
***U-6000AT⁺ Ultrasonic Nebulizer /
Membrane Desolvator Operator's
Manual***

Product Warranty Statement

SD Acquisition, Inc., DBA CETAC Technologies ("CETAC"), warrants any CETAC unit manufactured or supplied by CETAC for a period beginning on the date of shipment and ending on the sooner to occur of: (a) the date that is twelve (12) months from the date of installation, or (b) the date that is thirteen (13) months from the date of shipment. Units found in the reasonable judgement of CETAC to be defective in material or workmanship will be repaired or replaced by CETAC without charge for parts and labor. CETAC reserves the right to change or improve the design of any unit without assuming any obligation to modify any unit previously manufactured.

This warranty does not cover any unit that has been subject to misuse, neglect, negligence, or accident. The warranty does not apply to any damage to the unit that is the result of improper installation or maintenance, or to any unit that has been operated or maintained in any way contrary to the instructions specified in the CETAC instruction and operation manual. Operation of the CETAC unit inside a laboratory fume hood is contra-indicated and will void the warranty. Any attempt to repair or alter any CETAC unit by anyone other than by CETAC authorized personnel or agents will void this warranty. If any non-CETAC component is installed in the CETAC manufactured unit without the approval of CETAC, the warranty will be voided. In addition, this warranty does not extend to repairs made necessary by the use of parts, accessories or fluids which are either incompatible with the unit or adversely affect its operation, performance or durability. CETAC'S obligation under this warranty is strictly and exclusively limited to repair or replacement of defective CETAC parts, and no claim of breach of warranty shall be cause for cancellation or rescission of the contract of sale of any unit.

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Purchaser shall indemnify CETAC against any claim or liability which may be asserted as relates to the following: (i) the use to which any product supplied hereunder is put infringes the patent, copyright or other intellectual property rights of any third party; or (ii) any liability resulting from the failure by Purchaser to observe the terms of this Warranty.

Returned Product Procedures

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. CETAC must be notified within ninety (90) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from CETAC. No replacements will be provided nor repairs made for products returned without such approval. Any returned product must be accompanied by a return authorization number. The expense of returning the unit to CETAC for service will be paid by the buyer. The status of any product returned later than thirty (30) days after issuance of a return authorization number will be subject to review. Shipment of repaired products will generally be made forty eight (48) hours after the receipt.

Products may not be returned which are contaminated by radioactive materials, infectious agents, or other materials constituting health hazards to CETAC employees.

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If an out of warranty defect exists, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of repair and freight, or authorize the products to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number approval within fifteen (15) days of notification will result in the products being returned as is, at the buyers expense.

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CETAC Technologies
Customer Service & Support
14306 Industrial Road
Omaha, Nebraska 68144, USA
Phone (800) 369-2822 (USA only)
Phone (402) 733-2829
Fax (402) 733-1932
E-mail custserv@cetac.com

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CETAC Technologies strives to provide the scientific community with an unparalleled combination of effective technology and continuing value. Modular upgrades for existing instruments will continue to be a prime consideration as designs progress.

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SAFETY

Instruments, accessories, components or other associated materials **may not** be returned to CETAC Technologies if contaminated with biohazard or radioactive materials, infectious agents, or any other materials and/or conditions that could constitute a health or injury hazard to CETAC employees. Call Customer Service and Support if there is any question or doubt relative to decontamination requirements. CAUTION and WARNING statements, as applied in this document, shall be interpreted consistent with the following context: CAUTION applies only to potential property damage conditions; WARNING applies to potential personal injury conditions, in combination with or exclusive of potential property damage.

All user-serviceable components are specifically identified in this document as such; the balance shall be assumed to require the expertise of a factory service technician/engineer for adjustment, repair, replacement, modification, etc. Others not so qualified and performing these actions **shall do so at their own risk**. Furthermore, never operate the instrument without first reading and understanding the *U-6000AT Ultrasonic Nebulizer / Membrane Desolvator Operator's Manual*, and ensuring that it is operated safely and properly.

ORIGINAL PACKAGING

Retain original factory packaging for moves and factory return shipments. Shipping in anything other than the original fitted foam and container can result in incidental damage from which the purchaser will not be protected under warranty.

WARNING

Under all conditions the user must observe safe laboratory procedures during the operation of this product.

Notices and Compliance Declarations

**FEDERAL COMMUNICATIONS
COMMISSION (FCC) NOTICE**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential environment is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

MODIFICATIONS

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by CETAC Technologies, Inc. may void the user's authority to operate the equipment.

CABLES

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods to maintain compliance with FCC Rules and Regulations.

CANADIAN NOTICE

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the interference-causing equipment standard entitled "Digital Apparatus." ICES-003 of the Department of Communications.

AVIS CANADIEN

Cet appareil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe A prescrites dans la norme sur le matériel brouilleur: "Appareils Numériques," NMB-003 édictée par le ministre des Communications.

Notices and Compliance Declarations

POWER CORD SET REQUIREMENTS

The power cord set supplied with your instrument meets the requirements of the country where you purchased the instrument.

If you use the instrument in another country, you must use a power cord set that meets the requirements of that country.

WARNING

This equipment is designed for connection to a grounded (earthed) outlet. The grounding type plug is an important safety feature. To reduce the risk of electrical shock or damage to the instrument, do not disable this feature.

CAUTION

To reduce the risk of fire hazard and electrical shock, do not expose the unit to rain or humidity. To reduce the risk of electrical shock, do not open the cabinet. All maintenance is to be performed by an Authorized CETAC Service Provider.

Protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.

CLEANING INSTRUCTIONS

To clean the exterior surfaces of the instrument, complete the following steps:

- | | |
|---|--|
| 1 Shut down and unplug the instrument. | 3 Repeat step 2, using a towel dampened with clear water. |
| 2 Wipe the instrument exterior surfaces only using a towel dampened with a lab-grade cleaning agent. | 4 Dry the instrument exterior using a dry towel. |

WARNING

Do not allow any liquid to enter the instrument cabinet, or come into contact with any electrical components. The instrument must be thoroughly dry before you reconnect power, or turn the instrument on.

COOLING FAN OBSTRUCTION

The instrument cooling fan(s) shall remain unobstructed at all times. Do not operate the instrument if the cooling fan(s) are blocked or obstructed in any manner.

ENVIRONMENTAL


Operating Temperature:	10° to 30°C
Relative Humidity	0% to 95%


Operator's Manual Addendum
Notices and Compliance Declarations

WARNING
 FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH FUSES OF THE SPECIFIED TYPE AND CURRENT RATING.


FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH FUSES OF THE SPECIFIED TYPE AND CURRENT RATING.

⚠ AVERTISSEMENT
 POUR UNE PROTECTION CONTINUÉE CONTRE LES RISQUES D'INCENDIE, REMPLACER UNIQUEMENT PAR DES FUSIBLES DE MÊME TYPE ET AMPÉRAGE.

 **⚠ WARNING**
 DO NOT REACH UNDER OR BEHIND OVEN HEAT SHIELDS. KEEP FRONT CABINET DOOR TIGHTLY FASTENED TO PROTECT AGAINST SKIN BURN.


 **⚠ WARNING**
 DO NOT REACH UNDER OR BEHIND OVEN HEAT SHIELDS. KEEP FRONT CABINET DOOR TIGHTLY FASTENED TO PROTECT AGAINST SKIN BURN.

⚠ AVERTISSEMENT
 NE PAS GLISSER LA MAIN SOUS OU DÈRE LES ÉCRANS THERMIQUES DU FOUR. GARDER LA PORTE D'ACCÈS AU DEVANT DU BOÎTIER BIEN FERMÉE POUR ASSURER LA PROTECTION CONTRE LES BRÛLURES

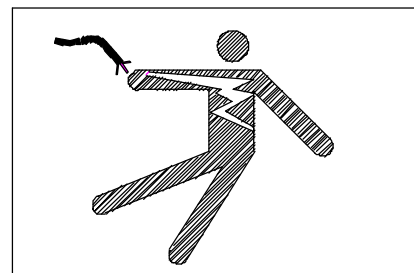
 **⚠ WARNING**
 THIS INSTRUMENT CONTAINS ELECTRICAL CIRCUITS, DEVICES, AND COMPONENTS OPERATING AT DANGEROUS VOLTAGES. CONTACT WITH THESE CIRCUITS, DEVICES, AND COMPONENTS CAN CAUSE DEATH, SERIOUS INJURY, OR PAINFUL ELECTRICAL SHOCK.
 OPERATORS AND OTHER UNAUTHORIZED PERSONNEL MUST NEVER OPEN THE MAIN COVER. THE MAIN COVER OF THIS INSTRUMENT MUST ONLY BE OPENED BY TRAINED, QUALIFIED, OR APPROVED SERVICE ENGINEERS.

