* on page 71.

18. Re-insert the Transfer Line tube assembly and tighten the large nut.

19. The column is now installed and the MS is ready to be pumped down. Confirm that the proper vacuum level is reached (on the TurboMass software Tune Page).

20. After initially heating the GC oven through one or two analysis cycles, the column nut may loosen. Re-tighten the column nut. After re-tightening, the column nut should not loosen any more.

Refilling the Reference Gas Vial

It is time to refill the reference gas vial when you lose reference gas peaks intensity and you do not see a liquid in the reference gas vial, or any time the mass spectrometer is vented, and the liquid in the vial level appears low.

NOTE: *You should check liquid level in the reference gas vial any time you need to remove the mass spectrometer cover and vent the instrument. Using a tool such as a dental mirror will help you observe the liquid level in the Reference Gas Vial.*

Items Required

- Lint-free, powder-free nitrile, nylon, or PVC gloves.

- Pasteur Pipette or 50 µL syringe.
- Heptacosa (FC43) (Part No. N6212407).

To refill the reference gas vial, follow this procedure:

WARNING

Make sure to vent the instrument and turn the power off.

1. Ensure that the solenoid has been switched off.

2. Locate the reference gas vial under the top cover of the instrument.

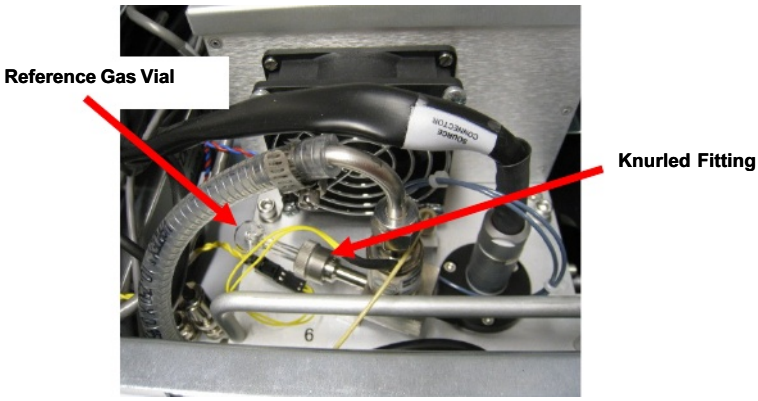


Figure 22 Reference gas vial and knurled fitting.

WARNING

The toxicity of the FC-43 calibrant is uncertain. Take appropriate precautions to avoid getting the calibrant on your skin or in your eyes.

3. Loosen the knurled fitting by ½ turn, and pull out the vial.
   A black O-ring may remain in the fitting.

4. Using a pipette or syringe, add 25 to 50 µL but no more than 50 µL of Heptacosa (FC43). See the following figure. Fill the bulb.

   Never add more than 50 µL.

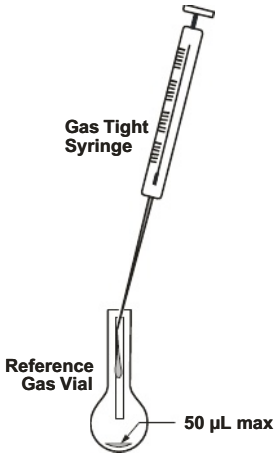


Figure 23 Filling the reference gas vial.

5. Re-insert the reference gas vial into the knurled fitting.
   Make sure the O-ring is still present and the tapered end of the ferrule faces the mass spectrometer.

6. Tighten the knurled fitting with your fingers until fingertight.

7. Replace the top cover and pump the system down to the proper vacuum.

8. From the Gas Menu select the Reference Gas Option from the drop down menu. Leave the Reference Gas Valve open for 60 minutes with Operate off to pump to pump out the gas from the bulb before tuning the mass spectrometer.

NOTE: *On the Tune Page the Gas drop down the select* ***Reference Gas On****.*

Replacing a Filament

This procedure is the same for both an EI or CI source.

CAUTION	*Make sure you are wearing lint-free, powder-free nitrile, nylon, or PVC gloves, and that you wipe each part with a methanol dampened Kimwipe.*

Items and Tools Required

- Filament assembly (Part No. E6470012).
- Methanol.
- Lint-free, powder-free nitrile, nylon, or PVC gloves.
- Aluminum foil or lint-free disposable cloth squares.

To replace a filament, follow this procedure.

1. Prepare a clean, uncluttered work area and place a square of aluminum foil with the shiny side up.
2. Remove the source by following the procedure Removing and Returning the Source on page 71.
3. Orient the source so that the filament faces you, then locate the filament retaining clip that holds it in place.

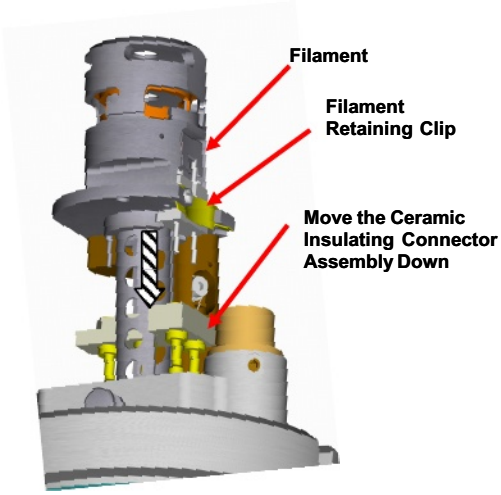


Figure 24 Moving the ceramic insulating connector assembly down.

CAUTION	*To ensure that the mass spectrometer remains contamination free, make sure you are wearing lint-free, powder-free nitrile, nylon, or PVC gloves, and that all tools have been cleaned with a methanol-dampened laboratory wipe.*

4. Using your thumb and forefinger, push down the ceramic insulating connector assembly to release it from the filament leads, trap lead, and repeller lead.

5. Press down on the retaining clip to release it from the locked position and swing it down.

6. The defective filament assembly will fall out of place, so carefully hold or catch it with your other hand.

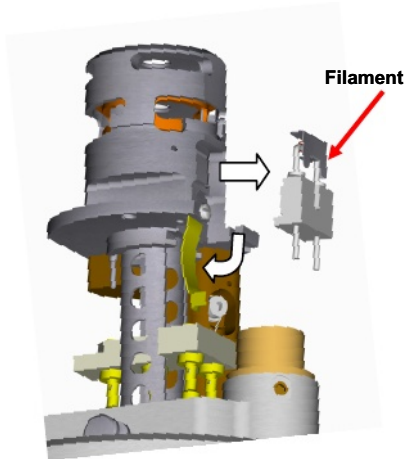


Figure 25 Removing the defective filament assembly.

7. Position the new filament assembly with the filament side up.
8. Position the new filament assembly with the coiled filament wire facing and centered in the orifice in the ion volume and the white ceramic rests on the tab.
9. Insert the Filament retaining clip into the slot in the block to hold it in place.
10. Align the four male gold leads (Trap, Repeller and Filament) with the four gold female connectors in the ceramic insulating connector assembly.
11. Carefully move the connector assembly upwards to fully encapsulate the four gold leads. You should be able to feel it “click” into position around the leads and close to the underside of the block.
12. Install the source assembly back into the mass spectrometer by following the procedure Removing and Returning the Source on page 71.

Source Maintenance

NOTE: *Before beginning this procedure, you may want to have on hand the following source component kits; Rebuild Kit Part No. N6480080 and N6480081.*

CAUTION	*To ensure that the mass spectrometer remains contamination free, wear lint-free, powder-free nitrile, nylon, or PVC gloves while performing this procedure.*

Disassembling

Prepare a clean, uncluttered work area and place a square of aluminum foil with the shiny side up. Obtain some clean, small containers (for example, small beakers) to store the small parts as you remove them.

1. Remove the source by following the procedure Removing and Returning the Source on page 71.

2. Orient the source so that the filament faces you, then locate the filament retaining clip that holds it in place.

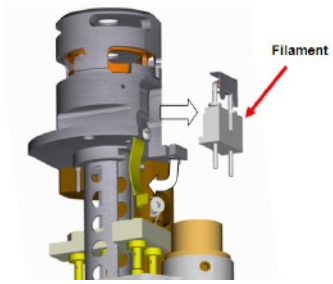


Figure 26 Removing the Filament.

3. Using your thumb and forefinger, push down the ceramic insulating connector assembly to release it from the filament leads, trap lead, and repeller lead.

4. Press down on the retaining clip to release it from the locked position.

5. The filament assembly will fall out of place, so carefully hold or catch it with your other hand.

CAUTION	*As you remove the source parts, note their placement and position in the source so that you can reassemble the source correctly. There is only ONE way to replace the parts in the source. The following illustrations should help you with the parts orientation and position.*

6. Turn Lens 3 counterclockwise until it disengages from the locking pin.

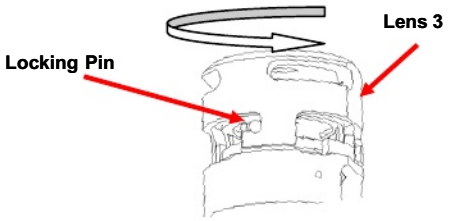


Figure 27 Removing Lens 3 from the source.

