
**U-5000AT Ultrasonic Nebulizer
Operator's Manual**

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1.0 General Description

The CETAC U-5000AT is an enhanced sample introduction system for ICP spectrometry. The system consists of an air-cooled piezoelectric transducer, an aerosol chamber, a temperature controlled heated U-tube and a temperature-controlled condenser. In addition, a built-in drain pump and an auto-tuned stabilized power supply provide excellent reproducibility and reliability.

To operate the U-5000AT, a liquid sample is pumped onto the piezoelectric transducer where the ultrasonic action efficiently converts it to a fine, dense aerosol. The nebulizer carrier gas flow then transports the wet aerosol through a heated U-tube where the solvent is vaporized. Subsequently, most of the solvent vapor is removed from the aerosol stream by passing the stream through a chilled condenser. The result is a dry, analyte-laden aerosol which is introduced to the plasma.

The U-5000AT improves limits of detection by both increasing the analyte transport efficiency and by stripping the solvent from the aerosol thereby reducing the solvent load on the plasma. Compared to typical pneumatic nebulizers, detection of sample analytes is generally enhanced by up to an order of magnitude when using the U-5000AT Ultrasonic Nebulizer. The enhancement in sensitivity is found with both ICP-AES and ICP-MS instruments.

2.0 Guideline to Installation

As with other laboratory equipment, the U-5000AT is a sensitive instrument which should be handled with care. The operator should read this manual and study the associated diagrams before installing or operating the U-5000AT system.

To achieve optimum performance from the U-5000AT, the ICP system must be in good operating condition. Check the ICP performance using a conventional pneumatic nebulizer before the U-5000AT installation. If the detection limits do not meet instrument specifications, consult the ICP manufacturer for assistance. If the detection limits are within the manufacturer's specifications, begin installation of the U-5000AT system.

3.0 Installation

Upon receipt of the U-5000AT system, inspect all items for damage according to the packaging checklist in the back of this manual. Installation of each component is discussed below.

Caution

Check the transducer cable to determine if it has been disconnected for shipment. Upon unpacking the unit, reconnect the cable to the connector located on the end of the transducer assembly (Figure 1: B,D). Failure to do so will trip (open) the RF circuit breaker.

3.1 Utility Cart Assembly

The utility cart provides a mobile station for the U-5000AT system. Set up the cart, according to the directions in the cart container. Place the U-5000AT on the top shelf with the Constant Temperature Cooling System (CTCS) and the waste bottle on the bottom shelf.

3.2 Constant Temperature Cooling System (CTCS) Installation

- 1) Connect the two insulated cooling hoses to the inlet and outlet of the CTCS.
- 2) Connect the **COOLANT OUT of the CTCS** to the **COOLANT IN of the U-5000AT**.
- 3) Connect the COOLANT IN of the CTCS to the COOLANT OUT of the U-5000AT.
- 4) Remove the CTCS reservoir cover and thermometer. Pour 5 liters of 1:1 ethylene glycol:water mixture into the CTCS reservoir. Replace the reservoir cover and ensure that the thermometer is inserted all the way into the hole in the center of the cover.

Note:

After initial use of the CTCS, add additional coolant to the reservoir to account for the coolant volume required to fill the U-5000AT condenser and hoses. Fill to within 1 inch of the top of the CTCS reservoir.

3.3 Drainage System Assembly

The U-5000AT drainage system removes both sample waste from the spray chamber and condensed solvent from the condenser. It consists of a built-in four roller peristaltic pump and the associated pump tubing and connectors (Figure 3: H,I,J,K,L). Connect the length of 1/8" I.D. Tygon tubing to the outlet of the "T" fitting (Figure 3: J) from the pump. Place the other end of the tubing into the waste bottle. The drain and pump tubing on the U-5000AT are user replaceable. To replace, refer to Sections 8.5 and 8.6.

3.4 Liquid Sample Delivery and Rinse System

The sample/rinse adapter (Figure 2: G) holds the sample tubing in place. It is mounted and aligned during assembly and should require no adjustment prior to use.

Sample liquid is delivered to the U-5000AT transducer through 0.5 mm I.D. PEEK sample tubing which is inserted through the glass sample inlet tube (Figure 2: K), located at the base of the aerosol chamber (Figure 2: F). For proper sample delivery, the end of the sample inlet tubing is cut at an angle of approximately 60 degrees. As previously mentioned, the sample/rinse adapter is mounted and aligned during assembly, however, it may become necessary to adjust this adapter or remove it and re-cut the end of the tubing periodically for optimum sample delivery. This procedure is outlined below:

- 1) Remove the three acorn nuts from the aluminum heat shield using the wrench stored in the U-5000AT chassis (Figure 1: F). Remove the heat shield by lifting the heat shield off the studs and then sliding it to the right past the ball joint clamp and lift off. This cover is designed for a snug fit for proper safety.
- 2) Remove the sample/rinse adapter from the glass sample inlet tube by carefully sliding the adapter along the glass sample inlet tube.
- 3) Re-cut the sample tubing at a 60 degree angle using a sharp razor blade. An improper cut or a blunt tip may cause inefficient nebulization.
- 4) Loosen the compression fitting nut which holds the PEEK sample inlet tubing. Adjust the tubing position to account for the removed section. Tighten the sample inlet compression fitting nut to hold the tubing in place.
- 5) To replace the adapter, first insert the sample inlet tubing, then slide the adapter back onto the glass tube.

