

Quartz H₂O T SHOT™

Infrared Inline Chemical Heater



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INTRODUCTION:

This high performance patented liquid chemical heater, has been designed to meet the strict purity requirements of the semiconductor industry, and the high reliability demanded by the wafer surface preparation, equipment manufacturer. Process Technology is confident that the performance of our HCQ IR heater unit will exceed your expectations.

Complete understanding of the contents of this manual, along with careful heater handling, will help prevent potentially hazardous conditions.





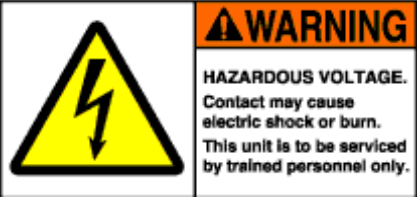


A thorough evaluation of this manual will promote an accident free environment, and maximize heater performance.

Notes regarding this Instruction Manual



1. Reproduction of the contents of this manual is strictly prohibited.
2. The contents of this manual are subject to change without prior notice.
3. The reader is encouraged to notify Process Technology if any questions arise regarding to the contents of this manual, prior to using the heater unit.
4. Manual part number is M-06-02 HCQ-IR Manual.

INTRODUCTION (Continued):

The following symbols and warning labels appear on the unit and in the instruction manual. The table below provides an explanation of each one.

DESCRIPTION	PICTORIAL DESCRIPTION
<p>DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.</p>	
<p>WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.</p>	
<p>CAUTION indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.</p>	
<p>DANGER: HAZARDOUS VOLTAGE ENCLOSED Voltage or current hazard sufficient to cause shock, burn or death. Disconnect and lock out power before servicing.</p>	
<p>WARNING: HAZARDOUS VOLTAGE Contact may cause electric shock or burn. This unit to be serviced by trained personnel only.</p>	
<p>CAUTION: HOT SURFACE. DO NOT TOUCH Heater column may be hot. Allow unit to cool before servicing.</p>	
<p>WARNING: INFRARED RADIATION INSIDE MACHINE. Eye damage may result. Do not look directly at light.</p>	

INTRODUCTION (Continued):

DESCRIPTION	PICTORIAL DESCRIPTION
<p>DANGER Water, pneumatic, hydraulic and electrical power sources present. Lockout ALL energy sources before servicing.</p>	 <div data-bbox="1068 281 1279 464" style="border: 1px solid black; padding: 5px;"> <p>⚠ DANGER</p> <p>Water, pneumatic, hydraulic and electrical power sources present. Lockout ALL energy sources before servicing.</p> </div>
<p>WARNING: HAZARDOUS CHEMICALS LOCATED WITHIN ENCLOSURE.</p>	 <div data-bbox="1068 485 1279 646" style="border: 1px solid black; padding: 5px;"> <p>⚠ WARNING</p> <p>Hazardous chemicals located within this enclosure.</p> </div>

Preliminary Safety Precautions:

Chemical Handling and Compatibility:

The heater chamber of the HCQ IR unit is made of semiconductor grade quartz material and an infrared heating element subassembly. Due to the material construction of the liquid heating chamber, only chemicals known to be compatible with quartz can be heated with the HCQ IR unit.


Chemical	Temperature (°C)
SC1 solution (H ₂ O ₂ , NH ₄ OH, DIW or UPDIW)	85
SC2 solution (H ₂ O ₂ , HCl, DIW or UPDIW)	85
Sulfuric acid (H ₂ SO ₄)	150
Phosphoric acid (H ₃ PO ₄)	165
Deionized Water (DIW or UPDIW)	95


Please consult Process Technology for the compatibility of any liquids that are not listed above.


Notes:

1. Heater operating temperature limit is 185°C. The temperatures listed above refer to typical process temperatures. At higher temperatures, Flarelock fittings may be required. Consult with your fluoropolymer-fitting manufacturer for pressure vs. temperature fitting specifications.
2. Ensure you follow the N2/CDA cooling flow requirement in all cases. See the facilities print provided with the unit.
3. For maximum process pressure, refer to mechanical facilities drawing at end of manual.