⚠ AVERTISSEMENT
 TOUT CONTACT AVEC LES HAUTES TENSIONS PEUT ENTRAÎNER LA MORT OU DES BLESSURES SÉVÈRES. CE

PANNEAU NE DOIT ÊTRE ENLEVÉ QUE PAR UN RÉPARATEUR QUALIFIÉ.

 **⚠ WARNING**
 THIS INSTRUMENT CONTAINS ELECTRICAL CIRCUITS, DEVICES, AND COMPONENTS OPERATING AT DANGEROUS VOLTAGES. CONTACT WITH THESE CIRCUITS, DEVICES, AND COMPONENTS CAN CAUSE DEATH, SERIOUS INJURY, OR PAINFUL ELECTRICAL SHOCK.
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⚠ WARNING
 CONTACT WITH DANGEROUS VOLTAGES CAN CAUSE DEATH OR INJURY. COVER TO BE REMOVED ONLY BY TRAINED SERVICE PERSONNEL.

⚠ AVERTISSEMENT
 TOUT CONTACT AVEC LES HAUTES TENSIONS PEUT ENTRAÎNER LA MORT OU DES BLESSURES SÉVÈRES. CE PANNEAU NE DOIT ÊTRE ENLEVÉ QUE PAR UN RÉPARATEUR QUALIFIÉ.

Notices and Compliance Declarations



WARNING
 CONTACT WITH DANGEROUS VOLTAGES CAN CAUSE DEATH OR INJURY. COVER TO BE REMOVED ONLY BY TRAINED SERVICE PERSONNEL.


AVERTISSEMENT

TOUT CONTACT AVEC LES HAUTES TENSIONS PEUT ENTRAINER LA MORT OU DES BLESSURES SÉVÈRES. CE PANNEAU NE DOIT ÊTRE ENLEVÉ QUE PAR UN RÉPARATEUR QUALIFIÉ.


WARNING
 HIGH LEAKAGE CURRENT - ENSURE PROPER GROUNDING

AVERTISSEMENT

COURANT DE FUITE ÉLEVÉ — FOURNIR UNE MISE À LA TERRE EFFICACE.









WARNING
 HOT GLASS AND METAL SURFACES INSIDE. KEEP LID TIGHTLY FASTENED TO PROTECT AGAINST SKIN BURN.
 FOR ACCESS, SET OVEN TEMPERATURE TO ZERO (OFF), OPEN LID, AND ALLOW TO COOL 5 MINUTES BEFORE TOUCHING GLASS TUBES OR INTERIOR METAL SURFACES.



WARNING
 HOT GLASS AND METAL SURFACES INSIDE. KEEP LID TIGHTLY FASTENED TO PROTECT AGAINST SKIN BURN.
 FOR ACCESS, SET OVEN TEMPERATURE TO ZERO (OFF), OPEN LID, AND ALLOW TO COOL 5 MINUTES BEFORE TOUCHING GLASS TUBES OR INTERIOR METAL SURFACES.

AVERTISSEMENT

SURFACES CHAUDES, LAISSER LE COUVERCLE HERMÉTIQUEMENT FERMÉ.
 POUR ACCÉDER, METTRE LA TEMPÉRATURE DU FOUR À ZÉRO, OUVRIR LE COUVERCLE ET LAISSER REFROIDIR 5 MINUTES AVANT DE TOUCHER LA VERRERIE OU TOUTE SURFACE MÉTALLIQUE INTÉRIEURE.

	<p>WARNING FOR CONTINUED PROTECTION AGAINST: * ELECTRICAL SHOCK</p>		<p>WARNING FOR CONTINUED PROTECTION AGAINST: * ELECTRICAL SHOCK</p>
	<p>* EYE DAMAGE (UV RADIATION)</p>		<p>* EYE DAMAGE (UV RADIATION)</p>
	<p>* SKIN BURNS</p>		<p>* SKIN BURNS</p>
<p>KEEP COVER FASTENED WHEN POWER IS ON. ALLOW TO COOL 5 MIN. (MAIN POWER OFF) BEFORE REMOVING COVER.</p>		<p>KEEP COVER FASTENED WHEN POWER IS ON. ALLOW TO COOL 5 MIN. (MAIN POWER OFF) BEFORE REMOVING COVER.</p>	

AVERTISSEMENT

POUR LA PROTECTION PERMANENTE CONTRE UN CHOC ÉLECTRIQUE, UNE BRÛLURE DES YEUX (RADIATION UV) OU DE LA PEAU, LAISSER LE COUVERCLE HERMÉTIQUEMENT FERMÉ LORSQUE L'APPAREIL EST SOUS TENSION.
 LAISSER REFROIDIR 5 MINUTES (APPAREIL ÉTEINT) AVANT D'ENLEVER LE COUVERCLE.

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U-6000AT⁺ Ultrasonic Nebulizer / Membrane Desolvator Operator's Manual

Contents

Preface

Preface

The *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator Operator's Manual* explains the procedures for installing, using, and maintaining the CETAC U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator. It also provides information about troubleshooting minor U-6000AT⁺ problems and describes the design of the system.

Who Should Read This Book

The primary audience for the *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator Operator's Manual* consists of analytical chemists and lab technicians. To use this manual effectively, you should have a strong knowledge of chemistry, a basic knowledge of electronic sampling equipment, at least a beginning level of computer experience, and working knowledge of an ICP-AES or ICP-MS.

How to Use This Book

The *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator Operator's Manual* contains seven chapters. You should read the chapters sequentially the first time. Thereafter, refer to the chapters separately as needed. The first chapter provides an introduction to the Ultrasonic Nebulizer/Membrane Desolvator. Subsequent chapters detail the primary tasks associated with the U-6000AT⁺.

The *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator Operator's Manual* contains the following chapters:

Chapter 1, "Introduction," provides you with an overview of the *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator's* function and design.

Chapter 2, "Preparing for Installation," discusses space and power requirements that must be met before the U-6000AT⁺ is installed. It also provides instructions for unpacking the Ultrasonic Nebulizer/Membrane Desolvator and ICP requirements.

Chapter 3, "Installing the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator," provides step-by-step procedures for installing the U-6000AT⁺ and connecting it to the analytical instrument.

Chapter 4, "Verifying Installation," explains initial operation of the U-6000AT⁺, ICP operation and system optimization.

Chapter 5, "Using the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator," describes the tasks you perform during daily operation of the U-6000AT⁺.

Chapter 6, "Maintaining the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator," explains daily, weekly, and periodic maintenance tasks.

Chapter 7, "Troubleshooting the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator," describes how to diagnose and correct minor U-6000AT⁺ and ICP problems.

Conventions Used in This Book

This book uses certain conventions to distinguish different types of information easily. This section describes these conventions.

Instructions

All step-by-step instructions are numbered and in bold, as in the following example.

1 Remove the sample/rinse adapter (G) from the glass inlet tube...

Preface

Many numbered instructions are followed by more detailed explanations.

Terminology

This book frequently uses the following terms:

<i>U-6000AT⁺</i>	Ultrasonic Nebulizer / Membrane Desolvator
<i>ICP-AES</i>	An inductively coupled plasma atomic emission spectrometer
<i>ICP-MS</i>	An inductively coupled plasma mass spectrometer
<i>Hz</i>	Hertz
<i>ID</i>	inside diameter
<i>LED</i>	Light-emitting diode
<i>PEEK</i>	Polyetheretherketone
<i>PTFE</i>	Polytetraflouroethylene
<i>PSI</i>	Pounds per square inch
<i>VAC</i>	Volts alternating current
<i>VDC</i>	Volts direct current

Notes

Notes contain a reminder about the effect of particular actions. They are indicated as follows:

Note:

This example shows how a note is displayed.

Cautions

Cautions indicate situations that require immediate attention to prevent harm to the Ultrasonic Nebulizer/Membrane Desolvator. Cautions are indicated as follows:

CAUTION

This example shows how a caution is displayed.

Warnings

Warnings indicate situations that could cause bodily harm. Warnings are indicated as follows:

WARNING

This example shows how a warning is displayed.

Where to Go for More Information

In addition to the *U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator Operator's Manual*, you can refer to the following resources:

- the software manual for the ICP instrument you are using
- CETAC Technologies Customer Service and Support:
 - 1 (800) 369-2822
 - 1 (402) 733-2829
 - 1 (402) 733-5292 (Fax)

Preface

1

Introduction

Introduction

The U-6000AT⁺ is a tandem sample introduction system for ICP spectroscopy. The U-6000AT⁺ may be operated with the ultrasonic nebulizer alone or in combination with the membrane desolvator, depending on the user's requirements.

