Agilent GC, GC/MS, and ALS

Site Preparation Guide

Agilent Technologies

Notices

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CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

7890A GC Site Preparation

This section outlines the space and resource requirements for GC, GC/MS, and automatic liquid sampler (ALS) installation. For a successful and timely installation of the instrument, the site must meet these requirements before beginning installation. Necessary supplies (gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents) must also be available. Note that performance verification requires the use of helium carrier gas, and for 5975 MSD systems using chemical ionization, methane reagent gas. Refer to the Agilent Web site at www.agilent.com/chem for the most up-to-date listing of GC, GC/MS, and ALS supplies and consumables.

Customer Responsibilities

The specifications in this manual outline the necessary space, electrical outlets, gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents required for the successful installation of instruments and systems.

If Agilent is delivering installation and familiarization services, users of the instrument should be present throughout these services; otherwise, they will miss important operational, maintenance, and safety information.

If Agilent is delivering installation and familiarization services, delays due to inadequate site preparation could cause loss of instrument use during the warranty period. In extreme cases, Agilent Technologies may ask to be reimbursed for the additional time required to complete the installation. Agilent Technologies provides service during the warranty period and under maintenance agreements only if the specified site requirements are met.

Dimensions and weight

Select the laboratory bench space before the system arrives. Pay special attention to the total height requirements. Avoid bench space with overhanging shelves. See Table 1.

The instrument needs space for proper convection of heat and ventilation. Allow at least 25 cm (10 in) clearance between back of the instrument and wall to dissipate hot air.

Table 1 Required height, width, depth, and weight

Product	Height	Width	Depth	Weight
7890A Series GCs	50 cm (19 in)	59 cm (23 in)	54 cm (21 in)	50 kg (112 lb)
With third detector	50 cm (19 in)	68 cm (27 in)	54 cm (21 in)	57 kg (125.4 lb)
5975 Series MSDs				
• Diffusion pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Standard turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Performance turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	41 kg (90 lb)
• Performance CI/EI turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	46 kg (100 lb)
Foreline pump				
Standard	21 cm (8 in)	13 cm (5 in)	31 cm (12 in)	11 kg (23.1 lb)
Oil-free	19 cm (7.5 in)	32 cm (13 in)	28 cm (11 in)	16 kg (35.2 lb)
7000A Series GC/MS				
• Performance turbo pump	47 cm (18.5 in)	35 cm (14 in)	86 cm (34 in)	49 kg (180 lb)
Foreline pump				
Standard	21 cm (8 in)	13 cm (5 in)	31 cm (12 in)	11 kg (23.1 lb)
G1888 Headspace sampler	56 cm (22 in)	46 cm (18.1 in)	64 cm (25 in)	46.3 kg (102 lb)
Additional space requirements				
• GC/MS operational and maintenance access		Requires 30 cm (1 ft) to its left		
• Typical laser printer		Requires 41 cm (16 in)		
• GC operational oven access		Requires ≥ 30 cm (12 in) open space above GC		
• GC with 7693A ALS injector		Requires 50 cm (19.5 in) above the GC		3.9 kg (8,6 lb) each
• GC with 7693A ALS tray		Requires 45 cm (17.5 in) left of the GC Requires 2 cm (1 inch) in front of GC		6.8 kg (15 lb) each
• GC with 7683B ALS injector		Requires 42 cm (16.5 in) above the GC		3.1 kg (7 lb) each

Table 1 Required height, width, depth, and weight (continued)

Product	Height	Width	Depth	Weight
• GC with 7683B ALS tray		Requires 30 cm (12 in) left of the GC		3.0 kg (7 lb)
• GC with CTC PAL Autosampler		Requires 66 cm (26 in) above the GC and 4 to 20 cm (1.5 to 8 in) to the left or right, depending on configuration		

Figure 1 Top view of typical installation (7890A GC/MS system with 7693A ALS)

A simple 7890A system that includes a GC, an ALS, and a computer would require about 168 cm (5.5 ft) of bench space. Allowi7ng for operational access and a printer, a total of 260 cm (8.5 ft) of bench space should be available for a full GC/MS system. Some repairs to the GC/MS or to the GC will also require access to the back of the instrument(s).

Note that the length of the GC/MS vacuum hose is 130 cm (4 ft 3 in) from the high vacuum pump to the foreline pump, and the length of the foreline pump power cord is 2 m (6 ft 6 in).

Power Consumption

Table 2 lists site power requirements.

- The number and type of electrical outlets depend on the size and complexity of the system.
- Power consumption and requirements depend on the country to which the unit ships. Find the instrument type and your line voltage to find your instrument's power requirements.
- The electrical outlet for the unit should have a dedicated ground. Voltage between ground and neutral should be less than 2.5 VAC.
- The voltage requirements for your instrument are printed near the power cord attachment.

Table 2 Power requirements

Product		Line voltage (VAC)	Frequency (Hz)	Current rating (amps)	Maximum continuous power consumption (VA)	Outlets required
Agilent 7890A	Standard oven	Americas: 120* single phase (–10% / +10%)	48–63	18.8	2250	1
		220/230/240 single/split phase (–10% / +10%)	48–63	10.2/9.8/9.4	2250	1
	Fast oven	Japan: 200 split phase (–10% / +10%)	48–63	14.8	2950	1
		220/230/240 †‡ single/split phase (–10% / +10%)	48–63	13.4 / 12.8 / 12.3	2950	1
5975 Series MSD		120 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		220–240 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		200 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1

Table 2 Power requirements (continued)

Product	Line voltage (VAC)	Frequency (Hz)	Current rating (amps)	Maximum continuous power consumption (VA)	Outlets required
7000A Series GC/MS	120 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
	220–240 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
	200 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
Data system PC system (monitor, CPU, printer)	100 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
	120 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
	200–240 (–10% / +5%)	50/60 ± 5%	15	1000	3–5

* Americas 120 VAC requires 20 amp dedicated line. Americas 240 VAC requires 15 amp dedicated line.

† Option 003, 208 VAC fast oven, uses a 220 VAC unit with operating range of 198 to 242 VAC. Most labs have 4-wire service resulting in 208 VAC at the wall receptacle. It is important to measure the line voltage at the receptacle for the GC.

‡ Power line conditioners should not be used with the GC.

WARNING **Do not use extension cords with Agilent instruments. Extension cords normally are not rated to carry enough power and can be a safety hazard.**

Although your GC should arrive ready for operation in your country, compare its voltage requirements with those listed in Table 2. If the voltage option you ordered is not suitable for your installation, contact Agilent Technologies.

CAUTION A proper earth ground is required for GC operations. Any interruption of the grounding conductor or disconnection of the power cord could cause a shock that could result in personal injury.

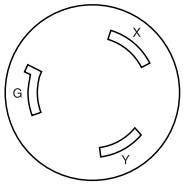
To protect users, the metal instrument panels and cabinet are grounded through the three-conductor power line cord in accordance with International Electrotechnical Commission (IEC) requirements.

The three-conductor power line cord, when plugged into a properly grounded receptacle, grounds the instrument and minimizes shock hazard. A properly grounded receptacle is one that is connected to a suitable earth ground. Be sure to verify proper receptacle grounding.

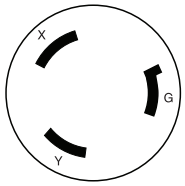
Connect the GC to a dedicated receptacle. Use of a dedicated receptacle reduces interference.

USA fast heating oven, 240 V

The 240 V fast heating oven requires 240 V/15A power. Do not use 208 V power. Lower voltage causes slow oven ramps and prevents proper temperature control. The power cord supplied with your GC is rated for 250 V/15A, and is a two-pole, three-wire cord with grounding (type L6-15R/L6-15P). See the figure below.



Receptacle L6-15R



Plug L6-15P

Canadian installation

When installing a GC in Canada, make sure your GC's power supply circuit meets the following additional requirements:

- The circuit breaker for the branch circuit, which is dedicated to the instrument, is rated for continuous operation.
- The service box branch circuit is marked as a "Dedicated Circuit."

Heat Dissipation

Use Table 3 to estimate the additional BTUs of heat dissipated from this equipment. Maximums represent the heat given off when heated zones are set for maximum temperatures.

Table 3 Heat dissipation

	Oven type	
	Standard oven ramp	**Fast oven ramp (options 002 and 003)**
Agilent 7890A	7681 BTU/hour maximum	10,071 BTU/hour maximum
Agilent 5975 Series	3000 BTU/hour including GC/MS interface	
Agilent 7000A Series	3000 BTU/hour including GC/MS interface	

Exhaust Venting

Hot air (up to 450 °C) from the oven exits through a vent in the rear. Allow at least 25 cm (10 in) clearance behind the instrument to dissipate this air.

WARNING **Do not place temperature-sensitive items (for example, gas cylinders, chemicals, regulators, and plastic tubing) in the path of the heated exhaust. These items will be damaged and plastic tubing will melt. Be careful when working behind the instrument during cool-down cycles to avoid burns from the hot exhaust.**

An optional oven exhaust deflector (G1530-80650) is available and may improve oven cooling by deflecting the exhaust air up and away from the instrument. For GCs with the exhaust deflector option installed, the exhaust is about 65 ft^3/min (1.840 m^3/min). Without the deflector, the exhaust rate is about 99 ft^3/min (2.8 m^3/min). The deflector outlet diameter is 10 cm (4 in).

During normal operation of the GC with many detectors and inlets, some of the carrier gas and sample vents outside the instrument through the split vent, septum purge vent, and detector exhaust. If any sample components are toxic or noxious, or if hydrogen is used as the carrier gas, the exhaust must be vented to a fume hood. Place the GC in the hood or attach a large diameter venting tube to the outlet for proper ventilation.

To further prevent contamination from noxious gases, attach a chemical trap to the vent(s).

Vent the GC/MS system externally to the building via an ambient-pressure vent system, within 460 cm (15 ft) of both the GC split vent and GC/MS foreline pump, or vent to a fume hood. Note that an exhaust vent system is not part of the building environmental control system, which recirculates air. Exhaust venting must comply with all local environmental and safety codes. Contact your Environmental Health & Safety (EHS) specialist.

Environmental conditions

Operating the instrument within the recommended ranges optimizes instrument performance and lifetime. Performance can be affected by sources of heat and cold from heating, air conditioning systems, or drafts. See Table 4. The conditions assume a noncondensing, noncorrosive atmosphere.

Table 4 Environmental conditions for operation and storage

Product	Conditions	Operating temp range	Operating humidity range	Maximum altitude
Agilent 7890A Series	Standard oven ramp	0 to 55 °C	5 to 95%	4,615 m
	Fast oven ramp (options 002 and 003)	0 to 55 °C	5 to 95%	4,615 m
	Storage	-20 to 70 °C	5 to 95%	
7000A Series	Operation	15 to 35 °C* (59 to 95 °F)	40 to 80%	4,615 m†
	Storage	–20 to 70 °C (–4 to 158 °F)	0 to 95%	
5975 Series	Operation	15 to 35 °C* (59 to 95 °F)	40 to 80%	4,615 m†
	Storage	–20 to 70 °C (–4 to 158 °F)	0 to 95%	

* Operation requires constant temperature (variations < 2 °C/hour)

† 5975B VL MSD: 2,300 m

Gas Selection

Table 5 lists gases usable with Agilent GCs and capillary columns. When used with capillary columns, GC detectors require a separate makeup gas for optimum sensitivity.

Table 5 Gases usable with Agilent GCs and capillary columns

Detector type	Carrier	Preferred makeup	Alternate choice	Detector, anode purge, or reference
Electron capture (ECD)	Hydrogen Helium Nitrogen* Argon/Methane*	Argon/Methane Argon/Methane Nitrogen Argon/Methane	Nitrogen Nitrogen Argon/Methane Nitrogen	Anode purge must be same as makeup
Flame ionization (FID)	Hydrogen Helium Nitrogen*	Nitrogen Nitrogen Nitrogen	Helium Helium Helium	Hydrogen and air for detector
Flame photometric (FPD)	Hydrogen Helium Nitrogen* Argon*	Nitrogen Nitrogen Nitrogen Nitrogen		Hydrogen and air for detector
Nitrogen-Phosphorus (NPD)	Helium Nitrogen*	Nitrogen Nitrogen	Helium† Helium	Hydrogen and air for detector
Thermal conductivity (TCD)	Hydrogen Helium Nitrogen*	Must be same as carrier and reference	Must be same as carrier and reference	Reference must be same as carrier and makeup

* Not generally suitable for GC/MS carrier gas.

† Depending on bead type, higher makeup gas flow rates (> 5 mL/min) may introduce cooling effects or shorten bead life.

Table 6 lists gas recommendations for packed column use. In general, makeup gases are not required with packed columns.

Table 6 Gases usable with Agilent GCs and packed columns

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Electron capture (ECD)	Nitrogen	Maximum sensitivity	Nitrogen
	Argon/methane	Maximum dynamic range	Argon/Methane
Flame ionization (FID)	Nitrogen	Maximum sensitivity	Hydrogen and air for detector.
	Helium	Acceptable alternative	

Table 6 Gases usable with Agilent GCs and packed columns (continued)

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Flame photometric (FPD)	Hydrogen Helium Nitrogen Argon		Hydrogen and air for detector.
Nitrogen-Phosphorus (NPD)	Helium	Optimum performance	Hydrogen and air for detector.
	Nitrogen	Acceptable alternative	
Thermal conductivity (TCD)	Helium	General use	Reference must be same as carrier and makeup.
	Hydrogen Nitrogen Argon	Maximum sensitivity* Hydrogen detection† Maximum hydrogen sensitivity[1]	

* Slightly greater sensitivity than helium. Incompatible with some compounds.