 WARNING	DO NOT OPERATE THE HCQ IR HEATER FOR ANY APPLICATION HEATING COMBUSTABLE OR FLAMABLE LIQUIDS.
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 WARNING	DO NOT PERMIT FLUID FLOW SHUT-OFF TO THE HCQ IR HEATER WHEN IT IS IN OPERATION. POSSIBLE DAMAGE DUE TO EXCESSIVE STEAM FORMATION MAY OCCUR.
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 WARNING	DO NOT OPERATE HCQ IR WITHOUT PRESENCE OF FLUID. A MINIMUM FLOW RATE OF 2LPM (0.5GPM) IS REQUIRED.
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 WARNING	OVER-TEMPERATURE THERMOCOUPLE MUST BE CONNECTED TO A SAFETY LIMIT CONTROLLER SET TO A THRESHOLD APPROPRIATE FOR THE PROCESS CHEMISTRY.
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Preliminary Safety Precautions (Continued):



Do not service or perform maintenance on the heater when power is on due to the danger of electric shock.



Do not touch the heater's exposed quartz surfaces during operation in order to avoid burns.



The lamps heat process fluid by infrared radiation, which is a source of potentially hazardous non-ionizing radiation. Avoid direct exposure to the light emitted from the lamps. The radiant light energy from the lamps is 259-228 THz, wavelength 1.16-1.32um and power output of 1.5-12KW.



If chemical leakage occurs, turn the power off at the main disconnect. Consult the chemical supplier's MSDS (Material Safety Data Sheet) for proper clean up and substance disposal. The relative high power to volume ratio of this heater can result in a fluid over-temperature condition if flow is stopped without heater shutdown.



If the electrical terminals are loose or dirty, faulty contact may occur and premature lamp failure can result. Periodically inspect terminal connections and contact surfaces. Consult the National Electrical Code for the minimum torque requirement for all electrical connections.

FACILITY REQUIREMENTS:

Before installing the Quartz H₂Ot Shot inline chemical heater confirm the facility requirements listed below.

Space Requirements:

This unit should be mounted in a process tool to allow adequate space for a maintenance technician to have access to the inlet and outlet plumbing connections. Make sure the heating elements access port is fully accessible. This access port should allow for replacement of the heating element without the need to disconnect any tubing or remove the heater from its location. In order to provide adequate access there should be at least 254mm (10 inches) clearance from the heating element access cover. This unit must be installed no higher than 1700mm (67 inches) relative to access floor, horizontally, and must be adequately protected from vibration or shock.



The HCQ IR heater has been designed to operate in an atmosphere that may be exposed to excessive corrosive fumes, high temperature, or humidity. The enclosure in which the HCQ IR heater is placed must be at least twice as big as the heater. If not, with a heater process temperature of 180°C, the ambient temperature inside the enclosure will increase up to 80°C.

Chemical Plumbing Requirements:

Refer to the Facilities Drawing provided with the unit for your heater's specific requirements. The heater unit is supplied with quartz standard male flare or grooves for Super 300 Pillar connections for chemical inlet and outlet connections, and PFA compression tube fitting for the N₂/CDA cooling gas inlet port. It is the user's responsibility to provide and install inlet and outlet plumbing connections, as well as cooling gas tubing to the heater unit. Follow the installation recommendations of your high purity fitting and tubing manufacturer, to properly outfit the heater unit. Note: The HCQ IR flared inlet/outlet fitting connection is Flaretek® II compatible.

In order to keep the heater unit free of vibration, thermal stressing, and tube dead loads, the tubing going to the heater unit must be fully supported. Thermal expansion of fluoropolymer tubing must be calculated and appropriate expansion loops must be incorporated. Any stresses induced on the liquid chemical lines may result in connection leaks or catastrophic heater failure due to quartz heat exchanger breakage.