The ultrasonic nebulizer improves detection limits by enhancing analyte transport efficiency and reducing solvent loading to the plasma. Compared to pneumatic nebulization, detection of sample analytes is typically improved by an order of magnitude with the ultrasonic nebulizer. Nevertheless, some solvent loading (such as water, organics) may still occur with the ultrasonic nebulizer alone. Injected water vapor causes oxide and hydride polyatomic ion interferences in ICP-MS. Organic solvent vapor loading causes carbide polyatomic ion interferences in ICP-MS as well as plasma instability and carbon deposition on sampling cones. In addition, organic solvent loading can cause elevated emission background, compromising detection by ICP-AES.

In operation, liquid sample is pumped onto the face of the piezoelectric transducer of the ultrasonic nebulizer where it is converted to a fine, dense aerosol. The nebulizer gas flow transports the wet aerosol through the heated U-tube where the solvent is vaporized. Solvent vapors are then condensed by the thermo-electric cooler and removed by the drain pump. The sample output may be sent directly to the ICP or to the membrane desolvator for further solvent removal.

The membrane desolvator preserves the high sample transport efficiency of the ultrasonic nebulizer and greatly reduces solvent loading into the ICP, thus alleviating solvent interferences. Solvent vapor is removed through a micro-porous PTFE tubular membrane while analyte continues through the tube and to the plasma. An argon flow (sweep gas) removes the solvent vapor from the exterior of the membrane.

Ultrasonic Nebulizer/Membrane Desolvator Components

The U-6000AT⁺ consists of two modules: an ultrasonic nebulizer (top) and a membrane desolvator (bottom). The ultrasonic nebulizer itself consists of two sub-modules: glassware (top) and electronics (bottom). The glassware module houses a piezoelectric transducer, aerosol chamber, temperature-controlled heated U-tube evaporator and a thermo-electric condenser. The electronics module contains a drain pump; dual PID temperature controllers and an auto-tuned RF power supply to provide excellent reproducibility and reliability.

The following components are located on the front of the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator. Each lettered item corresponds with a callout in Figure 1-1.

- A *Transducer assembly.*** Piezoelectric transducer that converts RF energy to ultrasonic oscillations and nebulizes the liquid sample.
- B *Aerosol chamber stand.*** This component holds the aerosol chamber and transducer on the front of the glassware module.
- C *Aerosol chamber.*** Glassware that holds the transducer assembly, where the sample is introduced, nebulized and mixed with argon carrier gas before entering the U-tube.
- D *Sample/rinse adapter.*** Internal o-rings retain it on the spray chamber inlet tube, and a compression fitting holds the sample inlet tubing in place.
- E *U-tube.*** The nebulized sample is vaporized in the U-tube before entering the condenser.
- F *Heat cords.*** The heat cords are wrapped around the exterior of the U-tube. Temperature regulation is achieved by the "Heater" controller.

Introduction

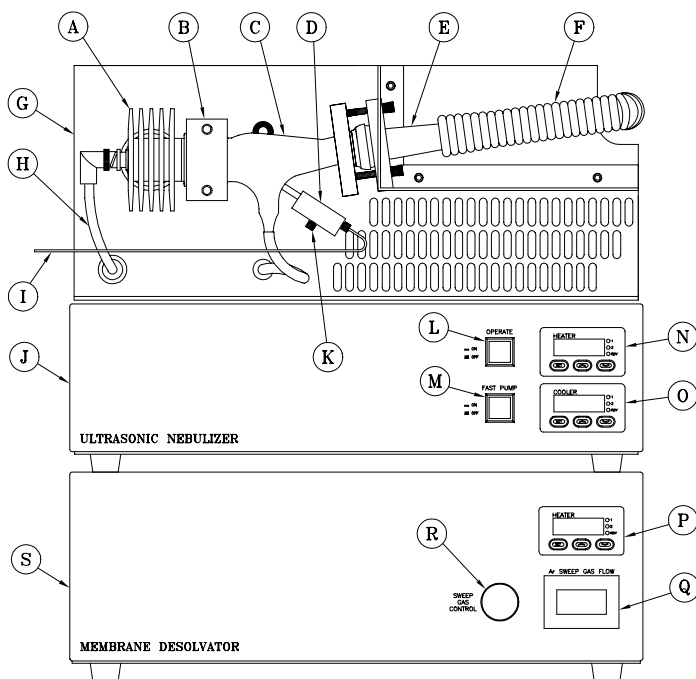


Figure 1-1. U-6000AT⁺ Design--Front View.

G Glassware module. Top module of ultrasonic nebulizer; houses transducer assembly, aerosol chamber, U-tube and condenser.

H Transducer RF cable. Cable that transmits the RF energy from the RF power supply to the transducer assembly.

I Sample inlet tubing. This tube delivers the liquid sample onto the transducer face for nebulization.

J Electronics module. Bottom module of ultrasonic nebulizer; houses drain pump, temperature controllers and RF power supply.

K Auxiliary rinse port. The luer fitting allows fast system rinse-out between samples.

- L Operate switch.** The push-on/push-off RF power control switch. It illuminates when the RF system is energized and operating.
- M Fast pump switch.** The push-on/push-off high-speed drain pump control switch. It illuminates during rapid pumping of the spray chamber and drain tubing after rinse-out.
- N Heater controller (nebulizer).** PID controller that regulates the temperature of the ultrasonic nebulizer's heat cords.
- O Cooler controller (nebulizer).** PID controller that regulates the temperature of the ultrasonic nebulizer's thermo-electric condenser.
- P Heater controller (desolvator).** PID controller that regulates the temperature of the membrane desolvator's heaters.
- Q Flow meter.** Digital readout of argon (sweep gas) flow, indicated units.
- R Flow control.** Pressure regulator adjustment to control argon (sweep gas) flow.
- S Membrane Desolvator module.** Pressure regulator adjustment to control argon (sweep gas) flow.

Introduction

The following components are located on the back of the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator. Each lettered item corresponds with a callout in Figure 1-2.

- A *Sample out tubing.*** Tubing that transfers the sample directly to the Membrane Desolvator or to the ICP.
- B *Top cover captive screws.*** Threaded fastener that securely locks the top cover to the chassis.
- C *Cooling fan.*** Removes the heat generated by the thermoelectric coolers.
- D *Top cover captive screws.*** Threaded fastener that securely locks the top cover to the chassis.
- E *Top cover.*** Removable, protects user from the heat cords and gives access to the sample out interface.
- F *Glassware module.*** Top module of ultrasonic nebulizer; houses transducer assembly, aerosol chamber, U-tube and condenser.
- G *Argon inlet fitting.*** Connection for the argon carrier gas.
- H *Drain tubing.*** There are three places of drainage, aerosol chamber, primary condenser (heated tube), and the secondary condenser (thermoelectrics).
- I *Electronics module.*** Bottom module of ultrasonic nebulizer; houses drain pump, temperature controllers and RF power supply.
- J *Waste drain tubing.*** The three drains (from H above) after the peristaltic pump.
- K *Drain pump.*** Three channel, four roller peristaltic pump used to pump the drains.
- L *Drain pump tubing.*** Three pieces of peristaltic pump tubing.

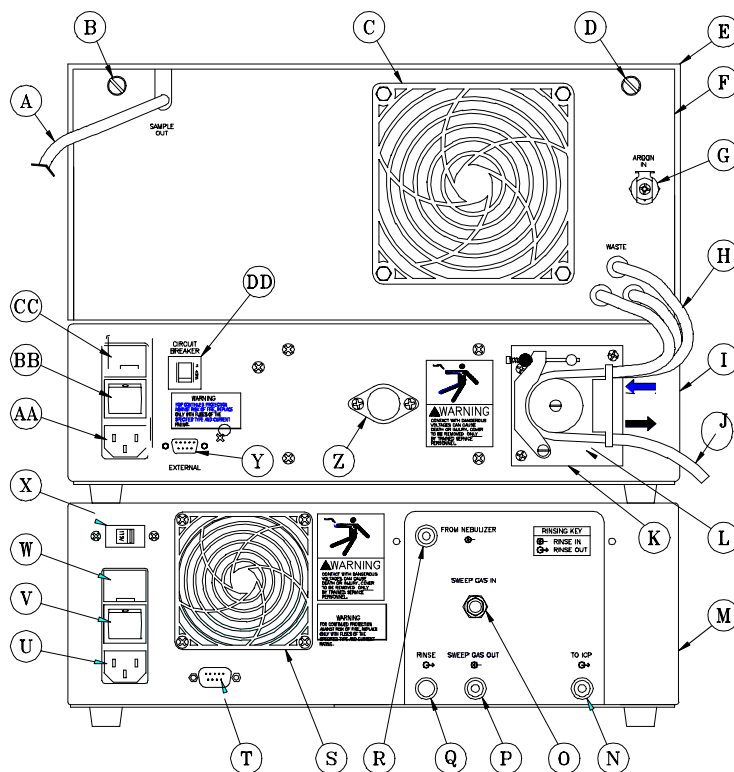


Figure 1-2. U-6000AT⁺ Design—Back View.

