

Preparing Your Laboratory for the ELAN DRC II ICP-Mass Spectrometer

PerkinElmer SCIEX ICP-MS instruments are complete systems with the exception of the following items which must be provided by the customer: electrical power, exhaust vents, argon gas supplies with approved regulator, DRC gas supply, and coolant system. The items shown in the following checklist need to be considered when preparing the laboratory for the instrument.

- Environmental conditions
- Electrical requirements
- Space requirements
- Exhaust ventilation
- Coolant requirements
- Argon gas requirements
- DRC (dynamic reaction cell) gas requirements

Environmental Conditions

The environment in which the instrument is installed should meet the following conditions.

- The room temperature should be between 15 and 30 °C (59-86 °F) with a maximum rate of change of 2.8 °C (5 °F) per hour.
- The relative humidity should be between 20 and 80%, noncondensing. For optimum performance, the room temperature should be controlled at 20 ± 2 °C (68 ± 3.6 °F), and the relative humidity should be between 35 and 50%.
- The instrument should not be operated at an elevation greater than 2,000 meters (6,500 feet) above sea level. Use of the instrument at elevations greater than 2,000 meters is subject to acceptance by local inspection authorities.

- For SEMI S2-0200 installations, a minimum of 300 Lux illumination is required at the floor level around the ELAN® DRC II instrument.

In order to minimize contamination problems, a dust-free environment is necessary. For ultra-trace techniques, environmental contamination becomes a limiting factor in the determination.

To quantitate ubiquitous elements such as Fe, Ca, K, Na, etc. below 1 ppb ($\mu\text{g/L}$), a class 1000 environment is necessary for sample preparation and analysis. This is not an indication of the performance limitations of the instrument, but a recommendation for an ultra-clean environment.

In addition, the instrument should be located in an area that is:

- Free of smoke and corrosive fumes
- Not prone to excessive vibration
- Out of direct sunlight
- Away from heat radiators

PerkinElmer SCIEX ICP-MS instruments have been designed for indoor use. The ELAN DRC II can be installed into a mobile laboratory if vibration is isolated.

WARNING:
Do not use the instrument in an area where explosion hazards may exist.

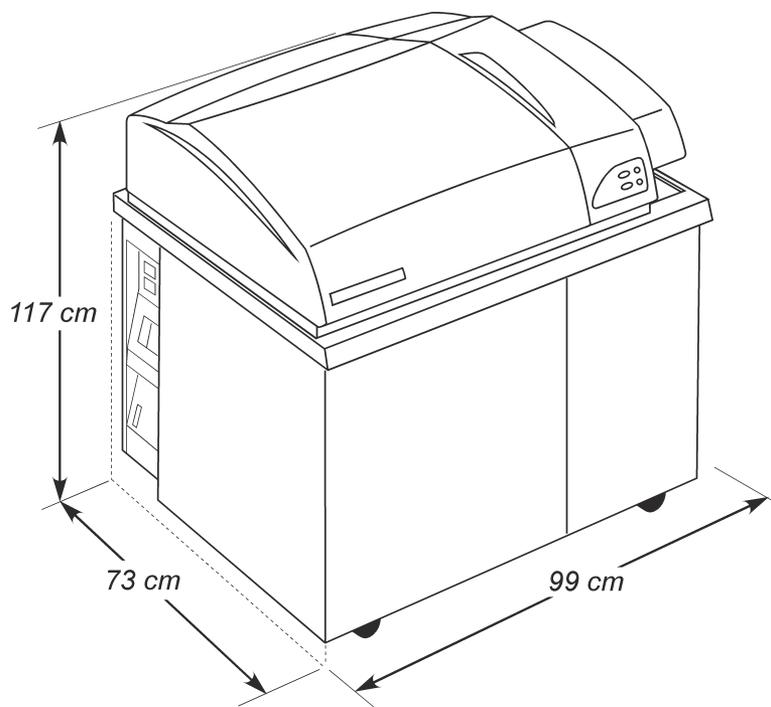


Figure 1. Dimensions of the ELAN DRC II ICP-MS.

Space Requirements

The system should be located near the required electrical and gas supplies as well as the coolant supply. If you are installing the system in a clean room, the roughing pumps can be remotely located to a distance of three meters (10 ft) from the DRC II. The roughing pumps are then connected to the system with an optional kit (Part No. WE02-3935) which contains power cables and vacuum hoses. There can be no more than 2 to 3 bends or couplings in the vacuum hose over its entire length. The diameter of the hose must remain at least 25 mm (1 in) ID.

