QuickTrace™ M-7500 Mercury Analyzer Operator Manual
Version 1.0.4
Part Number: 480116
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 with stagnant air 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.

The foregoing express warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability and fitness for a particular purpose. CETAC shall not be bound by any representations or statements on the part of its employees or agents whether oral or in writing and including any made in catalogues and other promotional material including technical details and specifications except where such representations and statements are expressly made part of this contract. CETAC assumes no responsibility for incidental, consequential or other damages, even if advised of such a possibility, including but not limited to loss or damage of property, loss of revenue, loss of use of the unit, loss of time, or inconvenience. CETAC’s liability on any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.
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 within five (5) working days after they are received.

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

Returned Product Warranty Determination

After CETAC’s examination, warranty or out of warranty status will be determined. If a warranted defect exists, the product will be repaired at no charge and shipped prepaid back to the buyer. If the buyer desires an air freight return, the product will be shipped collect. Warranty repairs do not extend the original warranty period.

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 buyer’s expense.
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.

WARNING

The handling of organomercurial concentrates which may be used in the preparation of process standards presents a substantial (potentially lethal) safety hazard. Only an experienced, professionally trained organo-metallic chemist, knowledgeable and skilled specifically in the safe handling of organomercurials (using approved apparatus and approved protection measures in an approved facility) should attempt to prepare diluted organomercurial process standards from concentrates.

NOTE

SD Acquisition, Inc., DBA CETAC Technologies assumes no liability for the handling of organomercurial concentrates or the preparation, handling, or use of diluted organomercurial process standards. Instead, CETAC Technologies recommends use of appropriate standard reference materials to validate sample preparation (dissolution/digestion) and use of inorganic mercury standards for instrument calibration.

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 QuickTrace™ Mercury Analyzer Operator 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.

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**WARNING**

Under all conditions the user must observe safe laboratory procedures during the operation of this product.
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 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-001 of the Department of Communications.

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.
Operator’s Manual Addendum

Notices and Compliance Declarations

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.

WARNING

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.
2. Wipe the instrument exterior surfaces only using a towel dampened with a lab-grade-cleaning agent.
3. Repeat step 2, using a towel dampened with clean water.
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%
**AVERTISSEMENT**

POUR UNE PROTECTION CONTINUÉ CONTRE LES RISQUES D'INCENDIE, REMPLACER UNIQUEMENT PAR DES FUSIBLES DE MÊME TYPE ET AMPÈRAGE.

**WARNING**

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

**Caution (refer to accompanying documents)**
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.

AVERTISSEMENT
SURFACES CHAudiES, LAISSER LE COUVERCLE HERMÉTIQUEMENT FERMÉ.
POUR ACCÉDER, METTRE LA TEMPERATURE DU FOUR À ZÉRO.
OUVRIR LE COUVERCLE ET LAISSER REFROIDIR 5 MINUTES AVANT DE TOUCHER LA VERRE ou TOUTE SURFACE MÉTALLIQUE INTÉRIEURE.

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

AVERTISSEMENT
POUR UNE PROTECTION INTERRROMPUE CONTRE LES RISQUES DE DOMMAGES AUX YEUX (DES RAYONS UV INVISIBLES" SONT PRÉSENTS LORSQUE LE COUVERCLE AINSI QUE LA CARTE DE CIRCUIT SONT ENLEVÉS), LAISSER LE COUVERCLE EN PLACE LORSQEE L'APPAREIL EST EN MARCHE.
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Glossary

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Preface
0. Preface

The QuickTrace™ M-7500 Mercury Analyzer Operator’s Manual provides an overview and explains the theory of operation of the CETAC QuickTrace™ M-7500 Mercury Analyzer. It also supplies QuickTrace™ M-7500 installation and operation information, technical specification data about the systems and sub-systems, and it details troubleshooting and maintenance procedures.

0.1 Who Should Read This Book

The primary audience for the QuickTrace™ M-7500 Mercury Analyzer Operator’s Manual consists of laboratory managers, chemists, technicians, field-service engineers and owners of the QuickTrace™ M-7500. To use this manual (and product) safely and effectively, at least a general knowledge of chemistry, electronic or laboratory equipment, and basic chemical handling procedures are required.

WARNING

Before operating the QuickTrace™ M-7500, ASX-520, or optional ADX-500, it is important to read this manual, the QuickTrace™ M-7500 Mercury Analyzer Software Manual, the ASX-520 Autosampler Operator’s Manual, and (if applicable) the ADX-500 Autodilutor Accessory Operator’s Manual.

0.2 How to Use This Book

The QuickTrace™ M-7500 Mercury Analyzer Operator’s Manual contains six chapters. Read the chapters sequentially the first time. Thereafter, refer to the chapters separately as needed. The first chapter provides an introduction, system features and performance specifications for the QuickTrace™ M-7500 Mercury Analyzer. Subsequent chapters detail
the installation, theory of operation, operation, maintenance, and troubleshooting procedures associated with the QuickTrace™ M-7500. These six chapters are followed by a Glossary of terms.

0.3 Conventions Used in This Book

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

Instructions

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

1 Remove the Gas-Liquid Separator.

Many numbered instructions are followed by more detailed explanations.

Menu Items

This book uses the following format for referring to menu items in the software:

Setting | Communication

The text before the arrow symbol is the name of the menu; the text after the arrow symbol is the menu choice.

Notes

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

Note:
This example shows how a note is displayed.

Cautions

Cautions indicate situations that require immediate attention to prevent harm to the QuickTrace™ M-7500 Mercury Analyzer System. 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.

0.4 Terminology

Terminology used in this manual may be found in the Glossary at the end of the manual.

0.5 Where to Go for More Information

In addition to the QuickTrace™ M-7500 Mercury Analyzer Operator’s Manual, the analyst can refer to the following resources:


The ASX-520 Autosampler Operator’s Manual.
The *ADX-500 Autodilutor Manual* (optional).

U.S. EPA Method 245.1; Method for Hg determination in drinking water.


U.S. EPA, Office of Solid Wastes. SW846 Method 7470A; Mercury in Liquid Waste (Cold-Vapor Technique).

U.S. EPA, Office of Solid Wastes, SW846 Method 7471A; Mercury in Solid or Semisolid Waste (Cold-Vapor Technique).


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Introduction
1. Introduction

1.1 Overview

The QuickTrace™ M-7500 Mercury Analyzer is specifically designed to measure trace levels of Mercury in aqueous solution by (CVAAS) Cold Vapor Atomic Absorption Spectrometry (i.e. without use of flame, plasma, furnace, etc.). Modular design permits remarkably easy maintenance access and a reduced countertop footprint. Sturdy construction, drift-stabilized double beam optics, thermal and electro-optical lamp stabilization, and an unusually stable “non-foaming” Gas-Liquid Separator (U.S.Patent #5,792,663) collectively afford exceptional structural integrity and signal stability. The QuickTrace™ M-7500 exhibits ultra-low signal noise and detection limits for an absorbance system that is fully compliant with EPA method #245.1.

1.2 System Features

Principal features of the QuickTrace™ M-7500 Mercury Analyzer:

The QuickTrace™ M-7500 incorporates the following features to form an automated, integrated Mercury analysis system.

- Computer-controlled four-channel high-performance peristaltic pump (12-roller pump head).
- Ozone-free Hg Lamp. No lamp ventilation is needed.
- Thermally controlled Hg lamp housing (for a stabilized Hg vapor lamp).
- Computer controlled Hg lamp power for lamp life extension.
- Stable high performance Gas-Liquid Separator (GLS). (U.S. Patent #5,792,663). Non-foaming/non-bubbling "thin liquid film" GLS design, which allows trouble-free direct analysis of blood, urine, and fish tissue digests as well as standard water and waste analysis.
- System liquid overflow detection/prevention.
• Rigid, shock and vibration-isolated optical rail (mounting the Hg lamp, collimator lens, cell oven, absorption tubes, camera, photo detectors, signal amplifier and A/D converter).
• Precise, self-aligning optical mounts, no optical alignment required, maximizing the convenience of instrument baseline zeroing. This design extends maintenance intervals without loss of performance.
• Long path (220 mm) absorbance cells.
• Hg lamp electro-optical feedback beam utilizing a high-performance solid-state detector for ultra-fine lamp stabilization.
• Fixed Optical Interference filters, three each (254 ± 2nm wavelength, 20%T, 12.7 mm dia.). No moving parts.
• Standard Nafion® dryer cartridge eliminates the need for Mg(ClO₄)₂ drying agent.
• Cell oven radiator surface up to 125°C (maximum).
• Stabilized double beam optics - traditional double-beam (sample and reference) utilizing dual high performance thermally stabilized sample and reference beam silicon detectors.
• Internal ADC (Analog-to-Digital Conversion).
• High-rate data sampling.
• Precise, stable, computer-controlled, carrier gas regulator. (Gas Control Unit (GCU)).
• Computer controlled system shutdown/standby routines.
• Integrated ASX-520 Autosampler for accommodation of calibration standards and up to 360 samples.
• An optional ADX-500 System Accessory is also available for automated dilution of over-ranged samples.
• RS-232 serial communications.
• Gas exhaust Hg vapor safety trap (solid crystalline KMnO₄).
1.3 System Performance Specifications

Principal performance specifications of the QuickTrace™ M-7500 Mercury Analyzer:

- Low detection limits: typically < 0.2ppt at 20mL/min carrier gas flow **. (Direct steady state absorbance mode, without preconcentration by gold amalgamation).
- Wide dynamic linear working range, ≥ four (4) orders of magnitude.
- Short term precision, maximum 1.5% RSD, typical ≤ 1% RSD**.
- Ultra-low drift rates ≤ 300μAbs/hr (after warm-up) raw uncorrected analog baseline on-screen drifts.
- Ultra-low short-term absorbance noise ≤ 10 μAbs (10^5 Abs).
- 0.1% "raw" Hg lamp stability (single beam output).
- Unusually fast washout ≈ 180 sec. from 1ppm Hg, at 350mL/min gas flow.
- Mercury Response: ≥ 6000 μAbs / ppb* at 100mL/min carrier gas flow.

* Using prescribed tubing, reagents, and pump speed.

** Three hour minimum warm-up using the standard Nafion® dryer and a gas flow equal to 20mL/min along with prescribed tubing and reagents. Using pump speed, uptake and rinse times specified for standard Nafion® Dryer in Table 1-1, and ≥16 s integration cycle selected on the "flattest" portion of the peak time profile.
Preparing for Installation
2. Preparing for Installation

Installing the QuickTrace™ M-7500 requires preparation. This chapter discusses what requirements must be met when obtaining supplies and choosing a location for the QuickTrace™ M-7500. It also describes how to successfully unpack the system prior to installation. Before installing the Mercury analyzer, first obtain the necessary supplies listed below. Next evaluate the laboratory layout to choose a suitable location. Once a location is chosen, carefully unpack the QuickTrace™ M-7500.