7. Remove the parts from the source.

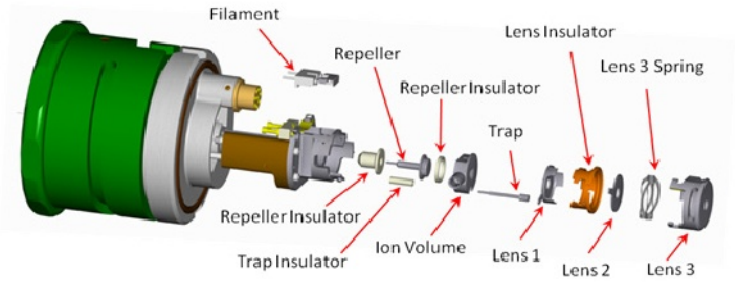


Figure 28 Removing the source parts for cleaning.

Cleaning

NOTE: *You can do the following cleaning method of aluminum oxide paste to polish the flat surfaces of the parts. For either cleaning method, the final step you* ***must*** *sonicate the parts in an ultrasonic bath of methanol for at least five minutes. Dry off the parts using lint-free tissue and/or clean compressed Nitrogen gas to prevent solvents from drying on these parts and leaving a residue*

1. Mix together aluminum oxide and de-ionized water and a few drops of methanol to make a watery paste.
2. Dip a wooden-stick cotton swab or a foam-pad swab in the solution and clean the darkened areas on the source. Work quickly to prevent the mixture from drying on the surface.
3. Place the cleaned components in de-ionized water prior to rinsing to prevent drying.

Rinsing

1. Add 50 mL of methanol to a 100 mL beaker, insert the source parts, and sonicate them in an ultrasonic bath for at least ten minutes.
2. Carefully drain the methanol.
3. Add 50 mL of acetone to the 100 mL beaker, insert the source parts, and sonicate in an ultrasonic bath for ten minutes.

CAUTION	*Do not allow the methanol and acetone to touch the O-ring on the source.*

4. Carefully drain the acetone.
5. Dry off the source parts using lint-free tissue and/or clean compressed nitrogen gas to prevent solvents from drying on these parts and leaving a residue.

   If you did not use acetone to rinse the parts, wrap them in a clean, lint-free cloth and bake them in the GC oven at about 80 ºC for about fifteen minutes.

Reassembling

1. Replace the source parts into the source as shown below. **Remember to insert the parts into the source only as positioned below.**
   You may want to insert the trap insulator and trap before you insert the repeller.

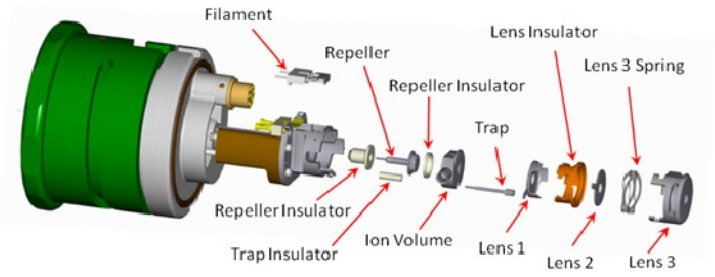


Figure 29 Replacing the source parts.

2. Align the Lens 3 grabbers with the pin on the source, then turn Lens 3 clockwise to lock it in place. See Figure 27.
3. Position the filament assembly with the coiled filament wire facing and centered in the orifice in the ion volume and the white ceramic rests on the tab.
4. Insert the Filament retaining clip into the slot in the block to hold it in place.
5. Align the four male gold leads (Trap, Repeller and Filament) with the four gold female connectors in the ceramic insulating connector assembly.
6. Carefully move the connector assembly upwards to fully encapsulate the four gold leads. You should be able to feel it “click” into position around the leads and close to the underside of the block.
7. Install the source assembly back into the mass spectrometer by following the procedure Removing and Returning the Source on page 71.

Mass Analyzer Maintenance (Advanced Users Only)

WARNING

*This procedure is intended for **advanced users only** that have been properly trained.*

The analyzer element of any high performance quadrupole mass spectrometer is, of necessity, a finely machined assembly that has been precisely aligned using specialized equipment. **Under no circumstances** should you ever disassemble the main mass analyzer assembly.

The mass spectrometer is fitted with prequads that act as a prefilter assembly designed to protect the analytical quads by intercepting the majority of any contamination. As a consequence, the analytical quads should never, under normal working conditions, require cleaning. Occasionally, it may be necessary to remove the prefilter rods for cleaning. The need to clean these rods is usually indicated by poor peak shape or loss of resolution, although other more likely causes, such as source contamination, should be eliminated first.

Items and Tools Required

- 4 mm hex wrench
- 5 mm hex wrench
- Lint-free, powder-free nitrile, nylon, or PVC gloves
- Aluminum foil
- Small flat-blade screwdriver
- Long flat-blade screwdriver
- Tweezers

Cleaning Materials

- Wooden stick cotton swabs
- Deionized Water
- 6000 Grade Micro Mesh (Part No. N9303420)

- 8000 Grade Micro Mesh (Part No. N9303421)
- 600 grit aluminum oxide in DI Water with a few drops of methanol to make a paste
- Acetone
- Methanol

When cleaning internal components it is important to maintain the quality of the surface finish. Deep scratches or pits can cause loss of performance. Where no specific cleaning procedure is provided, you should use fine abrasives to remove dirt from metal components. Recommended abrasives are:

- 6000 Grade Micro Mesh (Part No. N9303420).
- 8000 Grade Micro Mesh (Part No. N9303421).
- 600 grit aluminum oxide in DI Water with a few drops of methanol to make a paste

After cleaning with abrasives, it is necessary to wash all metal components in suitable solvents to remove all traces of grease, oil and, if micro-mesh is used, rubber. The recommended procedure is to swill or sonicate the components in a clean beaker of methanol for at least ten minutes and subsequently to blot them dry with lint-free tissue. Recommended solvents are:

After the components are reassembled, they should be blown with oil-free nitrogen to remove dust particles.

Removing and Returning the Ion Optics Assembly

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing or replacing parts. Hold the source by its handle only. Never touch these parts with ungloved (bare) fingers; oils will introduce contaminants into the system.*

WARNING

Make sure to vent the instrument and turn the power off and unplug the mass spectrometer from the AC power source.

The mass spectrometer contains high voltage. To prevent the risk of shock, unplug the line cord from the AC outlet and ***wait at least one minute*** *before opening or removing any instrument cover or panel.*

Tools Required:

- Medium sized Philips screwdriver
- 5 mm Allen Key

1. Power down and vent the Clarus SQ 8 MS.
2. Remove the source. See *Removing and Returning the Source* on page 71.
3. Use the medium sized Philips screwdriver to remove the two screws on the left access panel. See the following figure.

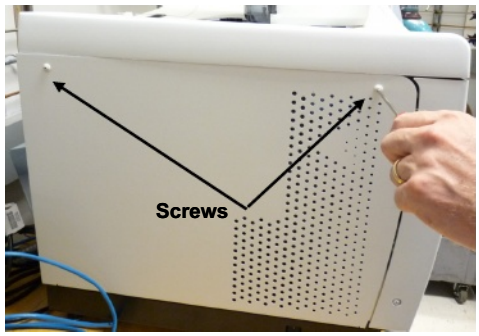


Figure 30 Removing the cover screws.

4. Remove the left access panel and place in a secure location.
5. Lift off the top cover by manipulating the slots on the right-hand side of the cover off the metal tabs on the instrument. See the following figure.

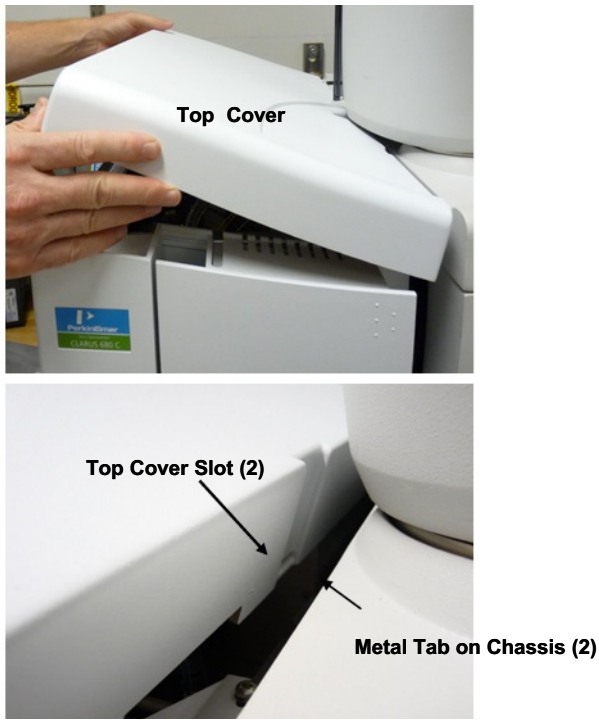


Figure 31 Removing the top cover.

6. Place the top cover in a safe location.
7. Loosen the two screws holding the plastic extensions in the front cover in place.
8. Tilt the front cover towards you slightly to provide clearance for removing the lid. It is not necessary to remove the front cover completely from the instrument.