- 6) Slide the adapter until the sample tubing touches the face of the transducer, then, slightly pull the adapter back to form a very narrow gap (approximately 0.2 to 0.4 mm) between the transducer and the tubing. This position allows proper adhesion of sample solution onto the transducer without any contact between the tubing and the transducer. At this point, the end of the sample tubing should be parallel to the transducer face.
- 7) If the length of the sample inlet tubing is not correct, remove the sample inlet adapter and repeat steps 4 through 6 until proper adjustment is achieved.
- 8) Replace the aluminum heat shield and tighten the three acorn nuts.

For high concentrations of sulfuric and nitric acid it is recommended that the Peek sample inlet tubing be replaced with the clear Tefzel sample inlet tubing supplied as an accessory with the U-5000AT. The Tefzel tubing performs much better when using these types of acid. To install the Tefzel tubing, follow the above outlined procedure for the Peek sample inlet tubing.

The auxiliary rinse port on the sample/rinse inlet adapter (Figure 2: J) provides the capability for rapidly cleaning the transducer faceplate between samples. This reduces memory effects. A rinse bottle is provided for this purpose. The auxiliary rinse port should always have the male luer plug inserted if the rinse port is not utilized. (The CETAC Auto Rinse System 2000 is available for automatic rinsing when an autosampler is used). To rinse between samples:

- 1) Remove the male luer plug from the auxiliary rinse port of the sample/rinse adapter (Figure 2: J) with a counter-clockwise twist.
- 2) Attach the male luer, on the end of the gum rubber tubing of the rinse bottle, into the rinse port using a clockwise motion.
- 3) Fill the auxiliary rinse bottle with deionized water.
- 4) Gently squeeze the handle of the bottle a few times to deliver deionized water to the transducer face. Rinse water should splash around the transducer area of the aerosol chamber each time the handle is squeezed.

3.5 Perform ICP Torch Interface

Depending on the ICP manufacturer and the model of the ICP, a torch adapter or spray chamber adapter is supplied for the interfacing of the U-5000AT to the ICP. The torch adapter requires removal of the

pneumatic nebulizer and the spray chamber. The adapter then connects to the bottom of the torch. The spray chamber adapter requires removal of the pneumatic nebulizer and the spray chamber baffle. The spray chamber adapter is then inserted inside the spray chamber.

- 1) If using a torch adapter, the pneumatic nebulizer and the spray chamber must be removed. If using a spray chamber adapter, the pneumatic nebulizer and the spray chamber baffle must be removed leaving the spray chamber in place.
- 2) Mount the spray chamber/torch adapter.
- 3) Make sure that the power is disconnected from the U-5000AT and the heated U-tube is cool before continuing.
- 4) Remove the bronze-colored plastic cover from the U-5000AT.
- 5) Remove the three acorn nuts from the aluminum heat shield. Remove the heat shield by lifting the heat shield off the studs and then sliding it to the right past the ball joint clamp and lift off. This cover is designed for a snug fit to ensure maximum safety.
- 6) Locate the glass sample outlet on the back of the white plastic condenser housing (Figure 1: U).
- 7) Connect the glass sample outlet tube of the U-5000AT to the ICP torch/spray chamber adapter using the 3/16" I.D. Tygon tubing.
- 8) Replace the heat shield and the bronze-colored plastic cover. Ensure the ICP torch has remained properly aligned and located in the induction coil according to the ICP manufacturers instructions.

Connect the nebulizer carrier gas from the ICP instrument to the U-5000AT using the ARGON IN connector (Figure 3: M) and 3/16" I.D. Tygon tubing.

Note:

Some ICPs utilize a pressure switch on the argon nebulizer gas that will not allow the user to reduce the pressure enough to get the 0.7 L/min flow of argon for the U-5000AT. With these ICPs, it is necessary to use an auxiliary flow restrictor between the nebulizer gas supply and the U-5000AT ARGON IN connector for control of the nebulizer argon flow. This flow restrictor will be provided by CETAC when necessary.