M Membrane Desolvator module. The lower unit that contains the temperature controlled membrane and sweep gas control.

N Aerosol-out (to ICP). The exit port from the membrane which connects directly to the ICP.

O Sweep gas inlet. Argon supply (40-120psi).

P Sweep gas outlet. The exit for the outer sweep gas which is taken to exhaust.

Q Membrane rinse port. Used to rinse the membrane.

Introduction

R Aerosol-in (from ultrasonic nebulizer). Sample from the ultrasonic nebulizer to the membrane.

S Cooling fan cover (desolvator). Removes the heat generated by the heated membrane .

T External connection (desolvator). Unused at this time.

U AC power module (desolvator). Mains voltage connected here.

V AC power switch (desolvator). Turns the desolvator power on or off.

W Fuse drawer (desolvator). Mains fuses for the desolvator.

X Voltage selector. Selects between 120 and 240VAC. This applies only to the membrane desolvator, not the ultrasonic nebulizer which is internally wired for a specific voltage.

Y External connection (nebulizer). Used to check the oscillator bias voltage and also to interface to other CETAC peripherals.

Z MOSFET transistor. Amplifier for the oscillator circuitry.

AA AC power module (nebulizer). Mains voltage connected here.

BB AC power switch (nebulizer). Turns the ultrasonic nebulizer power on or off.

CC Fuse drawer (nebulizer). Mains fuses for the ultrasonic nebulizer.

DDRF circuit breaker. This breaker protects the oscillator circuitry from faulty transducers or connections.

The following standard components/accessories are also included with each U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator:

- **ICP interface kit.** All parts to successfully interface to the ICP, including torch adapters and spray chambers, if needed.
- **Spare fuse kit.** Contains replacement fuses for the U-6000AT⁺.
- **Spare drain pump tubing kit.** Replacement tubing for the drain peristaltic pump.
- **Sample inlet extension tubing kit.** This is used when the sample peristaltic pump cannot be placed close enough to the U-6000AT⁺ to make a proper connection.
- **Argon tubing kit.** Contains all the necessary tubing to interface argon with the U-6000AT⁺.

Optional Accessories

If you are connecting the U-6000AT⁺ to a second ICP, want to automate sample introduction or between sample rinse-out, you may wish to purchase optional accessories for the Ultrasonic Nebulizer/Membrane Desolvator. The following accessories are available for the U-6000AT⁺:

- **Acid-proof O-ring kit.**
- **Organics tubing kit.**
- **Utility cart.** Holds the U-6000AT⁺ and related pieces.
- **ASX-510** Auto sampler.

Note:

Contact CETAC Technologies if you need additional accessories not listed, need added features to integrate the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator into your analytical system, or have unique requirements. Research and development of new features and

Introduction

accessories for the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator, often inspired by customer requests, is a continuing activity of CETAC Technologies.

***Preparing for
Installation***

Preparing for Installation

Installing the U-6000AT⁺ requires preparation. Before you install the system you should evaluate the physical arrangement of the laboratory to choose a suitable location. Once you choose a location, you must carefully unpack the U-6000AT⁺ prior to beginning the installation.

This chapter discusses what requirements must be met when you choose a location for the U-6000AT⁺. It also describes how to unpack the U-6000AT⁺ before installation.

Choosing a Location

Choosing a location for the U6000AT⁺ involves evaluating the lab environment for the availability of space and power. For the U-6000AT⁺ to function optimally, the location you select must meet specific requirements associated with each of these items. The following sections discuss space and power requirements.

Space Requirements

Most analytical applications benefit from the shortest sample flow path. Therefore, you should place the U-6000AT⁺ close to the analytical instrument. The recommended minimum footprint for countertop installation of the U-0006AT⁺ is 18" x 18" (45 cm x 45 cm).

Power Requirements

Place the U-0006AT⁺ within 1.2 meters of a power outlet. The voltage input requirements are 100-120 VAC \pm 10%, 50/60 Hz, 9A, or 220-240 VAC \pm 10%, 50/60 Hz, 4.5A, depending on the model.

There is a fuse drawer at the rear of the electronic module for both the ultrasonic nebulizer and the membrane desolvator. Each fuse drawer contains two fuses. You can remove the fuse drawer by unlatching the fuse holder with a small screwdriver.

WARNING

Disconnect the input power before attempting any fuse servicing.

For the ultrasonic nebulizer, replace the fuses with a GMC 5A, 250V slo-blow type for 100-120 VAC input voltage or a GMC 2.5A, 250V slo-blo type for 220-240 VAC input voltage.

For the membrane desolvator, replace the fuses with a GMC 5A, 250V slo-blow type for all input voltages.

WARNING

Replacement with a higher-rated fuse without first consulting CETAC Technologies or an authorized representative is done solely at the user's risk and is not recommended. Blown fuses indicate an abnormal condition, and replacement should be uncommon. Call Customer Service and Support if repeated fuse blowing occurs.

Preparing for Installation

Unpacking the U-6000AT⁺

Inspect external packaging upon receipt for holes, tears, smashed corners, or any other outward signs of damage from rough handling or abuse during shipment. Inspect all items during unpacking and notify the carrier immediately of any concealed damage.

Remove packing checklist from the shipping container, and check off items against it. Leave accessories in the packing unit until you are ready to install them on the U-6000AT⁺.

Note:

Do not throw away the factory packaging. Keep it for possible future use. This is one of the warranty conditions.

CAUTION

If condensation forms on or inside the U-6000AT⁺, allow it to dry thoroughly before connecting it to an AC power source and operating it. Failure to do so may cause equipment damage.

ICP Requirements

To achieve optimum performance from the U-6000AT⁺, the ICP system must be in good operating condition. Check the ICP performance using a conventional pneumatic nebulizer before the U-6000AT⁺ 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-6000AT⁺ system.

***Installing the U-6000AT⁺
Ultrasonic Nebulizer /
Membrane Desolvator***

Installing the U-6000AT⁺ System

The U-6000AT⁺ is designed for easy installation.

To install the U-6000AT⁺, you must first complete the following tasks. Each of these tasks will be discussed in detail later in this chapter.

- Drainage system assembly
- Liquid sample delivery and rinse system
- Establishing external connections
- Connecting the U-6000AT⁺ to the ICP torch

WARNING

Ensure that AC power is off (0 showing at the top edge of the rocker switches) on both the Ultrasonic Nebulizer and Membrane Desolvator before proceeding with installation.

Drainage System Assembly

The U-6000AT⁺ drainage system removes both sample waste from the spray chamber and condensed solvent from the condenser. It consists of a built-in three channel four roller peristaltic pump and the associated pump tubing and connectors.

Connect the three lengths of 1.8" I.D. Tygon tubing to the outlet of the fittings from the pump. Place the other ends of the tubing into the waste bottle. The drain pump tubing on the U-6000AT⁺ is user replaceable (see Chapter 6 Maintaining the U-6000AT⁺ Ultrasonic Nebulizer / Membrane Desolvator).

Liquid Sample Delivery and Rinse System

Sample Inlet Tubing

The sample/rinse adapter 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-6000AT⁺ transducer through 0.5 mm I.D. PEEK sample tubing which is inserted through the glass sample inlet tube located at the base of the aerosol chamber.

For high concentrations of sulfuric or 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-6000AT⁺. The Tefzel tubing performs much better when using these types of acids. To install the Tefzel tubing, follow the procedure for the PEEK sample inlet tubing.