If a computer was purchased from a source other than CETAC, see the QuickTrace™ M-7500 Mercury Analyzer Software Manual for details on how to install the QuickTrace™ M-7500 Software.

2.1 Supplies

2.1.1 Necessary Supplies

- **Inert Gas Regulator.**

  Two-stage, 50-200 psig secondary pressure gauge, with plumbing couple for either a cylinder or dewar capable of delivering 150 psig.

- **AC Power Strip (surge protected) with six outlets.**

- **Cylinder or Dewar, UHP Nitrogen or Ar gas.**

  Ultra-high purity, dry, research grade N\textsubscript{2} or 99.999\% purity Ar. The QuickTrace™ M-7500 has a user replaceable 2-micron filter, which prevents damage from particulates to the internal Gas Control Unit (GCU).

- **Mercury Standard Solution.**

  1000 ppm (minimum order quantity).
• **Hydrochloric Acid Trace Metal Grade (37%).**

  Trace metal HCl will be used in the preparation of Hg standards, SnCl₂ reagent and in some method applications. If an application is more demanding, a better grade of acid may be needed (e.g. double distilled).

• **Nitric Acid Trace Metal Grade (68-70%).**

  Trace metal HNO₃ will be used in sample preparation, cleaning glassware (lab glassware and the QuickTrace™ Gas-Liquid Separator) and added to the QuickTrace™ rinse solution to help maintain the cleanliness of the system during operation.

• **Stannous Chloride (Crystals, Di-Hydrate).**

  Two 500g containers minimum order, “suitable for Hg determination.” The stock SnCl₂ is introduced into the QuickTrace™ at a steady flow rate and therefore any Mercury contamination will be negated during the instrument zero.

• **Potassium Permanganate. Solid, crystalline.**

  The cheapest available grade at a minimum quantity is sufficient unless it is also to be used for oxidative sample preparation. This low-grade reagent stock is sufficient to fill a safety trap for retention of Hg vapor exhaust from the instrument.

• **Two-Propanol. High purity, “spectrophotometric” grade.**

  Two-propanol will be used for cleaning the optical cells and cell windows.

• **Kimwipes®.**

• **Additional Chemical Compounds.**
The sample preparation procedures of the intended analytical method may require additional chemical compounds. Refer to published method specifications.

2.1.2 Recommended Supplies

- Volumetric Flasks 100mL class A (TC) six each.
- Volumetric Flasks 1000mL class A (TC) two each.
- Precision Automatic Micropipettes, 10 to 1000 μL (TD).
- Replacement Tips for Micropipettes.
- Disposable Plastic dropping pipettes.
- Graduated Cylinders, 10 and 100 mL.
- Polypropylene or Polyethylene Bottle with Cap, 1 L.
- Weighing Balance, Top Loading, 0.1g readability (or better), any available capacity will work (1.1 Kg capacity is good).
- Laboratory Scoopula and Large Spatula.
- Stop-Watch (for measuring liquid uptake rates).
- Stirring Rod.
- Powder Funnel, wide bore stem, small overall size.
- Wrenches, adjustable 12” and 6”.
- Screw Drivers:
  - One small Phillips
  - One medium Phillips
  - One long-shank medium flat-blade
One small thin flat-blade

- Deionized Water.

- Flow Meter 0 - 500 mL/min. with 1 mL/min. readability, calibrated to user’s choice of carrier gas (Ar or N₂).

### 2.2 Choosing a Location

Choosing a location for the QuickTrace™ M-7500 involves evaluating the laboratory environment for the availability of space, ventilation and power. For the QuickTrace™ M-7500 to function optimally, the location selected must meet specific requirements associated with each of these items. The following sections discuss space, ventilation and power requirements.

### 2.3 Space Requirements

The QuickTrace™ M-7500 Mercury Analyzer System which includes the base unit, autosampler and peristaltic pump requires a minimum footprint for countertop installation of 84 cm x 70 cm x 76 cm (WxDxH). With the optional ADX-500 Autodilutor, the system width extends to a width of 89 cm total. A floor space of 30 cm x 30 cm is required for the liquid waste receptacle. The space for the waste can be directly below the analyzer, or directly in front of the lab bench and inline with the peristaltic pump. The computer used to operate the QuickTrace™ Mercury System needs a minimum space of 60 cm x 70 cm x 60 cm (WxDxH). At a very minimum, the overall width required is 150 cm to accommodate the QuickTrace™ and computer. See figure 2-1.
2.4 Ventilation

During operation, the QuickTrace™ M-7500 internally contains trace amounts of Mercury vapor. To prevent inhalation of the vapor, the QuickTrace™ M-7500 uses a solid KMnO₄ absorbent trap located on the back of the instrument. This trap absorbs the Mercury vapor prior to final exhaust; therefore no extra ventilation is required beyond that of a standard laboratory environment.

WARNING

Gases exhausting from the QuickTrace™ M-7500 cabinet, prior to the external Hg vapor trap (affixed to the rear cabinet panel) contain traces of Mercury vapor and must be treated as such. Do not run the QuickTrace™ M-7500 unless exhausted gas is properly “scrubbed” or removed. Either fill, maintain, and use the provided KMnO₄ absorbent trap or run a transfer line to a fume hood.
Locating the QuickTrace™ M-7500 directly in the path of an air conditioner or heater vent may cause baseline drift, and is not recommended.

**Notice:**

Due to the likelihood of accelerated damage from corrosion and dust, locating the QuickTrace™ M-7500 in a fume hood with stagnant air automatically voids the warranty.

### 2.5 Power Requirements

Place the QuickTrace™ M-7500 within 1.2 meters of a standard power outlet. The QuickTrace™ M-7500 instrument and peristaltic pump power input requirements are specified when ordering, either 115 VAC (50/60 Hz) or 220-240 VAC (50/60 Hz). Six power outlets are required, one each for the QuickTrace™ M-7500 Mercury Analyzer, peristaltic pump, ASX-520 Autosampler, optional ADX-500 Autodilutor, computer, and monitor. (An AC surge protected power strip with six or more outlets will suffice).

The QuickTrace™ M-7500 base unit is a fixed voltage instrument, either 115 VAC (50/60 Hz) or 220-240 VAC (50/60 Hz). Do not attempt to use any voltage other than what the instrument was manufactured for, i.e. do not plug a 220V line into a 115 V unit and vice versa. (Only the autosampler, peristaltic pump and optional autodilutor have “universal voltage” input. See the *ASX-520 Autosampler Operator’s Manual* and *ADX-500 Autodilutor Manual* for more information.)

The 115V QuickTrace™ M-7500 Instrument may be used directly in the U.S. (115 VAC 60 Hz), and in Japan (100 VAC 50/60 Hz) without modification. The 220V units may be used without modification wherever 208-240 VAC (50/60 Hz) power is available.

The power cord set supplied with the QuickTrace™ M-7500, ASX-520, optional ADX-500 and peristaltic pump meets the requirements of the
Preparation for Installation

country where the instrument was purchased. If the instrument is to be used in a country other than the one specified at the time of ordering, ensure that the voltage specified for that unit is the voltage used in that country. If necessary, obtain a new power cord set that meets the requirements of that country if necessary.

**WARNING**

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

### 2.6 Unpacking the QuickTrace™ M-7500

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

If the QuickTrace™ M-7500 or any of its components are shipped or removed from storage during cold weather, allow the packaged equipment to attain room temperature before opening and exposing to warm, humid air. It is usually sufficient to provide four to eight hours for this purpose.

If water damage has occurred (en route or at destination), or if condensation forms on or inside the QuickTrace™ M-7500 System, allow it to dry thoroughly before connecting it to an AC power source and operating it. Failure to do so may cause equipment damage. Also, notify CETAC Customer Service if any damage is revealed upon inspection.

Remove the packing checklist from the shipping container, and check off items against it. Leave accessories in the packing until needed.
Note:

Do not throw away the factory packaging. Keep it for possible future use.
Installing the QuickTrace™ M-7500
3.1 Placement of the ASX-520 Autosampler and Peristaltic Pump

Refer to figure 3-1 and 3-3.

1. **Place the ASX-520 Autosampler on top of the QuickTrace™ M-7500 base unit (BC).**

The placement is such that the autosampler tray (CB) is touching the optical cabinet (BD) of the base unit. The drip shield (BR) for the optical cabinet is placed directly over the lip of the autosampler tray.

2. **Place the analytical peristaltic pump (AA) directly to the left of the QuickTrace™ M-7500 base unit.**

Leave an ~1cm gap. The pump should also be set back so that its front edge is approximately in line with the boundary between the QuickTrace™ M-7500 base unit and the optical cabinet.

Figure 3-2 shows the placement of an optional ADX-500 Autodilutor.
Figure 3-1. Front Assembly of QuickTrace™ M-7500, ASX-520, and Peristaltic Pump.

AA - Peristaltic Pump
AB - GLS Drain Tubing to Pump
AC - Waste Tubing
AD - Drain Inlet “Tee”
AE - Sample Tube (from pump)
AF - Mixing “Tee”
AG - Drain Outlet “Tee”
AH - Tubing Bridge (outlet)
AI - Pump Power Switch
AJ - Tubing Bridge (inlet)
AK - Reagent Luer Fitting
AL - Reagent Sipper Tube
AM - Reagent Tube (from pump)
BA - GLS Drain Tubing
BB - Liquid Mix Tube (to GLS)
BC - M-7500 Base Unit
BD - Optical Cabinet
BE - Hinged Optical Door
BF - Locking Door Assembly
CA - Rinse Tubes (ASX-520)
CB - Autosampler Tray
CC - Rinse Station Fill Tube
CD - Rinse Overflow Tubing
CE - Rinse Station Overflow
CF - Rinse Station
CG - Sample Sipper Tubing
CH - ASX-520 Z-Axis Driver
CI - ASX-520 Autosampler
CJ - Sample Probe
CK - Standards Rack
CL - Sample Rack
CM - Sample Probe Guide
CN - ASX-520 Base
Installing the QuickTrace™ M-7500 with Autosampler

Figure 3-2. Front Assembly of QuickTrace™ M-7500, ASX-520, Peristaltic Pump, and Optional ADX-500 Autodilutor.