† For analysis of hydrogen or helium. Greatly reduces sensitivity for other compounds.

Agilent recommends that carrier and detector gases be 99.9995% pure. See Table 7. Air needs to be zero grade or better. Agilent also recommends using high quality traps to remove hydrocarbons, water, and oxygen.

Table 7 Carrier and reagent gas purity

Carrier and reagent gas requirements	Purity	Notes
Helium (carrier)	99.9995%	Hydrocarbon free
Hydrogen (carrier)	99.9995%	SFC grade
Methane reagent gas*	99.999%	Research or SFC grade
Isobutane reagent gas†	99.99%	Instrument grade
Ammonia reagent gas*	99.9995%	Research or SFC grade
Carbon dioxide reagent gas†	99.995%	SFC grade

* Required reagent gas for installation and performance verification, CI MSDs only.

† Optional reagent gases, CI MSDs only

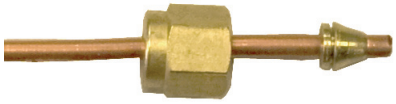
For installation checkout, Agilent requires the gas types shown in Table 8.

Table 8 Gases required for checkout

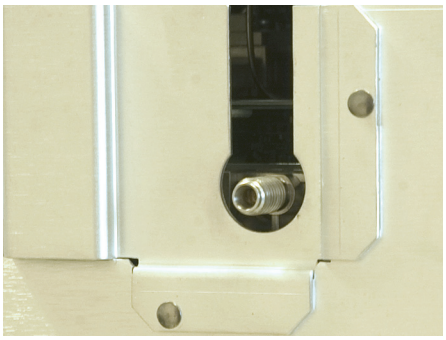
Detector	Gases required
FID	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air
TCD	Carrier and reference: helium
NPD	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air
uECD	Carrier: helium Anode purge and makeup: nitrogen
FPD	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air

Gas Supply

Supply instrument gases using tanks, an internal distribution system, or gas generators. If used, tanks require two-stage pressure regulators with packless, stainless steel diaphragms. The instrument requires 1/8-inch Swagelok connections to its gas supplies. See Figure 2. Plumb the gas supply tubing/regulators so that one 1/8-inch Swagelok female connector is available for each gas needed at the GC.



Swagelok nut and ferrules



Female Swagelok fitting on GC

Figure 2 Example Swagelok connector and hardware

Table 9 lists minimum and maximum delivery pressures for inlets and detectors, measured at the bulkhead fittings on the back of the instrument.

Table 9 Delivery pressures required at the GC/MS, in kPa (psig)

	Detector type					Inlet type				
	FID	**NPD**	**TCD**	**ECD**	**FPD**	**Split/Splitless 150 psi**	**Split/Splitless 100 psi**	**On-column**	**Purged packed**	**PTV**
Hydrogen	240–690 (35–100)	240–690 (35–100)			310–690 (45–100)					
Air	380–690 (55–100)	380–690 (55–100)			690–827 (100–120)					
Makeup	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)					
Reference			380–690 (55–100)							

Table 9 Delivery pressures required at the GC/MS, in kPa (psig) (continued)

	Detector type					Inlet type				
	FID	**NPD**	**TCD**	**ECD**	**FPD**	**Split/Splitless 150 psi**	**Split/Splitless 100 psi**	**On-column**	**Purged packed**	**PTV**
Carrier (max)						1,172 (170)	827 (120)	827 (120)	827 (120)	827 (120)
Carrier (min)						(20 psi) above pressure used in method				

Conversions: 1 psi = 6.8947 kPa = 0.068947 Bar = 0.068 ATM

Notes:

- If you have not requested option 305, you must supply pre-cleaned, 1/8-inch copper tubing and a variety of 1/8-inch Swagelok fittings to connect the GC to inlet and detector gas supplies.
- Cryogenic cooling with Liquid N_2 requires 1/4-inch insulated copper tubing.
- Cryogenic cooling with Liquid CO_2 requires 1/8-inch heavy-walled, stainless steel tubing.
- If you purchased automated valving, the valve actuation requires a **separate** pressurized, dry air supply at 380 kPa (55 psig). This air supply must end in a male fitting compatible with a 1/4-inch id plastic tube at the GC.
- Never use liquid thread sealer to connect fittings. Never use chlorinated solvents to clean tubing or fittings.

Table 10 lists the limits on total gas flow into the 7000A Series MSD.

Table 10 7000A Series total gas flow limitations

Feature	G3172A	G3174A
High vacuum pump	Performance turbo	Performance turbo, EI/PCI/NCI
Optimal gas flow mL/min*	1.0 to 2.0	1.0 to 2.0
Maximum recommended gas flow, mL/min	4.0	4.0
Maximum gas flow, mL/min†	6.5	4.0
Max column id	0.53 mm (30 m)	0.53 mm (30 m)

* Total gas flow into the GC/MS: column flow plus reagent gas flow (if applicable).

† Expect degradation of spectral performance and sensitivity.

Table 11 lists typical flows resulting from selected carrier and reagent gas source pressures.

Table 11 7000A Series carrier and reagent gases

Carrier and reagent gas requirements	Typical pressure range	Typical flow (mL/min)
Helium (required) (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Hydrogen (optional)* (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Methane reagent gas (required for CI operation)	103 to 172 kPa (15 to 25 psi)	1 to 2
Isobutane reagent gas (optional)	103 to 172 kPa (15 to 25 psi)	1 to 2
Ammonia reagent gas (optional)	34 to 55 kPa (5 to 8 psi)	1 to 2
Carbon dioxide reagent gas (optional)	103 to 138 kPa (15 to 20 psi)	1 to 2

* Hydrogen gas can be used for the carrier gas but specifications are based on helium as the carrier gas. Please observe all hydrogen gas safety cautions.

Table 12 lists the limits on total gas flow into the 5975 Series MSD.

Table 12 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
High vacuum pump	Diffusion	Standard turbo	Performance turbo	Performance turbo, EI/PCI/NCI
Optimal gas flow mL/min*	1.0	1.0	1.0 to 2.0	1.0 to 2.0
Maximum recommended gas flow, mL/min	1.5	2.0	4.0	4.0

Table 12 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
Maximum gas flow, mL/min†	2.0	2.4	6.5	4.0
Max column id	0.25 mm (30 m)	0.32 mm (30 m)	0.53 mm (30 m)	0.53 mm (30 m)

* Total gas flow into the GC/MS: column flow plus reagent gas flow (if applicable).

† Expect degradation of spectral performance and sensitivity.

Table 12 lists typical flows resulting from selected carrier and reagent gas source pressures.

Table 13 5975 Series carrier and reagent gases

Carrier and reagent gas requirements	Typical pressure range	Typical flow (mL/min)
Helium (required) (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Hydrogen (optional)* (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Methane reagent gas (required for CI operation)	103 to 172 kPa (15 to 25 psi)	1 to 2
Isobutane reagent gas (optional)	103 to 172 kPa (15 to 25 psi)	1 to 2
Ammonia reagent gas (optional)	34 to 55 kPa (5 to 8 psi)	1 to 2
Carbon dioxide reagent gas (optional)	103 to 138 kPa (15 to 20 psi)	1 to 2

* Hydrogen gas can be used for the carrier gas but specifications are based on helium as the carrier gas. Please observe all hydrogen gas safety cautions.

Gas Plumbing

WARNING **All compressed gas cylinders should be securely fastened to an immovable structure or permanent wall. Compressed gases should be stored and handled in accordance with the relevant safety codes.**

Gas cylinders should not be located in the path of heated oven exhaust.

To avoid possible eye injury, wear eye protection when using compressed gas.

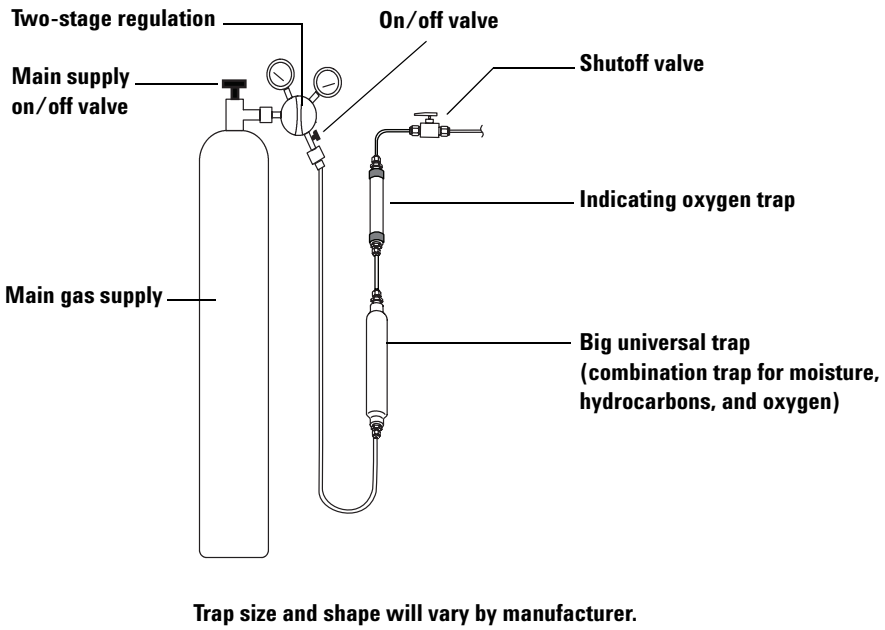


Figure 3 Recommended traps and plumbing configuration from a carrier gas cylinder

- Agilent strongly recommends two-stage regulators to eliminate pressure surges. High-quality, stainless-steel diaphragm-type regulators are especially recommended.
- On/off valves mounted on the outlet fitting of the two-stage regulator are not essential but are very useful. Be sure the valves have stainless-steel, packless diaphragms.

- FID, FPD, and NPD detectors require a dedicated air supply. Operation may be affected by pressure pulses in air lines shared with other devices.
- Flow- and pressure-controlling devices require at least 10 psi (138 kPa) pressure differential across them to operate properly. Set source pressures and capacities high enough to ensure this.
- Situate auxiliary pressure regulators close to the GC inlet fittings. This ensures that the supply pressure is measured at the instrument (rather than at the source); pressure at the source may be different if the gas supply lines are long or narrow.

Supply tubing for carrier and detector gases

Use only preconditioned copper tubing (part number 5180-4196) to supply gases to the instrument. Do not use ordinary copper tubing—it contains oils and contaminants.

CAUTION Do not use methylene chloride or other halogenated solvent to clean tubing that will be used with an electron capture detector. They will cause elevated baselines and detector noise until they are completely flushed out of the system.

CAUTION Do not use plastic tubing for suppling detector and inlet gases to the GC. It is permeable to oxygen and other contaminants that can damage columns and detectors.

Plastic tubing can melt if near hot exhaust or components.

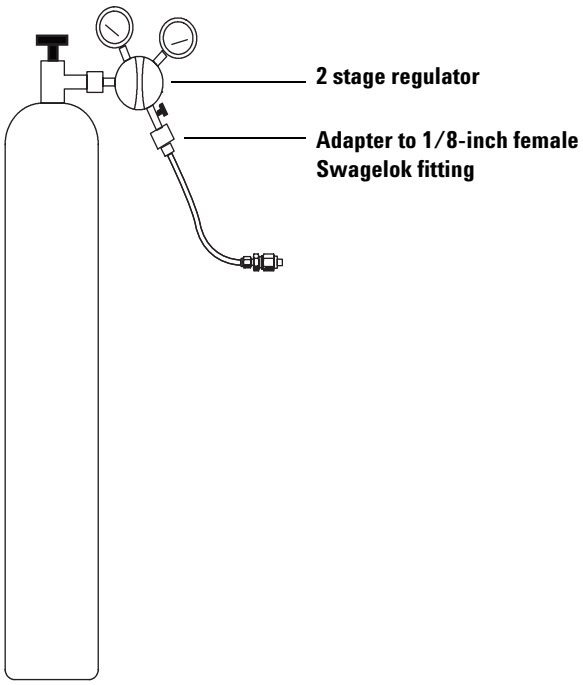
The tubing diameter depends on the distance between the supply gas and the GC and the total flow rate for the particular gas. Tubing of 1/8-in diameter is adequate when the supply line is less than 15 feet (4.6 m) long.

Use larger diameter tubing (1/4-in) for distances greater then 15 feet (4.6 m) or when multiple instruments are connected to the same source. Use larger diameter tubing if high demand is anticipated (for example, air for an FID).

Be generous when cutting tubing for local supply lines—a coil of flexible tubing between the supply and the instrument lets you move the GC without moving the gas supply. Take this extra length into account when choosing the tubing diameter.

Two-stage pressure regulators

To eliminate pressure surges, use a two-stage regulator with each gas tank. Stainless steel, diaphragm-type regulators are recommended.