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 at the factory, however, it may be 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 on the following pages:

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Installing the U-6000AT⁺ Ultrasonic Nebulizer / Membrane Desolvator

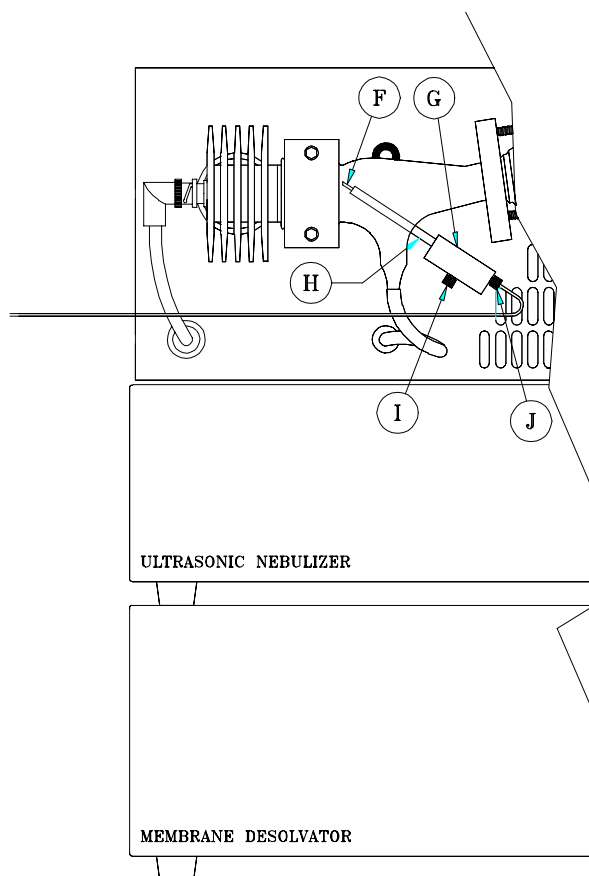


Figure 3–1. Sample Inlet Adapter and Tubing.

- 1 Remove the sample/rinse adapter (G) from the glass sample inlet tube by carefully sliding the adapter along the glass sample inlet tube.**
- 2 Re-cut the sample tubing (F) at a 60° angle, using a sharp razor blade: an improper cut or a blunt tip may cause inefficient nebulization.**
- 3 Loosen the compression fitting nut (J) 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.

- 4 Replace the adapter. First insert the sample inlet tubing, then slide the sample/rinse adapter back onto the glass tube.***
- 5 Slide the adapter until the sample tubing touches the face of the transducer. Lightly pull the adapter back to form a very narrow gap (approximately 0.2 - 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.***
- 6 If the length of the sample inlet tubing is not correct, remove the sample inlet adapter. Repeat steps 3 through 5 until proper adjustment is achieved.***

The auxiliary rinse port on the sample/rinse inlet adapter (Figure 3-2) provides the capability for rapidly cleaning the transducer face plate 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 (I) from the auxiliary rinse port of the sample/rinse adapter; use a counter-clockwise twist.***
- 2 Attach the male luer fitting. It is attached to the rubber tubing on the rinse bottle connect to the rinse port using a clockwise motion.***
- 3 Fill the auxiliary rinse bottle with deionized water.***
- 4 Gently squeeze the rinse bottle handle 2-5 times. 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.***

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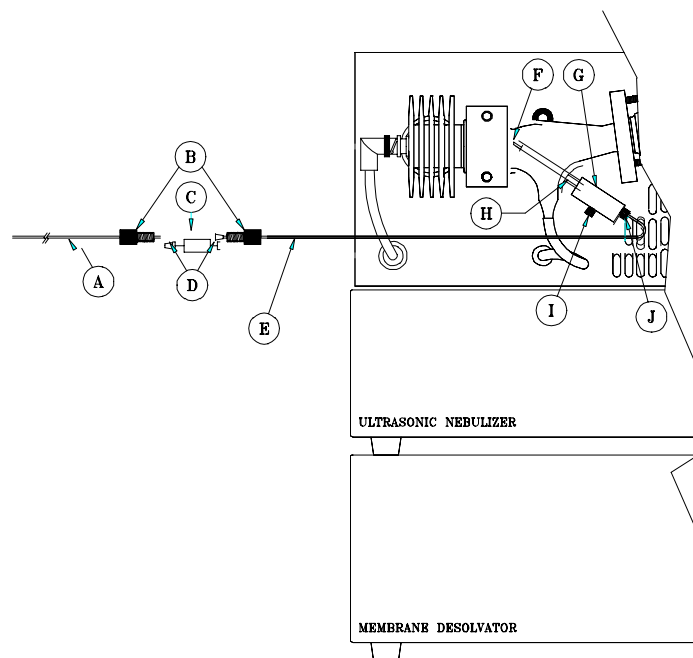


Figure 3–2. Sample Inlet Tubing Extension.

Sample Inlet Tubing Extension

Connecting the sample uptake peristaltic pump tubing directly to the U-6000AT⁺ is the most desirable arrangement. However, this may not always be possible or desirable. A sample inlet tubing extension kit is provided to accommodate this situation. The components of the sample inlet tubing extension kit are shown in Figure 3-2.

Establishing External Connections

The next step in the installation process involves connecting the U-6000AT⁺ to the power source, connecting the Ultrasonic Nebulizer to

the Membrane Desolvator, and connecting the Membrane Desolvator to the ICP Spectrometer. The following sections explain how to establish these connections.

Connecting the U-6000AT⁺ to the Power Source

Voltage-specified power cords are supplied with each U-6000AT⁺.

WARNING

Use only these power cords or exact replacements.

To connect the Ultrasonic Nebulizer to a power source, plug the cord in the power module located on the back panel of the nebulizer. Then plug the cord into an appropriate AC outlet (110 or 220 VAC $\pm 10\%$ 50/60 Hz depending on the model). Establish the same power connection for the Membrane Desolvator.

Connecting the Nebulizer Gas to the Ultrasonic Nebulizer

Connect the nebulizer gas from the ICP instrument to the Ultrasonic Nebulizer using the ARGON IN connector (Figure 3-3) and 3/16" I.D. Tygon tubing.

Note:

Some ICPs utilize a pressure switch on the nebulizer gas that will not allow the user to reduce the pressure enough to get the 0.6L/min or less argon flow required by the U-6000AT⁺. With these ICPs, it is necessary to use an auxiliary flow restrictor between the nebulizer gas supply and the U-6000AT⁺ ARGON IN connector for control of the nebulizer argon flow. This restrictor will be provided by CETAC when necessary.

Connecting the Ultrasonic Nebulizer to the Membrane Desolvator

- 1 Ensure that AC power is disconnected from the Ultrasonic Nebulizer and the heated U-tube is cooled off before beginning.***
- 2 Remove the Ultrasonic Nebulizer top cover. Do this by releasing the rear captive panel screws and carefully sliding the cover forward and then lifting it off. Locate the glass sample outlet tube located at the condenser outlet.***
- 3 Connect the glass sample outlet tube of the Ultrasonic Nebulizer to the FROM NEBULIZER port on the back of the membrane desolvator using 3/16" I.D. Tygon tubing. Place the Tygon tubing in the SAMPLE OUT opening or it will become pinched when the top cover is reinstalled and will cause unacceptable nebulizer performance.***
- 4 Replace the top cover and tighten the rear captive panel screws.***

Note:

If use of the membrane desolvator is not desired, simply attach the Tygon tubing from the SAMPLE OUT opening directly to the ICP. Depending on the ICP manufacturer or model, a spray chamber or torch adapter may be needed. These adapters are supplied by CETAC.

Connect the nylon sweep gas line to the SWEEP GAS IN port on the back of the Membrane Desolvator. A 1/4" Swagelok fitting is used. The other end of the sweep gas line may be attached to a separate argon cylinder or to a tee coming off the main instrument argon supply.

Connect 3/16" I.D. Tygon tubing to the SWEEP GAS OUT port on the back of the membrane desolvator. Attach the other end of the tubing to the ICP exhaust vent.

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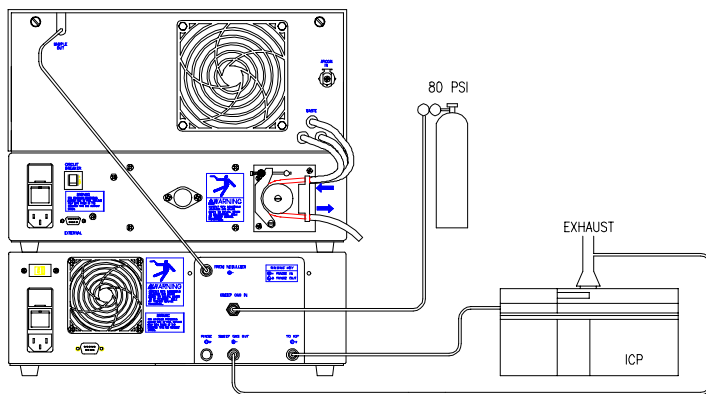


Figure 3-3. U-6000AT⁺ Tubing Diagram--Aqueous Samples.