AA - Peristaltic Pump
AB - GLS Drain Tubing to Pump
AC - Waste Tubing
AD - Drain Inlet “Tee”
AE - Sample Tube (from pump)
AF - Mixing “Tee”
AG - Drain Outlet “Tee”
AH - Tubing Bridge (outlet)
AI - Pump Power Switch
AJ - Tubing Bridge (inlet)
AK - Reagent Luer Fitting
AL - Reagent Sipper Tube
AM - Reagent Tube (from pump)
BA - GLS Drain Tubing
BB - Liquid Mix Tube (to GLS)
BC - M-7500 Base Unit
BD - Optical Cabinet
BE - Hinged Optical Door
BF - Locking Door Assembly
CA - Rinse Tubes (ASX-520)
CB - Autosampler Tray
CC - Rinse Station Fill Tube
CD - Rinse Overflow Tubing
CE - Rinse Station Overflow
CF - Rinse Station
CG - Sample Sipper Tubing
CH - ASX-520 Z-Axis Driver
CI - ASX-520 Autosampler
CJ - Sample Probe
CK - Standards Rack
CL - Sample Rack
CM - Sample Probe Guide
CN - ASX-5120 Base
CO - Dilutor Probe Guide
DA - Dilutor Probe
DB - Dilutor Uptake Tubing
DC - Dilutor Z-Axis Driver
DD - ADX-500 Autodilutor
DE - Dilutor Sample Loop
DF - Autodilutor Valve
DG - Autodilutor Syringe
DH - Diluent Uptake Tubing
3.2 Electrical Connections

Refer to figures 3-3 and 3-4.

Three power cords (four with optional ADX-500 Autodilutor) and two 24 universal VDC power adapters (three with optional ADX-500 Autodilutor) are included with the QuickTrace™ M-7500 system. One power cord each for the peristaltic pump, autosampler and the QuickTrace™ M-7500 base unit. One 24 VDC power adapter (each) for the autosampler and peristaltic pump.

1. Check that the base unit’s main power switch immediately below item (BH) is “off.”
2. Check that the main power switches to the ASX-520 (CV) and optional ADX-500 (DJ) are off (released “out” rather than pushed “in”).
3. Check that the main power switch to the peristaltic pump is in the off position (Refer to Figure 3-1 (AI)).
4. Place the on/off switches on the power adapters in the off position.
5. Insert the male jack plugs from power adapters into the female 24 VDC-in receptacles (CU) on the ASX-520 (optional ADX-500 (DK)), respectively.
6. Repeat (Step 5) for the peristaltic pump (reference figure not shown).
7. Insert the female power cord connector into the "Power Mains Connect/Disconnect" (BI) on the back of the QuickTrace™ M-7500 base unit and on the 24 VDC power adapters, then insert the other ends into a grounded surge protected power strip.
8. Plug the surge protection power strip into the AC outlet receptacle.

Do not apply power to the QuickTrace™ M-7500 at this time.
Figure 3-3. Rear View of QuickTrace™ M-7500, ASX-520, and Peristaltic Pump.

AA - Peristaltic Pump
BC - M-7500 (base unit)
BD - Optical Cabinet
BG - Lamp Power Switch
BH - Main Fuse Drawer
BI - Power Mains Connect/Disconnect
BJ - Auxiliary Fuse Holders
BK - Gas In
BL - 2 Micron Gas Filter
BM - Gas Exhaust
BN - Gas Exhaust Tubing
BO - Mercury Vapor Trap
BP - Fan Filter
BQ - Communication Ports (base unit)
BR - Plastic Drip Shield
BQ - Communication Ports (base unit)
CH - Z-Axis Driver (ASX-520)
CI - ASX-520 Autosampler
CJ - Sample Probe
CM - Sample Probe Guide
CN - ASX-520 Base
CP - Rinse Station Pump Clamp
CQ - Rinse Solution Out
CR - Rinse Solution In
CS - Auxiliary Connection (ASX-520)
CT - ASX-520 Communication Ports
CU - 24VDC Power in (ASX-520)
CV - Power Switch (ASX-520)
Figure 3-4. Rear View of QuickTrace™ M-7500, ASX-520, Peristaltic Pump, and Optional ADX-500 Autodilutor.
3.3 PC Interface

Refer again to figure 3-3.

The system utilizes two nine pin male RS232 serial communication ports, one for the QuickTrace™ M-7500 Mercury Analyzer base unit and one for the ASX-520 Autosampler. These can be found their respective completion kits.

1. Connect a female nine pin RS232 serial communication cable to the QuickTrace™ M-7500 base unit PC IN (BQ).
2. Connect a female nine pin RS232 serial communication cable to the ASX-520 COM1 (CT).
3. Connect the ASX-520 Autosampler cable to the COM1 port on the computer.
4. Connect the QuickTrace™ M-7500 base unit cable to the COM2 port on the computer.

3.4 Autosampler and Peristaltic Pump Auxiliary Cables

Refer again to figure 3-3.

Locate the pump auxiliary cable in the QuickTrace™ M-7500 completion kit. Both ends are a nine pin male connection.

1. Connect one end of the pump auxiliary cable to the back of the peristaltic pump.
2. Connect the other end of the cable to the pump port (female nine-pin (BQ)) on the back of the QuickTrace™ M-7500.

Locate the autosampler auxiliary cable in the QuickTrace™ M-7500 completion kit. One end is a 15-pin male connector. The other end is a 37-pin female connector.

3. Connect the 37-pin female connector to the back of the autosampler (CS).
4. Connect the 15-pin male connector to the (female 15-pin) autosampler port (BQ) on the back of the QuickTrace™ M-7500 base unit.
3.5 Installing the Autosampler Z-Drive and Sample Probe

See the ASX-520 Autosampler Operators Manual, and follow the instructions carefully.

3.6 Installing the Optional Autodilutor

See the ADX-500 Autodilutor Manual and follow the instructions carefully.

3.7 Verifying the Installation

Once installation of the QuickTrace™ M-7500 System is complete, it is important to verify that the system is installed correctly.

CAUTION

Attempting to use the QuickTrace™ M-7500 before ensuring that all components are installed correctly may result in damage to the system.

3.7.1 Testing the Interface

0. Install the QuickTrace™ M-7500 Software at this time if a PC was purchased from a source other than CETAC. It is important to view and understand the README.TXT file following the installation of the software.

1. Power on the QuickTrace™ M-7500, ASX-520, peristaltic pump, and optional ADX-500 Autodilutor.

   Note: Lamp on button must be depressed up (on position).

2. Check to ensure that the auxiliary port cables are connected to the equipment according to sections 3.3 and 3.4.

3. Start the QuickTrace™ Software.

   Note: Do not stabilize detectors.

4. When the software is initializing, it will test the connections to the peristaltic pump, QuickTrace™ M-7500 Instrument (base unit) and the ASX-520 Autosampler.
The QuickTrace™ M-7500 Software runs a test routine at startup to test the various interfaces throughout the system. The software will give a report on the status of the interface if there is a failure.

3.8 Verify the Software Configuration of COM Ports Manually

If the software does not find the QuickTrace™ M-7500 base unit or the ASX-520 Autosampler it will be necessary for the analyst to test them using the QuickTrace™ M-7500 Hg Software and the Hyperterminal.exe program provided with Windows.

To check or change the configuration in the QuickTrace™ M-7500 Hg Software:

1 Open the Specify Installed Hardware application, in the Start menu.

2 Verify that the autosampler and the Mercury analyzer are configured/connected to the correct COM ports. The default configuration is: M-7500 QuickTrace™ on COM2; ASX-520 Autosampler on COM1. If the configuration differs from the default, set the Mercury analyzer base unit to COM2 and the autosampler to COM1.

3 Press okay to save changes and exit the application.

4 Restart the QuickTrace™ Software.

If errors persist, the Windows HyperTerminal® program can be used to manually verify the communication through each serial port.

3.8.1 Using Windows HyperTerminal® Program

HyperTerminal® (if installed) can be found in the Start menu. Select the Programs/Accessories/Communications folder to find the HyperTerminal® program.
Note:
This manual assumes the reader and operator of the QuickTrace™ M-7500 Mercury Analyzer has a working knowledge of using standard Windows applications. For more information on how to use Windows, see your computer’s documentation.

1 Click on Hypertrm.exe. (It may be designated HyperTerminal®.)

2 If this is the first time that HyperTerminal® has been run on this computer, you may be asked to enter an area code and other dialing information. This information will not be used for our procedure, so enter any number you desire. Furthermore you may be prompted to install a modem – this is not necessary and can be ignored.

3 A dialog box titled "Connection Description" will appear. Enter a name significant to you, such as "QuickTrace M-7500."

4 A dialog titled "Phone number" or "Connect to" will appear. The only important field is the "connect using" field. Select "Direct to com1" or "COM1."

5 A COM port properties dialog box will appear. Be sure the settings are as follows: 9600-8-N-1 (9600 baud, 8 data bits, no parity, 1 stop bit) with no flow control. (As illustrated in the figure 3-5).

![Figure 3-5.](image)

6 Under the file menu select “Properties.”

7 A properties dialog box will appear.
8 Click on the setting tab. Click on the “ASCII Setup...” button. A dialog box will appear. Make sure the following settings are checked (Figure 3-6).

“Echo typed characters locally”

“Append line feeds to incoming line ends”

![Figure 3-6.](image)

9 Click OK to confirm these settings.

10 Go to file menu and select Save.

If you have changed the COM port properties, you may have to sever your connection and reconnect to have the new settings take effect. This can be done using two buttons on the toolbar – the one with the phone off the hook disconnects, the one with the phone on the hook reconnects.

![image](image)

Both the ASX-520 and the QuickTrace™ M-7500 base unit will respond to the command VER (capitalization is important).

The Mercury analyzer will respond ‘CETAC Technologies. Mercury Analyzer - ...’. The autosampler will respond ‘CETAC Technologies ASROM...’. If the responses are not received as expected, or on the expected COM ports, then this will indicate a hardware or Windows configuration problem.
3.9 Checking the Autosampler Components

See the ASX-520 Autosampler Operator’s Manual to verify configuration.

3.10 Testing the Sample Probe

Refer to the ASX-520 Autosampler Operator’s Manual and the QuickTrace™ M-7500 Software Manual to verify proper alignment and movement of the ASX-520.

3.11 Checking the Optional Autodilutor Performance (if applicable)

When the ASX-520 is powered up it checks to see if an autodilutor is connected (it cannot determine whether power is applied to the autodilutor). If an autodilutor is present and connected (and is detected by the ASX-520 Autosampler) then the ASX-520 will respond to the “VER” inquiry as follows:

Cetac Technologies ASROM V ...
Dilutor connected

If the second line is not present then the autodilutor was not properly connected to the autosampler when it was powered up.

To verify the functioning of the autodilutor directly the following command can be typed in (using HyperTerminal® COM1) “\VER” followed by <Enter>. The autodilutor should respond:

Cetac Technologies DIL ROM V ...
3.12 Carrier Gas Connection

Refer to Figure 3-7. Locate the plastic-shipping bag labeled “Completion Kit – QuickTrace™ M-7500.” It contains various small parts, tubing, fittings, computer CD-ROM, etc. In this bag, find the brass 2-micron gas filter (BL), with associated brass Swagelok™ fittings, and a short section of ETFE tubing (attached to the filter) which has been formed into a partial loop.