The type of regulator you use depends on the gas type and supplier. The Agilent catalog for consumables and supplies contains information to help you identify the correct regulator, as determined by the Compressed Gas Association (CGA). Agilent Technologies offers pressure-regulator kits that contain all the materials needed to install regulators properly.

Pressure regulator-gas supply tubing connections

Use Teflon® tape to seal the pipe-thread connection between the pressure regulator outlet and the fitting to which you connect the gas tubing. Instrument grade Teflon tape (part number 0460-1266), from which volatiles have been removed, is recommended for all fittings. Do not use pipe dope to seal the threads; it contains volatile materials that will contaminate the tubing.

Traps

Using chromatographic-grade gases ensures that the gas in your system is pure. However, for optimum sensitivity, install high-quality traps to remove traces of water or other contaminants. After installing a trap, check the gas supply lines for leaks.

Table 14 lists the recommended traps. See the Agilent online store for the complete listing of traps and trap accessories. As shown in Figure 3, install the indicating trap last so that it warns when the combination begins to fail.

Table 14 Recommended traps

Description	Part number
Big universal trap. Removes oxygen, moisture, hydrocarbons, carbon dioxide and carbon monoxide from helium gas streams.	RMS
Indicating oxygen trap (for carrier and ECD gases).	IOT-2-HP

Moisture in carrier gas damages columns. Agilent recommends installing a moisture trap after the source regulator and before any other traps.

A hydrocarbon trap removes organics from gases. Place it after a molecular sieve trap and before an oxygen trap, if they are present.

An oxygen trap removes 99% of the oxygen from a gas plus traces of water. Place it last in a series of traps. Because trace amounts of oxygen can damage columns and degrade uECD performance, use an oxygen trap with carrier and uECD gases. Do not use it with FID, FPD, or NPD fuel gases.

Cryogenic Cooling Requirements

Cryogenic cooling allows you to cool the oven below ambient temperature. A solenoid valve introduces liquid coolant, either carbon dioxide (CO_2) or nitrogen (N_2), to cool the oven to the desired temperature.

CO_2 and N_2 require different hardware on the GC.

Using carbon dioxide

WARNING **Pressurized liquid CO_2 is a hazardous material. Take precautions to protect personnel from high pressures and low temperatures. CO_2 in high concentrations is toxic to humans; take precautions to prevent hazardous concentrations. Consult your local supplier for recommended safety precautions and delivery system design.**

CAUTION Liquid CO_2 should not be used as a coolant for temperatures below –40°C because the expanding liquid may form solid CO_2—dry ice—in the GC oven. If dry ice builds up in the oven, it can seriously damage the GC.

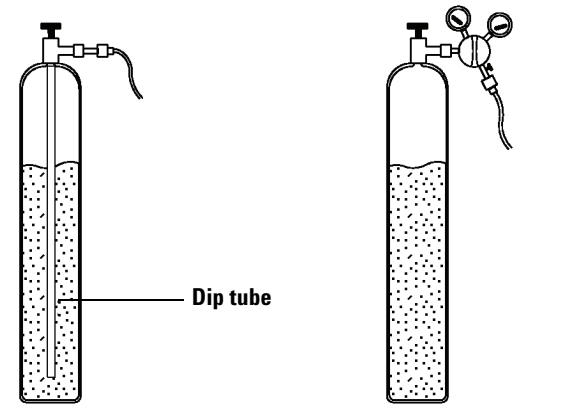
Liquid CO_2 is available in high-pressure tanks containing liquid. The CO_2 should be free of particulate material, oil, and other contaminants. These contaminants could clog the expansion orifice or affect the proper operation of the GC.

WARNING **Do not use copper tubing or thin-wall stainless steel tubing with liquid CO_2. Both harden at stress points and may explode.**

Additional requirements for the liquid CO_2 system include:

- The tank must have an internal dip tube or eductor tube to deliver liquid CO_2 instead of gas (see the figure below).
- Set the liquid CO_2 pressure to the GC at 4830 to 6900 kPa (700 to 1,000 psi) at a temperature of 25 °C.
- Use 1/8-inch diameter heavy-wall stainless steel tubing for supply tubing. The tubing should be between 1.5 and 15 m (5 and 50 feet) long.
- Coil and fasten the ends of the tubing to prevent it from “whipping” if it breaks.

- Do not install a pressure regulator on the CO_2 tank, as vaporization and cooling would occur in the regulator instead of the oven.
- Do not use a padded tank (one to which another gas is added to increase the pressure).



Using liquid nitrogen

WARNING **Liquid nitrogen is a hazard because of the extremely low temperatures and high pressures that may occur in improperly designed supply systems.**

Liquid nitrogen can present an asphyxiant hazard if vaporizing nitrogen displaces oxygen in the air. Consult local suppliers for safety precautions and design information.

Liquid nitrogen is supplied in insulated Dewar tanks. The correct type for cooling purposes is a low-pressure Dewar equipped with a dip tube—to deliver liquid rather than gas—and a safety relief valve to prevent pressure build-up. The relief valve is set by the supplier at 138 to 172 kPa (20 to 25 psi).

WARNING **If liquid nitrogen is trapped between a closed tank valve and the cryo valve on the GC, tremendous pressure will develop and may cause an explosion. For this reason, keep the delivery valve on the tank open so that the entire system is protected by the pressure relief valve.**

To move or replace a tank, close the delivery valve and carefully disconnect the line at either end to let residual nitrogen escape.

Additional requirements for the liquid N_2 system include:

- Set the liquid N_2 pressure to the GC at 138 to 207 kPa (20 to 30 psi).
- Make sure the supply tubing for liquid N_2 is insulated. Foam tubing used for refrigeration and air-conditioning lines is suitable for insulation. Since pressures are low, insulated copper tubing is adequate.
- Situate the liquid nitrogen tank close (within 1.5 to 3 m, or 5 to 10 feet) to the GC to ensure that liquid, not gas, is supplied to the inlet.

Maximum Length of Cables

The distance between system modules may be limited by some of the cabling and the vent or vacuum hoses.

- A GC/MS system foreline pump can be located on the laboratory bench or on the floor. It must be close to the MSD because it is connected by a 200-cm (79-inch) hose. The hose is stiff and cannot be bent sharply. The length of the vacuum hose is 130 cm (4.24 feet) from the high vacuum pump to the foreline pump, while the length of the foreline pump power cord is 2 meters (6.6 feet).
- The length of the Agilent-supplied remote cable is 2 meters (6.6 feet).
- The length of the Agilent-supplied LAN cable is 10 meters (32.8 feet).
- The lengths of the power cords are 2 meters (6.6 feet).
- The length of a G1888 Headspace Sampler transfer line is about 80 cm (31.5 inches).

Site LAN Network

If you intend to connect your system to your site's LAN network, you must have an additional shielded twisted pair network cable.

NOTE Agilent Technologies is not responsible for connecting to or establishing communication with your site LAN network. The representative will test the system's ability to communicate on a mini-hub or LAN switch only.

NOTE The IP addresses assigned to the instrument(s) must be fixed (permanently assigned) addresses. If you intend to connect your system to your site's network, each piece of equipment must have a unique, fixed (static) IP address assigned to it.

Basic Tools

The GC/MS comes with a few basic tools and consumables depending on the specific inlet and detector that you ordered. Below is a general list of what comes with the instrument.

Table 15 Basic tools

Tool or consumable	Used for
7890A GC	
T10 and T20 Torx wrenches	Removing tray. Removing covers to access gas control modules, traps, and pneumatic connections.
1/4-inch nut driver	FID jet replacement.
FID flow measuring insert	FID troubleshooting.
Column cutter, ceramic or diamond	Column installation.
1/8-inch Tee, Swagelok, brass	Connect gas supplies.
1/8-inch nuts & ferrules, Swagelok, brass	Connect gas supplies.
Inlet septa appropriate for type	Inlet seal.
Inlet insert or liner	Contains sample during vaporization in inlet.
GC/MS	
1.5-mm and 2.0-mm hex driver	Source maintenance (disassembly).
Tool bag	Holding GC and MS tools.
Q-Tips	Cleaning source parts.
Cloths	Keeping surfaces and parts clean.
Gloves	Reducing contamination on GC and MSD parts.
Funnel	Changing oil.
Hex key, 5 mm	Removing oil plug and screws in safety shield handle.

Table 16 lists other useful tools not included with the GC.

Table 16 Useful tools not included with GC

Tool	Used for
Custom Tee, G3430-60009	Connecting the same gas to front and back EPC module.
ECD/TCD Detector plug, 5060-9055	Inlet pressure decay test
1/8-inch Ball Valve, 0100-2144	Inlet pressure decay test (one per inlet)
Digital flow meter, Flow tracker 1000	Verifying flows, checking for leaks and plugs
Electronic gas leak detector	Locating gas leaks; safety checks when using Hydrogen
Column cutters	Cutting columns
T-10 and T-20 Torx drivers	Removing tray; removing covers to access EPC modules, traps, and possible leaks
1/8-inch tubing cutter (wire cutter type)	Cutting gas supply tubing
Assorted wrenches: 1/4-inch, 3/8-inch, 7/16-inch, 9/16-inch	Gas supply and plumbing fittings
Electronic vial crimper	Assuring consistently air-tight vial closure, regardless of who does the crimping

Table 17 lists consumables that you may wish to order. First time GC users should consider purchasing the following supplies in order to maintain their system and prevent interruptions in the use of their system. Please refer to the latest Agilent consumables and supplies catalog and to the Agilent web site at www.aglent.com/chem for part numbers and recommended maintenance periods.

Table 17 Additional consumables

Consumable category	Consumable
Inlet supplies	Septa, o-rings, liners, adapter, and seals
Inlet preventative maintenance (PM) kits	Kits with individual parts needed to maintain an inlet
Pneumatic supplies	Gases, traps, o-rings, seals, Swagelok fittings

Table 17 Additional consumables

Consumable category	Consumable
Column supplies	Nuts, ferrules, adapters, guard columns, retention gaps
Detector supplies	Jets, beads, liners, adapters, cleaning kits
Application supplies	Standards, columns, syringes

6890 Series GC Site Preparation

This section outlines the space and resource requirements for GC, GC/MS, and automatic liquid sampler (ALS) installation. For a successful and timely installation of the instrument, the site must meet these requirements before beginning installation. Necessary supplies (gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents) must also be available. Note that performance verification requires the use of helium carrier gas, and for 5975 MSD systems using chemical ionization, methane reagent gas. Refer to the Agilent Web site at www.agilent.com/chem for the most up-to-date listing of GC, GC/MS, and ALS supplies and consumables.

Customer Responsibilities

The specifications in this manual outline the necessary space, electrical outlets, gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents required for the successful installation of instruments and systems.

If Agilent is delivering installation and familiarization services, users of the instrument should be present throughout these services; otherwise, they will miss important operational, maintenance, and safety information.

If Agilent is delivering installation and familiarization services, delays due to inadequate site preparation could cause loss of instrument use during the warranty period. In extreme cases, Agilent Technologies may ask to be reimbursed for the additional time required to complete the installation. Agilent Technologies provides service during the warranty period and under maintenance agreements only if the specified site requirements are met.

Dimensions and weight

Select the laboratory bench space before the system arrives. Pay special attention to the total height requirements. Avoid bench space with overhanging shelves. See Table 18.

The instrument needs space for proper convection of heat and ventilation. Allow at least 25 cm (10 in) clearance between back of the instrument and wall to dissipate hot air.

Table 18 Required height, width, depth, and weight

Product	Height	Width	Depth	Weight
6890 Series GCs	54 cm (22 in)	55 cm (22 in)	54 cm (21 in)	50 kg (112 lb)
5975 Series MSDs				
• Diffusion pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Standard turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Performance turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	41 kg (90 lb)
• Performance CI/EI turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	46 kg (100 lb)
Foreline pump Standard Oil-free	 21 cm (8 in) 19 cm (7.5 in)	 13 cm (5 in) 32 cm (13 in)	 31 cm (12 in) 28 cm (11 in)	 11 kg (23.1 lb) 16 kg (35.2 lb)
G1888 Headspace sampler	56 cm (22 in)	46 cm (18.1 in)	64 cm (25 in)	46.3 kg (102 lb)
Additional space requirements				
• GC/MS operational and maintenance access		Requires 30 cm (1 ft) to its left		
• Typical laser printer		Requires 41 cm (16 in)		
• GC operational oven access		Requires ≥ 30 cm (12 in) open space above GC		
• GC with 7693A ALS injector		Requires 50 cm (19.5 in) above the GC		3.9 kg (8,6 lb) each
• GC with 7693A ALS tray		Requires 45 cm (17.5 in) left of the GC Requires 2 cm (1 inch) in front of GC		6.8 kg (15 lb) each
• GC with 7683B ALS injector		Requires 42 cm (16.5 in) above the GC		3.1 kg (7 lb) each
• GC with 7683B ALS tray		Requires 30 cm (12 in) left of the GC		3.0 kg (7 lb)
• GC with CTC PAL Autosampler		Requires 66 cm (26 in) above the GC and 4 to 20 cm (1.5 to 8 in) to the left or right, depending on configuration		

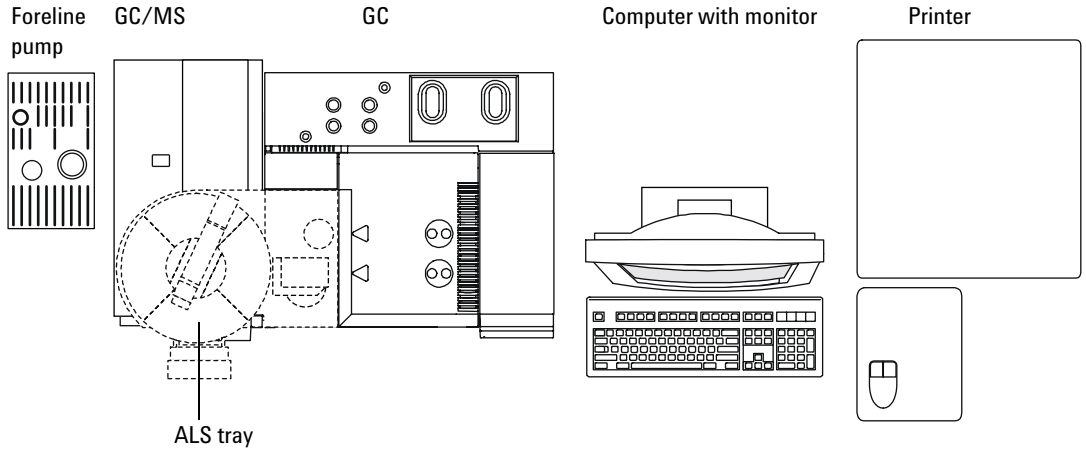


Figure 4 Top view of typical installation (6890 GC/MS system with ALS)

A simple 6890 system that includes a GC, an ALS, and a computer would require about 164 cm (5 ft 4 in.) of bench space. Allowing for operational access and a printer, a total of 255 cm (8 ft 4 in.) of bench space should be available for a full GC/MS system. Some repairs to the MSD or to the GC will also require access to the back of the instrument(s).