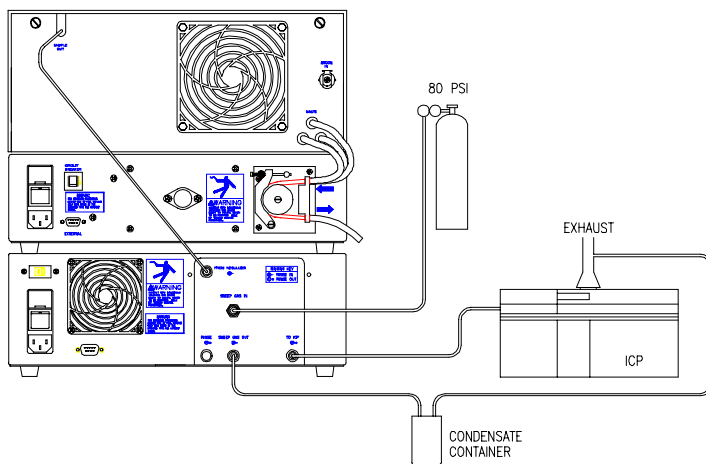


Figure 3-4. U-6000AT⁺ Tubing Diagram--Organic Samples.

Additional Connections for the Analysis of Organic Solvents

WARNING

- ***Prior to the analysis of volatile organic solvents, the user should provide an adequate container for safely collecting condensate from the sweep gas out line prior to exhaust (Figure 3-4). Precautions should be taken to assure solvents in condensate container are not mixed.***
 - ***Under other conditions the user must always insure connection of the sweep gas to a safe fume exhaust.***
-

Connecting the Membrane Desolvator to the Analytical Instrument

Depending on the ICP manufacturer and model, a torch adapter or spray chamber adapter is supplied for interfacing the U-6000AT⁺ to the ICP.

- 1 Mount the spray chamber/torch adapter on the ICP torch.***
- 2 Connect 3/16" I.D. tubing from the TO ICP port on the back of the membrane desolvator to the adapter (if necessary) on the ICP torch.***

4

Verifying Installation

Verifying Installation

Once installation of the U-6000AT+ is complete, it is important to verify that you have installed the system correctly. Attempting to use the U-6000AT+ before ensuring that it is installed correctly may result in damage to the system.

Verifying installation of the U-6000AT+ consists of three parts:

- Initial operation procedure
- ICP operation
- System Optimization

This chapter explains initial operation of U-6000AT+, ICP operation, and how to optimize the U-6000AT+.

Initial Operating Procedure

- 1 Plug the supplied power cords into the ultrasonic nebulizer and the membrane desolvator and then into the AC supply outlets.***
- 2 Turn on the power switch and allow the heater and condenser stages to preheat and precool. After approximately 10-15 minutes, all stages should be operating at a steady state as indicated by HEATER and COOLER temperature readings of $140^{\circ}\text{C} \pm 2^{\circ}$ and $3^{\circ}\text{C} \pm 1^{\circ}$, on the ultrasonic nebulizer and $160^{\circ}\text{C} \pm 2^{\circ}$ on the HEATER for the membrane desolvator.***

Note:

All temperature controllers are factory programmed and preset. Temperature settings should not be changed unless absolutely necessary to obtain acceptable nebulizer performance. Do not exceed controller settings of 120-160°C (HEATER's) and -5-10°C (COOLER).

- 3 Ensure the drain pump pressure shoe is engaged and all lines are connected.**
- 4 With the heating and cooling temperatures stabilized, turn on the nebulizer gas from the ICP and adjust flow to 0.6 L/min.**
- 5 Connect the sample peristaltic pump to the 0.5mm 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 have been included with the unit.**
- 6 Turn on the sample delivery pump and deliver deionized water at 2.5 ml/min.**
- 7 Press the OPERATE switch. The yellow switch light will illuminate and a dense mist should be observed inside the aerosol chamber.**

Verifying Installation

Note:

OPERATE switch illumination indicates the delivery of RF Power to the transducer. If the OPERATE switch does not illuminate after the OPERATE switch is pressed or the lamp goes out during operation, this indicates a fault in the RF system. Immediately shut down the unit and see Chapter 7, "Troubleshooting the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator".

- 8 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 and steady at this point. If not, see Chapter 7, "Troubleshooting the U-6000AT⁺ Ultrasonic Nebulizer/Membrane Desolvator".**

Note:

Although dilute hydrofluoric acid solutions will not harm the glassware of the U-6000AT⁺ or the ICP when nebulized for short periods, it should only be used when the transducer face becomes dirty, which is evidenced by weak or intermittent mist generation.

Reserve the remaining solution for future use.

- 9 Change the sample to deionized water and observe aerosol chamber drainage after 10-15 minutes of operation. If drainage is sufficient, there will be no fluid buildup in the aerosol chamber drain. Should a buildup occur, press the FAST PUMP switch until the fluid is cleared and check the drain tubing for leaks, restrictions, or insufficient pump shoe pressure. Repeat the drainage test. If drainage is still insufficient, shut down the U-6000AT⁺ and see chapter 7 - Troubleshooting.**
- 10 Turn off the OPERATE switch, the sample peristaltic pump, and the nebulizer gas supply to the ICP.**

ICP Operation

- 1 Ignite the ICP plasma as instructed in the ICP operating manual. The nebulizer gas flow rate should be set at a 0.6 L/min; the sweep gas at 2.0 L/min.**
- 2 Press the OPERATE switch to energize the transducer of the ultrasonic nebulizer.**
- 3 Prepare and aspirate a 100 mg/ml solution of yttrium into the plasma. The emission color and intensity in the plasma should be similar to that found when 1000 mg/ml of yttrium is aspirated with a pneumatic nebulizer. If the yttrium emission is weak, check for gas leaks in the U-6000AT⁺ or ICP system.**

System Optimization

It may be necessary to optimize the ICP system after installation of the U-6000AT⁺. Optimization procedures may include adjustment of gas flows, sample uptake rate, plasma viewing or sampling positions, ion optical settings, etc. Usually the signal-to-noise or signal to background ratio is the primary criterion for optimization. For detailed instructions on system optimization for aqueous or organic samples, perform the ICP/U-6000AT⁺ Optimization Procedures. After the system has been optimized, the U-6000AT⁺ is ready for routine operation.

Verifying Installation

Note:

Extreme conditions which may cause unstable plasma formation, torch erosion, or high reflected power should be avoided.

ICP-AES/Ultrasonic Nebulizer Optimization Procedure

1 Recommended operating conditions and operating ranges for aqueous sample analysis without the membrane desolvator for ICP-AES:

	<u>Normal Condition</u>	<u>Range</u>
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
Sample uptake rate	2.5 mL/min	1.0-3.0 mL/min
Ultrasonic nebulizer		
(heating temperature)	140 °C	120-160°C
(cooling temperature)	3°C	-5-10° C

2 Optimization of the ICP and the ultrasonic nebulizer 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 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 satisfactory for many applications. Optimum conditions may necessary, depending upon the ICP system used.

4 The recommended operating ranges for the ICP and the ultrasonic nebulizer are also listed above. Optimization of other parameters is usually not required; they are usually preset to the nominal values listed above.

ICP-AES/U-6000AT⁺ Optimization Procedure:

1 Recommended operating conditions and ranges for organic sample analysis with the membrane desolvation connected to the ultrasonic nebulizer. ICP-AES detection is used.

	Normal <u>Condition</u>	<u>Range</u>
ICP forward power	1400 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
Sample uptake rate	2.5 mL/min	1.0-3.0 mL/min
Ultrasonic nebulizer		
(heating temperature)	140°C	120-160°C
(cooling temperature)	3°C	-5-10° C
Membrane Desolvator		
(heating temperature)	160°C	120-160°C
Sweep gas flow	2.0 L/min	1.4-2.4 L/min

2 Prepare a 1ppm solution of an appropriate tuning element (e.g. Mn) in 2-propanol (isopropyl alcohol).

3 Start the ICP-AES and introduce the tuning solution via the U-6000AT⁺.

4 Adjust parameters such as nebulizer gas flow, sweep gas flow, observation height, plasma forward power, etc.. to obtain the best signal-to-background ratio.

Verifying Installation

ICP-MS/U-6000AT⁺ Optimization Procedure

1 Recommended operating conditions and ranges for aqueous sample analysis with the membrane desolvator connected to the ultrasonic nebulizer. ICP-MS detection is used.

	<u>Condition</u>	Normal <u>Range</u>
ICP forward power	1200 W	800-1500 W
Outer gas flow rate (plasma)	15L/min	12-20 L/min
Intermediate gas flow rate (auxiliary)	0.5L/min	0.0-2.0 L/min
Injector gas flow rate (nebulizer)	0.6 L/min	0.3-1.5 L/min
Sample uptake rate	2.5 mL/min	0.1-3.0 mL/min
Ultrasonic nebulizer (heating temp)	140°C	120-160°C
(cooling temp)	3°C	-5-10°C
Membrane desolvator heating temp	160°C	120-160°C
Sweep gas flow	2.0 L/min	1.4-2.4 L/min

2 Prepare a 10 ppb solution of Li, Co, In, Ce, and Pb in 1% HNO₃.

3 Start the ICP-MS and move to a graphics mode.

4 Introduce the above solution to the ICP-MS using the U-6000AT⁺. Monitor at least Ce(140), CeO(156), and In(115).

5 Adjust parameters such as nebulizer gas flow, sweep gas flow, sampling position, etc., to obtain high Ce and In signal and low CeO signal. The CeO/Ce ratio should be 0.04% or lower.