FACILITY REQUIREMENTS (Continued):

Electrical Requirements:

Reference the facilities print or electrical schematic provided with the unit to identify the electrical power requirements of this unit. Verify that the incoming electrical service is rated and fused for the required amperage draw.



Do not exceed the rated voltage. Irreparable damage to unit may result.

NOTE: Ensure electrical power fusing and disconnects meet local jurisdictional requirements. Fuse ratings noted in this document are for reference only. Ensure external electrical components comply with local requirements before operating this unit.

Cooling Gas Requirements:

A source of cooling gas, nitrogen (N₂) or clean dry air (CDA) at a maximum line pressure of 50 psi (3.4 bars) is required for the heater element cooling. All HCQ heaters use 6.4-mm (0.25-inch) compression fittings as the cooling gas inlet connection. This inlet fitting is connected to an internal cooling gas pressure switch, which must be wired in your heater safety control circuit.

If the cooling gas pressure switch does not detect adequate inlet gas pressure, the customer supplied heater safety circuitry must disable the heater and indicate a safety alarm.

The cooling gas flow rate needed for optimum heater performance depends upon the operating temperature of the unit. A customer provided flow meter will be needed to confirm the flow rate of the cooling gas. The table below provides the required range of cooling gas flow based upon the chemical operating temperature.

Process Temperature	Cooling Gas Flow Rate Range
Up to 65°C	42-56 LPM (1.5-2.0 SCFM)
66°-90°C	42-63 LPM (1.5-2.25 SCFM)
91°-135°C	49-70 LPM (1.75-2.5 SCFM)
136°-165°C	63-84 LPM (2.25-3.0 SCFM)

Any additional gas flow requirements will be listed on the facility drawing.



Providing too much or too little cooling gas to the heater may result in shortened life of the heating lamps

INSTALLATION:

Note: Before installation, carefully read this entire section. The installation of this unit must be performed by qualified technicians.

Inspection and unpacking:

Inspect the shipping crate for evidence of damage. If any damage is detected, contact the carrier immediately.

Visually inspect the unit itself for damage. If there is evidence of damage, notify Process Technology and the freight carrier immediately.

Verify the product model number listed on the packing list matches the model number of the unit provided. If these numbers do not match, or do not agree with your original purchase order, please contact the factory.

Plumbing:

The plumbing installation of this unit should only be performed by qualified technicians.

An automatic valve installed in the flow path of the process fluid before the unit which can be shut by a monitoring device (such as a leak detector) is recommended.



Verify that the water supply and cooling gas supply is shut off, and any necessary lockout/tagout devices are properly installed.

Refer to the facilities print provided with the unit for the specific inlet/outlet plumbing connections. The various plastic piping connections available (Unions, Flared tube fittings, etc) do not require very much force to properly seal. Once the plumbing connections have been made, test the connections for possible leaks and repair any leaks as needed.

Flared Compression Process Fluid Inlet and Outlet Connections:

Please note that the procedure specified below should only be performed once, when the tubing is first connected to the fittings. Once properly tightened, the fittings will not need to be re-tightened in the future.

- 1) Remove the protective plastic caps from the flared fittings on the Inlet and Outlet piping of the heater assembly.
- 2) Connect properly flared tubing to the flared fitting on the heater chamber assembly.
- 3) Tighten the fitting nuts until fitting nut contacts the flared tubing. Tighten an additional ¼ turn. Then tighten fitting nut to the **maximum** required torque value. See the table on the following page for the proper value.
- 4) Repeat this procedure for each of the flared tube fittings on the inline heater, including the bleed and drain fittings.

Plumbing (Continued):

- 5) Check for leaks at the fittings.
- 6) Circulate hot fluid through the heater at the operating temperature of the system, allowing the heater to reach operating temperature.
- 7) Cool down the heater to ambient. Re-tighten the fitting nut to the **minimum** torque value. See the table below for the proper value.