Note that the length of the GC/MS vacuum hose is 130 cm (4 ft 3 in) from the high vacuum pump to the foreline pump, and the length of the foreline pump power cord is 2 m (6 ft 6 in).

Power Consumption

Table 19 lists site power requirements.

- The number and type of electrical outlets depend on the size and complexity of the system.
- Power consumption and requirements depend on the country to which the unit ships. Find the instrument type and your line voltage to find your instrument's power requirements.
- The electrical outlet for the unit should have a dedicated ground. Voltage between ground and neutral should be less than 2.5 VAC.
- The voltage requirements for your instrument are printed near the power cord attachment.

Table 19 Power requirements

Product		Line voltage (VAC)	Frequency (Hz)	Current rating (amps)	Maximum continuous power consumption (VA)	Outlets required
Agilent 6890	Standard oven	Americas: 120* single phase (–10% / +5%)	48–66	18.8	2250	1
		220/230/240 single/split phase (–10% / +5%)	48–66	10.2/9.8/9.4	2250	1
	Fast oven	Japan: 200 split phase (–10% / +5%)	48–66	14.	2950	1
		220/230/240 † ‡ single/split phase (–10% / +5%)	48–66	13.4 / 12.8 / 12.3	2950	1
5975 Series MSD		120 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		220–240 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		200 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
Data system PC system (monitor, CPU, printer)		100 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
		120 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
		200–240 (–10% / +5%)	50/60 ± 5%	15	1000	3–5

* Americas 120 VAC requires 20 amp dedicated line. Americas 240 VAC requires 15 amp dedicated line.

† Option 003, 208 VAC fast oven, uses a 220 VAC unit with operating range of 198 to 242 VAC. Most labs have 4-wire service resulting in 208 VAC at the wall receptacle. It is important to measure the line voltage at the receptacle for the GC.

‡ Power line conditioners should not be used with 6890 or 7890A GCs.

WARNING **Do not use extension cords with Agilent instruments. Extension cords normally are not rated to carry enough power and can be a safety hazard.**

Although your GC should arrive ready for operation in your country, compare its voltage requirements with those listed in Table 19. If the voltage option you ordered is not suitable for your installation, contact Agilent Technologies.

Heat Dissipation

Use Table 20 to estimate the additional BTUs of heat dissipated from this equipment. Maximums represent the heat given off when heated zones are set for maximum temperatures.

Table 20 Heat dissipation

	Oven type	
	Standard oven ramp	**Fast oven ramp (options 002 and 003)**
Agilent 6890 Series	7681 BTU/hour maximum	10,071 BTU/hour maximum
Agilent 5975 Series	3000 BTU/hour including GC/MS interface	

Exhaust Venting

Hot air (up to 450 °C) from the oven exits through a vent in the rear. Allow at least 25 cm (10 in) clearance behind the instrument to dissipate this air.

WARNING **Do not place temperature-sensitive items (for example, gas cylinders, chemicals, regulators, and plastic tubing) in the path of the heated exhaust. These items will be damaged and plastic tubing will melt. Be careful when working behind the instrument during cool-down cycles to avoid burns from the hot exhaust.**

An optional oven exhaust deflector (G1530-80650) is available and may improve oven cooling by deflecting the exhaust air up and away from the instrument. For GCs with the exhaust deflector option installed, the exhaust is about 65 ft^3/min (1.840 m^3/min). Without the deflector, the exhaust rate is about 99 ft^3/min (2.8 m^3/min). The deflector outlet diameter is 10 cm (4 in).

During normal operation of the GC with many detectors and inlets, some of the carrier gas and sample vents outside the instrument through the split vent, septum purge vent, and detector exhaust. If any sample components are toxic or noxious, or if hydrogen is used as the carrier gas, the exhaust must be vented to a fume hood. Place the GC in the hood or attach a large diameter venting tube to the outlet for proper ventilation.

To further prevent contamination from noxious gases, attach a chemical trap to the vent(s).

Vent the GC/MS system externally to the building via an ambient-pressure vent system, within 460 cm (15 ft) of both the GC split vent and GC/MS foreline pump, or vent to a fume hood. Note that an exhaust vent system is not part of the building environmental control system, which recirculates air. Exhaust venting must comply with all local environmental and safety codes. Contact your Environmental Health & Safety (EHS) specialist.

Environmental conditions

Operating the instrument within the recommended ranges optimizes instrument performance and lifetime. Performance can be affected by sources of heat and cold from heating, air conditioning systems, or drafts. See Table 21. The conditions assume a noncondensing, noncorrosive atmosphere.

Table 21 Environmental conditions for operation and storage

Product	Conditions	Operating temp range	Operating humidity range	Maximum altitude
Agilent 6890 Series	Standard oven ramp	20 to 27 °C	50 to 60%	4,615 m
	Fast oven ramp (options 002 and 003)	20 to 27 °C	50 to 60%	4,615 m
	Storage	5 to 40 °C	5 to 95%	
5975 Series	Operation	15 to 35 °C* (59 to 95 °F)	40 to 80%	4,615 m†
	Storage	–20 to 70 °C (–4 to 158 °F)	0 to 95%	

Gas Selection

Table 22 lists gases usable with Agilent GCs and capillary columns. When used with capillary columns, GC detectors require a separate makeup gas for optimum sensitivity.

Table 22 Gases usable with Agilent GCs and capillary columns

Detector type	Carrier	Preferred makeup	Alternate choice	Detector, anode purge, or reference
Electron capture (ECD)	Hydrogen Helium Nitrogen* Argon/Methane*	Argon/Methane Argon/Methane Nitrogen Argon/Methane	Nitrogen Nitrogen Argon/Methane Nitrogen	Anode purge must be same as makeup
Flame ionization (FID)	Hydrogen Helium Nitrogen*	Nitrogen Nitrogen Nitrogen	Helium Helium Helium	Hydrogen and air for detector
Flame photometric (FPD)	Hydrogen Helium Nitrogen* Argon*	Nitrogen Nitrogen Nitrogen Nitrogen		Hydrogen and air for detector
Nitrogen-Phosphorus (NPD)	Helium Nitrogen*	Nitrogen Nitrogen	Helium† Helium	Hydrogen and air for detector
Thermal conductivity (TCD)	Hydrogen Helium Nitrogen*	Must be same as carrier and reference	Must be same as carrier and reference	Reference must be same as carrier and makeup

* Not generally suitable for GC/MS carrier gas.

† Depending on bead type, higher makeup gas flow rates (> 5 mL/min) may introduce cooling effects or shorten bead life.

Table 23 lists gas recommendations for packed column use. In general, makeup gases are not required with packed columns.

Table 23 Gases usable with Agilent GCs and packed columns

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Electron capture (ECD)	Nitrogen	Maximum sensitivity	Nitrogen
	Argon/methane	Maximum dynamic range	Argon/Methane
Flame ionization (FID)	Nitrogen	Maximum sensitivity	Hydrogen and air for detector.
	Helium	Acceptable alternative	

Table 23 Gases usable with Agilent GCs and packed columns (continued)

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Flame photometric (FPD)	Hydrogen Helium Nitrogen Argon		Hydrogen and air for detector.
Nitrogen-Phosphorus (NPD)	Helium	Optimum performance	Hydrogen and air for detector.
	Nitrogen	Acceptable alternative	
Thermal conductivity (TCD)	Helium	General use	Reference must be same as carrier and makeup.
	Hydrogen	Maximum sensitivity*	
	Nitrogen	Hydrogen detection†	
	Argon	Maximum hydrogen sensitivity[1]	

* Slightly greater sensitivity than helium. Incompatible with some compounds.

† For analysis of hydrogen or helium. Greatly reduces sensitivity for other compounds.

Agilent recommends that carrier and detector gases be 99.9995% pure. See Table 24. Air needs to be zero grade or better. Agilent also recommends using high quality traps to remove hydrocarbons, water, and oxygen.

Table 24 Carrier and reagent gas purity

Carrier and reagent gas requirements	Purity	Notes
Helium (carrier)	99.9995%	Hydrocarbon free
Hydrogen (carrier)	99.9995%	SFC grade
Methane reagent gas*	99.999%	Research or SFC grade
Isobutane reagent gas†	99.99%	Instrument grade
Ammonia reagent gas*	99.9995%	Research or SFC grade
Carbon dioxide reagent gas†	99.995%	SFC grade

* Required reagent gas for installation and performance verification, CI MSDs only.

† Optional reagent gases, CI MSDs only

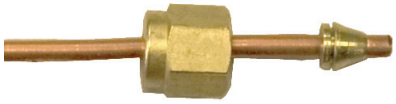
For installation checkout, Agilent requires the gas types shown in Table 25.

Table 25 Gases required for checkout

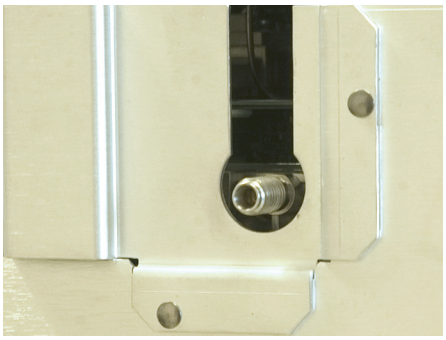
Detector	Gases required
FID	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air
TCD	Carrier and reference: helium
NPD	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air
uECD	Carrier: helium Anode purge and makeup: nitrogen
FPD	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air

Gas Supply

Supply instrument gases using tanks, an internal distribution system, or gas generators. If used, tanks require two-stage pressure regulators with packless, stainless steel diaphragms. The instrument requires 1/8-inch Swagelok connections to its gas supplies. See Figure 5. Plumb the gas supply tubing/regulators so that one 1/8-inch Swagelok female connector is available for each gas needed at the GC.



Swagelok nut and ferrules



Female Swagelok fitting on GC

Figure 5 Example Swagelok connector and hardware

Table 26 lists minimum and maximum delivery pressures for inlets and detectors, measured at the bulkhead fittings on the back of the instrument.

Table 26 Delivery pressures required at the GC/MS, in kPa (psig)

	Detector type					Inlet type				
	FID	**NPD**	**TCD**	**ECD**	**FPD**	**Split/Splitless 150 psi**	**Split/Splitless 100 psi**	**On-column**	**Purged packed**	**PTV**
Hydrogen	240–690 (35–100)	240–690 (35–100)			310–690 (45–100)					
Air	380–690 (55–100)	380–690 (55–100)			690–827 (100–120)					
Makeup	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)					
Reference			380–690 (55–100)							

Table 26 Delivery pressures required at the GC/MS, in kPa (psig) (continued)

	Detector type					Inlet type				
	FID	**NPD**	**TCD**	**ECD**	**FPD**	**Split/Splitless 150 psi**	**Split/Splitless 100 psi**	**On-column**	**Purged packed**	**PTV**
Carrier (max)						1,172 (170)	827 (120)	827 (120)	827 (120)	827 (120)
Carrier (min)						(20 psi) above pressure used in method				

Conversions: 1 psi = 6.8947 kPa = 0.068947 Bar = 0.068 ATM

Notes:

- If you have not requested option 305, you must supply pre-cleaned, 1/8-inch copper tubing and a variety of 1/8-inch Swagelok fittings to connect the GC to inlet and detector gas supplies.
- Cryogenic cooling with Liquid N_2 requires 1/4-inch insulated copper tubing.
- Cryogenic cooling with Liquid CO_2 requires 1/8-inch heavy-walled, stainless steel tubing.
- If you purchased automated valving, the valve actuation requires a **separate** pressurized, dry air supply at 380 kPa (55 psig). This air supply must end in a male fitting compatible with a 1/4-inch id plastic tube at the GC.
- Never use liquid thread sealer to connect fittings. Never use chlorinated solvents to clean tubing or fittings.