4.0 Initial Operation Procedure

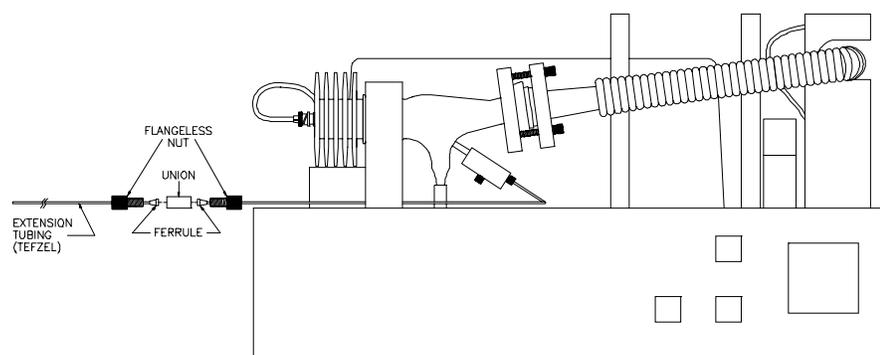
- 1) Verify that the voltage select plug on the U-5000AT is stamped with the proper operating line voltage (100 VAC **or** 115 VAC **or** 230 VAC) (Figure 1: T and Figure 2: P). If the nebulizer is to operate on a voltage other than that stamped on the plug, contact CETAC or an authorized service representative for the proper plug.
- 2) Plug in the power cords for the Constant Temperature Cooling System and the U-5000AT.

Set the CTCS temperature dial to 5 °C and turn on the power switch. It will take approximately 90 minutes to reach this temperature and stabilize. The cooling unit has stabilized when the heater light on the front panel intermittently lights and the thermometer reads 5°C. If the thermometer is not at 5 °C, adjust the temperature dial slightly.

Note:

After initial use of the CTCS, add additional coolant to the reservoir to account for the coolant volume required to fill the U-5000AT condenser and the hoses. Fill to within 1 inch of the top of the CTCS reservoir.

- 4) Adjust the pump speed knob on the rear of the U-5000AT to 3 (Figure 3: G). Ensure the drain pump pressure shoe is engaged.
- 5) Press the red POWER switch of the U-5000AT (Figure 2: S). The red light will illuminate. The temperature controller for the heated U-tube is preset at 140 °C and should stabilize in about 10 minutes (Figure 2: U). The temperature controller has stabilized when the "on" light on the front left of the temperature controller is intermittently lit and the two temperatures on the display both read 140 °C +/- 2 °C. The U-5000AT is equipped with a thermal safety switch (Figure 1: O). The thermal safety switch protects the unit from thermal overload.
- 6) Once the cooling and heating temperatures stabilize at 5 °C and 140 °C, respectively, turn on the nebulizer gas from the ICP and adjust to 0.7 L/min.
- 7) Connect the sample peristaltic pump to the 0.5 mm I.D. Peek sample tubing. If the Peek sample tubing is not long enough to connect to the sample peristaltic pump, a three foot piece of 0.5 mm I.D. Tefzel extension tubing and necessary fittings has been included with the unit. Refer to the illustration below for proper assembly of the fittings.



- 8) Turn on the pump and deliver deionized water at 2.5 mL/min.

Caution

Ensure the transducer cable has not become disconnected. If it has, connect the cable between the connector on the end of the transducer and the connector in the U-5000AT chassis (Figure 1: B,D,E and Figure 2: A).

- 9) Press the yellow OPERATE switch (Figure 2: R). The yellow light will illuminate and a mist should be observed inside the aerosol chamber. The yellow light is an indication of RF power to the transducer. (If this light does not illuminate after the OPERATE switch is pressed, the RF oscillator is not operating. Refer to Appendix 2 of this manual).
- 10) Prepare 250 mL of a 0.5% (v/v) solution of hydrofluoric acid and nebulize it for 20 to 30 seconds. The mist in the aerosol chamber should be dense at this point. If not, refer to Appendix 2 of this manual.

Note:

Although this dilute hydrofluoric acid will not harm the glassware system of the U-5000AT or the ICP when nebulized for short periods, it should only be used when the transducer face becomes dirty, which is evidenced by a weak or intermittent mist. Reserve the remaining solution for future use.

- 11) Begin to nebulize deionized water.
- 12) Adjust the PUMP SPEED knob (Figure 3: G) on the back of the U-5000AT such that the drain pump draws out excess sample solution faster than the sample pump is delivering the sample.

If the pump speed is too slow, the aerosol chamber (Figure 2: V) will begin to fill with liquid. Should this occur, press the FAST PUMP switch; the green light will illuminate (Figure 2: T). After the excess liquid has been removed from the aerosol chamber drain tube, press the green switch again; the green light will go out and the pump will return to its previous speed. At this point, increase the PUMP SPEED to prevent excess solution from collecting in the spray chamber.

- 13) Turn off the yellow OPERATE switch, the sample peristaltic pump, and the nebulizer gas supply to the ICP.