9. Use a 5 mm Allen key to loosen the four hex screws that hold the optics assembly in place. See the following figure.

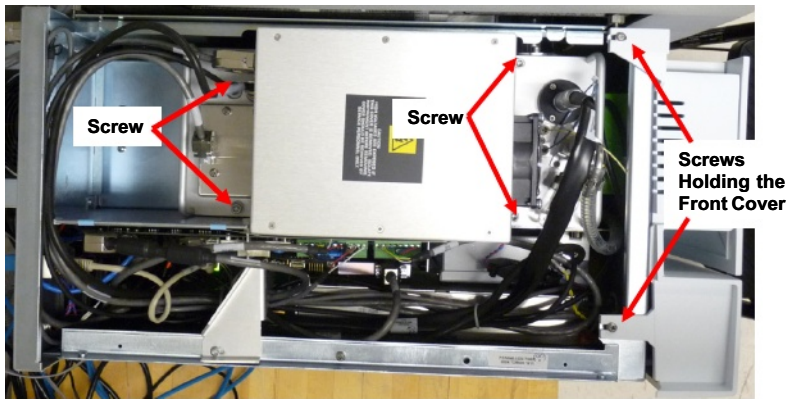


Figure 32 Removing the screws on the lid and the front cover.

10. From the rear of the optics assembly disconnect the four cables.

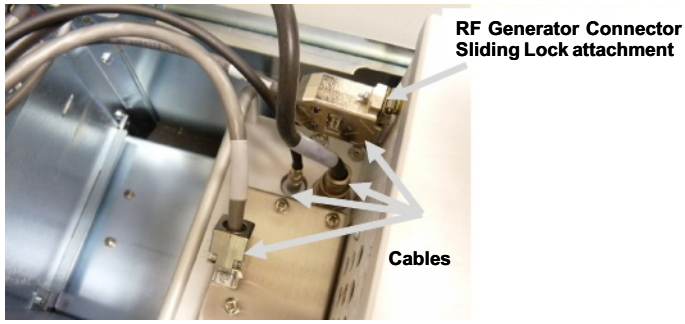


Figure 33 Disconnecting the cables at the rear of the optics assembly

11. Locate the Sliding Lock attachment on the RF Generator Cable connector, then press down on the Sliding Lock attachment to release the lock on the connector. See the following figures.

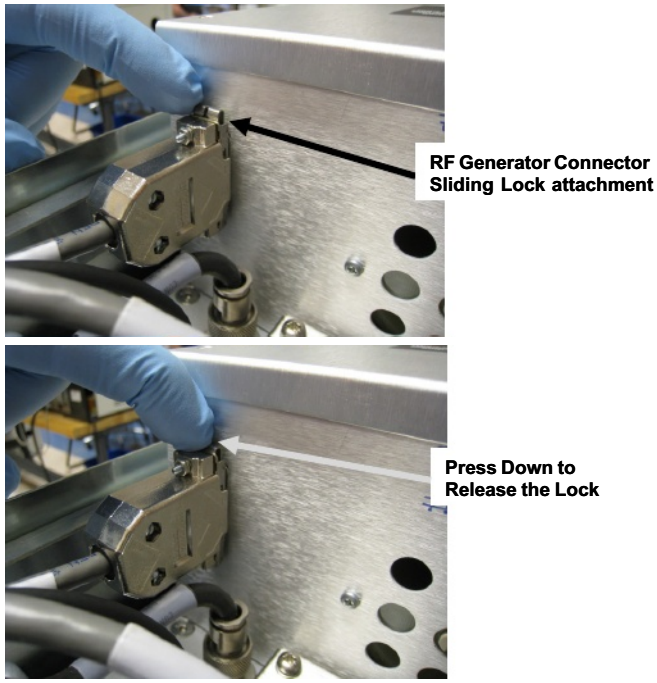


Figure 34 Sliding Lock attachment on the connector.

12. Remove the RF Generator Cable connector. See the following figure.

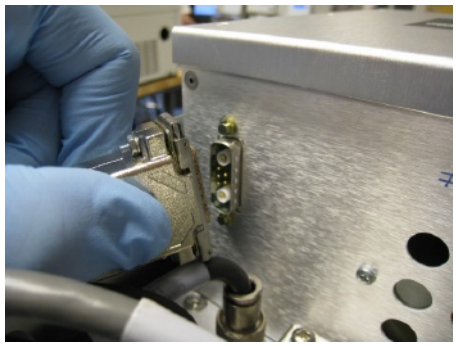


Figure 35 Removing the RF Generator cable.

NOTE: *The metal tube attached to the reference gas vacuum hose has a ferrule on it that may slip off when the nut is removed from the reference gas valve fitting.* ***Be careful*** *to avoid dropping the ferrule inside the instrument.*

13. From the front of the optics assembly disconnect the fan cable connector, reference gas valve cable connector, the source connector and the nut for the reference gas vacuum hose. See the following figure.

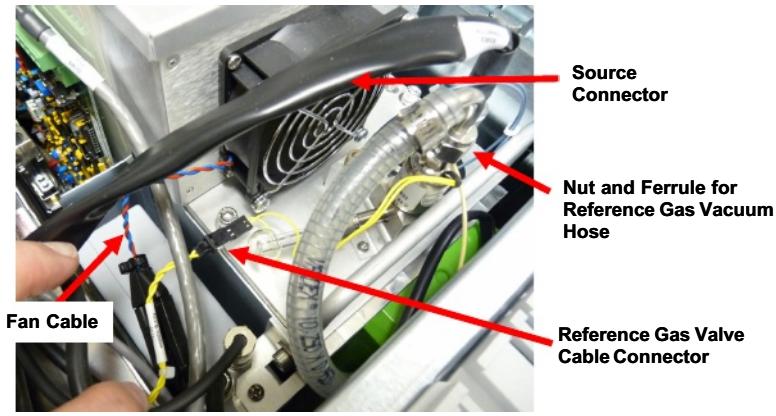


Figure 36 Disconnecting the cables at the front of the optics assembly.

14. Hold the ion optics assembly by its handles, lift it up, and place it on a clean surface.

15. Cover the vacuum manifold with aluminum foil.

Returning the Ion Optics Assembly

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing or replacing parts. Hold the source by its handle only. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

1. Remove the aluminum foil covering the vacuum manifold.

2. Ensure that the large O-ring around the ion optics assembly tub is properly set into place.

3. Hold the ion optics assembly by its handles and align the guide pins with the holes in the vacuum manifold.

4. Gently lower the ion optics assembly until it is seated on the vacuum manifold.
   Ensure that the large o-ring remains in place and does not move out of its groove in the tub.

5. Reconnect all cables at the front and rear of the optics assembly.

6. Make sure that the Sliding Lock attachment on the RF Generator Cable connector is in the “down” (unlocked) position prior to connecting it to the receptacle on the RF Generator box as shown in the following figure.

Figure 37 RF Generator cable connector.

7. Connect the RF Generator Cable connector to the receptacle on the RF Generator box. See the following figure.

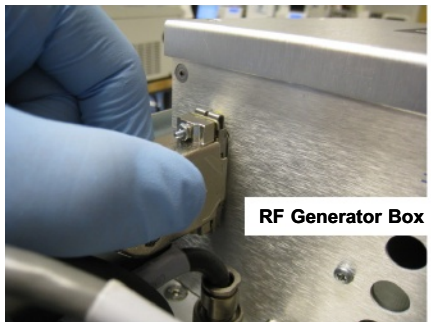


Figure 38 Reconnecting the RF Generator cable connector to the receptacle.

8. Using any Allen key, as shown in the following figure, pull up on the underside of the Sliding Lock attachment to lock the connector into place. See the following figure.

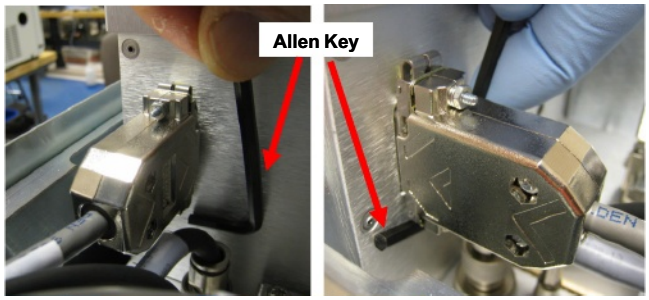


Figure 39 Sliding Lock attachment shown in the "up" (or locked) position.

9. Replace and tighten the ferrule and nut for the reference gas vacuum hose.

10. Secure the optics assembly in place with the four hex screws previously removed.

NOTE: ***Do not tighten these hex head screws beyond finger-tight.*** *The vacuum will pull the ion optics assembly top plate onto the large o-ring to create the seal. Over-tightening these screws may cause the ion optics assembly top plate to warp, which may cause a leak.*

11. Secure the top cover by securing the slots in the cover to the tabs on the instrument.

12. Use the medium sized Philips screwdriver to reattach the two screws on to the left access panel.

13. Replace the source. See *Removing and Returning the Source* on page 71.

Replacing the Electron Multiplier

The electron multiplier lifetime is dependent on the number of ions detected. You can increase its life by correctly using the solvent delay settings and minimizing air leaks.

To replace an electron multiplier:

1. Remove the ion optics assembly. See Removing and Returning the Ion Optics Assembly on page 96.

2. Release the electron multiplier by pressing the retainer clip then pull the electron multiplier from the assembly. See the following figure.