The ELAN DRC II is on wheels and can be moved for service and preventative maintenance. However, a space of at least 30 cm (12 in) behind the instrument is recommended. This space behind the instrument provides clearance for the vent hoses. Allow space on the right side of the instrument for an accessory cart or table. Access for most service procedures is through the front of the instrument.

For SEMI S2-0200 installations, clearances of 61 cm (24 in) behind the instrument, 91 cm (36 in) in front, and 76 cm (30 in) on the left side of the instrument must be maintained. In addition, it is required that the site floor be prepared to accommodate four 9mm diameter (3/8 in) bolts of appropriate length to secure the instrument against seismic activity.

System Layout

The ICP-MS system consists of the main instrument, the computer controller assembly, and a printer. The dimensions of the instrument are given in Figure 1. Table I lists the dimensions of the instrument and the computer. Table II lists the dimensions of the accessories.

The ELAN can be positioned in either a linear or an L-shaped configuration. In the L-shaped configuration, the computer and printer are positioned on one leg of the L. The instrument and an accessory table make up the other leg. A recommended workstation layout is shown in Figure 2.

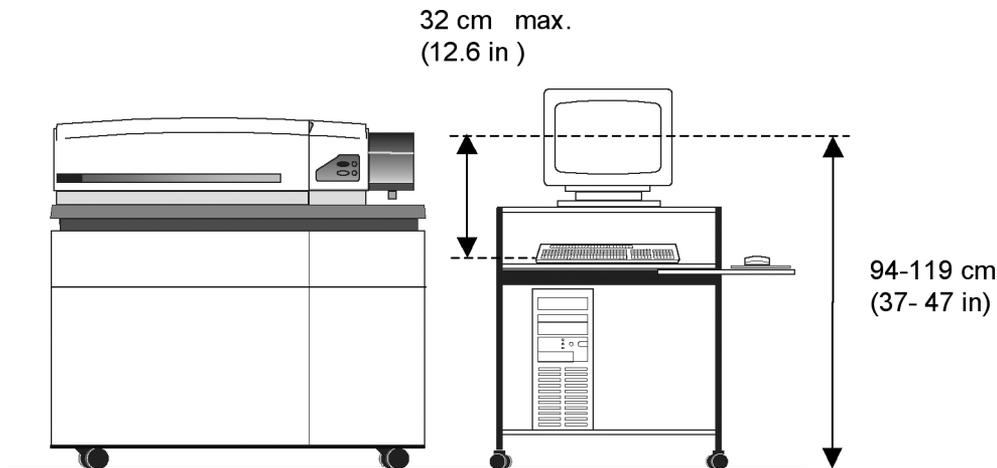


Figure 2. Recommended workstation layout.

Table I. Dimensions of the Instrument and Computer

Instrument	Width cm (in.)	Height cm (in.)	Depth cm (in.)	Weight kg (lb.)
ELAN DRC II	99 (39)	117 (46)	73 (29)	295 (650)
Work Surface Height		87 (34)		
DELL Computer	Dimensions will vary by model			
DELL Monitor	Dimensions will vary by model			
HP LaserJet 4200	42 (16.4)	37 (14.4)	43 (16.9)	20 (45)

Table II. Dimensions of the Accessories

Accessory	Width cm (in.)	Height cm (in.)	Depth cm (in.)	Weight kg (lb.)
Cooling System:				
Heat Exchanger (PolyScience 3370)	38 (15)	63.5 (25)	38 (15)	31.3 (69)
Refrigerated Chiller (PolyScience 6105PE)	38 (15)	63.5 (25)	67.3 (26.5)	81 (178)
FIAS 400MS	41.5 (16)	18.4 (7)	41 (16)	11 (24)
AS 93plus Autosampler	44 (17)	37 (15)	34 (14)	4 (9)

There should be sufficient space near the spectrometer for the various accessories (autosampler, FIAS, laser, electrothermal vaporizer, etc.). It is recommended that the accessories be placed on a movable cart or table to allow for easy servicing access.

The system computer may be placed on a bench or a separate computer table.