Fitting Size	Torque Value	
	Minimum value (cold)	Maximum value (cold)
13mm (½-inch) flared	1.24 N-m (11 in-lbs).	1.8 N-m (16 in-lbs).
19mm (¾-inch) flared	1.58 N-m (14 in-lbs).	3.2 N-m (28 in-lbs).
25mm (1-inch) flared	3.39 N-m (30 in-lbs).	5.1 N-m (45 in-lbs).



Do NOT tighten fitting nuts at elevated temperatures. Irreparable damage to the plumbing connections will result.

Plumbing (Continued):

Super 300 Type Pillar™ Process Fluid Inlet and Outlet Connections:

Super 300 Type Pillar Fittings use a “gauge ring” which is used to determine the proper tightness of the fitting connections.

- 1) Remove the protective plastic caps from the fittings on the Inlet and Outlet piping of the heater assembly.
- 2) Install appropriately sized Super 300 Type Pillar “gauge ring”

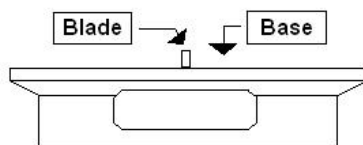


Figure 12: Gauge ring for Super 300 type Pillar fittings

- 3) Tighten the Pillar fitting nut until the tabs on the union nut makes contact with the gauge ring and pulls the blade. A clicking (crunching) sound will be heard at this point. Continue tightening the union nut until the bosses make full contact with the gauge ring.

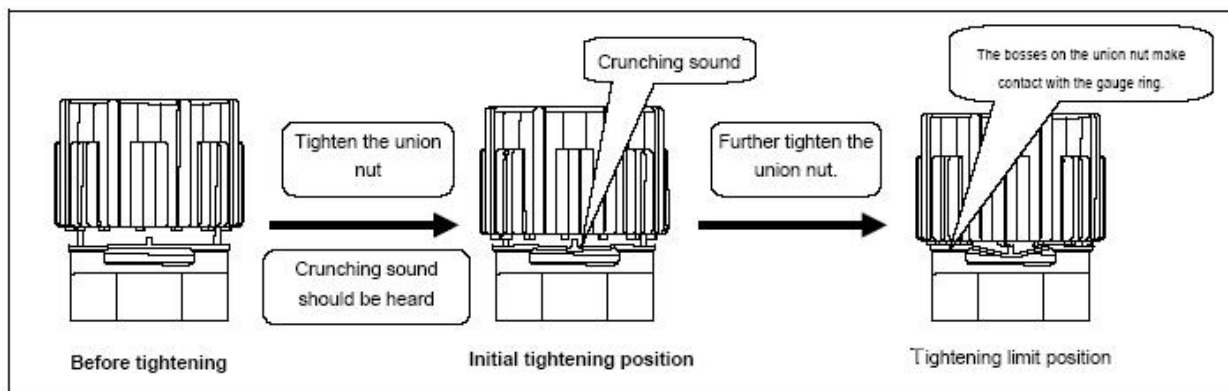


Figure 13: Super 300 type Pillar fittings tightening procedure

Plumbing (Continued):

Cooling Gas Supply Connection (6mm (1/4-inch) compression fitting)

- 1) Loosen and remove the compression nut. Remove the sealing cap from plumbing connection and discard.
- 2) Test fit the tubing to ensure proper length.
- 3) Slide the compression nut over the tubing.
- 4) Insert the tubing into the compression fitting. Tighten securely.


Cooling Gas Exhaust (12mm (1/2-inch) compression fitting) (optional)

- 1) Loosen and remove the compression nut. Remove the sealing cap from plumbing connection and discard.
- 2) Test fit the tubing to ensure proper length.
- 3) Slide the compression nut over the tubing.
- 4) Insert the tubing into the compression fitting. Tighten securely.

Wiring:

The wiring of this unit should only be performed by qualified technicians.

- 1) All safety interlocks must be wired to a latching circuit or in series with the overall system emergency stop circuit to prevent automatic restart after a fault condition. The minimum safety interlocks are the housing overtemperature switch, the cooling gas pressure switch and a customer-supplied emergency stop button.

