

Preparing Your Laboratory for the Optima 7000 DV ICP-OES Spectrometer

The PerkinElmer® Optima™ 7000 DV ICP-OES instrument is a complete system, with the exception of the following items: suitable working area, exhaust vents, gases and regulators, cooling water and a computer table or bench. These items must be provided by the analyst.

The ICP-OES system consists of the main instrument, the computer-controller assembly and a printer, the dimensions of which are given in Figure 3 and Table 3.

Suitable working area

The environment in which any instrument is housed is an important consideration. The instrument will operate with a laboratory temperature between 15 and 35 °C (59-95 °F) with a maximum rate of change of 2.8 °C (5 °F) per hour. For optimum instrument performance, the room temperature should be controlled at 20 ±2 °C. The instrument should be located away from direct sources of heat or cold. The relative humidity should be between 20 and 80%, non-condensing.

In order to minimize contamination problems, a relatively dust-free environment is necessary. Maximum dust levels should not exceed 36 million particles

(0.5 mm or larger) per cubic meter of air. Failure to operate the instrument in a relatively dust-free environment will necessitate more frequent maintenance and could, eventually, damage the instrument. As a reference, a normal, clean office environment would be 18 million to 36 million particles per cubic meter.

Another important consideration is to locate the instrument in an area free of corrosive fumes and excessive vibration.

The Optima 7000 DV instrument is bench-mounted and may need to be moved for service and preventative maintenance. Leaving a space of 45 cm (18 in) between all sides of the instrument and lab walls will facilitate access.

The heat dissipated directly into the room air by the Optima 7000 DV ICP-OES is about 2200 watts (6600 BTU/hr), most of which is removed if the system is properly vented. Additionally, the chiller dissipates about 3000 watts directly into the room.

Exhaust vent

The Optima 7000 DV ICP-OES requires one vent for the ICP torch. The torch venting system is

required to remove combustion fumes and vapors from the torch housing. Exhaust venting is important for a number of reasons:

- It will protect laboratory personnel from toxic vapors that may be produced by some samples.
- It will tend to minimize the effects of room drafts and the laboratory atmosphere on ICP torch stability.
- It will help to protect the instrument from corrosive vapors that may originate from the samples.
- It will remove dissipated heat that is produced by the ICP torch and RF power supply. The venting system should provide a flow rate of at least 5660 L/min (200 CFM). The temperatures of the exhaust gases upon exiting the instrument are about 200 °C (392 °F) at 1500 watts of RF power.

WARNING:

The use of ICP-OES instruments without adequate ventilation to outside air may constitute a health hazard. For example, the combustion of halogenated hydrocarbon produces toxic vapors. Extreme care should be taken that exhaust gases are vented properly.

The venting system should provide a flow rate of at least 5660 L/min (200 CFM).

The temperatures of the exhaust gases upon exiting the instrument are about 200 °C (392 °F) at 1500 watts of RF power.

The blower capacity depends on the duct length and the number of elbows or bends used to install the system. 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. Alternatively, smooth stainless-steel tubing may 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 a center line radius of 150 mm with a maximum bend angle of 45 degrees to reduce friction losses, and the number of elbows should be minimized.

Additional recommendations on the venting system include:

- Make sure the duct casing is installed using fireproof construction. Route ducts away from sprinkler heads.
- 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 back draft 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.
- 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 will cause an efficiency loss in the exhaust system.
- Ensure that the system is drawing properly by releasing smoke into the mouth of the vent. A synthetic “smoke” can be generated by placing open bottles of hydrochloric acid and ammonium hydroxide in the proximity of the vent opening.
- Equip the blower with a pilot light located near the instrument to indicate to the operator when the blower is on.

Vent positions

The venting system for the ICP torch should be positioned over the torch compartment chimney located on top of the sample compartment. For

proper instrument venting, order PerkinElmer Venting Kit (part number 03030447, 110V; 03030448, 230V). The minimum distance from the top of the instrument’s torch compartment chimney to the bottom of the extraction vent should be 7.5-12.5 cm (3-5 in). Figure 1 shows the location of the ICP torch exhaust vent.

Handling of gas cylinders and other suggested safety practices

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.