Drain Vessels

A 15-liter drain vessel is supplied with the ELAN DRC II ICP-MS. The vessel is made of HDPE (high density polyethylene) and is used to collect the effluent from the ICP sample introduction system.

The drain vessel should be placed to the right of the instrument. The drain vessel should NOT be stored in an enclosed storage area. The drain system should be checked regularly and replaced when necessary. Should it become necessary to replace the drain vessel, it should be made from a material not likely to be attacked by samples being analyzed. Glass or other brittle materials must not be used.

Liquid waste should always be segregated and clearly labeled. Never mix organic and inorganic liquids in the same drain vessel. Organic and inorganic drain vessels should never be stored in the same area.

Safe Handling of Gas Cylinders

Notice: The permanent installation of gas supplies is the responsibility of the user and should conform to local safety and building codes.

- Fasten all gas cylinders securely to an immovable bulkhead or a permanent wall.
- When gas cylinders are stored in confined areas, such as a room, ventilation should be adequate to prevent toxic or explosive accumulations. Move or store gas cylinders only in a vertical position with the valve cap in place.
- Locate gas cylinders away from heat or ignition sources, including heat lamps. Cylinders have a pressure-relief device that will release the contents of the cylinder if the temperature exceeds 52 °C (125 °F).
- When storing cylinders external to a building, the cylinders should be stored so that they are protected against temperature extremes (including the direct rays of the sun) and should be stored above ground on a suitable floor.
- Mark gas cylinders clearly to identify the contents and status (full, empty, etc.).
- Do not attempt to refill gas cylinders yourself.
- Use only approved regulators and hose connectors. Left-hand thread fittings are used for fuel gas tank connections whereas right-hand fittings are used for oxidant and support gas connections.
- Arrange gas hoses where they will not be damaged or stepped on and where things will not be dropped on them.
- Perform periodic gas leak tests by applying a soap solution to all joints and seals.
- It is strongly recommended that DRC gases be installed in a gas cabinet with adequate ventilation.

Facilities Requirements

Table III provides information on the gas and liquid services required for the ELAN DRC II. Tables IV and V show the electrical supply requirements and approximate power consumption of the ELAN DRC II and its major accessories.

Electrical Requirements

Power to the ELAN DRC II is to be delivered from two 30 A single-phase 200-240 V dedicated electrical branch circuits according to the power specifications in Table IV. Table V provides the electrical supply requirements and approximate power consumption of the major accessories

and options. If the power line is unstable, fluctuates or is subject to surges, additional control of the incoming power may be required. A means of electrically grounding the instrument must be available.

60-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. The installation kit includes two Hubbell No. 2621 plugs and two Hubbell No. 2620 receptacles for use with two 60 Hz single phase outlets. The instrument is wired for power at the time of installation.

50-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. It is up to the service person installing the

Table III. Services Required for the ELAN DRC II

Gases	<ul style="list-style-type: none"> ■ Argon, 414 ± 7 kPa (60 ± 1 psi) at 20 L/minute flow ■ Ammonia (99.999%), 48 ± 14 kPa (7 ± 2 psi) operating, 103.4 kPa (15 psi) maximum
Cooling	Coolant circulation of at least 3.8 L/min (1.0 gpm) at an operating pressure of 344 ± 14 kPa (50 ± 2 psi).

Table IV. ELAN DRC II Power Specifications

Power Consumption	
Maximum Volt Amperes (total, both circuits)	6000 VA
Maximum Continuous Current (per circuit)	20 A
Voltage Amplitude Specification	
Operating Voltage	200 - 240 V
Maximum Allowable Percent Sag	5%
Maximum Allowable Percent Swell	5%
Phase (single or three)	Single phase or three phase
Frequency Specification	
Operating Frequency	50 or 60 Hz
Allowable Frequency Variance	± 1 Hz
Waveform Specification	
Maximum Supply Voltage Total Distortion	5%
Maximum Supply Voltage Distortion by Single Harmonic	3%

Table V. Electrical Requirements of ELAN Accessories

Equipment	Voltage (AC)	Power
Computer	Depends on Model	Depends on Model
Printer: HP LaserJet 4200	100-127 V/220-240 V, 50/60 Hz	580 W
Cooling System:		
Heat Exchanger (PolyScience 3370)	208-240 V, 50/60 Hz, 2.75 A 120V, 60HZ, 5.5A	660 W
Refrigerated Chiller (PolyScience 6105PE)	208-230 V, 60 Hz, 8 A 240 V, 50 Hz, 8.5 A	2000 W
FIAS 400MS	110/220 V	600 W

instrument to wire it according to the power available at the lab. The single phase connectors must be supplied by either the customer or the local PerkinElmer office. For 50 Hz operation, Hubbell No. 2351 plugs and Hubbell No. 2350 receptacles are recommended. A means of electrically grounding the instrument must be available.