Install the looped end of the ETFE tube into the Swagelok™ bulkhead fitting labeled “GAS INLET” (BK), and tighten the fitting finger tight, then ¼ turn with an adjustable wrench. Make sure that the flow arrow on the gas filter is pointing in the direction to the gas in fitting (BK).

Determine how far the QuickTrace™ M-7500 is located from the gas supply (UHP Nitrogen or Argon). Allowing a generous service loop cut an appropriate length of 1/8" Nylon® tubing from the roll provided. Connect one end of this tube to the gas inlet side of the 2-micron brass filter (BL) and tighten the Swagelok™ fitting (BT) securely.

Note:
A 2-micron in-line filter must always be used and the carrier gas must be supplied to the QuickTrace™ M-7500 at 120 psig. The 2-micron filter has been selected for minimal pressure drop and minimal flow fluctuation. Do not substitute other filters.
Figure 3-7. Expanded Rear View of QuickTrace™ M-7500.

BJ - Auxiliary Duse Holders  
BN - Gas Exhaust tubing  
BT - 2 Micron Gas Filter Fitting  
BK - Gas In  
BO - Mercury Vapor Trap  
BU - Vapor Trap Luer Fitting  
BL - 2 Micron Gas Filter  
BP - Fan Filter  
BV - Vapor Trap Holder Clip  
BM - Gas Exhaust  
BS - Vapor Trap End Cap
Connect the other end of the nylon tube to the gas supply regulator, using ¼” NPT 1/8” Swagelok™ fitting provided.

Adjust the regulator so that its final output stage is guaranteed to be off or below 120 psig once the main supply valve is open. Do this before proceeding to the next step.

**Note:**
Exceeding 120 psig gas supply pressure to the QuickTrace™ M-7500 may blow the internal safety valve, causing the unit to malfunction until the pressure is reduced low enough to reseat the safety valve and then restored to 120 psig.

Turn on the gas supply and adjust the final regulator output stage to 120 psig.

**CAUTION**
Use only “research-grade,” “dry” UHP Nitrogen or Argon. Do not use “welding” grade gases - these may permanently damage the QuickTrace™ M-7500.

### 3.13 Mercury Trap (KMnO₄)

In the plastic bag labeled "Completion Kit - QuickTrace M-7500," find the polyethylene tube with a seven inch (17.8 cm) length of dark Viton® tubing attached to one end (BO). When filled with crystalline potassium permanganate, this will serve as the Mercury vapor trap. The vapor trap will clean the QuickTrace™ M-7500 exhaust vapors, to prevent the release of Mercury vapor into the lab atmosphere.

Refer back to Figure 3-7. Remove one end cap (BS) from the polyethylene tubular body (BO). Do NOT remove the heat shrink-wrapped Luer fitting (BU) from the end cap. Inspect both end cap interiors to ensure that the ends are lightly plugged with fine glass wool. If not, lightly pack a small loose wad of fine glass wool into the small i.d. section of each cap. Pack enough glass wool to stop the potassium permanganate from filtering through, but not restrict the gas flow. Once the glass wool is in place, use a powder funnel to fill this tube with dry crystalline solid potassium permanganate (KMnO₄). While filling, have one end fully capped, hold the other end straight upward,
and use the powder funnel to guide the KMnO₄ crystals into the tube. Fill to the top, tapping a finger lightly on the tube to settle the KMnO₄, and finally place the end cap on securely.

**WARNING**

Be sure to wear protective eyewear and safety gloves when handling chemicals.

Refer again to Figure 3-7. Snap the filled mercury trap into the black holder's (BV) under the silk-screen label "MERCURY TRAP (KMnO₄)." Attach the black Viton® tube (BN) to the PTFE tubing labeled "GAS EXHAUST" (BM). The Mercury vapor trap needs to be cleaned and refilled when the brown color approaches the open end. This is the formation of MnO₂ as the KMnO₄ is reduced. The Potassium permanganate may last at least one year depending on frequency of use, except in the unlikely event of a major overflow accident in the QuickTrace™ M-7500.

**Note:**

So long as the KMnO₄ is dry, free flowing (not caked), dark purple crystals, it is perfectly OK.

### 3.14 Nafion® Dryer Cartridge

CETAC’s Nafion®-based dryer cartridge¹ (figure 4-3 (L)) is designed as the standard recommended drying system for all CETAC Mercury Analyzers (it replaces the older magnesium perchlorate drying tube). Using the Nafion® dryer substantially reduces daily maintenance and setup time, since daily water saturation will not occur with the Nafion® membrane as it may with the earlier magnesium perchlorate system. It also lowers detection limits and yields more consistent performance. Nafion® cartridges typically last three to six months, whereas older magnesium perchlorate systems must be replaced/recharged at least once a week (if not daily).

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¹Nafion® is a registered trademark of DuPont (E.I. du Pont de Nemours and Company), which trademark is licensed to Perma Pure, Inc. and used (with permission) herein by SD Acquisition, Inc. DBA CETAC Technologies.
Nafion® Dryer Benefits:

- Efficient drying capability.
- No maintenance required.
- Improved long-term precision.
- Higher sensitivity.
- Lower detection limits.
- User can easily interchange Nafion® and perchlorate cartridges, if desired (but the Nafion® cartridge is recommended for all applications).
- Replace Nafion® cartridge every three to six months, depending on use.

The CETAC Nafion® dryer cartridge contains a tubular inner Nafion® membrane housed within an outer tube and coiled inside the cartridge. The argon or nitrogen carrier gas containing mercury and water vapor is swept along the inner Nafion® membrane, allowing water vapor to permeate the membrane selectively, whereas the membrane is not permeable to mercury vapor. On the “waste” side of the membrane, a counter gas flow, split from the carrier gas supply, selectively sweeps the water vapor out of the system, whereas non-permeating Mercury vapor proceeds to the sample cell.

The CETAC Nafion® dryer cartridge and associated plumbing is already pre-installed in your new QuickTrace™ M-7500 factory shipment. No further installation is required.

3.15 Plumbing Connections

A majority of the instrument plumbing is done at the factory, with the analyst only needing to:

1. Install the Peristaltic Pump Tubing.

2. Install the Mixing and Drain Tees.

3. Connect and Set up the ASX-520 Sipper Tube.
4 Connect and Set Up the QuickTrace™ M-7500 Reagent Bottle.

5 Connect and Set Up the QuickTrace™ M-7500 Waste Container.

6 Connect QuickTrace™ M-7500 to the Peristaltic Pump.

7 Connect the ASX-520 Rinse Station Tubes.

8 Connect and Set Up the Optional ADX-500 (if applicable).

9 Adjust Peristaltic Pump Tubing Clamp Tension.

To accomplish the above connections, refer to Table 3-1 (at the end of this chapter). Also, refer figures 3-8, 3-9, 3-10 and 3-11 as you complete the steps on the following pages.

In Figure 3-8, note that the peristaltic pump rotates clockwise. When referring to the pump, the source side (AJ) of the pump is the user's left when facing the pump, and the destination side (AH) is the right.

3.15.1 Installing the Peristaltic Pump Tubing

1 Release all four peristaltic pump channel clamps.

2 Locate the peristaltic pump tubing in the completion kit. There are two sets of pump tubing. The Santoprene® tubes with the yellow bridge stops are for the sample and drain channels. The Santoprene® tubes with the black bridge stops are for the reagent channel.

3 Install the first Santoprene® drain pump tube (cream colored tube with yellow bridge stops) on the pump head in the bottom channel (Z2 and Z4 in Figures 3-9 and 3-10).

4 Install the second Santoprene® drain pump tube in the next channel up (Z1 and Z3).

5 Install the third Santoprene® sample pump tube in the next channel (Y1 and Y2).

6 Install the Santoprene® reagent pump tube (cream colored tube with black bridge stops) in the top channel (X1 - X2).
Figure 3-8. Expanded View of Pump, Showing Tubing Connections.

AA - Peristaltic Pump
AB - GLS Drain Tubing to Pump
AC - Waste Tubing
AD - Drain inlet "Tee"
AE - Sample tube (from pump)
AF - Mixing "Tee"
AG - Drain Outlet "Tee"
AH - Tubing Bridge (outlet)

AI - Pump Power Switch
AJ - Tubing Bridge (inlet)
AK - Reagent Luer Fitting
AL - Reagent Sipper Tube
AM - Reagent Tube (from pump)
BA - GLS Drain Tubing
BB - Liquid Mix Tube (to GLS)

CA - Rinse Tubes (ASX-520)
CC - Rinse Station Fill Tube
CD - Rinse Overflow Tubing
CE - Rinse Station Overflow
CF - Rinse Station
CG - Sample Sipper Tubing
CN - ASX-520 Base

BC - M-7500 Base Unit
Figure 3-9. Peristaltic Pump Channel Labels.

- X₁ - Reagent Tubing Inlet
- Y₁ - Sample Tubing Inlet
- Z₁ - Drain Tubing Inlet
- Z₂ - Drain Tubing Inlet
- X₂ - Reagent Tubing Outlet
- Y₂ - Sample Tubing Outlet
- Z₃ - Drain Tubing Outlet
- Z₄ - Drain Tubing Outlet

Figure 3-10. Peristaltic Pump Tubing Connections.

- AC - Waste Tubing
- AD - Drain Inlet “Tee”
- AF - Mixing “Tee”
- AL - Reagent Sipper Tube
- AG - Drain outlet “Tee”
- BA - GLS Drain Tubing
- BB - Liquid Mix Tube (to GLS)
- CG - Sample Sipper Tubing
3.15.2 Installing the Mixing Tee and Drain Tees

1 Locate the smallest (1/16" dia.) polypropylene tee (AF) (Figure 3-10) provided in the completion kit. Install this tee on the destination side (AH) (Figure 3-8) of the pump. The tee is connected to the outlet of the reagent peristaltic pump tube (AM, X2) and the outlet of the peristaltic sample pump tube (AE, Y2) using opposing sides of the tee (AF).

2 Connect the remaining two larger 3/32" dia. tees (AD, AG) to the two peristaltic pump drain tubes. Directly opposing sides of tee (AD) should be installed between the inlet drain tubes at Z1, Z2. Tee (AG) should be installed at the outlets Z3 and Z4. Both right-angle side-arm ports of the tees are “open” at this point.
3.15.3 Setting Up the ASX-520 Sipper Tube and Connecting to the Pump

1. See the *ASX-520 Autosampler Operator's Manual* for proper autosampler installation, care, and maintenance.

2. Connect the sample tube (CG) (Figure 3-8) from the ASX-520 to the second from the top pump tube (Y1) on the source (inlet) side (AJ) of the peristaltic pump.