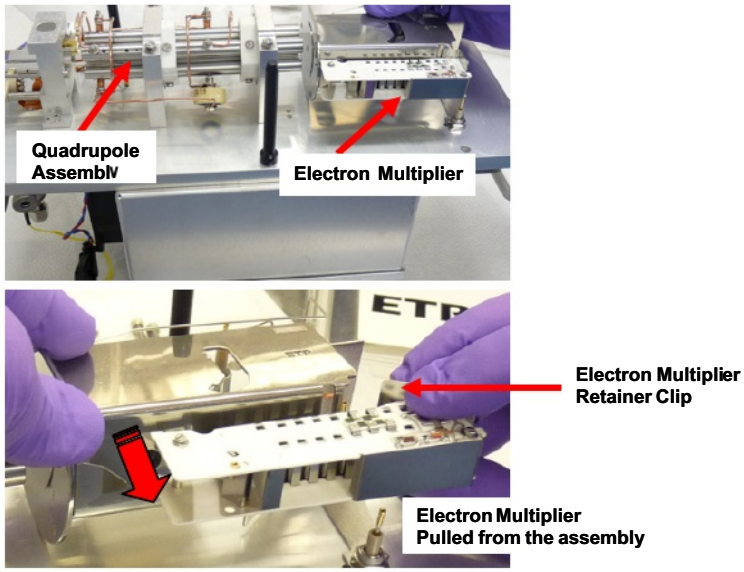


Figure 40 Removing the electron multiplier.

3. Replace with a new electron multiplier by sliding it forward toward the source and clipping it back into place.
4. Return the ion optics assembly. See Removing and Returning the Ion Optics Assembly on page 96.

Cleaning the Prequads

CAUTION	*To prevent contamination of the mass spectrometer, always wear clean, lint-free, powder-free nitrile, nylon, or PVC gloves before touching, removing or replacing parts. Never touch these parts with ungloved (bare) fingers, as this will introduce contaminants into the system.*

1. When operating under normal circumstances, you may not have to remove the prequads from the ion optics assembly but you will need to access the optics assembly. See Removing and Returning the Ion Optics Assembly on page 96.

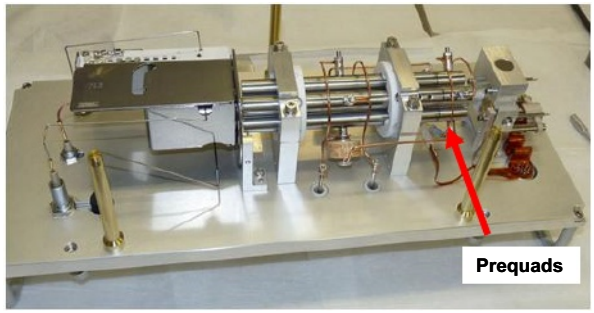


Figure 41 Location of the prequads in the optical assembly.

2. Using a very fine abrasive paper (8000 grade) clean the ion burns off the prefilters.
3. Wipe the prequads with a methanol dampened laboratory wipe.

4. Blow dry with helium or dry nitrogen.

5. Return the ion optics assembly to the vacuum manifold. See Removing and Returning the Ion Optics Assembly on page 96.

Vacuum System Maintenance

Vacuum system maintenance consists of the following:

- Checking the forepump to ensure the oil is at the proper level.
- Adding oil to the forepump reservoir.
- Replacing forepump oil.
- Replacing foreline trap pellets.

Complete pump instructions are in the instruction manual supplied with the pump.

Maintanenace of the Turbomolecular Pump

You should never service the turbomolecular pump. Call your PerkinElmer Service Representative for the maintenance and any problems you may have with the pump.

Checking the Forepump Oil Level

1. Locate the oil level indicator window on the forepump.

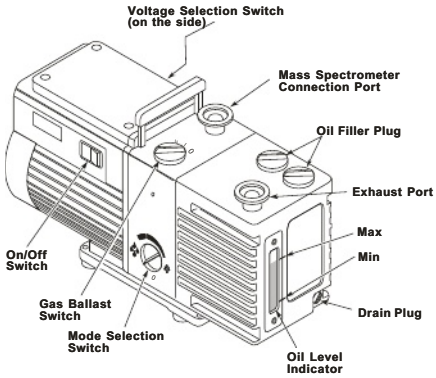


Figure 42 Location of the oil level indicator.

2. Determine if the oil level is between the Max Oil Level and Min Oil Level marks next to the window.
   - If the oil level is closer to the Min Oil Level mark, add oil. Use Edwards 45 oil (Part No. 09923492, 1 liter).
   - If it is near the scheduled six-month service, drain and refill the pump with clean oil.
   - If the oil is contaminated (indicated by a darkened color), try gas ballasting and if that does not help, drain and refill the pump with clean oil.

Adding Oil to the Forepump Reservoir

CAUTION *Vent the mass spectrometer before opening the plug to add oil.*

1. Unscrew and remove one of the filler plugs on the top of the pump.
2. Locate the bottle of pump oil supplied with the pump and add oil until it reaches the MAX mark on the top of the oil level indicator. Do not overfill.
3. Replace the oil filler plug by tightening it until it is fingertight. Do not overtighten the oil filler plug.
4. After restarting the pump and allowing it to run for a few minutes, recheck the oil level. If the oil level is below the MAX mark, repeat the above procedure by adding more oil until it reaches the MAX mark.

Decontaminating the Oil

The pump oil should be clear. If the oil is cloudy or discolored, it is contaminated with residual sample vapors.

1. Observe the oil in the oil level indicator.
2. Turn the mode selector fully counterclockwise to select the High Throughput mode and set the gas ballast control to the low flow (position I).
3. Run the pump until the oil appears clear.

Changing the Oil

1. Warm the oil by running the pump for at least 10 minutes, and then switch off the vacuum system.

2. Unplug the pump from the AC outlet and disconnect it from your vacuum system.

3. Remove one of the oil filler plugs.

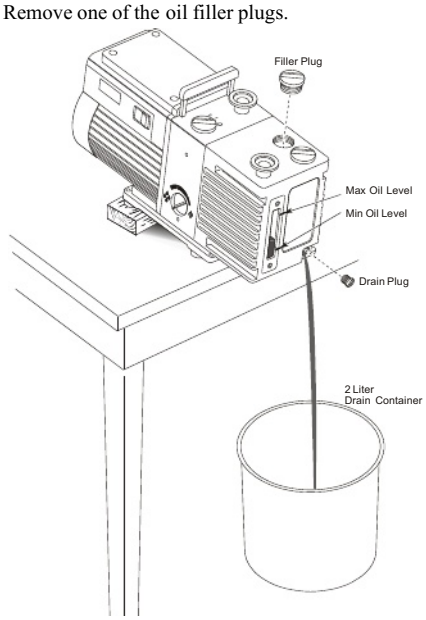


Figure 43 Draining forepump oil.

4. Place the pump on a table. Place a drain container under the drain plug. Raise the end of the pump opposite the drain plug by putting a block under it.

WARNING

If you were running toxic samples, the oil is contaminated as toxic waste. Handle and dispose of waste oil appropriately.

5. Remove the drain plug and allow the oil to drain into the container.
   If the pump oil was contaminated, pour clean oil into the filler hole and allow it to drain until the oil appears clear.
6. Replace the drain plug, remove the block and reconnect the vacuum system.
7. Add oil until it reaches the MAX mark on the top of the oil level indicator.
   Do not overfill.
8. Replace the oil filler plug by tightening it until it is fingertight.
   Do not overtighten the oil filler plug.
9. After restarting the pump and allowing it to run for a few minutes, recheck the oil level. If the oil level is below the MAX mark, repeat the above procedure by adding more oil until it reaches the MAX mark.

Inline Gas Purifiers

The inline gas purifier lets you change the trap without introducing contaminants into your system. This eliminates the need to flush the system. The trap contains oxygen, moisture and hydrogen adsorbents and is packed and purged under helium.

Color changes in the glass indicating trap will indicated when filter needs to be replaced.

The click on connector fitting has a spring loaded needle valve, which seals when the trap is removed and only opens when the new trap is connected and locked into position. When the click on connectors are installed into the gas line here is no need to loosen or tighten any fittings, the new trap will just click in.

Replacement Traps

Description	Part No.
Indicating Glass Triple Gas specific (He) Oxygen/Moisture/Hydrocarbons	N09306107
Indicating Glass Triple Gas specific (He) Oxygen/Moisture/Hydrocarbons with 1/8” Brass Connector (2)	N09306114
Indicating Glass Triple Gas specific (He) Oxygen/Moisture/Hydrocarbons with 1/8” Steel Connector (2)	N09306116

Click On Connectors

Description	Part No.
1/8” Brass Connector (2)	N09306119
1/8” Steel Connector (2)	N09306120
Stain steel Connector (for connecting two click on traps)	N09306121

Refer to the installation instructions that accompany your new in line gas purifier trap for detailed installation and operating instructions.

Changing from EI to CI Mode

Changing modes consists of the following:

- Connecting the CI gas.
- Changing the source and instrument control mode.
- Leak-checking.
- Setting-up CI.