Three-Phase-Operation Connections

If a three phase connection is required (by local electrical code), the instrument can be connected via a single line cord to two of the three sides of the three phase line. The three-phase line cord and connectors must be supplied by either the customer or the local PerkinElmer office. Four meters of No. 6 AWG grounding wire are provided with the instrument. A means of electrically grounding the instrument must be available.

Exhaust Vents

WARNING:

The use of ICP-MS instruments without adequate ventilation to outside air may constitute a health hazard. For example, the combustion of halogenated hydrocarbons produces toxic vapors. When ammonia is used as a dynamic reaction cell gas, it can be present at very trace amounts in the exhaust during purging of the gas lines. Extreme care should be taken that exhaust gases are vented properly.

The ELAN DRC II requires two separate vents. The top main vent exhausts the following:

- plasma
- vacuum pump exhaust**—including dynamic reaction cell gas
- DRC gas assembly manual Vent/Purge switches

A second vent is used for the blower that cools the roughing pumps, system power supply, and ICP generator.

The main venting system is required to remove combustion fumes and vapors from the torch housing, and to remove reaction cell gas. Exhaust venting is important for four reasons:

- It protects laboratory personnel from toxic vapors that may be produced by some samples.
- It minimizes the effects of room drafts and the laboratory atmosphere on ICP torch stability.
- It helps protect the instrument from corrosive vapors which may originate from the samples.
- It removes dissipated heat which is produced by the ICP torch, ICP power supply and the pump motors.

The main 100-mm (4-in) venting system must provide a flow rate of approximately 70 L/sec \pm 10% (150 ft³/min). The 150-mm (6-in)

venting system must provide a flow rate of approximately 210 L/sec \pm 10% (450 ft³/min). Both of the exhaust ports should be connected directly to flexible exhaust hoses.

The main torch box/cell gas exhaust must be installed, but there is an option for the coaxial RF generator and roughing pump exhaust. If a 150-mm (6-in) duct is not available, a 100-mm (4-in, 150 ft³/min) duct can be connected to the inner duct. Only the RF generator is exhausted in this case. The heat from the roughing pumps is released into the laboratory.

We recommend a 100-mm (4-in) ID torch box exhaust hose and a 150-mm (6-in) ID ICP Power Supply/Roughing Pump air exhaust hose. The ELAN is supplied with 3 m (10 ft) of 100-mm (4-in) and 3 m (10 ft) of 150-mm (6 in) flexible tubing. This tubing permits the movement of the instrument without disconnecting the vents from the laboratory system. See Table VI and Table VII for vent specifications.

**When the roughing pumps are mounted outside of the instrument, their exhaust needs to be vented into a separate 100-mm (4-in) exhaust line providing an exhaust flow rate of at least 10 L/sec (21 ft³/min). In operation, the pumps produce ~1400W (4700 BTU/hr) of heat—proper ventilation to remove this heat is required.

Table VI. Flow Rates and Anemometer Readings

Hose Diameter	Flow Rate	Anemometer Reading
100 mm (4 in)	70 L/s (150 ft ³ /min)	9 m/s (1695 fpm)
150 mm (6 in)	210 L/s (450 ft ³ /min)	11.5 m/s (2250 fpm)

Table VII. Hose Diameter and Venting Capabilities

Hose	Hose Diameter	Vented Outside Lab Watts (BTU/hr)
Torch Box Exhaust	100 mm (4 in)	200 (680)
ICP Power Supply/Roughing Pump	150 mm (6 in)*	2800 (9400)
ICP Power Supply Only	100 mm (4 in)	1400 (4700)

*If only the 100-mm (4-in.) ID ICP power supply exhaust hose is used, approximately 1400 W (4700 BTU/hr) of heat is vented into the lab. An independent room air conditioner [3000 W (10 000 BTU/hr)] is recommended to remove this additional heat.