Table 27 lists the limits on total gas flow into the 5975 Series MSD.

Table 27 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
High vacuum pump	Diffusion	Standard turbo	Performance turbo	Performance turbo, EI/PCI/NCI
Optimal gas flow mL/min*	1.0	1.0	1.0 to 2.0	1.0 to 2.0
Maximum recommended gas flow, mL/min	1.5	2.0	4.0	4.0

Table 27 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
Maximum gas flow, mL/min†	2.0	2.4	6.5	4.0
Max column id	0.25 mm (30 m)	0.32 mm (30 m)	0.53 mm (30 m)	0.53 mm (30 m)

* Total gas flow into the GC/MS: column flow plus reagent gas flow (if applicable).

† Expect degradation of spectral performance and sensitivity.

Table 27 lists typical flows resulting from selected carrier and reagent gas source pressures.

Table 28 5975 Series carrier and reagent gases

Carrier and reagent gas requirements	Typical pressure range	Typical flow (mL/min)
Helium (required) (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Hydrogen (optional)* (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Methane reagent gas (required for CI operation)	103 to 172 kPa (15 to 25 psi)	1 to 2
Isobutane reagent gas (optional)	103 to 172 kPa (15 to 25 psi)	1 to 2
Ammonia reagent gas (optional)	34 to 55 kPa (5 to 8 psi)	1 to 2
Carbon dioxide reagent gas (optional)	103 to 138 kPa (15 to 20 psi)	1 to 2

* Hydrogen gas can be used for the carrier gas but specifications are based on helium as the carrier gas. Please observe all hydrogen gas safety cautions.

Gas Plumbing

WARNING **All compressed gas cylinders should be securely fastened to an immovable structure or permanent wall. Compressed gases should be stored and handled in accordance with the relevant safety codes.**

Gas cylinders should not be located in the path of heated oven exhaust.

To avoid possible eye injury, wear eye protection when using compressed gas.

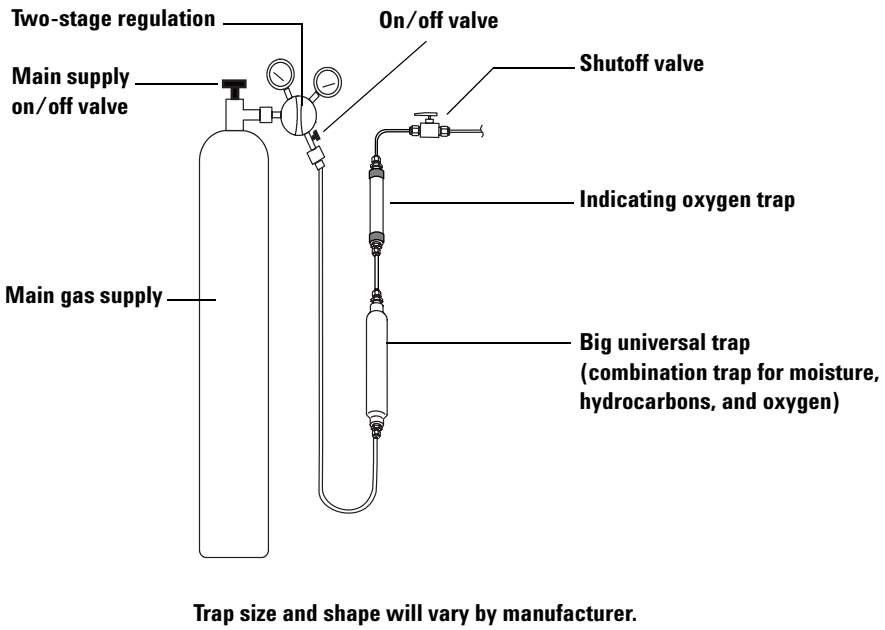


Figure 6 Recommended traps and plumbing configuration from a carrier gas cylinder

- Agilent strongly recommends two-stage regulators to eliminate pressure surges. High-quality, stainless-steel diaphragm-type regulators are especially recommended.
- On/off valves mounted on the outlet fitting of the two-stage regulator are not essential but are very useful. Be sure the valves have stainless-steel, packless diaphragms.

- FID, FPD, and NPD detectors require a dedicated air supply. Operation may be affected by pressure pulses in air lines shared with other devices.
- Flow- and pressure-controlling devices require at least 10 psi (138 kPa) pressure differential across them to operate properly. Set source pressures and capacities high enough to ensure this.
- Situate auxiliary pressure regulators close to the GC inlet fittings. This ensures that the supply pressure is measured at the instrument (rather than at the source); pressure at the source may be different if the gas supply lines are long or narrow.

Supply tubing for carrier and detector gases

Use only preconditioned copper tubing (part number 5180-4196) to supply gases to the instrument. Do not use ordinary copper tubing—it contains oils and contaminants.

CAUTION Do not use methylene chloride or other halogenated solvent to clean tubing that will be used with an electron capture detector. They will cause elevated baselines and detector noise until they are completely flushed out of the system.

CAUTION Do not use plastic tubing for suppling detector and inlet gases to the GC. It is permeable to oxygen and other contaminants that can damage columns and detectors.

Plastic tubing can melt if near hot exhaust or components.

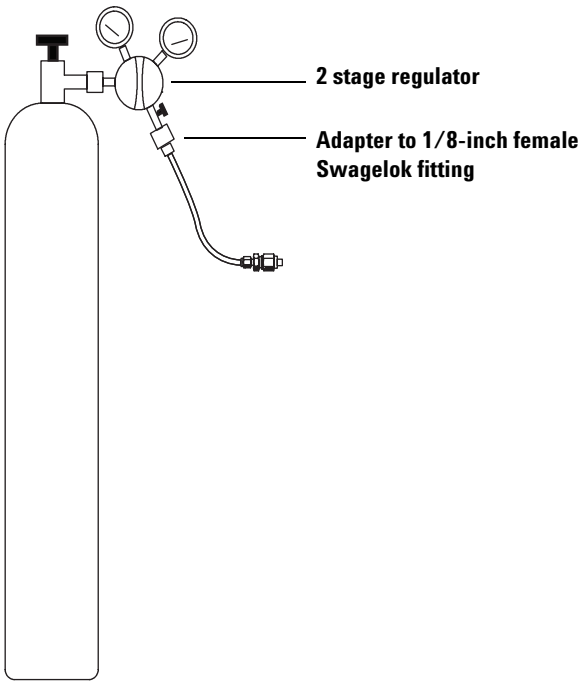
The tubing diameter depends on the distance between the supply gas and the GC and the total flow rate for the particular gas. Tubing of 1/8-in diameter is adequate when the supply line is less than 15 feet (4.6 m) long.

Use larger diameter tubing (1/4-in) for distances greater then 15 feet (4.6 m) or when multiple instruments are connected to the same source. Use larger diameter tubing if high demand is anticipated (for example, air for an FID).

Be generous when cutting tubing for local supply lines—a coil of flexible tubing between the supply and the instrument lets you move the GC without moving the gas supply. Take this extra length into account when choosing the tubing diameter.

Two-stage pressure regulators

To eliminate pressure surges, use a two-stage regulator with each gas tank. Stainless steel, diaphragm-type regulators are recommended.



The type of regulator you use depends on the gas type and supplier. The Agilent catalog for consumables and supplies contains information to help you identify the correct regulator, as determined by the Compressed Gas Association (CGA). Agilent Technologies offers pressure-regulator kits that contain all the materials needed to install regulators properly.

Pressure regulator-gas supply tubing connections

Use Teflon® tape to seal the pipe-thread connection between the pressure regulator outlet and the fitting to which you connect the gas tubing. Instrument grade Teflon tape (part number 0460-1266), from which volatiles have been removed, is recommended for all fittings. Do not use pipe dope to seal the threads; it contains volatile materials that will contaminate the tubing.

Traps

Using chromatographic-grade gases ensures that the gas in your system is pure. However, for optimum sensitivity, install high-quality traps to remove traces of water or other contaminants. After installing a trap, check the gas supply lines for leaks.

Table 29 lists the recommended traps. See the Agilent online store for the complete listing of traps and trap accessories. As shown in Figure 6, install the indicating trap last so that it warns when the combination begins to fail.

Table 29 Recommended traps

Description	Part number
Big universal trap. Removes oxygen, moisture, hydrocarbons, carbon dioxide and carbon monoxide from helium gas streams.	RMS
Indicating oxygen trap (for carrier and ECD gases).	IOT-2-HP

Moisture in carrier gas damages columns. Agilent recommends installing a moisture trap after the source regulator and before any other traps.

A hydrocarbon trap removes organics from gases. Place it after a molecular sieve trap and before an oxygen trap, if they are present.

An oxygen trap removes 99% of the oxygen from a gas plus traces of water. Place it last in a series of traps. Because trace amounts of oxygen can damage columns and degrade uECD performance, use an oxygen trap with carrier and uECD gases. Do not use it with FID, FPD, or NPD fuel gases.

Cryogenic Cooling Requirements

Cryogenic cooling allows you to cool the oven below ambient temperature. A solenoid valve introduces liquid coolant, either carbon dioxide (CO_2) or nitrogen (N_2), to cool the oven to the desired temperature.

CO_2 and N_2 require different hardware on the GC.

Using carbon dioxide

WARNING **Pressurized liquid CO_2 is a hazardous material. Take precautions to protect personnel from high pressures and low temperatures. CO_2 in high concentrations is toxic to humans; take precautions to prevent hazardous concentrations. Consult your local supplier for recommended safety precautions and delivery system design.**

CAUTION Liquid CO_2 should not be used as a coolant for temperatures below –40°C because the expanding liquid may form solid CO_2—dry ice—in the GC oven. If dry ice builds up in the oven, it can seriously damage the GC.

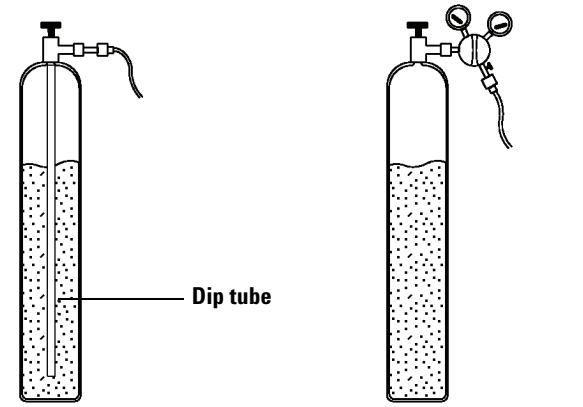
Liquid CO_2 is available in high-pressure tanks containing liquid. The CO_2 should be free of particulate material, oil, and other contaminants. These contaminants could clog the expansion orifice or affect the proper operation of the GC.

WARNING **Do not use copper tubing or thin-wall stainless steel tubing with liquid CO_2. Both harden at stress points and may explode.**

Additional requirements for the liquid CO_2 system include:

- The tank must have an internal dip tube or eductor tube to deliver liquid CO_2 instead of gas (see the figure below).
- Set the liquid CO_2 pressure to the GC at 4830 to 6900 kPa (700 to 1,000 psi) at a temperature of 25 °C.
- Use 1/8-inch diameter heavy-wall stainless steel tubing for supply tubing. The tubing should be between 1.5 and 15 m (5 and 50 feet) long.
- Coil and fasten the ends of the tubing to prevent it from “whipping” if it breaks.

- Do not install a pressure regulator on the CO_2 tank, as vaporization and cooling would occur in the regulator instead of the oven.
- Do not use a padded tank (one to which another gas is added to increase the pressure).



Using liquid nitrogen

WARNING

Liquid nitrogen is a hazard because of the extremely low temperatures and high pressures that may occur in improperly designed supply systems.

Liquid nitrogen can present an asphyxiant hazard if vaporizing nitrogen displaces oxygen in the air. Consult local suppliers for safety precautions and design information.

Liquid nitrogen is supplied in insulated Dewar tanks. The correct type for cooling purposes is a low-pressure Dewar equipped with a dip tube—to deliver liquid rather than gas—and a safety relief valve to prevent pressure build-up. The relief valve is set by the supplier at 138 to 172 kPa (20 to 25 psi).

WARNING **If liquid nitrogen is trapped between a closed tank valve and the cryo valve on the GC, tremendous pressure will develop and may cause an explosion. For this reason, keep the delivery valve on the tank open so that the entire system is protected by the pressure relief valve.**

To move or replace a tank, close the delivery valve and carefully disconnect the line at either end to let residual nitrogen escape.

Additional requirements for the liquid N_2 system include:

- Set the liquid N_2 pressure to the GC at 138 to 207 kPa (20 to 30 psi).
- Make sure the supply tubing for liquid N_2 is insulated. Foam tubing used for refrigeration and air-conditioning lines is suitable for insulation. Since pressures are low, insulated copper tubing is adequate.
- Situate the liquid nitrogen tank close (within 1.5 to 3 m, or 5 to 10 feet) to the GC to ensure that liquid, not gas, is supplied to the inlet.