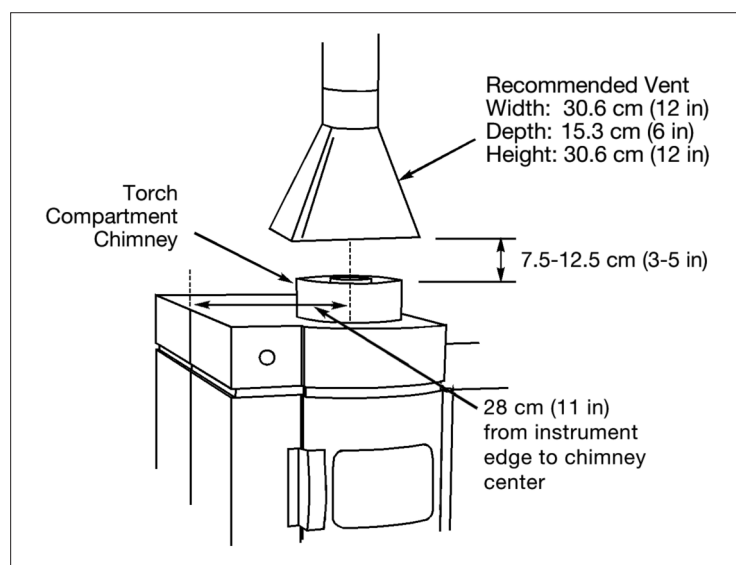


Figure 1. Vent for the Optima 7000 DV ICP torch.

- 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.
- 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.
- Never view the ICP torch directly without protective eye wear. Potentially, hazardous ultraviolet radiation may be emitted. Ordinary safety glasses will, in general, provide sufficient protection, but additional side shields will ensure a further margin of safety. Safety glasses will also provide mechanical protection for the eyes.
- ICP-OES instruments generate high amounts of radio-frequency energy in their RF power supply and torch boxes, which is potentially hazardous if allowed to escape. Safety devices and screening interlocks should not be bypassed or disconnected.
- The power supply of an ICP-OES is capable of generating potentially lethal voltages. No maintenance should be performed by anyone other than a PerkinElmer Service Specialist or the customer's own PerkinElmer-trained maintenance personnel.

- Water lines should be located away from electrical connections. Condensation and possible leaks may create an unsafe situation, if in proximity to electrical connections.

Gases for the Optima 7000 DV

Argon is used as the ICP torch gas with the Optima 7000 DV. Nitrogen is recommended for the optical purge gas, although argon can be used as well. The quality criteria for the argon and the nitrogen are shown in Table 1.

Table 1. Argon and Nitrogen Quality Criteria.

Specification	Argon	Nitrogen
Purity	≥ 99.996%	≥ 99.999%
Oxygen	≤ 5 ppm	≤ 5 ppm
Water	≤ 4 ppm	≤ 5 ppm
Nitrogen	≤ 20 ppm	
Hydrogen	≤ 1 ppm	
Hydrocarbons	≤ 1 ppm	

Either liquid or gaseous argon can be used with an ICP-OES system, although liquid is recommended. 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 to prevent the tank from becoming a safety hazard. Gas transfer lines from the argon tank should be contaminant-free and not made of plastic.

It is highly recommended that the optical path be purged with either nitrogen or argon. Nitrogen is the recommended purge gas due to its lower cost. Normal purge-gas usage is user-

selectable at either 1.0 L/min (low purge) or 5 L/min (high purge) for nitrogen (1.4 L/min or 7 L/min if argon is used) at 365 kPa (50 psig) pressure.

Gaseous argon tanks do not require venting and consequently can be stored for extended periods without loss. A tank of liquid argon containing 160 liters will typically last for approximately 80 hours of continuous ICP running time. A tank of gaseous argon will last five to six hours of ICP running time. The normal argon usage is 16-20 L/min with a maximum of 25 L/min, and the available argon pressure should be between 550 and 825 kPa (80-120 psig). Liquid argon and nitrogen may be purchased from your gas supplier. The Optima 7000 includes the hoses necessary for connecting the argon and nitrogen to the instrument (0.25-inch Swagelok® connection).

The argon gas regulator should provide a delivery pressure between 80 and 120 psi (550 to 825 kPa). The nitrogen purge gas regulator should provide a delivery pressure between 40 and 120 psig (275 to 825 kPa). A cylinder regulator that can be used with argon and nitrogen is available from PerkinElmer (part number N0770507). The regulator can be used with CGA 580 or CGA 590 fittings.

Shear gas

The Optima 7000 DV uses a shear gas to remove the plasma plume and to keep the heat away from the optics. Either clean air or nitrogen can be used for the shear gas. The shear flow is 25 L/min (1 cubic foot/min) at a minimum of 550 kPa (80 psig). While cylinders of compressed air can be used, an air compressor is more practical. However, because the shear gas must be clean and dry, the Optima 7000 DV includes an air-dryer

assembly. The air hoses are supplied with 0.25-inch Swagelok® fittings and the assembly mounts on the lab wall. In humid environments, this may not be adequate to ensure that the compressed air is dry. Additional filters or condensers may be a necessary part of the air supply system.