Vent Positions

Both of the ELAN DRC II vents are located on the back of the instrument. See Figure 3. The Torch Box exhaust vent is 23.75 cm (9.5 in) from the left side of the instrument when viewed from the rear and 101.25 cm (40.5 in) above the floor. The ICP Power Supply/roughing pump exhaust vent is 23.75 cm (9.5 in) from the left side of the instrument (rear view) and 64.4 cm (25.75 in) above the floor.

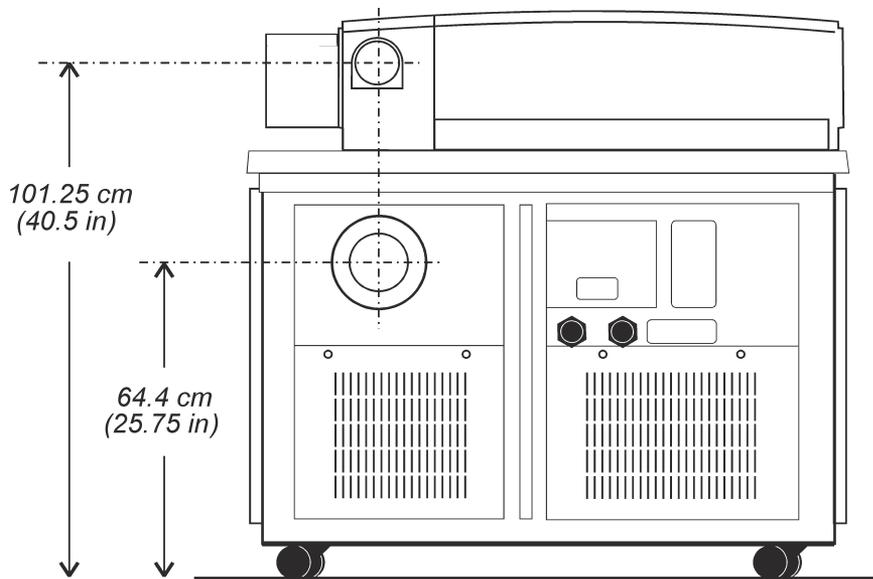


Figure 3. Vent locations, rear of the ELAN DRC II ICP-MS.

Venting System Recommendations

The exhaust flow rate at the instrument (the ability to vent the system) is dependent on customer provided blower, the duct length, material and the number of elbows or bends used. If an excessively long duct system or a system with many bends is used, a stronger blower may be necessary to provide sufficient exhaust volume at the instrument. Smooth stainless steel tubing should be used instead of flexible stainless steel tubing where flexibility is not required to reduce system friction loss or “drag.” A length of smooth stainless steel ducting has 20-30% less friction loss than a comparable length of flexible ducting. When smooth stainless steel tubing is used, elbows must be used to turn corners. These elbows should turn at no more than 45 degrees between straight sections to reduce friction losses, and the number of elbows should be minimized.

Additional recommendations on the venting system include:

- The duct casing and venting system should be made of materials suitable for temperatures as high as 70 °C (160 °F) and be installed to meet local building code requirements.
- Locate the blower as close to the discharge outlet as possible. All joints on the discharge side should be airtight, especially if toxic vapors are being carried.
- Equip the outlet end of the system with a backdraft damper and take the necessary precautions to keep the exhaust outlet away from open windows or inlet vents and to extend it above the roof of the building for proper dispersal of the exhaust.
- Equip the exhaust end of the system with an exhaust stack to improve the overall efficiency of the system.
- For best efficiency, make sure the length of the duct that enters into the blower is a straight length at least ten times the duct diameter. An elbow entrance into the blower inlet causes a loss in efficiency.
- Provide make-up air in the same quantity as is exhausted by the system. An airtight lab causes an efficiency loss in the exhaust system.
- Ensure that the system is drawing properly by placing a piece of cardboard over the mouth of the vent.
- Equip the blower with an indicator light located near the instrument to indicate to the operator when the blower is on.

- For SEMI S2-0200 compliant operation, the laboratory must be equipped with an exhaust ventilation system monitor. The monitor shall provide an audible or visual warning to the user in the event that the exhaust ventilation system airflow drops below a pre-determined level.

Cleaning the Instrument

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

Cleaning procedures can be found in the ELAN DRC II Hardware Guide.