ICP-MS/U-6000AT⁺ Optimization Procedure

1 Recommended operating conditions and ranges for organic sample analysis with the membrane desolvator connected to the ultrasonic nebulizer. ICP-MS detection is used.

	<u>Condition</u>	<u>Normal Range</u>
ICP forward power	1300 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)	0.6L/min	0.3-1.5 L/min
Sample uptake rate	2.5 mL/min	1.0-3.0 mL/min
Ultrasonic nebulizer heating temp	140°C	120-160°C
Ultrasonic nebulizer cooling temp	-5°C	-5-10°C
Membrane desolvator heating temp	160°C	120-160°C
Sweep gas flow	2.0 L/min	1.4-2.4 L/min
Oxygen flow (See note)	5 mL/min	0-10 mL/min

2 Prepare a 10ppb solution of Li, Co, In, and Pb in 2-propanol (isopropyl alcohol).

3 Start the ICP-MS and introduce the above solution via the U-6000AT⁺.

4 Adjust parameters such as nebulizer gas flow, sweep gas flow, sampling position, ion optic voltages, etc., to obtain the best signal-to-noise ratio.

Note:

Oxygenated organic solvents (e.g., 2-propanol) may be run directly through the U-6000AT⁺ to the ICP-MS. To analyze non-oxygenated organic solvents (e.g., toluene, hexane), a low flow of oxygen is teed into the sample line leading from the membrane desolvator to the ICP torch. This small amount of oxygen helps prevent carbon buildup on the ICP-MS sampling cones.

U-6000AT⁺ Ultrasonic Nebulizer / Membrane Desolvator Operator's Manual
Verifying Installation

***Using the U-6000AT⁺
Ultrasonic Nebulizer /
Membrane Desolvator***

Using the U-6000AT+ Ultrasonic Nebulizer / Membrane Desolvator

The U-6000AT+ is both reliable and easy to use. Before using the U-6000AT+, however, ensure that your lab environment provides operating conditions that will prolong the life of the U-6000AT+. Once the proper operating conditions are met, you can setup the system.

Establishing Optimal Conditions

The U-6000AT+ operates reliably even under less than ideal conditions. It is not, however, indestructible. Malfunction or damage can occur if specific operating conditions are not met. Meeting these conditions requires that you create the proper lab environment, replace components that wear out under normal use, and purchase the appropriate supplies for use with the system. The following sections explain how to meet these conditions.

Note:

Damage or malfunction that results from unsatisfactory operating conditions may constitute misuse and abuse and be excluded from warranty coverage.

Creating the Lab Environment

To Create satisfactory operating conditions in your lab environment, follow these guidelines:

- ***Operate the U-6000AT+ in a conventional lab environment where the temperature is 50-86°F(10-30°C); the humidity is 20-70% non-***

condensing; and the unit is not exposed to excessive flammable or corrosive materials.

- ***Avoid rough handling of the U-6000AT⁺. If possible, do not expose the system to vibration or shock.***
- ***Protect the U-6000AT⁺ from long-term exposure to condensation, corrosive materials, solvent vapor, continual standing liquids, or large spills. Exposures of this type can damage the electronics.***
- ***Observe the same general electrostatic discharge precautions as with any other integrated circuit electronic device. Low humidity environments, especially when combined with static-generating materials require maximum care.***

WARNING

Discharge static buildup and ground to the U-6000AT⁺ cabinet before performing any maintenance. Do not touch or short-circuit bare contacts.

Avoid using the U-6000AT⁺ if strong electromagnetic interference or radio frequency interference is present.

Replacing the U-6000AT⁺ Components

The following U-6000AT⁺ components wear out under normal use and must be replaced periodically.

- ***Transducer***
 - ***Peristaltic pump tubing***
 - ***Sample inlet tubing***
 - ***Sample inlet extension tubing***
 - ***Connecting Tygon tubing***
-

If you fail to replace these components when they deteriorate, the U-6000AT⁺ will not function properly. For more information about replacing the U-6000AT⁺ components, see Chapter 6 "Maintaining the U-6000AT⁺ Ultrasonic Nebulizer / Membrane Desolvator."

Startup Procedure

- 1 If the U-6000AT⁺ has been turned off for an extended period of time, turn on the AC power switch and allow HEATER and COOLER temperatures to reach operating values and stabilize (approximately 10-15 minutes).***
 - 2 Ignite the ICP plasma according to the ICP operating manual. Adjust operating parameters to optimized values.***
 - 3 Press the Ultrasonic Nebulizer OPERATE switch.***
 - 4 Turn on the sample peristaltic pump and deliver deionized water to the transducer. The ultrasonic nebulizer should stabilize in 15 minutes or less. If necessary, aspirate the dilute hydrofluoric solution to achieve a dense aerosol. The Ultrasonic Nebulizer is now ready for routine analysis.***
-

Shutdown Procedure

- 1 Aspirate deionized water for at least 3 minutes. Momentarily rinse the entire transducer face plate and its surrounding area by introducing water through the auxiliary rinse port of the aerosol chamber.***
-

Note:

Rinse-out is a recommended preventive maintenance procedure that will retard the accumulation of deposits on the transducer face plate and inside the glassware from corrosive samples.

- 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 liquid is considered drained when none can be observed flowing in the drain tubing.**
- 5 Turn off the FAST PUMP switch, followed by the AC power switch. Turn off the ICP plasma and the gas supplies according to the ICP system operating manual.**

Temperature Controller Operation

The temperature controllers normal operation displays the actual temperature. The setpoint for each temperature controller can be viewed by simply pressing the button labeled SET on the respective temperature controller. When the button is released, the actual temperature is again displayed. The setpoint temperature can be changed by following the steps below:

- 1 Press and hold the SET button and press the up or down arrow until the desired setpoint is reached**
- 2 Release the SET button and the actual temperature will be displayed.**

Switching from Organic Samples to Aqueous Samples and Vice Versa

If organic solvents are to be analyzed after an aqueous sample with the U-6000AT⁺, 2-propanol (isopropyl alcohol) should be first nebulized for at least 5 minutes to clean out the system. Turn on the nebulizer gas flow to 0.7 L/min.

When returning to aqueous samples, use 2-propanol again to clean the U-6000AT⁺, followed by deionized water. Again have the nebulizer gas on.

WARNING

The U-6000AT⁺ is not recommended for the analysis of sulfuric acid.

***Maintaining the U-6000AT⁺
Ultrasonic Nebulizer /
Membrane Desolvator***

Maintaining the U-6000AT+ Ultrasonic Nebulizer / Membrane Desolvator

Routine maintenance of the U-6000AT+ consists of daily and weekly cleaning of specific components. Routine maintenance also includes checking the U-6000AT+ components for leaks or other damage. Additional periodic maintenance task may be required, including replacement of the following U-6000AT+ components: Ultrasonic Nebulizer, transducer, peristaltic tubing, sample inlet tubing, sample inlet extension tubing, and Tygon tubing components.

WARNING

The U-6000AT+ must be turned off and the AC power cords unplugged before performing any maintenance on the system.

Transducer Assembly Removal

- 1 Turn off the ultrasonic nebulizer and the ICP as described in the shutdown procedure.***
- 2 Disconnect the RF cable connector from the transducer assembly.***

Note:

Note the orientation of the assembly and the transducer mounting screws before removal so the new transducer is reinstalled with the same orientation!

- 3 Remove the transducer using a hex-head transducer wrench supplied with the U-6000AT⁺. 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 straight out of the aerosol chamber neck. Wipe off any liquids or other contaminants inside the neck of the aerosol chamber. Take extreme care to avoid damaging the glass sample introduction tube - fragile!**

Transducer Assembly Installation

- 1 The spare transducer assembly and screw/spring set is packaged in a protective box and collar which should not be discarded. Remove the spare transducer from the box and examine the crystal face for cleanliness. Cleaning can be accomplished by gently wiping the crystal face with a water moistened lint-free tissue.**
- 2 Place the O-ring back on the aerosol chamber and ensure the O-ring is smoothly seated against the glass bezel inside.**
- 3 Align the spare transducer assembly with one hand and replace the spring-loaded socket head screws. When tightened properly, the screw heads should be flush with the second fin (from the cable connector end) of the transducer heat sink. Proper seating of the O-ring can be observed through the aerosol chamber.**

CAUTION

Do not over tighten the screws!