	Verify that the electrical supply is shut off, and any necessary lockout/tagout devices are properly installed.
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Refer to the facilities print and/or electrical schematic for proper wiring connections and specifications. Before the plumbing is connected to this unit, verify that the electrical supply is shut off. Apply any plumbing lockout/tagout devices as required by factory guidelines.

Onsite Heater servicing and troubleshooting:

Heater Servicing:

Under normal operating conditions, the HCQ IR heater unit will provide an extended service life beyond the warranty limits. The IR elements of the heater unit are considered consumable items; this is due to the nature of their operation. Even though Process Technology has designed the HCQ IR heater to maximize the life of the heater elements, their MTBF (Mean Time Between Failures) will depend on the heater cycle time and particular application. To improve the heating element MTBF, the nature of the quartz halogen cycle demands maintaining optimum halogen cycle working temperatures and cooling capability.

Note that in order to prevent premature failure of the IR lamp subassembly, it is necessary to provide a small amount of cooling gas (air or nitrogen). A 1/4" PFA compression tube fitting is provided as an integral part to the heater to connect the cooling gas supply. Refer to table in *Cooling Gas Requirements* section for the flow rate. Note that the pressure switch is factory set to close contact when adequate gas pressure is present at the heater. Refer to the heater facilities print for pressure setting. Higher volumes of cooling gas can adversely affect the IR's bulb life.

Note: *As a preventive maintenance, it is recommended to inspect and replace the lamp subassembly every 6 months. Refer to the HCQ lamp replacement manual (Manual name M-06-01, provided with replacement lamp assembly) for procedure.*

Onsite Heater servicing and troubleshooting (Continued):

Heater Troubleshooting:

When troubleshooting, refer to the Facilities Drawing provided with the unit for your heater's specific requirements.

Problem	Cause	Solution
Heater will not turn on	<ol style="list-style-type: none"> 1. Power to the heater has not been activated 2. Incorrect heater safety over-temperature value 3. There is a faulty power connection to the heater 4. Incorrect connection between thermocouple and heater controller 5. Pressure supplied at the cooling air pressure switch is less than the minimum Cooling Gas psig. 	<ol style="list-style-type: none"> 1. Turn on the power to the heater 2. The heater safety over-temperature value is too low 3. Check power connections between heater and controller 4. Check proper thermocouple (Type "J"). Check polarity matches controller. 5. Increase pressure supplied to heater safety pressure switch.
Heater stops shortly after being turned on	<ol style="list-style-type: none"> 1. Heater over-temperature safety setting value is too low. 2. Heater is running dry. 3. Re-circulation pump has stopped or there is liquid stagnated and over heated. 4. There is a leak condition inside the heater. 	<ol style="list-style-type: none"> 1. Increase the over-temperature set value to 185°C. 2. Check chemical dispensing to re-circulation loop. 3. Check chemical flow through re-circulation loop. 4. Check for leakage source and resolve condition.
Heater will not stabilize at temperature setting	<ol style="list-style-type: none"> 1. Control PID values are not optimum 	<ol style="list-style-type: none"> 1. Reset control PID values to proper operating conditions.
Heater unit is not heating	<ol style="list-style-type: none"> 1. IR lamp failure. 2. Improper connection between heating element subassembly and socket end. 3. Under rated voltage supplied to the heater unit. 	<ol style="list-style-type: none"> 1. Replace the heating element subassembly. 2. Check heating element connection according to procedure stated in heater servicing section. 3. Check for proper voltage according to the heater requirements. See heater specifications.

Recommended PM (Preventive Maintenance) Schedule:

As a preventive maintenance, Process Technology recommends the following procedure every six months: With the heater on and 100% duty cycle, using an Amp clamp type meter placed on one of the power wires to the heater, read the current drawn. With all the bulbs functioning, the current draw will be approximately the same as specified on the facilities drawing. If the current read out is less than the indicated value, chances are not all the halogen bulbs are functioning and the lamp subassembly should be replaced.