Coolant Requirements

The ELAN DRC II system requires a regulated source of filtered coolant. The coolant supply should be filtered (free of sediment), and have a pH between 6.5 and 8.5. It should be hardness-free with <1 ppm of heavy minerals. The recirculator operating pressure should be 344 ± 13 kPa (50 ± 2 psi). A coolant flow of at least 3.8 L/min (1.0 gpm) is required.

A recirculating system containing a corrosion inhibitor is specified to protect the aluminum components of the cooling system and the interface. Sufficient pre-mixed coolant (Part No. WE01-6558) is supplied for the Heat Exchanger or Refrigerated chiller. If laboratory temperatures do not exceed 30 °C (86 °F), the heat exchanger can be used in place of a refrigerated chiller. For laboratories where the temperature can exceed 30 °C (86 °F), a refrigerated chiller is required. The heat exchanger must be located in a well ventilated area where the air temperature will not exceed 30 °C (86 °F).

For 60 Hz installations – the M3370 heat exchangers come with either NEMA L6-15P (230V) or NEMA L5-15P (120V) connectors. The refrigerated chiller comes with a NEMA L6-15P connector.

For 50 Hz installations – the refrigerated chiller comes with a CEE 7 connector. The M3370 heat exchanger comes with a NEMA L6-15P connector.

Argon Gas Requirements

Argon is used as the ICP torch gas with the ELAN DRC II. The quality criteria for argon is listed below.

Purity	≥ 99.996%
Oxygen	< 5 ppm
Hydrogen	< 1 ppm
Nitrogen	< 20 ppm
Water	< 4 ppm

Either liquid or gaseous argon can be used with an ICP-MS system. The choice of liquid argon or gaseous argon tanks is determined primarily by the availability of each and the usage rate. Liquid argon is usually less expensive per unit volume to purchase, but cannot be stored for extended periods. If liquid argon is used, the tank should be fitted with an over-pressure regulator which will vent the tank as necessary in order to prevent the tank from becoming a safety hazard.

Gaseous argon tanks do not require venting and consequently can be stored for extended periods without loss. A tank of liquid argon containing 4300 ft³ will last for approximately 100 hours of continuous ICP running time. A tank of gaseous argon will last 5 to 6 hours of ICP running time. The normal argon usage is 14-20 L/min.

A cylinder regulator (Part No. 0303-0284) which can be used with argon is available from PerkinElmer. The regulator can be used with CGA 580 or CGA 590 fittings and includes a color-coded hose with 1/4-inch Swagelok fittings to permit direct connection to the regulator and to the instrument gas controls. Liquid argon may be purchased from your gas supplier.

PerkinElmer SCIEX ICP-MS instruments include the tubing necessary for connecting argon to the instrument.

DRC Gas Requirements

The customer is required to supply the dynamic reaction cell gas (or DRC gas) for introduction into the dynamic reaction cell. The type of gas used varies with the customer application, but the most common DRC gas used with the DRC II is anhydrous ammonia.

PerkinElmer SCIEX provides the pressure regulator, gas delivery tubing, and quick connector. The pressure regulator is capable of supplying the DRC gas at a working pressure of 48 kPa (7 psi). The quick connector is affixed to the inlet fitting for DRC gas A on the rear panel of the ELAN DRC II. Plumbing for a second DRC gas (DRC gas B) is available as an option. Fittings which are susceptible to attack by ammonia (such as brass) or contain O-rings which are not clearly labeled E, EP, or EPDM must never be used in the DRC gas line.

For SEMI S2-0200 compliant operation, the supply line for the anhydrous ammonia gas, the DRC gas, should be doubly-contained and exhausted.

The anhydrous ammonia gas used by the dynamic reaction cell must meet Electronic grade or Semiconductor grade specifications (99.999% pure, in liquid form). The DRC is shipped with a CGA-660 ammonia cylinder fitting. Ammonia DRC gas cylinders should use this type of fitting when ordered from your local gas supplier.

The DRC gas is consumed at a typical rate of 0.5 mL/min; therefore only a very small cylinder (60 L, 2 ft³) of gas is required. DRC gas cylinders should be secured upright in a ventilated enclosure such as a cabinet or fume hood. For additional types of DRC gases, the customer must purchase a double stage regulator capable of supplying 3 mL/min at the pressure listed in Table III. A suitable double stage regulator with the correct cylinder fittings can be purchased from your local gas supplier.