3.15.4 Connect and Set Up the QuickTrace™ M-7500 Reagent Bottle

1. Find the 11 inch (28cm) length of Teflon® tubing inside the reagent bottle. This is the “Reagent Sipper Tube” (AL). Set this tube aside.

2. Fill and cap the reagent bottle with 10% SnCl₂ (in 7% HCl v/v). The reducing agent will be used with the QuickTrace™ M-7500 system during operation of the system. The Luer cap is placed on a bulkhead Luer fitting of the reagent bottle cap for storage to help preserve the SnCl₂.

3. To connect the reagent bottle to the QuickTrace™ M-7500 instrument, connect the 11 inch Teflon® reagent sipper tube (AL) to the top peristaltic pump tube (X1), on the source side (AJ) of the peristaltic pump.

4. Prior to using the QuickTrace™ M-7500 and after wetting of the Gas-Liquid Separator remove the small Luer cap and insert the reagent tube (AL) down through the bulkhead Luer fitting (AK) and into the reagent bottle. To ensure that no precipitated solids are pumped through the QuickTrace™ M-7500 System, the reagent tube (AL) should not touch the bottom of the reagent bottle.

5. When finished using the QuickTrace™ M-7500 for any significant period of time (e.g. more than 30 min). Manually remove the reagent tube (AL) from the reagent bottle, place it in a beaker of rinse water, and replace the small Luer cap onto the fitting (AK). This will help preserve the SnCl₂. This saves the bulk volume reagent from being “wasted” when not in use, and it slows air oxidation of the SnCl₂.
3.15.5 Connect and Set Up the Waste Container

1 Find a three foot (91 cm) length of thin-walled Tygon® tubing in the completion kit. This is the waste "drain" tube (AC).

2 Find a Luer male barbed fitting (look for this in the 10 liter waste container). Also, locate a capped Luer fitting already mounted on the top of the 10-liter waste container cap. Remove one of these caps and screw the loose barbed Luer fitting onto the mounted luer fitting. Attach one end of the three-foot (91cm)-drain tube (AC) to this mounted barbed Luer fitting. Now, connect the other end of the drain tube to drain tee (AG) on the destination side (AH) of the pump. To prevent pressure buildup in the 10-liter waste container, be sure that at least one of the two vents on the 10-liter waste container are open (uncapped) during operation.

3.15.6 Connect the QuickTrace™ M-7500 Mercury Analyzer to the Peristaltic Pump

1 Connect the “1-> Liq. Mix ->” (BB) (Figure 3-11) tubing to the QuickTrace™ M-7500 GLS to the remaining open port on the mixing tee (AF) on the destination side (AH) of the pump. The Liquid Mix tubing (BB) and the drain tubing (BA) are designed to come out the top of the QuickTrace™ M-7500, and between the QuickTrace™ M-7500 and the ASX-520, just behind the bottom left front foot of the ASX-520.

2 Connect the “4 <- Drain <-” tubing (BA) from the QuickTrace™ M-7500 GLS to the remaining drain tee (AD) port on the source side (AJ) of the peristaltic pump.

3.15.7 Connect the ASX-520 Rinse Station Tubing

The ASX-520 Aautosampler peristaltic rinse pump rotates clockwise. The rinse station is always filled from the bottom port and drained from the top port. For a full description of how to set up the ASX-520 rinse station tubing, see the ASX-520 Autosampler Operator’s Manual. It should be noted there are two configurations.
Circulating rinse (Figure 3-8, (CA)).

CETAC recommends the circulating rinse setup for most applications.

Fill the rinse bottle with trace metal grade 1% HCl/HNO₃ v/v.

Note:
When analyzing samples and standards of high concentration such as 20ppb or greater use a stronger concentration of acid i.e., 5% HCl/HNO₃ or greater.

Locate in the completion kit the ¼” OD Tygon® tubing and refer back to Figure 3-8 and Figure 3-12. The tubing will need to be cut to the appropriate lengths.

In this case, the rinse station (CF) overflow port (CE) is connected by tube (CD) to the ASX-520 pump (Pump inlets are “CR” and pump outlets are “CQ”).

1. Connect one pump inlet (CR) to the rinse bottle (the tube should go to the bottom of the rinse bottle).

2. Connect the other inlet (CR) to fitting (CE) of the rinse station (Figure 3-8, CF).

3. Connect the ASX-520 pump outlet (Figure 3-12, CQ), corresponding to (CR) inlet from the rinse bottle to the fill port (CC) at the bottom of the rinse station (CF) in Figure 3-8.

4. Connect the other ASX-520 pump outlet (Figure 3-12, CQ), corresponding to (CR) inlet from overflow port (CE) of the rinse station (CF), back to the rinse bottle for circulation as shown in Figure 3-8 (CA).

The rinse return tube should be cut so that the end is placed in upper ¼ of the rinse bottle.

5 If the clamps are not closed, close them now.

Rinse to Drain.

This configuration empties the rinse supply bottle much faster, but is available for testing procedures that require, by law, for safety reasons,
or for unusually stringent cross-contamination protection, that the rinse overflow go directly to the waste bottle.

Refer to Figure 3-8.

1. **Connect a long tube with a Luer fitting to the back of the ASX-520 at the output side (CQ, Figure 3-12) of the ASX-520 drain pump (corresponding to (CR) rinse station overflow).**

2. **Connect the Luer fitting directly to one of the two vents on the top of the 10-liter waste receptacle.**

   The rinse water overflow (Figure 3-8, CE) proceeds directly via tube CD to an ASX-520 pump inlet (Figure 3-12, CR), through the pump, and from that outlet (Figure 3-12, CQ) directly to the large waste bottle on the floor.

### 3.15.8 Connect the Optional ADX-500 (if applicable)

Refer to Figures 3-2 and 3-4, as well as ADX-500 Autodilutor manual.
Figure 3-12. Rinse Tubing Installation Connections.

CP - Rinse Station Pump Clamp  CQ - Rinse Solution Out  CR - Rinse Solution In
3.16.9 Peristaltic Pump Tubing Clamp Tension

Refer again to Figures 3-8, 3-9, 3-10, and 3-11.

1. Disconnect “11→HG VAPOR→12” tube from the GLS vapor outlet.

2. Open the QuickTrace™ M-7500 Software.

3. Open the QuickTrace™ M-7500 hardware controls (See QuickTrace™ M-7500 Software Manual) by pressing the Instrument button, or select Window|Instrument.

4. With zero clamp tension on the tubing (screws nearly unscrewed), snap all four clamps into place and start the peristaltic pump at 50% speed (See QuickTrace™ M-7500 Software Manual).
   
   Set gas flow to 100ml/min.

Read through steps 5-8 before proceeding. It is extremely important to set the peristaltic pump drain clamps in a timely fashion after the GLS begins to fill with liquid. Failing to do so will trigger the liquid level sensor safety feature.

---

**WARNING**

Do not start liquid flow without the carrier gas being on and pressure set to 120 psi, and flow set to 100ml/min. Otherwise, fluid backfill into the gas ballast can occur.

Refer to software manual for instrument control.

5. Place the ASX-520 sipper tube into rinse station. Use the mouse and click the “Up” button, then the “Park” button. Visually verify the sipper’s movement.

6. Place the ASX-520 sipper into the rinse station (CF) and then manually increase the clamp tension on the Santoprene® sample tubing (Y₁ - Y₂) until liquid uptake begins in the sipper tube.
7 Watch the liquid flow as it makes its way from the ASX-520 rinse station (CF), to the pump (Y1 -> Y2), through the mixing tee (AF), and to the Gas-Liquid Separator (Figure 3-11, (2)).

The GLS will begin to fill with rinse solution.

8 Increase the clamp tension on both of the drain tubing clamps (cream-colored drain tubing with yellow bridge stops Z1-Z3 and Z2-Z4) until flow begins from the drain port (3) of the GLS and the liquid level begins to drop.

Do this quickly before the GLS fills to the point were the overflow protection is activated. The GLS should slowly drain to empty, even though sample continues to be delivered to the top of the frosted center post. The GLS is intended to operate “empty” with only a thin film of liquid continuously wetting the frosted center post and exiting the drain. The GLS should never fill completely and overflow with liquid due to the liquid overflow protection.

9 Tighten both drain tube clamps equally to ensure even flow to each.

Check this by observing the segmented flow at both drain tees (AD, AG). The rate of flow in and out should be balanced through both Santoprene® drain lines. Adjust the clamp tension (Z1-Z3 and Z2-Z4) to keep the GLS empty and to achieve a smooth, balanced, segmented flow at AD, AG, and AC. Unstable drain flow can cause baseline noise in the system.

10 Start the SnCl₂ flow.

1) Place the SnCl₂ uptake tube in the reagent bottle
2) Close the clamp.
3) Increase the reagent clamp tension (X1-X2) until reagent uptake begins in the tube.
4) Adjust the clamp so that the flow from the SnCl₂ bottle is smooth, with no jerks in the flow.

11 Once liquid is running through the QuickTrace™ M-7500, note that the drain tubing clamp tension is properly adjusted by watching the flow through the Gas-Liquid Separator.

The GLS should remain empty and liquid exiting the GLS should appear nearly motionless, with no flutter or instability at point three.
The flow into the GLS should be as smooth and pulse free as possible.

View this closely at the top of the GLS frosted center post. The liquid should stream continuously from the capillary tip to the top of the post, and the liquid column spanning the gap between the capillary tip and post should be nearly “motionless,” with minimal fluctuation and no jerkiness or discontinuity. If this is not the case check that the “gap” between the bottom of the GLS capillary insert tube and the top of the GLS frosted center post is ~0.5 mm (range of 0.3-0.6 mm). If not, very carefully slide this insert up or down, as needed. Refine the clamp tension of the sample (Y1-Y2) and reagent (X1-X2) channels as needed to stabilize the liquid flow to the GLS.

A flow check with a 10ml graduated cylinder (less than 100mm tall) and stopwatch should yield a sample uptake rate of ~5 mL/min, and a reagent uptake rate of ~1.8 mL/min with the QuickTrace™ M-7500 peristaltic pump running at 50% speed. Check liquid flow stability at the drain exit (3) of the GLS after final adjustments of clamp tension to sample and reagent pump tubing.

Flow Check Procedure – Reagent:
1. Fill the 10ml graduated cylinder with 10ml DI water
2. Simultaneously place the reagent sipper tube in the graduated cylinder and start the stopwatch.
3. After 30 seconds, remove the uptake tube from the cylinder.
4. Measure the water remaining in the cylinder, and calculate the reagent flow rate.

