Preparing Your Laboratory for the DVS Sciences Inc. CyTOF® Ver.6, May, 2011

DVS Sciences CyTOF® mass cytometer is a complete system with the exception of the following items which must be provided by the customer: electrical power, exhaust vents, and argon gas supply with approved regulator. 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
- Argon gas requirements

Environmental Conditions

WARNING:

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

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.

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

The CyTOF has been designed for indoor use.

Space Requirements

The system should be located near the required electrical and gas supplies as well as the coolant supply. The CyTOF 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. Allow space (minimum 50 cm) on the left side of the instrument for access to circuit breakers. Access for most service procedures is through the left side and front of the instrument.

System Layout

The CyTOF system consists of the main instrument, a refrigerated chiller and a system computer. The dimensions of the instrument are given in Table I. Table II lists the dimensions of optional accessories. The CyTOF® can be positioned in either a linear or an L-shaped configuration. In the L-shaped configuration, the computer is positioned on one leg of the L. The instrument and an accessory table make up the other leg. There should be sufficient space near the cytometer for the optional accessories such as an autosampler. 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.

Table I. Dimensions of the Instrument

Instrument	**Width cm (in.)**	**Height cm (in.)**	**Depth cm (in.)**	**Weight kg (lb)**
CyTOF	103 (40.5)	143 (56)	74 (29)	295 (650)

Table II. Dimensions of Accessories

Accessory	**Width cm (in.)**	**Height cm (in.)**	**Depth cm (in.)**	**Weight kg (lb)**
Refrigerated Chiller (PolyScience 6105PE)	38 (15)	63.5 (25)	67.3 (26.5)	81 (178)
Autosampler (optional)	39 (16)	24 (10)	36(14)	20 (44)

Drain Vessel

A small drain vessel (500 mL) is supplied with the CyTOF. The vessel is used to collect the effluent from the sample introduction system. 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 dangerous 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.

Facilities Requirements

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

Electrical Requirements

Power to the CyTOF is to be delivered from two 30 A single-phase 200-230 V AC, 50-60 Hz 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. The instrument is supplied with 400 cm of 6 AWG green/yellow wire for grounding purposes.

60-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. The installation kit includes two NEMA L6-30 plugs (250 V, 30A) for use with two 60 Hz single phase outlets. The instrument is wired for power at the time of installation. A means for electrically grounding the instrument must be available.

50-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. It is up to the service person installing the instrument to wire the cables with the appropriate plugs.. The single phase connectors must be supplied by the customer. 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 to two phases of the three phase line. The three-phase plugs must be supplied by the customer. A means of electrically grounding the instrument must be available.

Table III. Services required for the CyTOF

Gas	Argon at 345 ± 7 kPa (50 ± 1 psi) at 20 L/min flow
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. CyTOF Power Specifications

Power Consumption	
Maximum Volt Amperes (total, both circuits)	9000 VA
Maximum Continuous Current (per circuit)	20 A
Voltage Amplitude Specification	
Operating Voltage	200 - 230 V AC
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 Accessories

Equipment	Voltage (AC)	Power
Computer	depends on model	depends on model
Cooling System		
Refrigerated Chiller (PolyScience 6105PE)	Plugged into the CyTOF	Plugged into the CyTOF
Autosampler	Plugged into the CyTOF	Plugged into the CyTOF

Exhaust vents

WARNING:

The use of CyTOF instrument without adequate ventilation to outside air may constitute a health hazard. Extreme care should be taken that exhaust gases are vented properly.

The CyTOF requires two separate vents. The top main vent exhausts the following:

- plasma
- vacuum pump exhaust

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. Exhaust venting is important for four reasons:

- It protects laboratory personnel from ozone and hot argon generated in plasma
- 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 ± 10% (150 ft^3/min). The 150-mm (6-in) venting system must provide a flow rate of approximately 210 L/sec ± 10% (450 ft^3/min). Both of the exhaust ports should be connected directly to flexible exhaust hoses. 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 CyTOF 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. PLEASE NOTE THAT THE EXHAUST FLOW VALUES ARE SPECIFIED FOR THE "OPEN END" CONFIGURATION OF THE RECEIVING DUCTS. SHOULD THE FLOW CONTROL SYSTEM BE USED, THE ACTUAL VALUES OF THE FLOW THROUGH THE 4" and 6" CHANNELS SHOULD BE ADJUSTABLE TO ACCOMMODATE FOR THE LOAD (CyTOF) FLOW RESTRICTION. FOR EXAMPLE, WITH THE 4" CHANNEL AT 150 CFM "OPEN END" FLOW, THE EFFECTIVE FLOW WITH THE CyTOF CONNECTED IS 65 CFM. FOR THE 450 CFM "OPEN END FLOW" THROUGH THE 6" CHANNEL, THE EFFECTIVE FLOW WITH CYTOF CONNECTED IS ~ 180 CFM.

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)

Vent Positions

Both of the CyTOF vents are located on the back of the instrument. The Torch Box exhaust vent is 12.5 cm (5 in) from the left side of the instrument when viewed from the rear and 100 cm (40 in) above the floor. The ICP Power Supply/roughing pump exhaust vent is 50 cm (20 in) from the left side of the instrument (rear view) and 65 cm (22 in) above the floor.

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.

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 CyTOF Mass Cytometer Guide.

Coolant Requirements

The CyTOF 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 241 ± 13 kPa (35 ± 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.

Argon Gas Requirements

Argon is used as the ICP torch gas with the CyTOF. 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 ft^3 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. Liquid argon may be purchased from your gas supplier. DVS Sciences instruments include the tubing necessary for connecting argon to the instrument. The customer provides the two-stage regulator for attaching to the argon tank, for provision of ~ 100 psi pressure measured at the entrance to the instrument. The actual pressure at the tank may have to be higher than 100 psi, in order to accommodate the pressure drop on the delivery tubing.

A no-weld (pressure fittings only) stainless steel argon delivery tubing is recommended in order to preserve argon purity.

DVS Sciences Inc.
70 Esna Park Drive
Markham
Ontario L3R 6E7
Canada
telephone: (1) 905 513 1704
www.DVSsciences.com