5.0 ICP Operation

- 1) Ignite the ICP plasma as instructed in the ICP operating manual. The nebulizer gas flow rate should be set at 0.7 L/min.
- 2) Press the yellow OPERATE switch to energize the transducer of the U-5000AT.
- 3) Begin aspirating a 100 µg/mL solution of yttrium into the plasma. The emission color and intensity in the plasma should be similar to that found when 1000 µg/mL of yttrium aspirated with a pneumatic nebulizer. If the yttrium emission is weak, check for gas leaks in the U-5000AT/ICP system.

6.0 System Optimization

It may be necessary to optimize the ICP system after installation of the ultrasonic nebulizer. Optimization procedures may include adjustment of the nebulizer gas and the auxiliary gas flow rates, the sample uptake rate, the plasma gas flow rate and the viewing height. Usually the signal-to-noise ratio or signal-to-background ratio is the primary criterion for optimization. During optimization, ensure the plasma is properly sustained. Extreme conditions which may cause unstable plasma formation, torch erosion, or high reflected power should be avoided. For detailed instructions on system optimization, refer to Appendix 1 in the back of this manual. After the system has been optimized, the ultrasonic nebulizer is ready for routine operation.

7.0 Routine Operation

7.1 Start-up Procedure

- 1) If the constant temperature cooling system is off, turn it on and let the temperature stabilize (approximately 90 minutes).
- 2) Press the POWER switch of the U-5000AT. The heated U-tube temperature should stabilize in about 10 minutes.
- 3) Initiate the plasma according to the ICP operating manual. Adjust the ICP operating conditions to previously optimized values.
- 4) Press the OPERATE switch.
- 5) Turn on the sample peristaltic pump and deliver deionized water to the transducer. The ultrasonic nebulizer should stabilize in about 15 minutes. If necessary, aspirate the dilute hydrofluoric solution to achieve a dense aerosol. The ultrasonic nebulizer is now ready for routine analysis.

7.2 Shutdown Procedure

- 1) Aspirate deionized water for at least 3 minutes. Momentarily rinse the entire transducer faceplate and its surrounding area by introducing water through the auxiliary rinse port of the aerosol chamber (Figure 2: J). This procedure prevents accumulation of corrosive liquid samples on the transducer faceplate and the glassware.
- 2) Turn off the sample peristaltic pump and let the nebulizer run dry for about 15 seconds.
- 3) Turn off the OPERATE switch.
- 4) Press the FAST PUMP switch and allow the pump to drain all liquid from the system. All the liquid will be drained when no liquid can be seen flowing out of the drain tubing.
- 5) Turn off the green FAST PUMP switch followed by the red POWER switch. If desired, the CTCS may be left on overnight to eliminate the 90 minute cool-down time.
- 6) Turn off the plasma and the gas supplies according to the ICP system operating manual.

8.0 Maintenance

Caution

The U-5000AT should be turned off and the power cord unplugged before performing any maintenance on the instrument!

8.1 Transducer Assembly Removal

- 1) Turn off the ultrasonic nebulizer and the ICP as described in the shutdown procedure.
- 2) Disconnect the transducer cable connector from the end of the transducer assembly (Figure 1: D).

Note:

The orientation of the assembly and the transducer mounting screws before removal so that the new transducer can be oriented the same way!

- 3) Pull out the hex-head transducer wrench stored in the U-5000AT chassis (Figure 1: F). Hold the transducer assembly firmly with one hand and remove the three spring-loaded socket head screws using the wrench.
- 4) Carefully slide the transducer assembly and the O-ring from the aerosol chamber. Wipe off any droplets in the opening of the aerosol chamber without touching the fragile glass sample tube.

8.2 Transducer Assembly Installation

- 1) The spare transducer assembly and screw/spring set are packaged in a protective handling box which should not be discarded. Remove the spare transducer from the box and ensure the transducer face is clean. This can be accomplished by gently wiping the crystal face with a water moistened lint-free tissue.
- 2) Place the O-ring back into the aerosol chamber and ensure the O-ring is smoothly seated against the glass bezel inside.
- 3) Align the spare transducer assembly with the screw holes in the aerosol chamber stand and slide it into the aerosol chamber.

Hold the transducer assembly with one hand and replace the spring-loaded socket head screws. The heads of the screws should be flush

with the second fin (from the cable connector end) of the transducer heat sink.

Caution

Do not over tighten the screws! Proper seating of the O-ring can be observed through the aerosol chamber.

- 5) Reconnect the transducer cable connector to the end of the transducer assembly and replace the transducer wrench.

8.3 RF Circuit Breaker

The RF circuit breaker will trip if an open circuit occurs anywhere in the RF cable and the OPERATE switch is on. If an open does occur the RF circuit breaker will trip in approximately seven seconds. The RF circuit breaker is located on the right rear of the unit under the square black heat sink (Figure 3: C). To reset the RF circuit breaker:

- 1) Turn the unit off.
- 2) Check to ensure the RF cable between the transducer heat sink and the U-5000AT chassis is installed and securely connected (Figure 1: B,D,E and Figure 2: A).
- 3) Reset the RF circuit breaker by simply pressing the plastic mechanism in until it latches.
- 4) Attempt to operate the unit. If the RF circuit breaker subsequently trips, contact your authorized service representative or CETAC.