Flow Check Procedure - Sample Probe:
1. Fill the 10ml graduated cylinder with 10ml DI water.
2. Move the sample probe to the middle of rack three (3:30 if set for a 60 position rack).
3. Position the graduated cylinder beneath the sample pProbe.
4. Simultaneously click the Down button and start the stopwatch.
5. After 30 seconds click the Up button.
6. Measure the water remaining in the cylinder, and calculate the flow rate.
7. Park the sample probe.
Note:
When properly adjusted the tension on the bottom three peristaltic pump tubes should be the same and the tension screw for the top pump tube (reagent tube) should be screwed 1 to 2 mm farther in.

Once the clamp tension on the pump tubing is established, relieve their stretch.

1. Unclamp reagent and sample clamps.
2. Park the sample probe.
3. Press the Up button to remove the sample probe from the rinse station.
4. Remove the sipper tube from the SnCl₂.
5. Allow the waste line to empty.
6. Unclamp waste line clamps.
7. Turn the pump off using the software controls.

Do not leave tubes clamped in place when the system is not being used. The next time the system is used, hook the tubes and close the quick-release mechanisms. No screw adjustments will be needed. Previous clamp tension is “remembered” as the quick release is engaged and disengaged.
**Note: Overflow Protection**

During normal operation of the QuickTrace™ M-7500 if liquid begins to fill up the GLS the overflow protection will engage. Release sample and reagent quick-release pump clamps completely. This will immediately stop the GLS from overflowing liquid into the drying cartridge when the operator acknowledges the overflow error.

1) Check for a clog in the drain line and see if the drain tube is pinched behind the snap-on front cabinet. If not, proceed to step two.

2) Re-engage pump clamps, resume pumping, and loosen or tighten both drain tubing clamp tension \((Z_1-Z_3,Z_2-Z_4)\) in slight increments until the liquid level in the GLS begins to drop. It should eventually empty. If drainage does not occur, remove the GLS drain tube and re-inspect for a clog. Clean or replace this tube as needed. Check again that the drain interconnect tubing AB is not pinched between the electrical cabinet and the snap-on optical cabinet. The flow from the drain tubing to the waste bottle should be as smooth as possible. This can be observed in the segmented drain line flow and should be balanced between the two drain channels in the pump.
Summary of User Tubing Installation Connections  
(Refer to Figures 3-8, 3-9, 3-10, and 3-11)

<table>
<thead>
<tr>
<th>ITEM:</th>
<th>CONNECTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSTALLATION OF PUMP TUBING:</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 1st Santoprene® (cream) pump tube; yellow bridge stops - "drain pump tube" | From: Z₂ (pump bridge "in")  
To: Z₄ (pump bridge "out") |
| 2nd Santoprene® (cream) pump tube; yellow bridge stops - "drain pump tube" | From: Z₁  
To: Z₃ |
| 3rd Santoprene® (cream) pump tube; yellow bridge stops - "sample pump tube" | From: Y₁  
To: Y₂ |
| 4th Santoprene® (cream) pump tube; black bridge stops - "reagent pump tube" | From: X₁  
To: X₂ |

**PUMP TUBING CONNECTIONS Inlet Side, (AJ)**

<table>
<thead>
<tr>
<th>ITEM:</th>
<th>CONNECTION:</th>
</tr>
</thead>
</table>
| 1/16" o.d. x 11" Teflon® sipper tube (AL); | From: Reagent Bottle-SnCl₂  
To: X₁ (reagent pump tube inlet end) |
| ASX-520 Sipper Tube (CG); (1.0 mm i.d. x 3.5 ft, Teflon®) | From: Autosampler Sample Probe  
To: Y₁ (sample pump tube inlet end) |
| Labeled Silicone (white) Drain Tube End (AB); (Label: "4 <-- DRAIN <--") | From: Gas-Liquid Separator Drain (3)  
To: 1st 3/32" Polypropylene Drain Tee (AD) Sidearm Port |
| (Already attached to QuickTrace M-7500 , GLS (3)) |                             |
| Z₁ 1st Drain Pump Tube, inlet end; | To: Drain Tee (AD) In-line port |
| Z₂ 2nd Drain Pump Tube, inlet end; | To: Drain Tee (AD) remaining in-line port |

**PUMP TUBING CONNECTIONS Outlet Side, (AH)**

<table>
<thead>
<tr>
<th>ITEM:</th>
<th>CONNECTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>X₁  Reagent Pump Tube, outlet end;</td>
<td>To: 1/16&quot; Polypropylene Mixing Tee (AF), 1&quot; in-line port</td>
</tr>
<tr>
<td>Y₁  Sample Pump Tube, outlet end;</td>
<td>To: Mixing Tee (AF) remaining in-line port</td>
</tr>
<tr>
<td>Labeled Viton® (black) Liquid Mix Inlet Tube (BB); (Label: &quot;1 --&gt; Liq. Mix--&gt;&quot;)</td>
<td>To: Mixing Tee (AF) open sidearm port</td>
</tr>
<tr>
<td>(Already mounted on QuickTrace M-7500 , leading to GLS inlet (2))</td>
<td></td>
</tr>
<tr>
<td>Z₁ 1st Drain Pump Tube, outlet end (Z₁);</td>
<td>To: 2nd 3/32&quot; Polypropylene Drain Tee (AG) in-line port</td>
</tr>
<tr>
<td>Z₂ 2nd Drain Pump Tube, outlet end (Z₂);</td>
<td>To: Drain Tee (AG) remaining in-line port</td>
</tr>
<tr>
<td>Clear Tygon® Drain hose (AC) (1/8&quot; o.d. 3 foot length)</td>
<td>To: Drain Tee (AG) open sidearm port</td>
</tr>
</tbody>
</table>

**WASTE BOTTLE**

<table>
<thead>
<tr>
<th>ITEM:</th>
<th>CONNECTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Tygon® Drain hose (AC) (remaining end)</td>
<td>To: Barbed Luer fitting on Large Waste Container</td>
</tr>
</tbody>
</table>

Table 3-1. Summary of Tubing Connection.
Using the QuickTrace™ M-7500
Using the QuickTrace™ M-7500

Operation of the QuickTrace™ M-7500 is done almost strictly through the QuickTrace™ M-7500 Software interface provided with the QuickTrace™ M-7500 System.

For a detailed description of the software see the QuickTrace™ M-7500 Mercury Analyzer Software Manual.

The following chapter covers physical operation instructions to achieve optimum performance.

4.1 Theory of Operation

4.1.1 ASX-520 Autosampler

The Autosampler is prepared for operation by loading sample vials (up to 360) of digested samples, into selected positions of the sample racks (up to four). Vials of calibration standards (up to 10) are placed in user-selected positions of the standards rack or in user selected sample racks. Rinse solution, for sample-to-sample probe decontamination, and waste containers are emptied and filled, respectively.

After the host computer is programmed with sampling parameters (See QuickTrace™ M-7500 Software Manual), the system is ready for unattended operation to begin. The autosampler operates under computer control to move the sample uptake probe to any sample position; the rinse station, reference standard, blank, etc., in a user-programmed sequence. The sample uptake probe (sipper tube) supplies the multi-channel peristaltic pump's sample inlet.

For further information, see the ASX-520 Auto Sampler Operator's Manual.
4.1.2 QuickTrace™ M-7500 Automated Mercury Analyzer

4.1.2.1 Sample Introduction & Stannous Chloride Reactor

Refer to Figure 4-1 to trace the path of liquids through the QuickTrace™ M-7500 System. An acidified digested aqueous sample from the autosampler is introduced, via peristaltic pump (Y₁ and Y₂), as Hg²⁺ dissolved in solution. A reducing agent, 10% stannous chloride solution (SnCl₂ in 7% HCl), is introduced in a parallel pump channel (X₁ and X₂). The sample and reagent (SnCl₂) streams (Y₂, X₂) join at the mixing tee (1), and immediately enter the QuickTrace™ M-7500 tubing reactor ("Liquid Mix"). Sn²⁺ reduces Hg²⁺ in solution to Hg⁰ while the mixture is en route to the Gas-Liquid separator (GLS). At this stage and prior to the GLS, the analyte is present as a finely dispersed emulsion of liquid (metallic) Hg⁰ micro-droplets, in excess SnCl₂ solution medium.

NOTE:
The CETAC QuickTrace™ M-7500 Mercury Analyzer measures inorganic mercury (free Hg²⁺ or HgCl₂, which is subject to efficient stannous chloride reduction in the QuickTrace™ M-7500 tubing reactor); using inorganic Mercury standard solutions for instrument calibration. If insoluble Mercury, bound Mercury, or organomercurials are present in samples, an appropriate sample dissolution/digestion procedure will have to be employed to convert these other forms to free inorganic Hg²⁺ or HgCl₂, prior to analysis with the QuickTrace™ M-7500.
Figure 4-1. QuickTrace™ M-7500 Systems and Sub-Systems Functional Block Diagram.
4.1.2.2 Gas-Liquid Separation

The finely dispersed Hg⁰/SnCl₂ emulsion is introduced into the top of the GLS (Gas-Liquid Separator (2)). The Hg⁰/SnCl₂ emulsion flows over the frosted GLS center post in a relatively thin film, covering the entire post from top to bottom. A carrier gas simultaneously enters the bottom of the GLS tangentially (10). The carrier gas (Ar or N₂) swirls around the wetted center post and upwards toward the GLS gas exhaust port (11).

Hg⁰ droplets in the thin emulsion film quickly evaporate into the gas vortex surrounding the post. The carrier gas stream efficiently sweeps this Hg⁰ vapor (along with some evaporated water) upward and out of the GLS gas exhaust (11), and on to the drying (12, 13) and optical section (14, 15) of the QuickTrace™ M-7500 for CVAAS analysis.

The majority of the water bulk, containing excess reducing agent, acid, any non-participating "spectator ions," and reaction by-products, finally drains out the bottom of the GLS (3) and is pumped to waste (4 and Z₁ to Z₄).

**Note:**

The GLS operates “empty” with no liquid level. The liquid bulk spreads out as a film that wets the center post. At the bottom of the post, the film collects at a single point and is then continuously pumped to waste, so the “liquid level” should not rise in the GLS.

4.1.2.3 Carrier Gas

Refer again to Figure 4-1 to trace the path of the carrier gas. A clean, dry carrier gas, such as UHP N₂ or Argon, must be supplied to the back of the instrument at 120 psig. The computer controlled Gas Control Unit (GCU) regulates the pressure across a sapphire orifice (5), to produce primary flow rates in the range of 20-350 mL/min. The carrier gas first enters the reference cell (6) to facilitate measurement of the incident radiant power (P₀) at 253.652nm (253.7nm). It exits (7) and passes through the empty ballast tank¹ (8 and 9). The carrier gas next passes through the GLS (10) to pick up Hg⁰ vapor from the reduced sample. The carrier gas and Hg⁰ vapor exit the GLS (11) and enter (12) a Nafion® drying cartridge where water vapor is removed (13). For the Nafion® dryer, an auxiliary sweep gas from a secondary sapphire orifice (5A) enters an auxiliary port (12A) and selectively removes water vapor from the dryer cartridge at 13A.