Maximum Length of Cables

The distance between system modules may be limited by some of the cabling and the vent or vacuum hoses.

- A GC/MS system foreline pump can be located on the laboratory bench or on the floor. It must be close to the MSD because it is connected by a 200-cm (79-inch) hose. The hose is stiff and cannot be bent sharply. The length of the vacuum hose is 130 cm (4.24 feet) from the high vacuum pump to the foreline pump, while the length of the foreline pump power cord is 2 meters (6.6 feet).
- The length of the Agilent-supplied remote cable is 2 meters (6.6 feet).
- The length of the Agilent-supplied LAN cable is 10 meters (32.8 feet).
- The lengths of the power cords are 2 meters (6.6 feet).
- The length of a G1888 Headspace Sampler transfer line is about 80 cm (31.5 inches).

Site LAN Network

If you intend to connect your system to your site's LAN network, you must have an additional shielded twisted pair network cable.

NOTE Agilent Technologies is not responsible for connecting to or establishing communication with your site LAN network. The representative will test the system's ability to communicate on a mini-hub or LAN switch only.

NOTE The IP addresses assigned to the instrument(s) must be fixed (permanently assigned) addresses. If you intend to connect your system to your site's network, each piece of equipment must have a unique, fixed (static) IP address assigned to it.

Basic Tools

The GC/MS comes with a few basic tools and consumables depending on the specific inlet and detector that you ordered. Below is a general list of what comes with the instrument.

Table 30 Basic tools

Tool or consumable	Used for
6890N GC	
T10 and T20 Torx wrenches	Removing tray. Removing covers to access gas control modules, traps, and pneumatic connections.
1/4-inch nut driver	FID jet replacement.
FID flow measuring insert	FID troubleshooting.
Column cutter, ceramic or diamond	Column installation.
1/8-inch Tee, Swagelok, brass	Connect gas supplies.
1/8-inch nuts & ferrules, Swagelok, brass	Connect gas supplies.
Inlet septa appropriate for type	Inlet seal.
Inlet insert or liner	Contains sample during vaporization in inlet.
GC/MS	
1.5-mm and 2.0-mm hex driver	Source maintenance (disassembly).
Tool bag	Holding GC and MS tools.
Q-Tips	Cleaning source parts.
Cloths	Keeping surfaces and parts clean.
Gloves	Reducing contamination on GC and MSD parts.
Funnel	Changing oil.
Hex key, 5 mm	Removing oil plug and screws in safety shield handle.

Table 31 lists other useful tools not included with the GC.

Table 31 Useful tools not included with GC

Tool	Used for
Custom Tee, G3430-60009	Connecting the same gas to front and back EPC module.
ECD/TCD Detector plug, 5060-9055	Inlet pressure decay test
1/8-inch Ball Valve, 0100-2144	Inlet pressure decay test (one per inlet)
Digital flow meter, Flow tracker 1000	Verifying flows, checking for leaks and plugs
Electronic gas leak detector	Locating gas leaks; safety checks when using Hydrogen
Column cutters	Cutting columns
T-10 and T-20 Torx drivers	Removing tray; removing covers to access EPC modules, traps, and possible leaks
1/8-inch tubing cutter (wire cutter type)	Cutting gas supply tubing
Assorted wrenches: 1/4-inch, 3/8-inch, 7/16-inch, 9/16-inch	Gas supply and plumbing fittings
Electronic vial crimper	Assuring consistently air-tight vial closure, regardless of who does the crimping

Table 32 lists consumables that you may wish to order. First time GC users should consider purchasing the following supplies in order to maintain their system and prevent interruptions in the use of their system. Please refer to the latest Agilent consumables and supplies catalog and to the Agilent web site at www.aglent.com/chem for part numbers and recommended maintenance periods.

Table 32 Additional consumables

Consumable category	Consumable
Inlet supplies	Septa, o-rings, liners, adapter, and seals
Inlet preventative maintenance (PM) kits	Kits with individual parts needed to maintain an inlet
Pneumatic supplies	Gases, traps, o-rings, seals, Swagelok fittings

Table 32 Additional consumables (continued)

Consumable category	Consumable
Column supplies	Nuts, ferrules, adapters, guard columns, retention gaps
Detector supplies	Jets, beads, liners, adapters, cleaning kits
Application supplies	Standards, columns, syringes

6850 Series GC Site Preparation

This section outlines the space and resource requirements for GC, GC/MS, and automatic liquid sampler (ALS) installation. For a successful and timely installation of the instrument, the site must meet these requirements before beginning installation. Necessary supplies (gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents) must also be available. Note that performance verification requires the use of helium carrier gas, and for 5975 MSD systems using chemical ionization, methane reagent gas. Refer to the Agilent Web site at www.agilent.com/chem for the most up-to-date listing of GC, GC/MS, and ALS supplies and consumables.

Customer Responsibilities

The specifications in this manual outline the necessary space, electrical outlets, gases, tubing, operating supplies, consumables, and other usage-dependent items such as columns, vials, syringes, and solvents required for the successful installation of instruments and systems.

If Agilent is delivering installation and familiarization services, users of the instrument should be present throughout these services; otherwise, they will miss important operational, maintenance, and safety information.

If Agilent is delivering installation and familiarization services, delays due to inadequate site preparation could cause loss of instrument use during the warranty period. In extreme cases, Agilent Technologies may ask to be reimbursed for the additional time required to complete the installation. Agilent Technologies provides service during the warranty period and under maintenance agreements only if the specified site requirements are met.

Dimensions and weight

Select the laboratory bench space before the system arrives. Pay special attention to the total height requirements. Avoid bench space with overhanging shelves. See Table 33.

The instrument needs space for proper convection of heat and ventilation. Allow at least 25 cm (10 in) clearance between back of the instrument and wall to dissipate hot air.

Table 33 Required height, width, depth, and weight

Product	Height	Width	Depth	Weight
6850 Series GCs	51 cm (20 in)	29 cm (12 in) 34 cm (14 in) CO_2 37 cm (15 in) 6850 ALS	57 cm (23 in)	< 23 kg (51 lb)
5975 Series MSDs				
• Diffusion pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Standard turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	39 kg (85 lb)
• Performance turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	41 kg (90 lb)
• Performance CI/EI turbo pump	41 cm (16 in)	30 cm (12 in)	54 cm (22 in)	46 kg (100 lb)
Foreline pump Standard Oil-free	 21 cm (8 in) 19 cm (7.5 in)	 13 cm (5 in) 32 cm (13 in)	 31 cm (12 in) 28 cm (11 in)	 11 kg (23.1 lb) 16 kg (35.2 lb)
G1888 Headspace sampler	56 cm (22 in)	46 cm (18.1 in)	64 cm (25 in)	46.3 kg (102 lb)
Additional space requirements				
• GC/MS operational and maintenance access		Requires 30 cm (1 ft) to its left		
• Typical laser printer		Requires 41 cm (16 in)		
• GC operational oven access		Requires ≥ 30 cm (12 in) open space above GC		
• GC with 7693A ALS injector		Requires 50 cm (19.5 in) above the GC		3.9 kg (8,6 lb) each
• GC with 7683B ALS injector		Requires 42 cm (16.5 in) above the GC		3.1 kg (7 lb) each
• GC with CTC PAL Autosampler		Requires 66 cm (26 in) above the GC and 4 to 20 cm (1.5 to 8 in) to the left or right, depending on configuration		

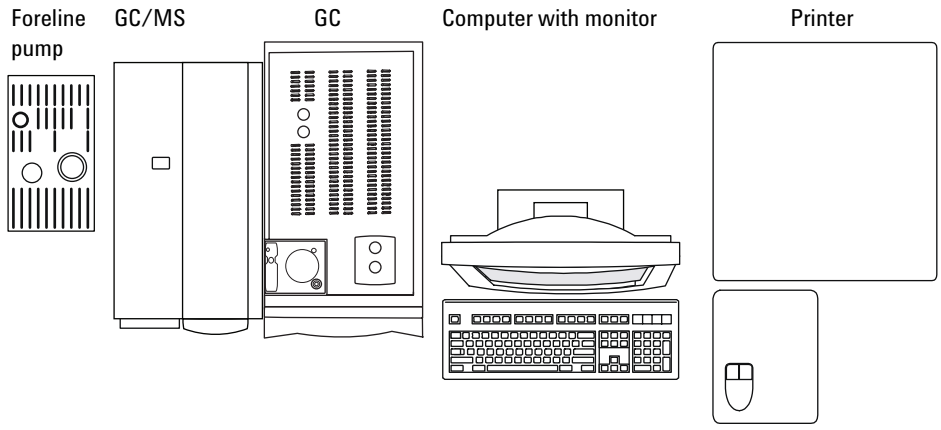


Figure 7 Top view of typical installation (6850 GC/MS system with ALS)

A simple 6850 system that includes a GC, an ALS injector, and a computer would require about 138 cm (4 ft 6 in) of bench space. Allowing for operational access and a printer, a total of 229 cm (7.5 ft) of bench space should be available for a full GC/MS system. Some repairs to the MSD or to the GC will also require access to the back of the instrument(s).

Note that the length of the GC/MS vacuum hose is 130 cm (4 ft 3 in) from the high vacuum pump to the foreline pump, and the length of the foreline pump power cord is 2 m (6 ft 6 in).

Power Consumption

Table 34 lists site power requirements.

- The number and type of electrical outlets depend on the size and complexity of the system.
- Power consumption and requirements depend on the country to which the unit ships. Find the instrument type and your line voltage to find your instrument's power requirements.
- The electrical outlet for the unit should have a dedicated ground. Voltage between ground and neutral should be less than 2.5 VAC.
- The voltage requirements for your instrument are printed near the power cord attachment.

Table 34 Power requirements

Product		Line voltage (VAC)	Frequency (Hz)	Current rating (amps)	Maximum continuous power consumption (VA)	Outlets required
6850	Standard oven	Japan: 100 single phase (–10% / +10%)*	48–63	15	1440	1
		Americas: 120 single phase (–10% / +10%)*	48–63	12	1440	1
		230 single/split phase (–10% / +10%)*	48–63	9	2000	1
	Fast oven	120 single phase (–10% / +10%)*	48–63	20	2400	1
		220/230/240 single/split phase (–10% / +10%)*	48–63	11	2400	1
		200/208 single/split phase (–10% / +10%)*	48–63	12	2400	1
5975 Series MSD		120 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		220–240 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1
		200 (–10% / +5%)	50/60 ± 5%	8	1100 (400 for foreline pump only)	1

Table 34 Power requirements (continued)

Product	Line voltage (VAC)	Frequency (Hz)	Current rating (amps)	Maximum continuous power consumption (VA)	Outlets required
Data system PC system (monitor, CPU, printer)	100 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
	120 (–10% / +5%)	50/60 ± 5%	15	1000	3–5
	200–240 (–10% / +5%)	50/60 ± 5%	15	1000	3–5

* Requires an isolated ground and dedicated outlet.

WARNING **Do not use extension cords with Agilent instruments. Extension cords normally are not rated to carry enough power and can be a safety hazard.**

Although your GC should arrive ready for operation in your country, compare its voltage requirements with those listed in Table 34. If the voltage option you ordered is not suitable for your installation, contact Agilent Technologies.

CAUTION A proper earth ground is required for GC operations. Any interruption of the grounding conductor or disconnection of the power cord could cause a shock that could result in personal injury.

To protect users, the metal instrument panels and cabinet are grounded through the three-conductor power line cord in accordance with International Electrotechnical Commission (IEC) requirements.

The three-conductor power line cord, when plugged into a properly grounded receptacle, grounds the instrument and minimizes shock hazard. A properly grounded receptacle is one that is connected to a suitable earth ground. Be sure to verify proper receptacle grounding.

Connect the GC to a dedicated receptacle. Use of a dedicated receptacle reduces interference.

Canadian installation

When installing a GC in Canada, make sure your GC's power supply circuit meets the following additional requirements:

- The circuit breaker for the branch circuit, which is dedicated to the instrument, is rated for continuous operation.
- The service box branch circuit is marked as a “Dedicated Circuit.”

Heat Dissipation

Use Table 35 to estimate the additional BTUs of heat dissipated from this equipment. Maximums represent the heat given off when heated zones are set for maximum temperatures.

Table 35 Heat dissipation

	Oven type	
	Standard oven ramp	**Fast oven ramp (option 002)**
Agilent 6850 Series	< 4800 BTU/hour maximum	< 4800 BTU/hour maximum
Agilent 5975 Series	3000 BTU/hour including GC/MS interface	

Exhaust Venting

Hot air (up to 350 °C) from the oven exits through a vent in the rear. Allow at least 25 cm (10 in) clearance behind the instrument to dissipate this air.

WARNING **Do not place temperature-sensitive items (for example, gas cylinders, chemicals, regulators, and plastic tubing) in the path of the heated exhaust. These items will be damaged and plastic tubing will melt. Be careful when working behind the instrument during cool-down cycles to avoid burns from the hot exhaust.**

An optional oven exhaust deflector (G2630-60710) is available and may improve oven cooling by deflecting the exhaust air up and away from the instrument.