8.4 Main Fuse Replacement

The main fuses are located in the rear of the unit and are part of the power cord connector (Figure 3: E).

- 1) Turn off the unit and unplug the power cord.
- 2) Use a small flat blade screwdriver to pop open the fuse holder.
- 3) Replace the defective fuse with a GMC 5A, 125V slo-blow if operating on 100/115 VAC or a GMC 2.5A, 250V slo-blow if operating on 230 VAC.

Caution

Use of a different fuse other than the one specified can damage the electrical components of the U-5000AT!.

- 4) Replace the power cord and attempt to operate the unit. If the new fuse subsequently blows, contact your authorized service representative or CETAC.

8.5 Pump Tubing Replacement

Phar-Med tubing (3/32" I.D., 1/32" wall) is used for the peristaltic drain pump. This tubing may be purchased pre-cut from CETAC.

- 1) Unlatch the pressure shoe.
- 2) Remove the old pump tubing by snapping the tubing connectors out of the tubing keeper (Figure 3: I).
- 3) If the tubing is not ordered from CETAC, cut 2 3-3/4" long pieces using a razor blade. Attach the plastic connectors.
- 4) Place the new tubing with connectors in the tubing keeper. Firmly press the connector into the tubing keeper slot until it locks into place.

8.6 Drain Tubing Replacement

- 1) To replace the drain tubing, turn off the operate switch and the sample peristaltic pump.
- 2) Turn on the FAST PUMP switch and pump all liquid from the system.
- 3) Turn off the U-5000AT and unplug the power cord and all external tubing and hoses.
- 4) Remove the brown-colored plastic cover. Carefully turn the unit upside down. Support the unit under the white plastic condenser using a book, for example, to make the bottom of the unit level.

Use a flat blade screwdriver to turn each of the four fasteners 1/4 turn counterclockwise and remove the small cover.

Caution

Remove only the small cover! A tubing diagram is located inside this cover. Note that only the tubing connected to the aerosol chamber drain and the condenser drains is replaceable.

- 6) Remove the old drain tubing from the glass drains by carefully using a razor blade to slit the tubing for easier removal.

- 7) Using 1/8" I.D. Tygon tubing, cut new tubing to the same length as the old. To install the new tubing, moisten one end with water and stretch that end with a tubing stretcher or needle nose pliers. **Do not stretch the tubing on the end that attaches to the plastic tubing connectors!**

Carefully push the tubing onto each glass drain until it stops. Each piece of tubing should be pushed on at least 1/4".

Caution

Do not force the tubing, it may break the glass connectors!

- 9 Connect the other end of the tubing to the appropriate "T" or tubing connector.
- 10) After changing the tubing, replace the cover. Ensure that each of the fasteners is locked in.
- 11) Turn the unit right side up, replace the covers, and reconnect all tubing and hoses.
- 12) Plug in the power cord.