Connecting the CI Gas

WARNING

***Hazardous gas vapors**. When using ammonia gas when running in the chemical ionization (CI) mode, it is necessary to vent the mass spectrometer effluent from the forepump exhaust into a fume hood or charcoal trap.*

WARNING

***Explosive Hazard.** If the hydrogen, methane or iso-butane is turned on without a column attached to the injector and/or detector fittings inside the oven, the gas could diffuse into the oven creating the possibility of an explosion.*

If the mass spectrometer is not under vacuum, hydrogen, methane or iso-butane can fill the vacuum chamber thereby creating an explosive hazard.

To avoid possible injury, do not turn on the hydrogen, methane or iso-butane unless a column is attached, all joints have been leak tested, and the mass spectrometer is under vacuum with the forepump exhaust properly vented to a fume hood.

Recommended Gases

Reagent gases used in chemical ionization (CI) are methane with a minimum purity of 99.999%, isobutene with a minimum purity of 99.98% and ammonia with a minimum purity of 99.998%. Carrier gas tubing should be ultra-clean.

Methane and isobutene require a gas delivery pressure of 15 psi (104 kPa) to the bulkhead fitting on the back of the mass spectrometer. A two-stage stainless steel diaphragm, high purity regulator is. A single-stage stainless steel diaphragm, high purity, rated for corrosive service is required for ammonia. Clean tubing must be used. It must be solvent-washed and nitrogen-dried. The bulkhead connector at the rear of the instrument is a 1/8 inch Swagelok fitting.

WARNING

If ammonia is used for chemical ionization, all fittings and tubing must be stainless steel to avoid corrosion. Also, the forepump must be vented to a fume hood or trap.

To prepare mass spectrometer for CI:

NOTE: *Make sure to purge the CI line before you attach it to the rear of the mass spectrometer.*

1. Obtain the CI gas cylinder for your analysis.
2. Connect the gas line to the CI Gas connector on the rear of the mass spectrometer.
3. Ensure that the mass spectrometer is at the proper vacuum level.
4. Turn on the CI gas and set the delivery pressure to 15 psi (104 kPa).
5. Leak-check all connections.

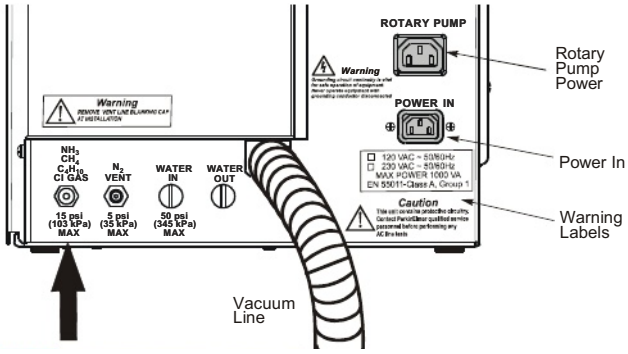


Figure 44 CI Gas connection on the rear panel of the mass spectrometer.

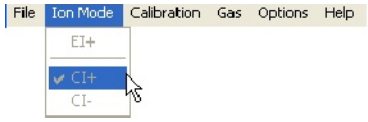
Changing to CI

To change from the EI to the CI mode:

1. Remove the EI source by following the procedure Removing and Returning the Source on page 71.

2. Install the CI source by following the procedure Removing and Returning the Source on page 71.
   Properly cover and protect the EI source and put it in a safe place.

3. Select **CI+** from the **Ion Mode** menu.
   The CI+ window appears.



4. Select **Pump** from the **Options** menu.
   This starts the forepump and the turbomolecular pump.

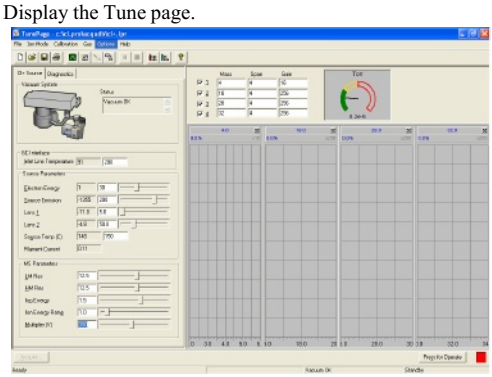
5. In the **Vacuum Pressure Gauges** area of the window, observe the Pirani gauge time line and the Penning gauge time line. Wait about 5 minutes until the vacuum gauge achieves about 2.5 x 10-5.

Leak Checking

Before running in the CI mode, confirm that the column is properly installed and the system is leak-free. The best way to check this is by running CI without the reagent gas.

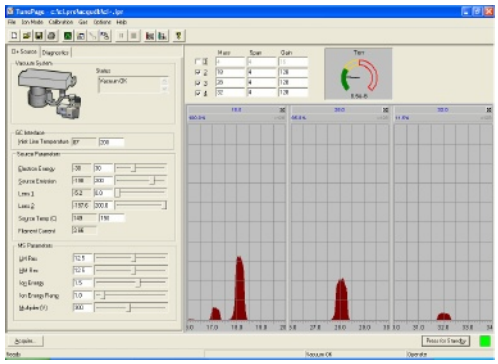
To leak check a system:

1. Display the Tune page.



2. Select **CI+** from the **Ion Mode** menu.

3. Click **Press for Operate** and observe the air/water masses.



The CI source running in the CI mode without reagent gas to produce an EI emission similar to the EI mode but with reduced sensitivity. You will leak-check your system this way.

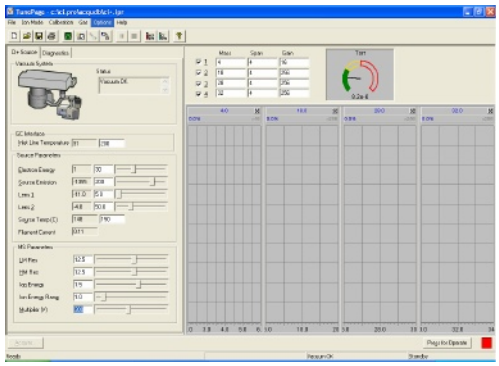
If mass 28 is larger than mass 18, you have a leak. Determine the source of the leak and correct it. For example, leak-check all fittings and connections.

Setting-Up CI

After verifying that no leaks exist, you can proceed to set up the CI mode for an analysis.

Setting the Parameter Values

1. Display the following CI window:



2. Set the values as shown in the following table.

Parameter:	CI+ Values and Comments:
Electron energy	30 eV
Emission	Should be below 200 µA, although 200 to 300 µA is acceptable. (Above 200 mA may cause hydrocarbon “cracking” patterns with methane and isobutane.) Emission measures the real emission current, i.e. the source current from the source block, there is no trap "source current" in CI.
Lens 1 and 2	The tuning of these lenses may be different from the optimum values set for EI, since the source pressure is much higher in CI.
Multiplier	1300V to 1600V
Ion Energy	Approx. 1. Similar to EI.
Source temperature	150 ºC

Adjust the Reagent Gas for CI+

When running in the CI+ mode with reagent gas off, the resulting EI spectra have about 10x lower sensitivity than with the EI source.

If using methane reagent gas, the reagent ions at m/z 17 (CH_5^+) and 29 ($C_2H_5^+$) should be of approximately equal intensity. Maximize the m/z 29 intensity. With m/z 29 maximized, the ion at m/z 16 should be about 1% of the m/z 17 peak height. (Higher

indicates a leak at the transfer line/inner source connection.) Operate slightly to the low-pressure side of the maximum to minimize gas load on the MS. (The vacuum gauge pressure will be $1.5x10^{-4}$ to $5x10^{-4}$ Torr.)

If using ammonia reagent gas, reagent ions at m/z 18 ($N1H_4^+$) and 35 [$(NH_3)_2H^+$] should be present and the ions at m/z 35 should be optimized.

If using isobutane reagent gas, the reagent ions at m/z 43 ($C_3H_7^+$) and 57 ($C_4H_9^+$) should be tuned in the approximate ratio of 1:2.

The following example uses methane reagent gas.

NOTE: *The CI reagent gas adjustment knob controls a delicate needle valve. To avoid damaging the needle valve, do not overtighten it. Always use the CI gas button on the screen to turn off the CI gas.*

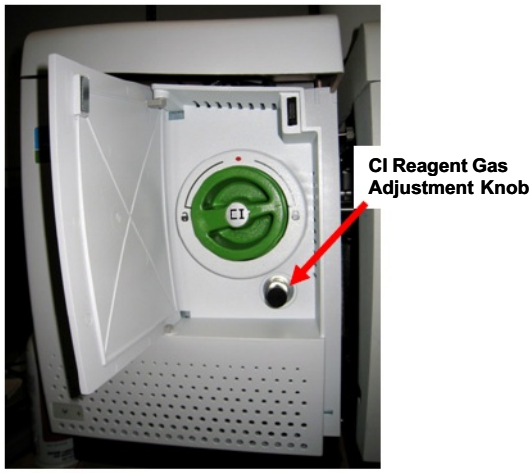


Figure 45 CI reagent gas adjustment knob.