During normal operation of the GC with many detectors and inlets, some of the carrier gas and sample vents outside the instrument through the split vent, septum purge vent, and detector exhaust. If any sample components are toxic or noxious, or if hydrogen is used as the carrier gas, the exhaust must be vented to a fume hood. Place the GC in the hood or attach a large diameter venting tube to the outlet for proper ventilation.

To further prevent contamination from noxious gases, attach a chemical trap to the vent(s).

Vent the GC/MS system externally to the building via an ambient-pressure vent system, within 460 cm (15 ft) of both the GC split vent and GC/MS foreline pump, or vent to a fume hood. Note that an exhaust vent system is not part of the building environmental control system, which recirculates air. Exhaust venting must comply with all local environmental and safety codes. Contact your Environmental Health & Safety (EHS) specialist.

Environmental conditions

Operating the instrument within the recommended ranges optimizes instrument performance and lifetime. Performance can be affected by sources of heat and cold from heating, air conditioning systems, or drafts. See Table 36. The conditions assume a noncondensing, noncorrosive atmosphere.

Table 36 Environmental conditions for operation and storage

Product	Conditions	Operating temp range	Operating humidity range	Maximum altitude
6850 Series	Standard oven ramp	15 to 35 °C	5 to 95%	4,615 m
	Fast oven ramp (options 002 and 003)	15 to 35 °C	5 to 95%	4,615 m
	Storage	-5 to 40 °C	5 to 95%	
5975 Series	Operation	15 to 35 °C* (59 to 95 °F)	40 to 80%	4,615 m†
	Storage	–20 to 70 °C (–4 to 158 °F)	0 to 95%	

Gas Selection

Table 37 lists gases usable with Agilent GCs and capillary columns. When used with capillary columns, GC detectors require a separate makeup gas for optimum sensitivity.

Table 37 Gases usable with Agilent GCs and capillary columns

Detector type	Carrier	Preferred makeup	Alternate choice	Detector, anode purge, or reference
Electron capture (ECD)	Hydrogen Helium Nitrogen* Argon/Methane*	Argon/Methane Argon/Methane Nitrogen Argon/Methane	Nitrogen Nitrogen Argon/Methane Nitrogen	Anode purge must be same as makeup
Flame ionization (FID)	Hydrogen Helium Nitrogen*	Nitrogen Nitrogen Nitrogen	Helium Helium Helium	Hydrogen and air for detector
Flame photometric (FPD)	Hydrogen Helium Nitrogen* Argon*	Nitrogen Nitrogen Nitrogen Nitrogen		Hydrogen and air for detector
Thermal conductivity (TCD)	Hydrogen Helium Nitrogen*	Must be same as carrier and reference	Must be same as carrier and reference	Reference must be same as carrier and makeup

* Not generally suitable for GC/MS carrier gas.

Table 38 lists gas recommendations for packed column use. In general, makeup gases are not required with packed columns.

Table 38 Gases usable with Agilent GCs and packed columns

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Electron capture (ECD)	Nitrogen	Maximum sensitivity	Nitrogen
	Argon/methane	Maximum dynamic range	Argon/Methane
Flame ionization (FID)	Nitrogen	Maximum sensitivity	Hydrogen and air for detector.
	Helium	Acceptable alternative	

Table 38 Gases usable with Agilent GCs and packed columns (continued)

Detector type	Carrier gas	Comments	Detector, anode purge, or reference
Flame photometric (FPD)	Hydrogen Helium Nitrogen Argon		Hydrogen and air for detector.
Thermal conductivity (TCD)	Helium	General use	Reference must be same as carrier and makeup.
	Hydrogen Nitrogen Argon	Maximum sensitivity* Hydrogen detection† Maximum hydrogen sensitivity[1]	

* Slightly greater sensitivity than helium. Incompatible with some compounds.

† For analysis of hydrogen or helium. Greatly reduces sensitivity for other compounds.

Agilent recommends that carrier and detector gases be 99.9995% pure. See Table 39. Air needs to be zero grade or better. Agilent also recommends using high quality traps to remove hydrocarbons, water, and oxygen.

Table 39 Carrier and reagent gas purity

Carrier and reagent gas requirements	Purity	Notes
Helium (carrier)	99.9995%	Hydrocarbon free
Hydrogen (carrier)	99.9995%	SFC grade
Methane reagent gas*	99.999%	Research or SFC grade
Isobutane reagent gas†	99.99%	Instrument grade
Ammonia reagent gas*	99.9995%	Research or SFC grade
Carbon dioxide reagent gas†	99.995%	SFC grade

* Required reagent gas for installation and performance verification, CI MSDs only.

† Optional reagent gases, CI MSDs only

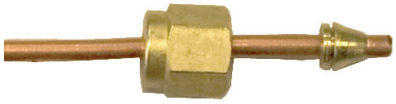
For installation checkout, Agilent requires the gas types shown in Table 40.

Table 40 Gases required for checkout

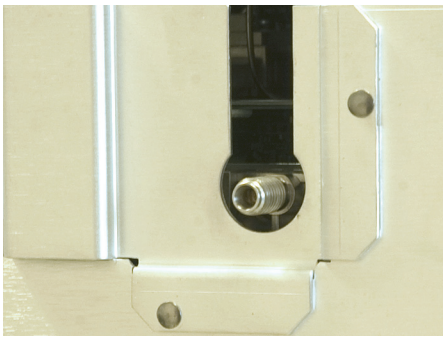
Detector	Gases required
FID	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air
TCD	Carrier and reference: helium
uECD	Carrier: helium Anode purge and makeup: nitrogen
FPD	Carrier: helium Makeup: nitrogen Fuel: hydrogen Aux gas: Air

Gas Supply

Supply instrument gases using tanks, an internal distribution system, or gas generators. If used, tanks require two-stage pressure regulators with packless, stainless steel diaphragms. The instrument requires 1/8-inch Swagelok connections to its gas supplies. See Figure 8. Plumb the gas supply tubing/regulators so that one 1/8-inch Swagelok female connector is available for each gas needed at the GC.



Swagelok nut and ferrules



Female Swagelok fitting on GC

Figure 8 Example Swagelok connector and hardware

Table 41 lists minimum and maximum delivery pressures for inlets and detectors, measured at the bulkhead fittings on the back of the instrument.

Table 41 Delivery pressures required at the GC/MS, in kPa (psig)

	Detector type				Inlet type				
	FID	TCD	ECD	FPD	Split/Splitless 150 psi	Split/Splitless 100 psi	On-column	Purged packed	PTV
Hydrogen	240–690 (35–100)			310–690 (45–100)					
Air	380–690 (55–100)			690–827 (100–120)					
Makeup	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)	380–690 (55–100)					
Reference		380–690 (55–100)							

Table 41 Delivery pressures required at the GC/MS, in kPa (psig) (continued)

	Detector type				Inlet type				
	FID	**TCD**	**ECD**	**FPD**	**Split/Splitless 150 psi**	**Split/Splitless 100 psi**	**On-column**	**Purged packed**	**PTV**
Carrier (max)					1,172 (170)	827 (120)	827 (120)	827 (120)	827 (120)
Carrier (min)					(20 psi) above pressure used in method				

Conversions: 1 psi = 6.8947 kPa = 0.068947 Bar = 0.068 ATM

Notes:

- If you have not requested option 305, you must supply pre-cleaned, 1/8-inch copper tubing and a variety of 1/8-inch Swagelok fittings to connect the GC to inlet and detector gas supplies.
- Cryogenic cooling with Liquid CO_2 requires 1/8-inch heavy-walled, stainless steel tubing.
- If you purchased automated valving, the valve actuation requires a **separate** pressurized, dry air supply at 380 kPa (55 psig). This air supply must end in a male fitting compatible with a 1/4-inch id plastic tube at the GC.
- Never use liquid thread sealer to connect fittings. Never use chlorinated solvents to clean tubing or fittings.

Table 42 lists the limits on total gas flow into the 5975 Series MSD.

Table 42 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
High vacuum pump	Diffusion	Standard turbo	Performance turbo	Performance turbo, EI/PCI/NCI
Optimal gas flow mL/min*	1.0	1.0	1.0 to 2.0	1.0 to 2.0
Maximum recommended gas flow, mL/min	1.5	2.0	4.0	4.0

Table 42 5975 Series total gas flow limitations

Feature	G3170A	G3171A	G3172A	G3174A
Maximum gas flow, mL/min†	2.0	2.4	6.5	4.0
Max column id	0.25 mm (30 m)	0.32 mm (30 m)	0.53 mm (30 m)	0.53 mm (30 m)

* Total gas flow into the GC/MS: column flow plus reagent gas flow (if applicable).

† Expect degradation of spectral performance and sensitivity.

Table 42 lists typical flows resulting from selected carrier and reagent gas source pressures.

Table 43 5975 Series carrier and reagent gases

Carrier and reagent gas requirements	Typical pressure range	Typical flow (mL/min)
Helium (required) (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Hydrogen (optional)* (column and split flow)	345 to 552 kPa (50 to 80 psi)	20 to 50
Methane reagent gas (required for CI operation)	103 to 172 kPa (15 to 25 psi)	1 to 2
Isobutane reagent gas (optional)	103 to 172 kPa (15 to 25 psi)	1 to 2
Ammonia reagent gas (optional)	34 to 55 kPa (5 to 8 psi)	1 to 2
Carbon dioxide reagent gas (optional)	103 to 138 kPa (15 to 20 psi)	1 to 2

* Hydrogen gas can be used for the carrier gas but specifications are based on helium as the carrier gas. Please observe all hydrogen gas safety cautions.

Gas Plumbing

WARNING **All compressed gas cylinders should be securely fastened to an immovable structure or permanent wall. Compressed gases should be stored and handled in accordance with the relevant safety codes.**

Gas cylinders should not be located in the path of heated oven exhaust.

To avoid possible eye injury, wear eye protection when using compressed gas.

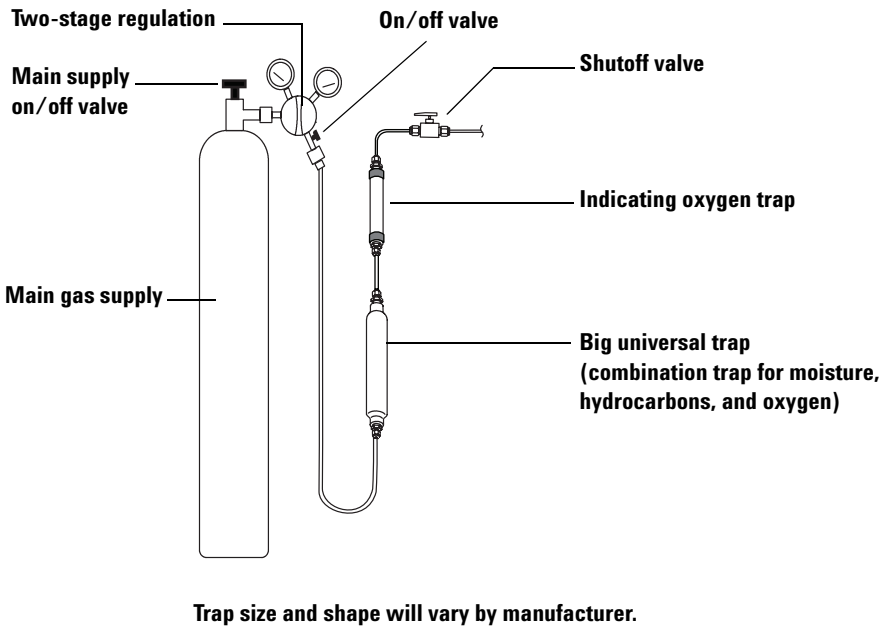


Figure 9 Recommended traps and plumbing configuration from a carrier gas cylinder

- Agilent strongly recommends two-stage regulators to eliminate pressure surges. High-quality, stainless-steel diaphragm-type regulators are especially recommended.
- On/off valves mounted on the outlet fitting of the two-stage regulator are not essential but are very useful. Be sure the valves have stainless-steel, packless diaphragms.

- FID and FPD detectors require a dedicated air supply. Operation may be affected by pressure pulses in air lines shared with other devices.
- Flow- and pressure-controlling devices require at least 10 psi (138 kPa) pressure differential across them to operate properly. Set source pressures and capacities high enough to ensure this.
- Situate auxiliary pressure regulators close to the GC inlet fittings. This ensures that the supply pressure is measured at the instrument (rather than at the source); pressure at the source may be different if the gas supply lines are long or narrow.

Supply tubing for carrier and detector gases

Use only preconditioned copper tubing (part number 5180-4196) to supply gases to the instrument. Do not use ordinary copper tubing—it contains oils and contaminants.

CAUTION Do not use methylene chloride or other halogenated solvent to clean tubing that will be used with an electron capture detector. They will cause elevated baselines and detector noise until they are completely flushed out of the system.

CAUTION Do not use plastic tubing for suppling detector and inlet gases to the GC. It is permeable to oxygen and other contaminants that can damage columns and detectors.

Plastic tubing can melt if near hot exhaust or components.