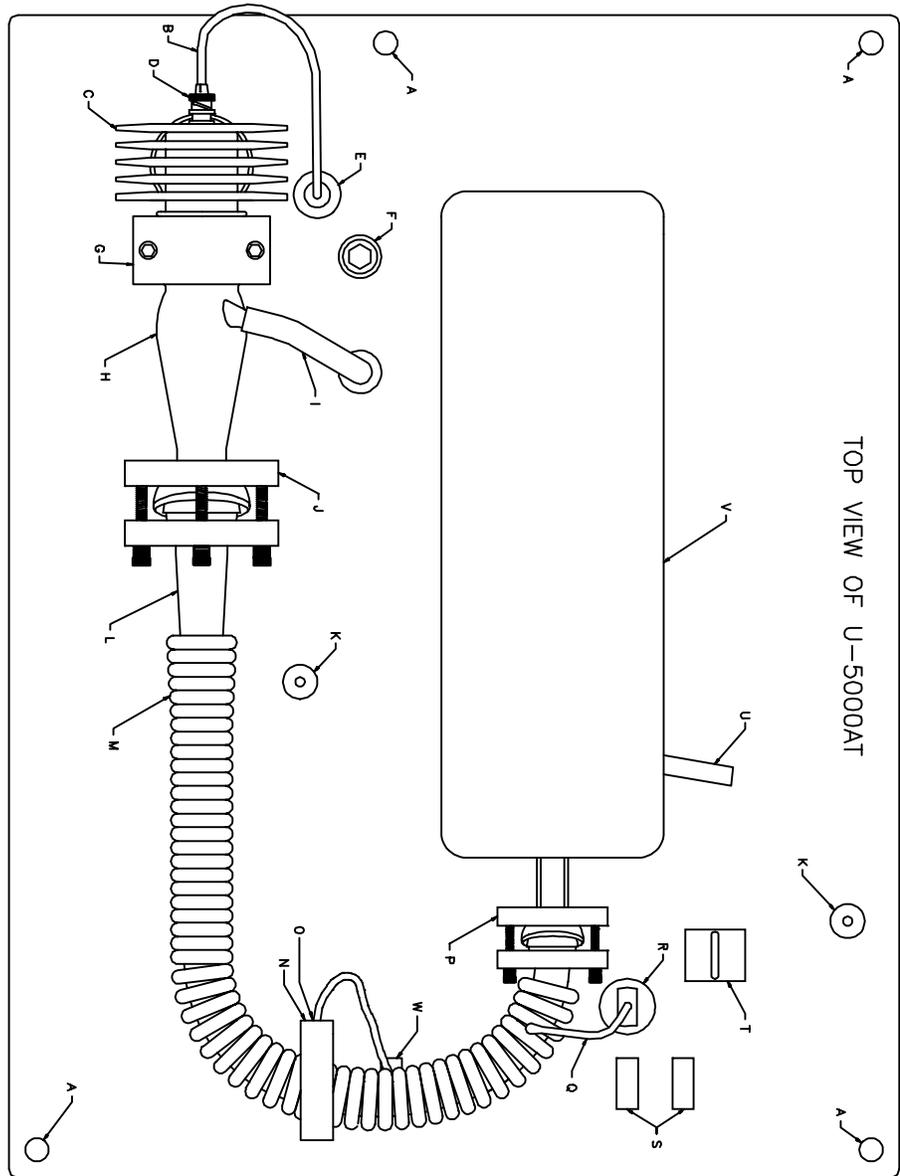


Figure 1.

Top View of the U-5000AT Ultrasonic Nebulizer (Figure 1)

- A) Lexan cover guides.
- B) Transducer RF cable.
- C) Transducer heat sink.
- D) Transducer cable connector.
- E) Chassis cable connector.
- F) Heat shield/transducer wrench.
- G) Aerosol chamber stand.
- H) Aerosol chamber.
- I) Argon carrier gas tubing.
- J) Teflon 28/15 ball/socket clamp.
- K) Aluminum heat shield support post.
- L) Glass U-tube.
- M) U-tube heat cords.
- N) Teflon U-tube support.
- O) Thermal safety switch.
- P) Teflon 18/9 ball/socket clamp.
- Q) Thermocouple wire.
- R) Thermocouple socket.
- S) Heat cord plugs.
- T) Voltage select plug.
- U) Glass sample outlet tube.
- V) Condenser box.
- W) Thermal safety switch plug.