- 4 Reconnect the RF cable to the connector on the transducer assembly and store the transducer wrench.***
-

RF Circuit Breaker

To protect the RF generator electronics, a re-settable circuit breaker will trip (open) in approximately twenty seconds if a fault occurs anywhere in the RF output circuit or cable when the OPERATE switch is on. The RF circuit breaker is re-settable and is located on the right rear of the electronics module (next to the AC power module containing the power cord receptacle, AC power switch and fuse drawer). To reset a tripped RF circuit breaker:

- 1 Turn the AC power switch off (0).***
 - 2 Check the RF cable and connections at the transducer, bulkhead feed through on the glassware module and electronics module.***
 - 3 Reset the RF circuit breaker by pressing the rocker switch down until it latches.***
 - 4 Turn AC power and OPERATE switched on. If the RF circuit breaker trips again, contact you authorized service representative or CETAC Technologies for assistance.***
-

Main Fuse Replacement

The main fuses are located in the AC power module fuse drawers located at the right rear of the electronics modules of the Ultrasonic Nebulizer and Membrane Desolvator. To replace blown fuses:

- 1 Turn the AC power switch to off (0) and disconnect the AC power cord.**
- 2 Use a small flat blade screwdriver to unlatch the fuse holder.**
- 3 Replace the defective fuse with a GMC 5A, 250V slo-blow if operating on 100/115 VAC or 230 VAC.**

WARNING

Use of a different fuse other than those specified can damage the electrical components of the U-6000AT⁺, constitute a fire hazard or result in personal injury.

- 4 Replace the power cord, turn AC power and OPERATE switches on. If the new fuses blow, do not attempt to operate the unit. Contact your authorized service representative or CETAC Technologies for assistant.**
-

Drain Pump Tubing Replacement

To replace pump tubing:

- 1 Unlatch the pressure show.**
 - 2 Remove the old pump tubing by snapping the tubing connectors out of the tubing keeper.**
 - 3 Reuse the plastic connectors. Phar-Med tubing (3/32" I.D., 1/32" wall) is used on the peristaltic drain pump; it may be purchased pre-cut from CETAC Technologies. If using bulk tubing, cut three 3 3/4" lengths using a sharp razor blade.**
 - 4 Place the new tubing with connectors in the tubing keeper. Firmly press the connectors into the tubing keeper slots until they lock in place.**
 - 5 Reconnect all external drain tubing.**
-

Rinse Procedure for the Membrane Desolvator

The membrane may need to be thoroughly rinsed after the analysis of organic samples containing high concentrations of nonvolatile residues or after analysis of aqueous samples containing high concentrations of solids. The length of time between rinses in a routine operation depends on the types of samples analyzed. Analysis of samples containing less than 5% of nonvolatile residues is recommended. When the organic solvent removal efficiency decreases or the ICP becomes unstable, the membrane should be rinsed. The following procedure describes how to rinse the membrane desolvator. Please refer to Figure 6-1 for the respective tubing diagram.

Note:

If aqueous samples were analyzed, 1% HNO₃ may be used to rinse the membrane.

- 1 Turn the AC power switch to off (0) and disconnect the AC power cords. Allow the heater to cool to room temperature.***
- 2 Disconnect the 3/16" Tygon tubing leading from the Ultrasonic Nebulizer to the Membrane Desolvator.***
- 3 Disconnect the 3/16" Tygon tubing leading from the membrane Desolvator to the ICP torch.***
- 4 Connect one of the rinse inlet Y-connectors between the From Nebulizer port and the Sweep Gas Out port.***
- 5 Connect the other rinse inlet Y-connector between the Rinse and To ICP ports.***
- 6 Fill the 50 mL glass syringe with toluene and fill the membrane via the syringe adapter through the From Nebulizer and Sweep Gas Out ports.***

- 7 Let the solvent soak the membrane for about 10 minutes.**
- 8 Use another 50 mL of toluene to flush the membrane, collecting the overflow from the other Y-connector.**
- 9 Flush the membrane with air several times using an empty syringe.**
- 10 Reestablish power to the Membrane Desolvator and turn the AC power switch on. Adjust the sweep gas to 2.0 L/min and flush the membrane with Ar for at least 15 minutes.**
- 11 Reconnect the membrane desolvator to the Ultrasonic Nebulizer and the ICP torch.**

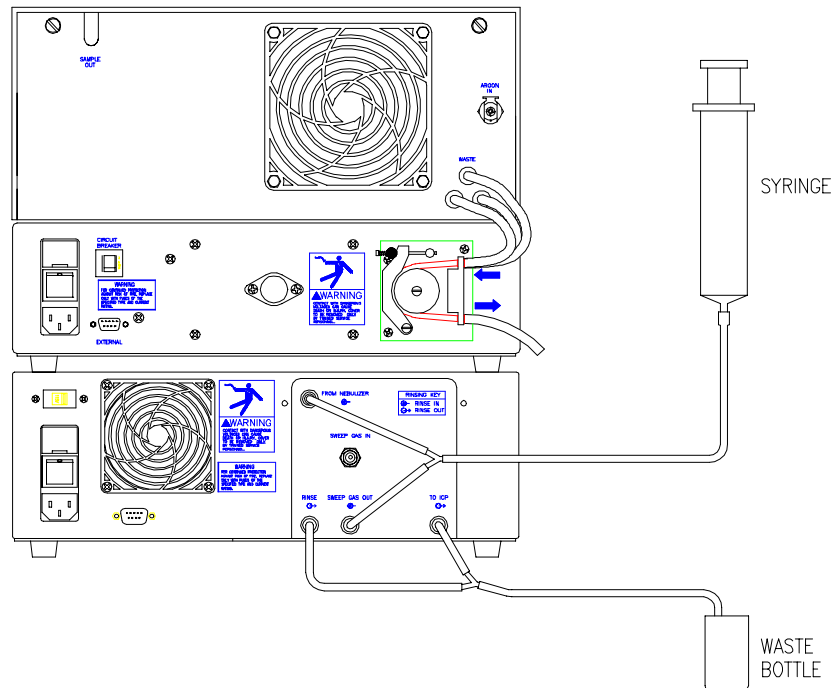


Figure 6–1. Tubing Connections for Rinsing the Membrane.

***Troubleshooting the
U-6000AT+ Ultrasonic
Nebulizer / Membrane
Desolvator***

Troubleshooting the U-6000AT+ Ultrasonic Nebulizer / Membrane Desolvator

The U-6000AT+ is both easy to operate and reliable. However, problems with the system may occur. When the U-6000AT+ does not function properly, try to isolate the problem to determine if it originates in the analytical instrument, sample preparation, the Ultrasonic Nebulizer, or the Membrane Desolvator.

This chapter explains how to troubleshoot U-6000AT+ problems. If you cannot solve a problem using the steps given in this chapter, contact CETAC Technologies Customer Service and Support.

Phone: (800) 369-2822

(402) 733-2829

Fax: (402) 733-1932

Heater and Cooler Temperature Controller Problems

1 Heater controllers do not illuminate.

Power cord not plugged into AC wall outlet. Plug in power cord.

Main fuses blown. Replace main fuses (5A 250V Slo-Blo).

2 *Display of temperature controller reads "Er 4".*

Open thermocouple, bad connection, or broken wire. Replace/repair thermo couple wire.

3 *Cooler temperature controller will not cool to setpoint.*

Thermoelectric cooler defective. Condenser module defective.

Fan on back not running.

4 *Heater and Cooler temperature controller reads room temperature.*

Heat cord or condenser heating element fuse blown. Replace respective fuse.

5 *Heater temperature controller stops illuminating.*

Thermal safety switch tripped due to excessive temperature. Heat controller is defective or solid-state relay is defective.

Mist/Aerosol Chamber Problems

1 *Poor and/or unstable mist generation.*

Sample inlet tubing improperly adjusted/cut. Readjust sample inlet tubing, or re-cut and readjust

Sample uptake too low, nebulizer gas too high, transducer face dirty. Clean transducer face with 0.5%(v/v) hydrofluoric rinse solution.

Transducer failure. Replace transducer.

Operate lamp does not illuminate, no aerosol present, RF circuit breaker open. Reset RF circuit breaker.

If problem persists after resetting the RF circuit breaker. Replace the transducer.

2 Water backing up into aerosol chamber.

Drain system not functioning properly. Tighten pressure shoe or replace drain pump tubing.

Sample inlet flow is too great.

Plasma Problems

1 Plasma flickers excessively or is unstable.

Condenser drain system not functioning properly. Thaw condenser if frozen. Find blockage in drainage system.

Check all gas line connections. Make sure all connections are tight and correct.

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