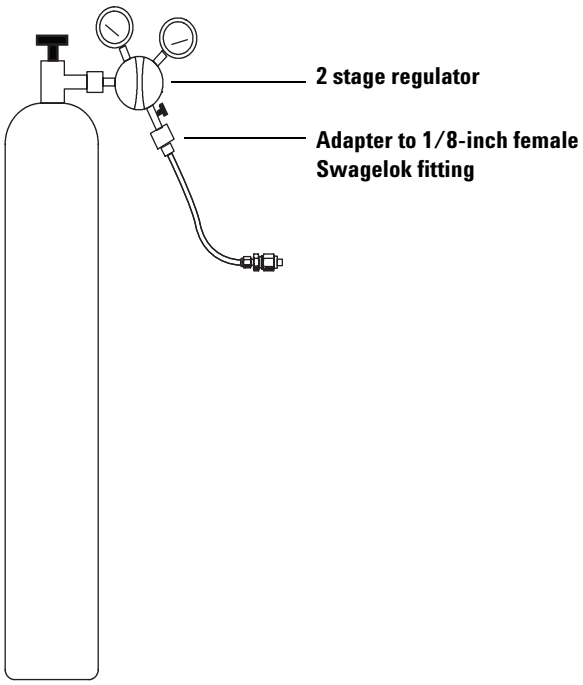
The tubing diameter depends on the distance between the supply gas and the GC and the total flow rate for the particular gas. Tubing of 1/8-in diameter is adequate when the supply line is less than 15 feet (4.6 m) long.

Use larger diameter tubing (1/4-in) for distances greater then 15 feet (4.6 m) or when multiple instruments are connected to the same source. Use larger diameter tubing if high demand is anticipated (for example, air for an FID).

Be generous when cutting tubing for local supply lines—a coil of flexible tubing between the supply and the instrument lets you move the GC without moving the gas supply. Take this extra length into account when choosing the tubing diameter.

Two-stage pressure regulators

To eliminate pressure surges, use a two-stage regulator with each gas tank. Stainless steel, diaphragm-type regulators are recommended.



The type of regulator you use depends on the gas type and supplier. The Agilent catalog for consumables and supplies contains information to help you identify the correct regulator, as determined by the Compressed Gas Association (CGA). Agilent Technologies offers pressure-regulator kits that contain all the materials needed to install regulators properly.

Pressure regulator-gas supply tubing connections

Use Teflon® tape to seal the pipe-thread connection between the pressure regulator outlet and the fitting to which you connect the gas tubing. Instrument grade Teflon tape (part number 0460-1266), from which volatiles have been removed, is recommended for all fittings. Do not use pipe dope to seal the threads; it contains volatile materials that will contaminate the tubing.

Traps

Using chromatographic-grade gases ensures that the gas in your system is pure. However, for optimum sensitivity, install high-quality traps to remove traces of water or other contaminants. After installing a trap, check the gas supply lines for leaks.

Table 44 lists the recommended traps. See the Agilent online store for the complete listing of traps and trap accessories. As shown in Figure 9, install the indicating trap last so that it warns when the combination begins to fail.

Table 44 Recommended traps

Description	Part number
Big universal trap. Removes oxygen, moisture, hydrocarbons, carbon dioxide and carbon monoxide from helium gas streams.	RMS
Indicating oxygen trap (for carrier and ECD gases).	IOT-2-HP

Moisture in carrier gas damages columns. Agilent recommends installing a moisture trap after the source regulator and before any other traps.

A hydrocarbon trap removes organics from gases. Place it after a molecular sieve trap and before an oxygen trap, if they are present.

An oxygen trap removes 99% of the oxygen from a gas plus traces of water. Place it last in a series of traps. Because trace amounts of oxygen can damage columns and degrade uECD performance, use an oxygen trap with carrier and uECD gases. Do not use it with FID or FPD fuel gases.

Cryogenic Cooling Requirements

Cryogenic cooling allows you to cool the oven below ambient temperature. A solenoid valve introduces liquid coolant to cool the oven to the desired temperature.

Using carbon dioxide

WARNING **Pressurized liquid CO_2 is a hazardous material. Take precautions to protect personnel from high pressures and low temperatures. CO_2 in high concentrations is toxic to humans; take precautions to prevent hazardous concentrations. Consult your local supplier for recommended safety precautions and delivery system design.**

CAUTION Liquid CO_2 should not be used as a coolant for temperatures below –40°C because the expanding liquid may form solid CO_2—dry ice—in the GC oven. If dry ice builds up in the oven, it can seriously damage the GC.

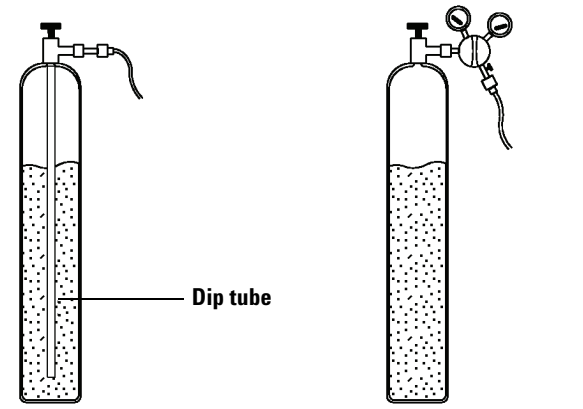
Liquid CO_2 is available in high-pressure tanks containing liquid. The CO_2 should be free of particulate material, oil, and other contaminants. These contaminants could clog the expansion orifice or affect the proper operation of the GC.

WARNING **Do not use copper tubing or thin-wall stainless steel tubing with liquid CO_2. Both harden at stress points and may explode.**

Additional requirements for the liquid CO_2 system include:

- The tank must have an internal dip tube or eductor tube to deliver liquid CO_2 instead of gas (see the figure below).
- Set the liquid CO_2 pressure to the GC at 4830 to 6900 kPa (700 to 1,000 psi) at a temperature of 25 °C.
- Use 1/8-inch diameter heavy-wall stainless steel tubing for supply tubing. The tubing should be between 1.5 and 15 m (5 and 50 feet) long.
- Coil and fasten the ends of the tubing to prevent it from “whipping” if it breaks.
- Do not install a pressure regulator on the CO_2 tank, as vaporization and cooling would occur in the regulator instead of the oven.

- Do not use a padded tank (one to which another gas is added to increase the pressure).



Maximum Length of Cables

The distance between system modules may be limited by some of the cabling and the vent or vacuum hoses.

- A GC/MS system foreline pump can be located on the laboratory bench or on the floor. It must be close to the MSD because it is connected by a 200-cm (79-inch) hose. The hose is stiff and cannot be bent sharply. The length of the vacuum hose is 130 cm (4.24 feet) from the high vacuum pump to the foreline pump, while the length of the foreline pump power cord is 2 meters (6.6 feet).
- The length of the Agilent-supplied remote cable is 2 meters (6.6 feet).
- The length of the Agilent-supplied LAN cable is 10 meters (32.8 feet).
- The lengths of the power cords are 2 meters (6.6 feet).
- The length of a G1888 Headspace Sampler transfer line is about 80 cm (31.5 inches).

Site LAN Network

If you intend to connect your system to your site's LAN network, you must have an additional shielded twisted pair network cable.

NOTE Agilent Technologies is not responsible for connecting to or establishing communication with your site LAN network. The representative will test the system's ability to communicate on a mini-hub or LAN switch only.

NOTE The IP addresses assigned to the instrument(s) must be fixed (permanently assigned) addresses. If you intend to connect your system to your site's network, each piece of equipment must have a unique, fixed (static) IP address assigned to it.

Basic Tools

The GC/MS comes with a few basic tools and consumables depending on the specific inlet and detector that you ordered. Below is a general list of what comes with the instrument.

Table 45 Basic tools

Tool or consumable	Used for
6850 Series GC	
T10 and T20 Torx wrenches	Removing tray. Removing covers to access gas control modules, traps, and pneumatic connections.
1/4-inch nut driver	FID jet replacement.
FID flow measuring insert	FID troubleshooting.
Column cutter, ceramic or diamond	Column installation.
1/8-inch Tee, Swagelok, brass	Connect gas supplies.
1/8-inch nuts & ferrules, Swagelok, brass	Connect gas supplies.
Inlet septa appropriate for type	Inlet seal.
Inlet insert or liner	Contains sample during vaporization in inlet.
GC/MS	
1.5-mm and 2.0-mm hex driver	Source maintenance (disassembly).
Tool bag	Holding GC and MS tools.
Q-Tips	Cleaning source parts.
Cloths	Keeping surfaces and parts clean.
Gloves	Reducing contamination on GC and MSD parts.
Funnel	Changing oil.
Hex key, 5 mm	Removing oil plug and screws in safety shield handle.

Table 46 lists other useful tools not included with the GC.

Table 46 Useful tools not included with GC

Tool	Used for
Custom Tee, G3430-60009	Connecting the same gas to front and back EPC module.
ECD/TCD Detector plug, 5060-9055	Inlet pressure decay test
1/8-inch Ball Valve, 0100-2144	Inlet pressure decay test (one per inlet)
Digital flow meter, Flow tracker 1000	Verifying flows, checking for leaks and plugs
Electronic gas leak detector	Locating gas leaks; safety checks when using Hydrogen
Column cutters	Cutting columns
T-10 and T-20 Torx drivers	Removing tray; removing covers to access EPC modules, traps, and possible leaks
1/8-inch tubing cutter (wire cutter type)	Cutting gas supply tubing
Assorted wrenches: 1/4-inch, 3/8-inch, 7/16-inch, 9/16-inch	Gas supply and plumbing fittings
Electronic vial crimper	Assuring consistently air-tight vial closure, regardless of who does the crimping

Table 47 lists consumables that you may wish to order. First time GC users should consider purchasing the following supplies in order to maintain their system and prevent interruptions in the use of their system. Please refer to the latest Agilent consumables and supplies catalog and to the Agilent web site at www.aglent.com/chem for part numbers and recommended maintenance periods.

Table 47 Additional consumables

Consumable category	Consumable
Inlet supplies	Septa, o-rings, liners, adapter, and seals
Inlet preventative maintenance (PM) kits	Kits with individual parts needed to maintain an inlet
Pneumatic supplies	Gases, traps, o-rings, seals, Swagelok fittings

Table 47 Additional consumables

Consumable category	Consumable
Column supplies	Nuts, ferrules, adapters, guard columns, retention gaps
Detector supplies	Jets, beads, liners, adapters, cleaning kits
Application supplies	Standards, columns, syringes

7693A Automatic Liquid Sampler Site Preparation

This section outlines the space and resource requirements for a 7693A automatic liquid sampler (ALS). For a successful and timely installation of the ALS, the site must meet these requirements before beginning installation. Necessary supplies (operating supplies, consumables, and other usage-dependent items such as vials, syringes, and solvents) must also be available. Refer to the Agilent Web site at www.agilent.com/chem for the most up-to-date listing of GC, GC/MS, and ALS supplies and consumables.

Customer Responsibilities

The specifications in this manual outline the necessary space, electrical outlets, tubing, operating supplies, consumables, and other usage-dependent items such as vials, syringes, and solvents required for the successful installation of instruments and systems.

If Agilent is delivering installation and familiarization services, users of the instrument should be present throughout these services; otherwise, they will miss important operational, maintenance, and safety information.

If Agilent is delivering installation and familiarization services, delays due to inadequate site preparation could cause loss of instrument use during the warranty period. In extreme cases, Agilent Technologies may ask to be reimbursed for the additional time required to complete the installation. Agilent Technologies provides service during the warranty period and under maintenance agreements only if the specified site requirements are met.

Dimensions and Weight

Select the laboratory bench space before the system arrives. Pay special attention to the total height requirements. Avoid bench space with overhanging shelves. See Table 1.

Table 1 Required height, width, depth, and weight

Product	Height (cm)	Width (cm)	Depth (cm)	Weight (kg)
G4513A Injector	51	16.5	16.5	3.9
G4514A Tray	29	44	43	6.8
G4515A Bar Code Reader	not applicable	not applicable	not applicable	0.3
G4522A Cooling Accessory	not applicable	not applicable	not applicable	2.2 (plus water weight)
Additional space requirements				
• GC with 7693A ALS injector		Requires 50 cm (19.5 in) above the GC		
• GC with 7693A ALS tray		Requires 45 cm (17.5 in) left of the GC		

Power Consumption

The 7693A injectors, tray, and bar code reader/heater/mixer draw power from the GC. No other power source is required.

Environmental Conditions

Operating the instrument within the recommended ranges optimizes instrument performance and lifetime. The sampler system operates in the same environment as its parent GC. See:

7820A GC Table 4

The conditions assume a noncondensing, noncorrosive atmosphere.

Table 2 Environmental conditions for operation and storage

Product	Conditions	Operating temp range	Operating humidity range	Maximum altitude
G4513A Injector, G4514A Tray, G4515A Bar Code Reader	Operation	–5 to 45 °C	5–95%	4,300 m

Chiller Supplies

If using the optional G4522A Cooling Accessory, you will need to supply:

- A water chiller
- Tubing and 1/8-inch Swagelok fittings to connect the chilled water and return water to the chiller
- A container or drain to dispose of condensate from the tray

Basic Tools

The 7693A ALS comes with a few basic tools and consumables depending on the hardware that you ordered. Below is a general list of what comes with the instrument.

Table 3 Basic tools and consumables

Tool or consumable	Used for
T10 Torx wrench	Replacing turret. Replacing syringe carriage.
T35 Torx wrench	Removing tray.
Sample vial starter pack	
Syringe, 10 uL	