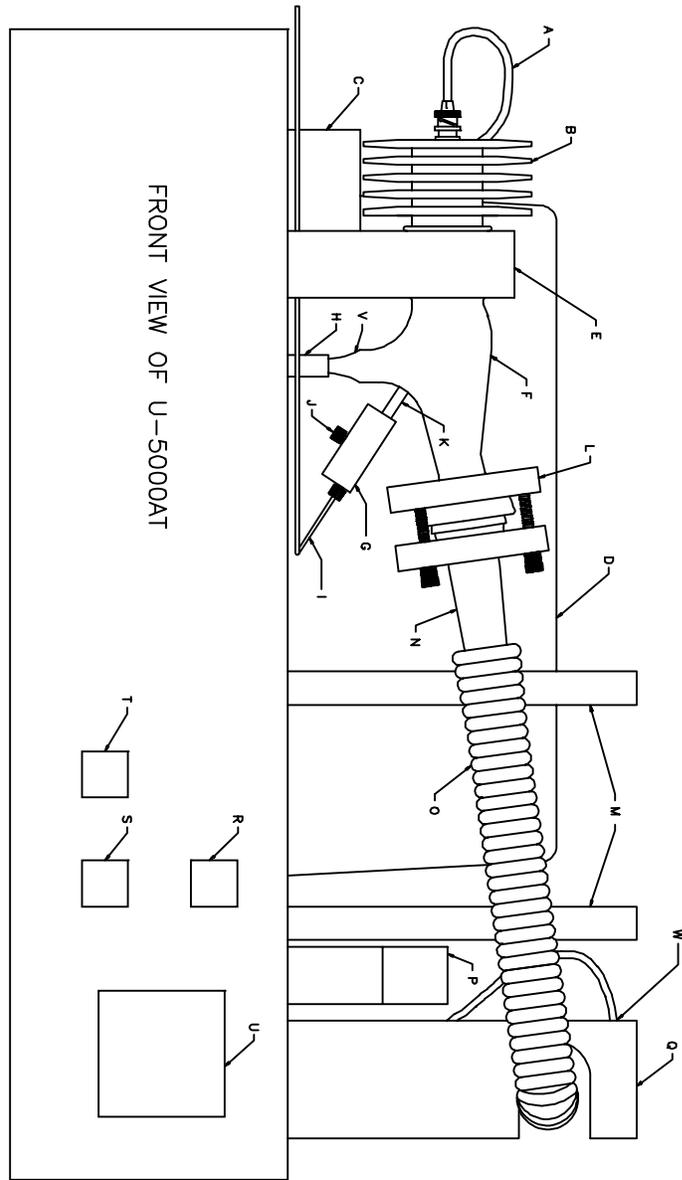
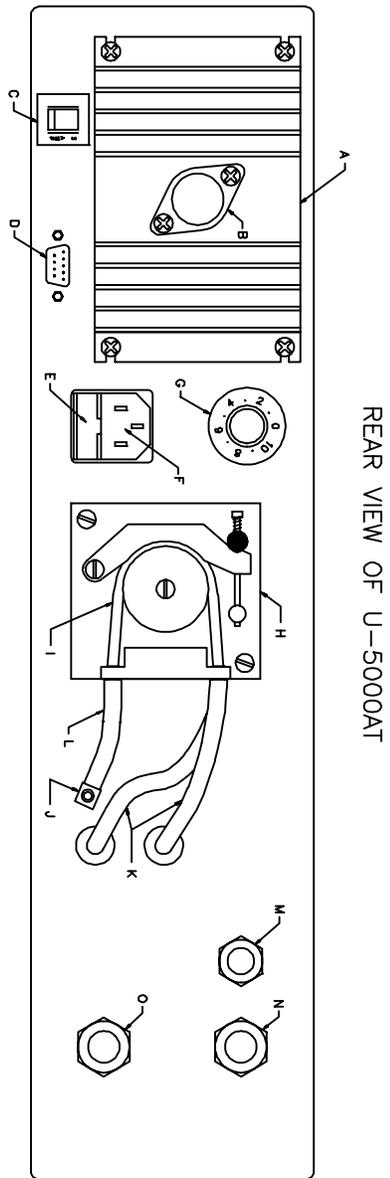


Figure 2.

**Front View of the U-5000AT Ultrasonic Nebulizer
(Figure 2)**

- A) Transducer cable.
- B) Transducer heat sink.
- C) Transducer cooling chimney.
- D) Condenser box.
- E) Aerosol chamber stand.
- F) Glass aerosol chamber.
- G) Sample/rinse adapter.
- H) Aerosol chamber drain tubing.
- I) PEEK sample tubing.
- J) Auxiliary rinse port.
- K) Glass sample inlet tube.
- L) Teflon 28/15 ball/socket clamp.
- M) Aluminum heat shield support post.
- N) Glass U-tube.
- O) U-tube heat cords.
- P) Voltage select plug.
- Q) Teflon U-tube support.
- R) Operate switch.
- S) Power switch.
- T) Fast pump switch.
- U) Temperature controller.
- V) Aerosol chamber glass drain tube.
- W) Thermal safety switch.



REAR VIEW OF U-5000AT

Figure 3.

**Rear View of the U-5000AT Ultrasonic Nebulizer
(Figure 3)**

- A) Transistor heat sink.
- B) Transistor.
- C) RF circuit breaker.
- D) External connector.
- E) Main fuse holder.
- F) AC power cord connector.
- G) Pump speed knob.
- H) Drain pump assembly.
- I) Drain pump tubing.
- J) "T" fitting.
- K) Tygon drain tubing from U-5000AT.
- L) Tygon drain tubing to waste bottle.
- M) Argon in connector.
- N) Coolant in connector.
- O) Coolant out connector.

Appendices

Appendix 1. ICP/U-5000AT Optimization Procedure

- 1) Recommended operating conditions and operating ranges for aqueous sample analysis:

	Normal Condition	Range
ICP forward power	1200 W	800-1500 W
Outer gas flow rate (plasma)	15 L/min	12-20 L/min
Intermediate gas flow rate (auxiliary)	0.5 L/min	0.0-2.0 L/min
Injector gas flow rate (nebulizer)	0.7 L/min	0.3-1.5 L/min
Observation height	15 mm	10-20 mm
U-5000AT sample uptake rate	2.5 mL/min	1.0-3.0 mL/m
U-5000AT heating temp.	140° C	60-180° C
U-5000AT cooling temp.	5° C	0-15° C

- 2) Optimization of the ICP and the USN systems may be necessary to achieve the optimum sensitivity for specific elements in various aqueous samples. S/B ratios or S/N ratios may be used as the objective function for optimization procedures.
- 3) For the initial start-up procedure, the recommended operating conditions listed above may be used. These parameters represent compromise operating conditions for most elements and most aqueous samples and may be used satisfactorily for many applications. Optimum conditions may vary, depending upon the ICP system used.