1. Carefully turn the delicate CI reagent gas adjustment knob fully clockwise until you feel it stop.

2. Select CI Gas On from the Gas menu. A check mark appears next to the option.

NOTE: *Always turn on the CI gas before Operate to avoid a pressure surge hitting the filament.*

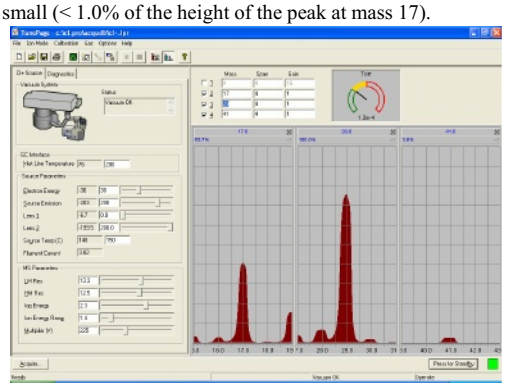
3. Click **Press for Operate** and monitor the Penning gauge as you adjust the CI gas. Observe that mass 16 initially grows larger. As pressure increases in the ion chamber of CI source, the mass 29 peak will begin to grow. Keep the pressure below 5 e-4 Torr.

4. When using methane gas, carefully turn the CI adjustment knob counterclockwise until m/z 16 is low or non-existent, and m/z 29 is maximized. As you turn the knob, reduce the multiplier voltage to keep the peaks on scale.

   - A typical multiplier value is 1335.
   - m/z 17 and 29 will typically be 80 – 100%.

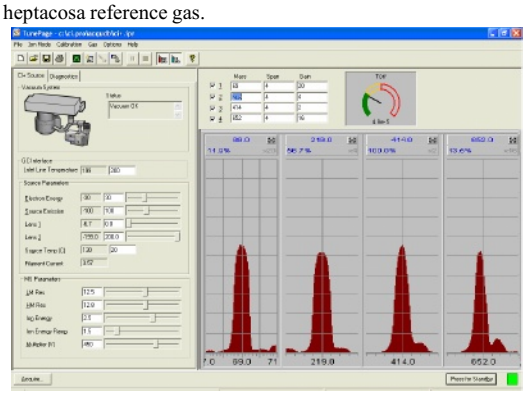
5. Continue to turn the knob counterclockwise. Observe that the pressure increases and mass 41 will start to grow. Stop when mass 29 is at 100%.

6. Turn the knob to maximize the intensity of mass 29. Also verify that mass 16 is small (< 1.0% of the height of the peak at mass 17).



If mass 16 does not appear as a small peak, STOP. You probably have a gas leak at the transfer line/inner source connection. Locate and correct the leak.

7. After you have maximized the peak, slightly decrease the reagent gas by turning the knob clockwise 1/8 turn.
8. Tuning may be optimized on the m/z 69, 219, 414, and 652 ions of the heptacosa reference gas.



9. Click **Press for Standby** to turn off Operate, followed by the CI gas.
   You are now ready to run your CI+ analysis.

Adjust the Reagent Gas for CI-

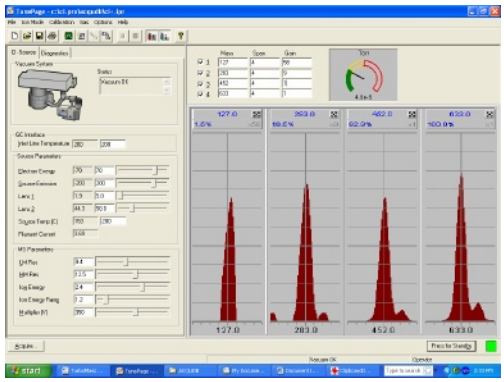
1. Open the CI gas inlet by selecting CI Gas from the Gas menu. Wait at least 10 seconds before clicking **Press for Operate**.

Parameter:	CI– value and comments:
Electron Energy	30 to 70 eV (This parameter should be optimized.)
Emission	200 to 300 µA is acceptable (Emission measures the real emission current, i.e. the source current from the source block, there is no separate measurement of source current in CI.)
Lens 1 and 2	The tuning of these lenses may be different from the optimum values set for EI, since the source pressure is much higher in CI.

Multiplier	1300V to 1600V
Source temperature	150 °C is standard. Higher temperatures keep the source cleaner, but may increase fragmentation. For example, down a little from EI to minimize fragmentation. 120 °C is the practical lower limit.
Ion Energy	Approx. 1 or 2

2. Optimize the amount of reagent gas flowing into the source by using two heptacosa ions, m/z 452 and 633, which usually produce relative intensities of 65 – 85% and 95% respectively.
   Heptacosa can be used to calibrate the m/z range for negative ion CI analyses.

3. Maximize the peak intensities, then slightly decrease the reagent gas by turning the knob clockwise 1/8 turn.



Optimize the tuning parameters for maximum intensity.

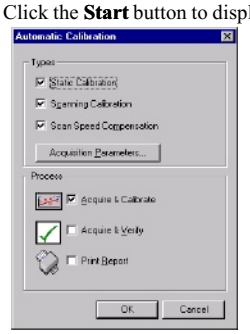
4. Save the Tune page parameters by selecting **Save As…** from the **File** menu.

5. Select **Calibrate Instrument** from the Tune page **Calibration** menu.

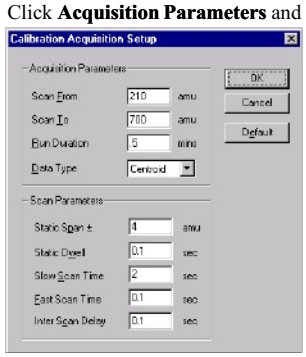
6. Select **heptaneg.ref** from the drop-down menu.

CAUTION	*Make sure the "Use Air Refs" check box is not selected.*

7. Click the **Start** button to display the following dialog box.



8. Click **Acquisition Parameters** and enter the following values.



9. Click OK to begin calibration.
   You are now ready to run CI analysis.

Troubleshooting 5

Overview

The following sources of problems can occur in gas chromatography and mass spectrometry:

- ***The operator:*** When the operator is new to chromatography/mass spectrometry and/or a new instrument, problems can be introduced during the learning curve. Once the operator becomes familiar with both the technique and the instrument, this problem source diminishes greatly.
- ***The sample:*** Unlike clean standards, real world samples such as environmental samples can introduce problems because they are difficult to handle, have complicated matrices, contain unknown constituents, etc.
- ***The column:*** The column is most often the major factor contributing to poor analyses. The more a column is used, the greater the possibility of contamination, loss of substrate, etc. Columns do not last forever and should be changed when results become suspect.
- ***The gas flow system:*** Gas leaks are a major concern in gas chromatography and can lead to many problems.
- ***The vacuum system:*** Vacuum leaks are a major concern in mass spectrometry and can lead to many problems.
- ***Ion Optics:*** Over time, the ion optics can become contaminated. This results in reduced sensitivity and difficult or impossible tuning.
- ***The electronics:*** The problem must be identified as either chromatographic or hardware. Electronics used in the system can malfunction.
- ***Data handling:*** Today, most chromatographers rely on sophisticated data handling systems to integrate their results. Some problems can be related to the incorrect data handling parameter settings or hardware problems with the computer.

Spare Components

The following list contains items you should have on hand to help solve problems.

- ***New syringes:*** a syringe can break, become plugged or begin leaking. Always have spare syringes available.
- ***Duplicate columns:*** a column does not last forever; always have a duplicate column on hand in the event that your separation begins to degrade. Also, capillary columns can be damaged if oxygen is introduced at high temperatures. A duplicate column will allow you to determine if the column is the cause of the problem.
- ***Septa:*** this is the one area of the gas chromatograph that requires routine maintenance. Always have spare septa available.
- ***Leak detector:*** the gas flow system can be a problem as fittings wear with age and can begin to leak. You should have a thermal conductivity leak detector to help find and fix leaks.
- ***Injector liners:*** are made of glass or fused silica and can be easily broken when removed. You should keep a supply of spare liners on hand. Please remember that you cannot run satisfactory analyses without an injector liner.

Logical Troubleshooting Steps

There are some simple steps that you should take when trying to locate a problem. Use the following guide to troubleshoot your system.

1. Note the symptoms - define the problem. Compare your runs with good analysis, that is, with the results normally obtained.
2. Systematically eliminate possible causes.

   The first rule here is, "What did you change last?" Many times a problem arises when a change is made to the system, such as changing a gas tank, column, septum or glass liner. If the problem occurred after such a change, then the change is the most likely cause of the problem.

Change the simplest thing first. For example, if you suspect a gas leak, the easiest change to make is the GC septum instead of replumbing the internal pneumatics.

Change only one parameter at a time and check for its effect. If you change three items at once and your problem goes away, you may not know which of the three moves or combination of moves corrected the problem. This way, if the problem happens again, you will know exactly what corrective action to take.

Troubleshooting Chart

Problem	Probable Cause	Solution
Mass Spectrometer will not turn on (no indication of power to the instrument).	AC line cord not plugged into an AC outlet.	Plug the Mass Spectrometer AC line cord into an AC outlet.
	No AC power to the outlet.	Check the outlet.
	Fuse blown.	Call a PerkinElmer service engineer.
Mass Spectrometer is on but the forepump is not running.	Forepump is not plugged into the AC outlet on the rear of the mass spectrometer.	Plug the forepump line cord into the mass spectrometer.
	Forepump is not operating correctly (mass spectrometer does not pump down).	Make sure the forepump is switched on.
	Blown fuse in Mass Spectrometer.	Call a PerkinElmer service engineer.