¹ The ballast tank guards against “rare” liquid back-siphoning accidents in the unlikely event of improper system shutdown.
Finally, the dry Hg⁰/carrier gas mixture exits the dryer (13) and enters the sample cell (14) for measurement of transmitted radiant power (P) at 253.7 nm.

Ultimately, the gas stream (carrier gas and Hg⁰) exits the sample cell (15) and is exhausted to a solid KMnO₄ trap (16) where Hg⁰ is absorbed, and clean carrier gas passes to the lab atmosphere.

### 4.1.2.4 Optics and Cold Vapor AAS

Refer again to Figure 4-1 to trace the optical path of the QuickTrace™ M-7500. The Cold Vapor AAS (Atomic Absorption Spectrometry) process within the sample cell begins with a low pressure, high frequency, thermally stabilized, electro-optically regulated Hg vapor lamp, which produces the Hg emission spectrum. Emitted light is collimated (L₁) and projected in two parallel, isolated beams one each through the reference and sample cells. Absorbance of 253.7 nm radiation by Hg⁰ vapor (derived from the chemically reduced sample and GLS) occurs only in the sample cell. P is thereby decreased, relative to \( P₀ \). To prevent Hg⁰ vapor condensation and speed system washout (between samples) both cells are heated and thermally controlled to maintain the internal cell gas temperature at constant. A cell temperature of \( \approx 50 \degree C \) is the maximum temperature when the cell oven temperature is set to 125\degree C. User optimized settings below this value (e.g. 37\degree C gas \( \approx 60 \degree C \) oven temperature setting) may yield better system stability and lower detection limits, for low concentration work.

#### Note:

Due to system design and stabilization parameters, there is a substantial temperature differential between the oven radiator plate and the flow cell gas. The oven radiator temperature must actually be set to 125\degree C to maintain the maximum actual cell gas temperature of 50\degree C for fast washout during higher concentration analysis. Lower settings may be user-selected to minimize detection limits; e.g. the default oven radiator setting of 60\degree C results in a more optimal actual cell gas temperature of \( <37 \degree C \), for lowest concentration detection.

Radiation from the cells enter the binocular camera, where both collimated beams are independently focused (L₂) and filtered (F) before reaching separate, matched, silicon detectors (D). Narrow band 254 nm; 2nm interference filters (F) remove all radiation but the strong 253.7 nm Hg⁰ "resonance line" from both the sample (P) and reference (\( P₀ \)) beams. By a photovoltaic effect, the two high performance analytical silicon detectors
(D) convert the 253.7nm light beams into electrical analog signals, proportional to radiant power (P and P₀). These outputs are processed by an analog circuit board to yield an electrical signal proportional to optical absorbance (Abs = -log (P/P₀)). The analog board is directly mounted to the detectors for shortest possible electrical connection distance and lowest possible noise. This output is fed to a 24 bit Analog-to-Digital-Converter (ADC) and then to the system processor. Only after digital conversion does the data travel over a significant (ribbon) cable length to the system processor. The lowest possible absorbance noise (≤ 10⁻⁵ Abs, ≤ 10 µAbs, as processed digital signal (three standard deviation unit detection limit (DL)) is thereby maintained.

4.1.2.5 Analog to Digital Conversion (ADC) and System Processor

At the system processor, the absorbance (log ratio) signal is processed further to produce a digital number. This process is repeated at high speed. The resulting digital data stream is sampled at high frequency, in real-time, by the system processor. The system processor transmits the data to the host computer via an RS-232 serial communications link.

4.2 Software

In the host computer, the sample absorbance value is drift corrected, blank subtracted, if through blank is desired. The absorbance value is then measured against a calibration curve derived from previously obtained absorbance values of calibration standards.

The QuickTrace™ M-7500 Mercury Analyzer Software operates under a Windows environment. The QuickTrace™ M-7500 Software provides complete instrument, autosampler and autodilutor (if applicable) control. The QuickTrace™ M-7500 Software also provides a variety of EPA compliant quality control functions, display features, report generation and diagnostic routines.

If the sample overranges the user-defined microabsorbance (µabs), the software will automatically interrupt the sequence and initiate an extended rinse period. If the optional ADX-500 Autodilutor is installed (See Section 3.5), the software will direct the ASX-520 to perform a user defined dilution of the sample into a new tube. The system will analyze this diluted sample and then resume the primary analytical sequence for remaining undiluted samples.

The user interface is sufficiently powerful that it will satisfy the requirements of experienced technically advanced analysts and scientists.
4.3 ADX-500 Autodilutor Accessory (Optional)

An optional ADX-500 Autodilutor Accessory may be attached to the ASX-520 Autosampler. The CETAC ADX-500 Autodilutor Accessory is designed to work in conjunction with the QuickTrace™ M-7500 Mercury Analyzer base unit and the ASX-520 Autosampler. It adds the ability to automatically dilute and analyze samples, which are over the calibration range. It performs on-line dilution of the sample, controlled by user configurable software.

Over-ranged samples are diluted by a user defined dilution factor of up to 1:10, with additional sequential dilutions available as a software option. The user can configure the software to dilute samples upon over-range of the calibration curve, where the intensity is above the high standard, or upon over-range of the system analog electronics.

The autodilutor is connected to a reservoir of diluent solution (calibration blank). Whenever a sample overranges (user defined) the system, a pre-defined aliquot of the over-ranged sample is drawn up and dispensed into a pre-designated empty vial in the ASX-520 Autosampler rack. The ADX-500 then dispenses a pre-programmed volume of diluent solution into the pre-dispensed sample aliquot with sufficient force to induce turbulence and ensure mixing.

The system software then analyzes the diluted sample prior to resuming the remaining programmed sequence of (undiluted) samples and QC standards.

For further information, see the ADX-500 Autodilutor Accessory Operator's Manual and the QuickTrace™ M-7500 Mercury Analyzer Software Manual.
4.4 Removing the Optical Front Cabinet

The optical front cabinet is designed to easily "snap off" and then "snap on" again. This is to allow extremely easy access for maintenance and/or service of the optical rail, oven, camera, detector module, exterior front plumbing, and glassware systems.

4.4.1 Snap-Off

Before using the snap-on/snap-off feature, pull the entire instrument forward so that the optical cabinet overhangs the edge of the lab bench, with the instrument feet about an inch (3-cm) back from the edge of the bench.

Refer back to Figure 3-1. Open the front access door (BE) and unscrew three captive safety/shipping screw-knobs. To do this, completely loosen the screw (BF) with a flat-blade screwdriver, and open the front access to its fullest extent. Screw "BF" is captive and won't fall out of the door.

Look inside the optical front cabinet and locate the three metal screw-knobs (one on top of the optical rail and two below) which secure the optical front cabinet (BD) to the electrical cabinet (BC). Use a flat-blade screwdriver to loosen all three of these screw-knobs completely. They are "captive" and won't fall out of the panel. Close the front access door (BE) and screw it back down securely (BF).

To snap the optical front cabinet off, stand directly in front of it, grab it by the two ends, and pull on the whole front cabinet (straight away from the instrument). It should come off easily (See Figure 4-2).
Figure 4-2. Snap-off of front cabinet.

**CAUTION**

Always be sure the three internal safety/shipping screws are unscrewed, and that the access door (BE) is closed and screwed back down (BF) before pulling on the cabinet ends.

Now the optical rail and external front plumbing are easily accessible for any desired maintenance, check, or service operation (See Figure 4-3).

Figure 4-3. Front of QuickTrace™ M-7500 with the optical cabinet cover removed.
4.4.2 Snap-On

Refer to Figure 4-4. After completing the maintenance/service operation simply guide the optical cabinet cover (male) ball studs (one on each of four corners) into the mating (female) snap sockets (A, Figure 4-4) of the electrical cabinet. Gently push on the two ends of the optical cabinet cover until the cabinet snaps into place. Inspect all four corners of the optical front cabinet. If one or more corners failed to "snap-in" on the first try, push on that corner, and the snap should engage. If any corner does not snap-on easily, remove the front optical cabinet completely and inspect the perimeter of the front panel on the electrical cabinet. If any tubing is in a position where it is likely to "pinch" between the two cabinets reposition the tubing to alleviate the interference, and try again. The analyst is advised to re-engage and re-tighten the three safety/shipping metal screw-knobs (B) with a screw driver, and to close the front access door and re-tighten its metal screw-knob (BF, figure 3-1) with a screw driver.

Figure 4-4. Exposed Front of the QuickTrace™ M-7500 Mercury Analyzer.
4.5 Preparing Reagents and Calibration Standards

Always use high purity gas, chemicals, acids, water, standards, and clean glassware for analysis. It may be necessary to acid wash and rinse all glassware more than once to eliminate contamination for the most sensitive mode of operation (<20ppt).

Recommended Chemical Concentrations:

<table>
<thead>
<tr>
<th>Reagent</th>
<th>10%(w/v) SnCl₂ in 7%(v/v) HCl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standards for Instrument Calibration</td>
<td>All instrument calibration standards (Hg²⁺) are prepared in 7%(v/v) HCl then an aliquot of standard is treated to the same procedure as a sample prior to instrument calibration.</td>
</tr>
<tr>
<td>Rinse</td>
<td>1%(v/v) HCl/HNO₃ trace metal grade in the autosampler rinse reservoir bottle.</td>
</tr>
</tbody>
</table>

**NOTE:**

HCl media should be used for stock standard preparation! Hg standards in nitric acid (only) are unstable at ppb levels and below. With 7% HCl media (in glass at room temperature), the standards are stabilized for weeks at the ppb level, and for several days at the ppt level. Standards should be 7%(v/v) HCl even after final dilution.

**NOTE:**

1% HCl/HNO₃ rinse prevents carryover contamination from high samples and standards to subsequent low samples. (Deionized water (alone), as rinse does not ensure this.)
NOTE:

The CETAC QuickTrace™ M-7500 Mercury Analyzer measures inorganic Mercury (free Hg^{2+} or HgCl_{2}, which is subject to efficient stannous chloride reduction in the QuickTrace™ M-7500 tubing reactor). Inorganic Mercury standard solutions are used for instrument calibration. If insoluble Mercury, bound Mercury, or organomercurials are present in samples, an appropriate sample dissolution/digestion procedure will have to be employed to convert these forms to free inorganic Hg^{2+} or HgCl_{2} prior to analysis with the QuickTrace™ M-7500. If it is desired to confirm the oxidative digestion procedure accuracy (recovery) regarding organomercurials, then organomercurial standards or appropriate standard reference materials would have to be carried through the digestion as "process standards."