The recommended operating ranges for the ICP and the USN are also listed above. **The most sensitive operating parameters are injector gas flow, forward power, and observation height; these particular parameters should be the first optimized.** Optimization of other parameters is usually not required; they are usually preset to the nominal values listed above.

- 5) Simplex optimization may be used to optimize all the above parameters simultaneously. The above ranges of operating conditions may be used as the boundary limits of the simplex method.

Note:

An optimization data sheet has been included on the following page.

The parameters specified are for a standard ICP torch.

Conditions will vary for instruments utilizing low gas flow torches or for ICP/MS instruments.

Appendix 2. Troubleshooting		
Problem	Possible Cause	Solution
Poor and / or unstable mist generation.	Sample inlet tubing improperly cut or adjusted.	Readjust or cut sample inlet tubing as described in section 3.4.
	Sample uptake rate too low.	Readjust.
	Nebulizer gas too high	Readjust.
	Transducer face dirty.	Clean transducer face as described in the INITIAL OPERATION section.
	Transducer failure	Replace transducer as described in the MAINTENANCE section.
Power lamp does not illuminate. Heat controller does not illuminate.	Power cord not plugged into AC wall outlet.	Plug power cord into AC wall outlet.
	Main fuse blown.	Install a new main fuse as described in the MAINTENANCE section.
Power lamp does not illuminate/ Heat controller DOES illuminate.	Voltage select plug not installed.	Install correct voltage select plug for either 115VAC or 230VAC. NOTE: Install a 2.5A, 250V slo-blo fuse if using 230VAC or a 5A, 125V slo-blo if using 115VAC, into main fuse holder.
Top display of heat controller reads EEE/heat cords do not warm up.	Thermocouple connector not plugged into U-5000AT chassis. Break in thermocouple wire.	Contact service representative.
Operate lamp does not illuminate, no aerosol present.	RF circuit breaker tripped (opens).	Reset circuit breaker as described in the MAINTENANCE section.
Water backing up into aerosol chamber.	Drain system not functioning properly.	Refer to the INITIAL OPERATION section.
Plasma flickers excessively/ is unstable.	Condenser drain system not functioning properly.	Refer to INITIAL OPERATION section.
	Water in sample out transfer tubing to ICP.	Ensure CTCS is on and set at 5°C.
During operation heat controller display stops illuminating.	Thermal safety switch tripped due to excessive temperature.	Contact service representative.
<p>CAUTION: If a fuse is replaced and subsequently blows again, contact CETAC or your authorized service representative.</p> <p>Any other problems? Contact CETAC Technologies Inc. (U.S.A.) directly. Phone: (800) 369-2822 Fax: (402) 733-5292</p>		

Appendix 3. Packaging Check List

Container 1:

- Instruction manual and warranty card
- U-5000AT Ultrasonic Nebulizer (1)
- Plastic U-5000AT protective cover (1)
- Insulated coolant hoses (2)

Container 2:

- Waste bottle (1)
- U-5000AT power cord (1)
- Torch and/or spray chamber adapter
- Spare Transducer (1)
- Sample out tubing (3/16"/4.8mm I.D.) Tygon (5'/152.4mm)
- Argon in tubing (3/16"/4.8mm I.D.) Tygon (5'/152.4mm)
- Drain tubing (1/8"/3.2mm I.D.) Tygon (5'/152.4mm)
- Argon in tubing connector (1)
- Auxiliary rinse bottle with tubing.
- Peristaltic pump tubing (1.30mm I.D.) (3)
- Tefzel sample inlet tubing (0.5mm I.D.) (1)
- Extension tubing kit (union, flangeless nut (2), ferrule (2), Tefzel tubing (3'/91.4mm))
- Replacement drain pump tubing (2)
- Spare drain pump tubing connector (4)
- Spare male luer plug (auxiliary rinse port) (1)
- Spare sample inlet tubing ferrule (1)
- Spare fuse, main power, GMC 5A, 250V, slo-blo used only for 100/115VAC operation
- Spare fuse, main power, GMC 2.5A, 250V, slo-blo used only for 230VAC operation

Container 3:

- Constant Temperature Cooling System (CTCS) (1)
- Instruction manual and warranty card

Container 4:

- Utility cart (1)
- Instruction sheet

Optional Accessories

- Acid-proof O-ring kit (resistant to concentrated acid)
- Organics tubing kit
- Auto Rinse 2000 (automatic auxiliary rinsing system)

Other items needed for installation (not provided)

- 5 L ethylene glycol/water mixture (or antifreeze coolant/water mixture, 1:1 by volume)
- Sharp razor blade
- Flat blade screwdriver
- Wash bottle with deionized (DI) water
- 250 mL of 0.5% (v/v) hydrofluoric acid rinse solution
- 250 mL of 100 ppm yttrium check solution
- High precision peristaltic pump