Problem	Probable Cause	Solution
The ultimate pressure is poor.	Is the cooling inadequate?	Check the cooling-air flow and correct if possible.
		Check the cooling-air duct for obstructions and correct as necessary. If the cooling air flow is fine and there are no obstructions contact your PerkinElmer service representatives.
	Is the backing pressure high?	Check for a leak in the backing pipeline and poor backing pump performance. Correct as necessary.
The pump is very noisy or there is excessive vibration or both.	Is the noise irregular and getting progressively worse?	If so, a bearing may be defective. Contact your PerkinElmer service representative.
	Is the pump making a constant high pitched noise?	If so, the rotor may be out of balance. Contact your PerkinElmer service representative.

Problem	Probable Cause	Solution
Turbo pump will not accelerate	Pump malfunction.	Call a PerkinElmer service engineer.
	Pump controller malfunction.	Call a PerkinElmer service engineer.
	GC is not properly configured.	Set the proper GC configuration for your site.
Vacuum light continues to blink.	Large leak.	Locate vacuum leak and correct.
	Foreline trap has excessive moisture.	Replace filter.
	Rotary pump set to gas ballast.	Switch the gas ballasting off.
	Rotary pump requires oil change.	Change oil.
High mass spectra appears as a large blotch, or loss of high mass spectra.	Bad tune.	Run AutoTune.
Drastic change in mass peak shape for no apparent reason.	Bad tune.	Run AutoTune.
No spectra, or large blotch.	Bad tune.	Run AutoTune.

Problem	Probable Cause	Solution
No spectra, or very little spectra at the low mass end.	Bad tune.	Run AutoTune.
No spectra, not even noise at a high multiplier voltage.	Loose electrometer cable.	Reset the cable.
	Defective electrometer board.	Call a PerkinElmer service engineer.
	Multiplier near the end of its lifetime.	Replace the multiplier.
No filament current.	Defective filament.	Replace the filament.
Wavering baseline (by several hundred counts).	Defective outer source temperature sensor or a defective electrometer.	Replace the temperature sensor.
		Call a PerkinElmer service engineer.
Increasingly setting higher multiplier voltage settings.	Multiplier near the end of its lifetime.	Replace the multiplier.

Problem	Probable Cause	Solution
Poor or inadequate sensitivity.	Leaking injector septum.	Replace the septum.
	Leak from injector ferrules.	Tighten/replace ferrules.
	Foreign material in the injector.	Clean the injector.
	Peak splitting.	Prevent double injections.
		Dry the outside of the injector needle.
		Replace the injector septum.
	Injector and column are more active toward acid/base compounds.	Install a silanized injector liner, or silanize the current injector liner.
		Check or replace the injector packing material, such as quartz wool.
		Cut off the first 30 cm of the column and rerun the test mix. If the results do not improve replace the column.

Problem	Probable Cause	Solution
Solvent tailing.	Inadequate splitter flow.	Increase the splitter flow.
	Column not properly installed in the injector.	Reinstall the column in the injector.
Loss of high end compounds.	Temperature setting too low on the injector, column oven or transfer line.	Increase the injector, column oven or transfer line temperature to allow the less volatile compounds of the sample to reach the mass spectrometer.
Peaks at masses 28 (nitrogen) and 32 AMU (oxygen) are in a ratio of < 4 to 1, and the peak at mass 28 is larger than the peak at mass 18.	Leaks in or around vacuum or column fittings.	Tighten the fittings and connection points to the high vacuum system. Set the injector split flow to 50:1.
Peaks at masses 14 and 16 are larger than the peak at mass 28.	Leaks or improper tuning.	Tighten the fittings and connection points to the high vacuum system. Set the injector split flow to 50:1. Run AutoTune.

Problem	Probable Cause	Solution
Poor sensitivity (correct amount of sample is reaching the mass spectrometer).	Column is improperly positioned in the ion source.	Reinstall the column and check the cut at the end that fits in the source.
	Improper tuning, or a dirty or defective ion source.	Check the tuning. Increase the multiplier voltage.
		Shut down the system, remove the inner source, clean or replace lenses in the outer source, and install a new filament.
Loss of resolution (especially at high mass).	Dirty prequadrupole rods.	Clean the prequadrupole rods.
Mass assignment drifts.	Large temperature fluctuations in the laboratory.	Stabilize the lab temperature, or isolate the GC/MS system from large temperature fluctuations.
Mass assignment incorrect.		Run mass calibration.
Skewed spectra.	Improper scan speed (too slow for the narrow peaks produced by capillary columns).	Increase the scan speed.
Unusually high repeller voltage.	Repeller dirty.	Clean repeller.

Problem	Probable Cause	Solution
Unusually high emission setting.	Ion volume dirty.	Clean the inner source.
	Prefilters dirty.	Clean the prefilters.
	Poor tuning.	Retune.
Tuning peaks show precursors (forward slope shoulders).	Poor tuning.	Retune.
	Dirty prefilter.	Clean prefilters.
	Dirty source.	Clean source.
	Particulates on analyzer rods.	Clean the particulates of the rods with a methanol-dampened lab wipe.
		Blow the particulates off the rods with helium or dry nitrogen.
	Defective or damaged analyzer.	Call a PerkinElmer service engineer.
No reference peak.	Reference gas off.	Turn on the reference gas.
	Empty reference vial.	Visually check and refill.
	Faulty solenoid.	Listen for click when activating/deactivating the valve.

Problem	Probable Cause	Solution
Inconsistent peak widths.	Poor tubing.	Retune.
	Ground loop from GC and MS on different power supplies.	Unify supplies.
Peaks shifted from their nominal mass position.	Poor calibration.	Perform mass calibration.
Tuned peaks are too narrow.	Over-resolved tuning.	Retune.
Tuned peaks are too wide.	Under-resolved tuning.	Retune.
Big peaks observed at m/z 18, 28, 32.	Air leak developed.	Check column connections.
	Change carrier gas tank.	Fit oxygen scrubber.
	Moisture from recent source clean/column change.	Bake out source overnight.
No ion beam but the filament status OK.	Large air leak.	See procedure for leak-checking.
	Detector voltage too low.	Increase multiplier value.
	Electronics failure.	Call a PerkinElmer service engineer.
Poor sensitivity. Beam instability/peaks breaking up.	Column improperly installed.	Check and reinstall the column if necessary.

Problem	Probable Cause	Solution
	Piece of column broken off in the ion chamber.	Remove the inner source, check for and remove piece of column.
	Source filament is bent.	Check and replace filament if necessary.
	RF generator malfunction.	Call a PerkinElmer service engineer.
	Analyzer drive electronics malfunction.	Call a PerkinElmer service engineer.
Total Ion Chromatogram too high.	Dirty source.	Clean the source.
	Contamination from poor handling technique.	Set source and transfer line to 250 ºC and maintain this temperature overnight.
	Stationary phase of column de-polymerizing (bleeding).	Change column.
	Air leak.	Find the leak and fix it.
	Poor quality carrier gas.	Replace the carrier gas tank.
	Carrier gas filter is ineffective and needs replacing.	Replace the carrier gas filter.
No noise on mass chromatogram.	Detector multiplier voltage too low.	Increase the multiplier voltage.

Problem	Probable Cause	Solution
Excessive noise.	Dirty source.	Clean the source.
	GC and MS on separate power supplies.	Connect GC and MS together with the ground strap.
	Multiplier voltage too high.	Run AutoTune.
	Data acquisition thresholds set too low.	Raise the thresholds.
Instrument won't calibrate (after retuning and recalibrating).	Poor AutoTune/Manual tune.	Retune.
	Contaminated ion source.	Clean the ion source. Set the source temperature to 250 ºC and maintain this temperature overnight.
	Source too hot/cool.	Set the correct source temperature.
	Air leak.	Find the leak and fix it.
	Wrong calibration reference file selected.	Select the correct file.
	Incorrect calibration calculation parameters.	Set the calibration parameters to the default values.
	No calibration gas.	Refill the calibration gas vial.
	Incorrect electron energy.	Reset to 70 eV.

Chromatography Related

Problem	Probable Cause	Solution
Inconsistent retention time.	Injector septum leak.	Replace the septum.
	Carrier gas manifold leak.	Locate and fix the leak.
Rising Total Ion Chromatogram baseline.	Column bleed.	Disconnect the column from the mass spectrometer and condition the column.
	Vacuum leak.	Locate and fix the leak.
Discreet high intensity contaminant peaks.	Column bleed.	Disconnect the column from the mass spectrometer and condition the column.
	Injector septum bleed.	Replace the septum and/or glass liner.
Tailing peaks (sloping on RHS).	Improperly installed column.	Check the column and reinstall if necessary.
	Injector too cool.	Raise the injector temperature.
	Interface temperature too cool.	Raise the interface temperature.
	Inadequate carrier gas flow.	Set proper flow.