Drain vessels

A drain vessel (part number 09904991) and end cap (part number N0690271) are supplied with the Optima 7000 DV ICP-OES systems. The vessel is made of plastic and is used to gather the effluent from the ICP torch. The drain vessel should be placed on the floor in front of the ICP-OES. 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. Separate drain vessels must be

used for acid-containing aqueous and organic samples.

Location

Typically, the Optima 7000 DV is positioned with the computer and printer on the bench next to the instrument or on an adjacent table. The computer and printer must not be placed on the instrument. A table for the instrument is available (part number N0773106). The dimensions are listed below (Figure 2).

The instrument must be placed under the exhaust vent for the torch compartment and near the electrical, water and gas supply points.

The instrument is supplied with a power cord 2.5 m (99 in) long and the following hoses:

Argon and nitrogen hoses: 2.5 m (8 ft)

Water hoses (2): 6.0 m (20 ft)

Air hose for shear gas*: 3.7 m (12 ft)

*The air dryer filter should be located within the 3.7 m (146 in) length of the air hose.

Electrical services

NOTICE:

A means of electrically grounding the instrument must be available.

The Optima 7000 DV instrument is supplied with a 2.5 m (8 ft) power cable that supplies both the spectrometer and the RF generator. The Optima 7000 DV requires a 200-240 VAC, 50/60 Hz ($\pm 1\%$) electrical line with a separate dedicated circuit breaker. Only single-phase power is needed.

The line should be rated at 15 amps, though the instrument does not draw all of this capacity. The Optima 7000 DV draws 12 amps at 230 V. The maximum power consumption is 2800 volt-amperes.

NOTICE:

The Optima 7000 DV must not have a Ground Fault Circuit Interrupter (GFCI) protected outlet. The instrument will trip the interrupter if this type of outlet protection is used.

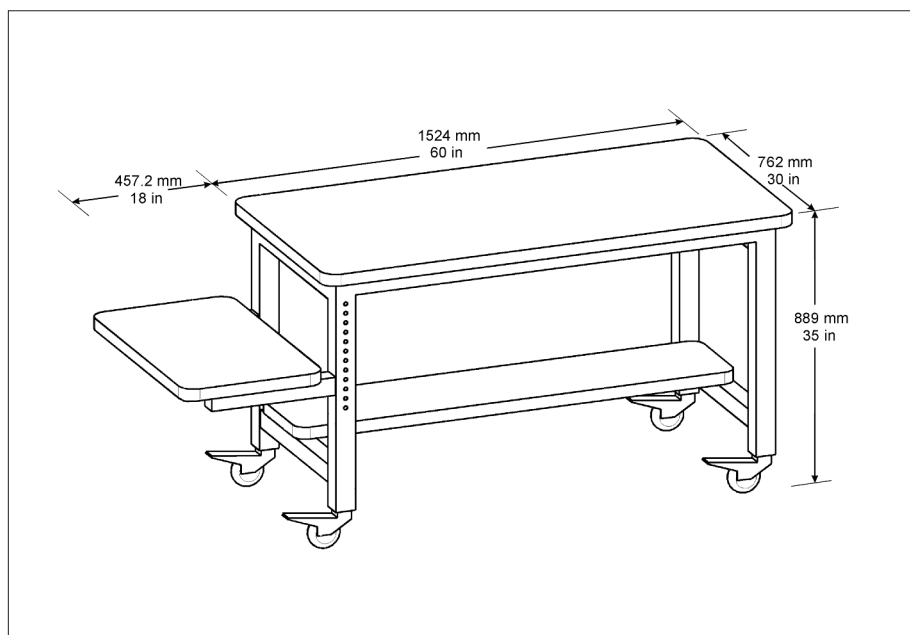


Figure 2. Table for the Optima 7000 DV (N0773106).

The Optima 7000 DV is equipped with an IEC 309 250 V 16/20 A 2-pole plus protective earth plug (Hubbell® part number C320P6SVL, PerkinElmer part number 09997530) that inserts into a receptacle (Walther part number 410306, PerkinElmer part number 09290304). Alternative surface mount receptacle (Walther part number 111306, PerkinElmer part number 09290305). Both receptacles are shipped with the instrument.

NOTICE:

Do not replace the IEC 309 instrument power plug.

Cooling requirements

The Optima 7000 DV requires a recirculating cooling system (chiller) to dissipate heat from the RF coil and the oscillator. The requirements for the chiller are:

Cooling Capacity at 20 °C: 2850 watts

Temperature Stability: ± 0.5 °C

Pump Rate: 4 gal/min at 55 psi max

A PolyScience® 6106PE Recirculating Chiller meets these requirements and is recommended for the instrument. The PolyScience® 6106PE is available through PerkinElmer in the following two configurations:

208/230V, 50 Hz (part number N0772025)

208/230V, 60 Hz (part number N0772026)

An additional 200-240 V line is required for the chiller. A Hubbell®

number 4560 receptacle (NEMA L6-15R configuration) is supplied with the PolyScience® 6106PE chiller.