- 1) In addition to the lamp inspection, the heater's safety devices should also be inspected.
 - a) Test the Over-temperature Sensor T/C(s). First, disconnect power to the heater and heater controls. Once the heater has cooled down to room temperature, disconnect the Over-temperature Sensor T/C from the control circuit and test it using a thermocouple reader. Take a reading of the ambient temperature near the heater and verify that the two readings are similar. Reconnect the Over-temperature Sensor T/C to the control circuit.
 - b) Test the Pressure Switch. Power the heater controls. Starting with the gas off, slowly increase the gas flow until the Pressure Switch closes and completes the safety circuit. Verify this happens when the gas flow reaches 1.5 SCFM or the gas flow rate specified on the facility drawing.
 - c) Test the Bi-metallic Thermal Switch safety circuit. First, remove power to the heater and the heater controls then disconnect one of the leads of the Bi-metallic Thermal Switch from the safety circuit. Return power to the heater controls and verify that the safety circuit is open and the contactor is not activated. Remove power and reconnect the Bi-metallic Thermal Switch to the safety circuit.

Disposal:

Precaution is required during disposal of this product due to the potentially hazardous chemicals that may be contained in the heater vessel. In addition, it is possible that chemical residue will exist inside the heater housing if the vessel has become damaged. Disposal should be done in accordance with applicable local laws. No part of the heater is reusable or recyclable by the user and may only be reused by the factory for re-work or refurbishing.

WARRANTY:

All PROCESS TECHNOLOGY equipment, heaters and controls have been carefully inspected before shipping and are warranted to be free from defects in workmanship and materials for a period of one year from date of purchase on a pro-rated basis. At its option, PROCESS TECHNOLOGY will repair or replace any defects that are exhibited under proper and normal use. PROCESS TECHNOLOGY disclaims any responsibility for misuse, misapplication, negligence or improper installation of equipment, tempering or other operating conditions that are beyond its control (such as excessively high or low cooling gas supply pressure). PROCESS TECHNOLOGY makes no warranty or representation regarding the fitness for use or the application of its products by the customer.

All products and components not manufactured by PROCESS TECHNOLOGY will carry the original manufacturer's warranty, copies of which are available upon request. PROCESS TECHNOLOGY makes no warranty or representation, expressed or implied, with respect to the products not manufactured by PROCESS TECHNOLOGY.

Products must be installed and maintained in accordance with PROCESS TECHNOLOGY instructions.

PROCESS TECHNOLOGY is not liable for labor costs incurred in removal, reinstallation, or unauthorized repair of the product or for damage of any type including incidental or consequential damage.

PROCESS TECHNOLOGY neither assumes nor authorizes any representative of PROCESS TECHNOLOGY or any other person to assume for it any other liabilities in connection with the sale of the products. This warranty may not be verbally changed or modified by any representative of PROCESS TECHNOLOGY.

Shipping Damages:

Claims against freight carriers for damage in transit must be filed by the customer at the time of delivery or as soon as possible.

Returns:

No product shall be returned to PROCESS TECHNOLOGY without first obtaining a return material authorization (RMA) number from a PROCESS TECHNOLOGY representative. All returns must be freight prepaid. Freight collect or shipments without authorization will be refused.

Information:

PROCESS TECHNOLOGY will endeavor to furnish such advice as it may be able to supply with reference to the use by buyer of any material purchased, but PROCESS TECHNOLOGY makes no guarantees and assumes no obligation or liability for advice given verbally or in print or the results obtained. Buyer assumes all risk and liability that may result from the use of any material, whether used by itself or in combination with other products. No suggestion for product use shall be construed as a recommendation for its use in infringement on any existing patent.

Conflict Between Documents:

Acceptance of this offer is expressly conditioned upon agreement to all terms and conditions contained herein. In the event of a conflict between the terms and conditions of purchaser's purchase order, and PROCESS TECHNOLOGY's terms and conditions, proposal or offer, the latter shall govern.