Problem	Probable Cause	Solution
	Dirty injector liner.	Clean or replace.
	Column has active sites.	Equilibrate or replace.
Chromatographic peaks too wide.	Injector too cool.	Raise injector temperature.
	Sample overloading the column.	Use a split injection or a smaller sample.
	Incorrect GC oven program.	Enter a new oven program.
Discrimination of relative peak intensities.	Poor resolution or improper tuning.	Retune.
	Unstable filament.	Replace filament.
	Poor calibration.	Recalibrate.
	Air leaks at detector.	Check He/Air ratio.
Peaks are flat-topped.	Signal strength exceeds dynamic range of detector.	Reduce multiplier voltage.
	Sample is too strong.	Dilute or split.
High baseline.	Dirty sample.	Prepare and filter a new sample.
	Air leak at injector.	Locate and fix the air leak.
	Contaminated carrier gas.	Replace the gas tank.

Problem	Probable Cause	Solution
Slowly falling baseline (from a high initial value).	Split valve left closed during acquisition.	Open the split valve.
	Inadequate purge flow rate.	Increase flow rate.
	Poor off for too long.	Reduce purge time.
Low sensitivity.	Dirty source.	Clean the source.
	Poor column performance.	Replace column.
	Dirty injector.	Replace injector liner.
	Source temperature not optimized.	Set the proper source temperature.
	Detector voltage set too low.	Increase multiplier voltage.
	Tune not set correctly.	Run AutoTune.
	Poor filament alignment.	Realign or replace filament.
	Incorrect column position in the source.	Reposition the column.

Problem	Probable Cause	Solution
Poor reproducibility.	Dirty source.	Remove and clean the source.
	Defective injector liner.	Replace injector liner.
	Defective syringe.	Replace syringe.
	Old or damaged filament.	Examine and replace filament.
	Poor tuning.	Retune.
	Poor calibration.	Recalibrate.
	Air leak.	Locate and fix.
	Active sites in column/liner.	Replace column/liner.
	Intermittent source heater failure.	Call a PerkinElmer service engineer.
Poor S/N on test standards.	See low sensitivity causes above.	
	Incorrect GC/MS method	Use the correct method.
	Accidental split injection.	Set the proper split.
	Detector voltage set too low.	Increase multiplier voltage.
	Column flow rate too high.	Reset the column flow rate.

Spectral Related

Problem	Probable Cause	Solution
Noisy spectra.	Dirty source.	Remove and clean the source.
	Peak detection threshold set too low.	Raise the thresholds.
	Multiplier voltage set too high.	Lower the multiplier voltage.
Spectrum distortion.	Scanning too fast or slow.	Reset the scan rate.
Incorrect Isotope ratios.	Poor calibration.	Recalibrate.
	Incorrect tune.	Retune.
	Defective filament.	Replace filament.
	Air leak.	Find and fix.
Missing Isotopes in spectrum.	Bad calibration.	Recalibrate.
	Poor tuning.	Retune.
	Dirty source.	Clean source.
	Sample too weak.	Use a higher sample concentration.
	Peak detection thresholds set too high.	Lower the thresholds.
	Multiplier voltage set too low.	Raise the multiplier voltage.

Problem	Probable Cause	Solution
	Contamination.	Locate the contamination and eliminate it.
	Co-eluting components.	Change your sample preparation or chromatography.
	Incorrect column alignment.	Reinstall the column.
Section of a mass range missing from a spectrum.	Corruption of data file.	Reacquire data.
	Scanning too fast.	Reduce the rate.
	Hard disk has too much fragmentation.	Defrag the hard drive.
	Hard disk full.	Remove unnecessary files.
Molecular Ion too weak.	Source temperature too high.	Reduce the source temperature.

Communications Related

Problem	Probable Cause	Solution
Will not boot MS.	PC (computer) to MS cable has a loose connection.	Check and reset the cable.
	Transient in power supply has halted communications.	Reboot the PC (computer).
Will not control GC.	RS 232 communications cable loose connections.	Check and restart the mass spectrometer.
	Power failure/transient surge to GC or autosampler.	
	GC electronic malfunction.	Call a PerkinElmer service engineer.
Communication cable intermittent contact.	GC electronics malfunction.	Call a PerkinElmer service engineer.
Crashes when starting an acquisition.	Software corrupted.	Reload software.
	Rotary pump malfunction.	Call a PerkinElmer service engineer.

Forepump Related

Problem	Probable Cause	Solution
Pump does not start.	Forepump switched off.	Switch on the pump.
	Blown fuse.	Call a PerkinElmer service engineer.
	Electrical supply voltage does not match that of the pump motor.	Determine the correct voltages, and correct. Check the voltage switch at the pump.
	The outlet filter is blocked.	Find and unblock.
Pump has failed to reach vacuum.	Pressure measurement or gauge head gives an incorrect indication of pressure.	A contaminated Pirani gauge can indicate a pressure several times higher than the actual. Replace if necessary.
	Pump contains the wrong type of oil.	Drain and refill with the correct oil - Edwards Ultragrade 19 Oil. Consult your Edwards Pump instruction manual.
	Mode selector and/or gas ballast control are incorrectly set.	Check and set to correct position.
	High oil level.	Drain to the high oil level mark.
	Low oil level.	Check and fill to correct level.

Problem	Probable Cause	Solution
	Contaminated oil.	Drain and refill with new oil.
	Vacuum fitting dirty or damaged.	Check and replace if necessary.
Noisy Pump.	Motor fan cover damaged.	Call a PerkinElmer service engineer.
	Worn motor bearings.	Call a PerkinElmer service engineer.
	Oil contaminated with solid particles.	Determine cause and replace oil.
	Oil saturated from CI analysis.	Drain and refill with clean oil.

Problem	Probable Cause	Solution
External oil leak.	Outer shaft seal worn or damaged.	Call a PerkinElmer service engineer.
	Oil box gaskets deteriorated.	Call a PerkinElmer service engineer.
	Oil leak from gas ballast control.	Call a PerkinElmer service engineer.
	Oil leak from drain plug.	Tighten the drain plug or replace.
	Oil leak from sight glass.	Tighten sight glass screws or call a PerkinElmer service engineer.

Message Dialogs

When operating the instrument message dialog boxes will sometimes appear. The following table is the Icon Key followed by tables that show the Message Title, icon, dialog message and recommended action.

Icon Key

Icon	Meaning
	Press this icon to close the message.
	Press this informational icon to get more details on the message.

Message Title	Icon	Message	Action
System not at pressure	 Caution	The system has not reached the proper operating pressure. The filament could be damaged by starting the system now. Do you wish to continue?	Press **Yes** if you wish to continue. Press **No** if you wish to stop. See the Maintenance chapter in this *Hardware Guide* for the procedure to replace a filament.
Safe to vent		The vacuum system is off and the system can now be vented. The GC carrier gas should be turned off.	Press **OK** to close the message.

Message Title	Icon	Message	Action
Vacuum Leak Detected		The backing pump could not reach the necessary vacuum level to start the turbo pump. There could be a problem with a vacuum leak, the backing pump or the vacuum gauge. The backing pump will be turned off. Make sure that the vent valve is closed before restarting the backing pump.	Press **OK** to close the message. Check the system for any leaks and correct. If the problem continues contact your PerkinElmer service representatives.
Vacuum Gauge Failure		There is a problem with the vacuum gauge.	Press **OK** to close the message. Restart the system, if you still have this failure message contact your PerkinElmer service representatives.
Pump failure- Safe to Vent		The vacuum system is off and the system can now be vented. The carrier gas should be turned off. There is a problem with the turbo pump.	Press **OK** to close the message. Check the cooling-air flow and correct if possible. Check the cooling-air duct for obstructions and correct as necessary. If the cooling air flow is fine and there are no obstructions contact your PerkinElmer service representatives.

Message Title	Icon	Message	Action
Vacuum Leak-Safe to Vent		The vacuum system is off and the system can now be vented. The carrier gas should be turned off A Vacuum Leak has been detected. Please look in the Hardware Guide for additional instruction.	Press **OK** to close the message. Check the system for any leaks and correct. If the problem continues contact your PerkinElmer service representatives.
Vacuum Gauge Failure-Safe to Vent		The vacuum system is off and the system can now be vented. The carrier gas should be turned off. There is a problem with the vacuum gauge. Please look in the Hardware Guide for additional instruction.	Press **OK** to close the message. To replace the vacuum gauge contact your PerkinElmer service representatives.
Exit TurboMass-Vacuum System pumping down		The vacuum system is in the process of the pumping down the spectrometer. Exiting TurboMass at this time may prevent a successful pump down.	Press **OK** to close the message.
Exit TurboMass-Vacuum System pumping down		The vacuum system is in the process of shutting down. Exiting TurboMass at this time may prevent a successful completion of this task.	Press **OK** to close the message.

Message Title	Icon	Message	Action
Backing Pump is on		The system is not in an operating state. A vacuum leak or a vacuum gauge failure could have occurred. If the transfer line or the source temperatures are above 100C, please wait until they have cooled before pressing OK. Pressing the OK button will turn off the backing pump.	If the transfer line or the source temperatures are above 100C, please wait until they have cooled before pressing **OK**. Pressing the **OK** button will turn off the backing pump.
Problem with Vacuum		The backing pump could not reach the necessary vacuum level to start the turbo pump. There could be a problem with a vacuum leak, the backing pump or the vacuum gauge. The backing pump will be turned off. Make sure that the vent valve is closed before restarting the backing pump.	Press **OK** to close the message.

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PerkinElmer
710 Bridgeport Avenue
Shelton, CT 06484-4794, U.S.A.

Internet: http://www.perkinelmer.com
email: info@perkinelmer.com