Summary: Facilities required

Tables 2 and 3 provide the power requirements and dimensions, respectively, for the Optima 7000 DV and its major accessories. The electrical-supply requirements and approximate power consumption for the ICP-OES and major accessories are given in Table 1. PerkinElmer instruments will normally operate within a 10% range of the specified voltage and within 1 Hz of the specified frequency, unless otherwise noted. If the power line is unstable, fluctuates in frequency or is subject to surges, additional control of the incoming power may be required.

Table 2. Services required for the Optima 7000 DV system. The Optima 7000 DV is a computer-controlled, bench-mounted instrument, with one exhaust vent.

Gases	Argon	485-825 kPa	1-25 L/min	
	Nitrogen	200-825 kPa	1-5 L/min	
Shear gas	Air or Nitrogen	550 kPa	25 L/min	
Coolant		200-550 kPa	4 L/min (1 gal/min)	15-25 °C (59-77 °F)
Power	Optima 7000 DV	200-240 V	50/60 Hz	16/20-amp single-phase
	Computer and Printer	115 V 230 V	60 Hz 50 Hz	
	PolyScience® 6106PE	208/230 V 208/230 V	60 Hz 50 Hz	15-amp single-phase 15-amp single-phase or 13-amp single-phase (U.K.)

Table 3. Dimensions of Optima 7000 DV and Accessories.

Product	Width	Height	Depth	Power	Weight
Optima 7000 DV	132 cm (52 in)	76 cm (30 in)	81 cm (32 in)	2200 watts	141 kg (310 lb)
S10 Autosampler	46 cm (18.1 in)	53 cm (20.9 in)	38 cm (14.9 in)	250 watts	5 kg (10.1 lb)
HP® LaserJet® Printer*	42 cm (16.5 in)	38 cm (14.8 in)	45 cm (17.8 in)	330 watts	20.4 kg (45 lb)
Computer Keyboard	48.3 cm (19 in)	4.3 cm (1.7 in)	21.6 cm (8.5 in)	–	2 kg (4 lb)
Computer CPU (minitower)*	18 cm (7.1 in)	42.6 cm (16.8 in)	44.7 cm (17.6 in)	200 watts	10 kg (22 lb)
Computer Monitor 24 in flat panel	56.0 cm (22 in)	43.6 cm (17.2 in)	17.2 cm (6.8 in)	300 watts	6.8 kg (15 lb)
PolyScience® 6106PE	36.5 cm (14.5 in)	61 cm (24 in)	67.3 cm (26.5 in)	2000 watts	81 kg (178 lb)

* Typical dimensions for printers and computers, based on an HP® LaserJet® 4250 printer and a Dell® Optiplex® 755 computer system.

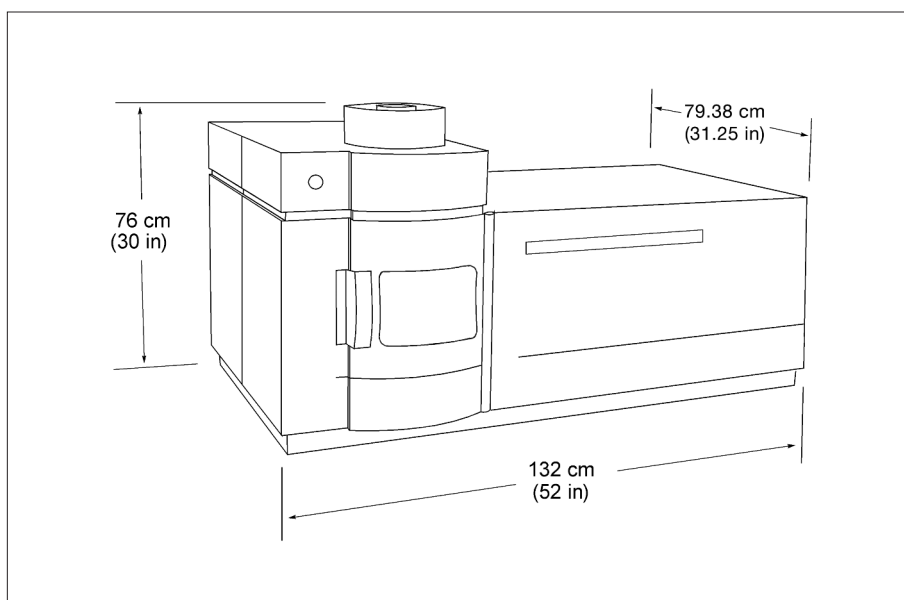


Figure 3. Optima 7000 DV ICP-OES spectrometer dimensions.

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