NOTE:

SD Acquisition, Inc., DBA CETAC Technologies assumes no liability for the handling of organomercurial concentrates or the preparation, handling, or use of diluted organomercurial process standards.

WARNING

The handling of organomercurial concentrates, which may be used in the preparation of process standards, presents a substantial (potentially lethal) safety hazard. Only an experienced, professionally trained organo-metallic chemist, knowledgeable and skilled specifically in the safe handling of organomercurials (using approved apparatus and approved protection measures in an approved facility) should attempt to prepare diluted organomercurial process standards from concentrates. Always be sure to obtain and carefully read the MSDS (Material Safety Data Sheets) before handling organomercurials!

In most cases, CETAC Technologies recommends that samples be oxidized following standard, safe, well known, approved sample dissolution or digestion procedures, and that the QuickTrace™ M-7500 instrument calibration standards be prepared only from inorganic Mercury concentrates or diluted from commercially available inorganic Mercury standard solution concentrates. Where possible, the recommended means of overall process (dissolution/digestion + QuickTrace™ M-7500 analysis)
validation should be through use of commercially available standard reference materials (SRM's) of composition matching (or similar to) the samples and containing certified, known mercury levels in a concentration range similar to the samples. (Being by far the safest alternative, this SRM approach to overall process validation should be used whenever possible, and is nearly always preferred to preparing diluted process standards from hazardous organomercurial concentrates!)

### 4.6 Selecting Operational Parameters

**Oven Radiator Temperature**

- Ambient - 125°C

**Carrier Gas**

- N₂ UHP, high purity grade cylinder (dry, research grade) or Argon, high purity grade (e.g. liquid dewar boil-off or cylinder).

**Gas Flow Rate**

- 20 - 350 ml/min

**Pump Rate**

- 0 - 100%

See Table 4-1 and the *QuickTrace™ M-7500 Mercury Analyzer Software Manual* for a more complete listing of optimal instrument setups.

### 4.7 Starting the QuickTrace™ M-7500

To start the QuickTrace™ M-7500 from a complete shut down condition, turn on the QuickTrace™ M-7500 base unit and the ASX-520 Autosampler. Make sure that the front cabinet is snapped on and the cabinet door is closed.

Begin the system warm-up period by setting the oven radiator surface temperature to the desired temperature per Section 4.7.1. From a cold start, it takes 90 minutes for the optical rail, lamp, detectors, and analog...
QuickTrace™ M-7500 Mercury Analyzer Operator’s Manual

Using the QuickTrace™ M-7500

electronics to thermally stabilize. For ultimate detection limit performance, 90 to 180 minutes of stabilization may be required.

**Warm-up times (by concentration range):**

<table>
<thead>
<tr>
<th>From:</th>
<th>0.2 - 5 ppb</th>
<th>&lt; 0.2 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Standby Condition (lamp off, main power on, gas off)”</td>
<td>≤ 5 min</td>
<td>≤ 30 min.</td>
</tr>
<tr>
<td>“Cold Shutdown (lamp off, main power off, gas off)”</td>
<td>≤ 90 min.</td>
<td>≤ 180 min.</td>
</tr>
</tbody>
</table>

**Detector Stabilization**

OFF ON

**Note:**

The detector, electronics, gas and optical systems heat up much slower than the oven radiator plate. It takes considerably longer than the point at which the oven temperature (E) appears to stabilize. Approximately 90 – 180 minutes are needed from a cold start condition to achieve overall thermal stability (depending on required DL).

### 4.7.1 Setting the Oven Temperature

The oven will already be preset to a default radiator temperature of 70°C. To change the oven temperature, refer to Figure 4-4. Open the optical cabinet door and push the "set" button (D) on the heat controller (G), which is located above the oven and on the front panel of the QuickTrace™ M-7500 electrical cabinet (inside the front optical cabinet). Hold the set button (D) down and simultaneously depress the up or down buttons (H) until the desired set point is achieved (in °C). Release all buttons. The display (E) now continuously reads the oven radiator surface. When fully warmed up and the gas is flowing, a maximum oven radiator surface set point of 125°C yields approximately 50°C gas temperature in the optical flow cells. This maximum temperature of 50°C (gas) is for fastest cell washout at relatively high Mercury levels (>10 ppb). For better baseline stability and lowest detection limits, an oven radiator setting of 60°C will yield <37°C gas temperature in the optical/flow cell.
4.8 Analysis of Samples

Once the QuickTrace™ M-7500 has warmed up, check that the four channel peristaltic pump is plugged in, and that the method pump speed is set to the desired speed (See QuickTrace™ M-7500 Software Manual). Make sure the pump tubing is installed and tension is adjusted per Section 3.16.1 and Section 3.16.9. Check also that supply gas is connected and 120psig pressure is applied to the unit per Section 3.13. The system software controls the peristaltic pump and gas flows. Ensure that the KMnO₄ trap is filled per Section 3.14. The analyst may now operate the QuickTrace™ M-7500 to perform analysis of samples. The QuickTrace™ M-7500 Mercury Analyzer Software Manual has been developed specifically to assist the analyst in this task. Refer to this manual to perform the desired analytical tasks. Once finished, the analyst should place the QuickTrace™ M-7500 instrument in either Standby (See the QuickTrace™ M-7500 Mercury Analyzer Software Manual) or cold shutdown condition.

At the beginning of each day or after any period of pump inactivity and prior to analysis ensure that the GLS center post is fully wetted.

1. Perform the wetting of the GLS by initiating a gas flow anywhere from 300-350 mL/min.

2. Check that the bottle supplying the ASX-520 rinse station is filled with clean trace metal grade 1% HCl/HNO₃ v/v rinse solution.

3. Turn peristaltic pump on.


Note:

Concentration ranges greater than 20 ppb may require a higher percent acid in the rinse solution. A 5% HCl/HNO₃ v/v should be sufficient for the highest concentration mode.

5. Disconnect “11->HG Vapor->12” tube from the GLS vapor outlet.

6. Using the quick-release mechanisms, fully release the clamp tension on the lower two tube channels (drain channels) of the peristaltic pump (Figure 3-9, Z1 to Z4) on.

7. Pinch the drain tube prior to the tee (AD, Figure 3-8) on the inlet side (AJ) of the peristaltic pump. Using the sample and reagent tubes, pump rinse solution (from the ASX-520 rinse
station) and DI water in place of the stannous chloride reagent, respectively.

8. With the drain pump tubes unclamped, the GLS should begin to fill with liquid. Once the liquid level rises, gas will bubble through it.

9. Allow the GLS to fill until a gas bubble propels a "meniscus" upward to wet the post all along its length, including its top. (THE POST IS NOW WETTED).

10. When this happens, immediately re-engage the quick-release clamps on the drain pump tubes. Do not let the liquid level rise high enough to initiate the GLS overflow protection. If the GLS overflow is initiated refer to the \textit{QuickTrace™ Software Manual} to reinitiate the peristaltic pump and then restart the GLS wetting procedure. With the drain tube clamps properly re-engaged and the pump running, the liquid level will stop rising and begin draining.

11. Once the GLS has "emptied," leave the pump running (keep liquid flowing), reconnect “11->HG Vapor->12" tube to the GLS vapor outlet.

12. Place reagent tube in the SnCl₂.

13. Method setup and sequence generation may be started at this time. See the \textit{QuickTrace™ M7500 Software Manual} for the proper procedure for method setup and sample analysis routines.

\textbf{Note:}

If you don't want to consume stannous chloride reagent during a "standby" condition, you may alternatively keep the GLS center post wetted by immersing the reagent sipper tube in a beaker of deionized water (with the sample sipper tube also immersed in the ASX-520 rinse station).

\section*{4.9 QuickTrace™ M-7500 Startup Summary}

\subsection*{4.9.1 Cold start}

Power up QuickTrace™ M-7500 Mercury Analyzer System for a minimum of one hour for ppb ranges and approximately three hours for the most demanding low-level ppt ranges.
4.9.2 Warm start

When the instrument and autosampler have been on for the appropriate warm up time, the system should be stable enough to follow the start-up procedure for a warm start.

**Note:**
The QuickTrace™ M-7500 Mercury System may be left powered up with the lamp and the gas off for extended periods to expedite the start up procedure.

1. Initiate QuickTrace™ M-7500 Software (if software was left open and in standby, open the QuickTrace™ M-7500 controls and start the autosampler rinse pump (click pump on and probe down)).
2. Turn on lamp and initiate the carrier gas flow (See the QuickTrace™ Software Manual) making sure the main gas supply is on. A minimum of a 15-minute warm-up time is required.
3. Clean and rinse the 2L rinse bottle with DI water and refill with trace metal grade 1% HCl / HNO₃ solution.
4. Place the autosampler rinse tubing into the rinse bottle.
5. Prepare a fresh 10% SnCl₂H₂O w/v 7% HCl v/v solution if old solution is yellow (oxidized) or precipitated. Prepare only what you need to complete the calibration and sample run including all QC checks and spikes. The reagent flow is ≈ 1.5 ml/min 50% pump speed.
6. Verify that the sample capillary (inlet insert) is 0.5mm above the Gas-Liquid Separator (GLS) center post.
7. Open vents on waste container.
8. Inspect peristaltic pump tubing for wear and flat spots (replace if necessary). Place the peristaltic pump tubing in their appropriate shoes and holder clips. **Do not lock shoe clamps at this time.**
9. Place the reagent capillary in a beaker of DI water and using the QuickTrace™ M-7500 controls start the peristaltic pump at 100% pump speed.

10. Lock down the peristaltic shoe clamps.

11. Inspect liquid flows. The GLS drain should be flowing smoothly with no build up or pulsing of liquid. The waste line from the peristaltic pump to the waste container should be liquid-gas etc... with no vibration. **If this is not the case upon inspection, stop immediately and change GLS drain line and or waste line.**

12. Wet the GLS center post with carrier gas flowing at a flow rate of 300 to 350 mL/min per Section 4.8.

13. Inspect the rinse station for a convex liquid bubble adhering to the sample probe. If this is not the case, change the rinse pump peristaltic tubing.

14. Attach GLS exhaust tube to the GLS.

15. Place the reagent capillary in the reagent bottle.

16. Open the appropriate worksheet (See QuickTrace™ M-7500 Software Manual) and verify that the gas flow of the method matches what is listed in QuickTrace™ M-7500 controls, if the flow is not the same make the necessary change and click set gas. This will stabilize the gas flow prior to zeroing the optics.

17. Record lamp mA's in a daily instrument logbook.

18. Zero the QuickTrace™ M-7500 using the auto zero.


20. Peak profile the high standard and verify baseline and sample integration times. Record μAbs and concentration of the peak profile standard in a daily instrument logbook. **Note: This operation should be performed on the highest standard.**

21. Calibrate instrument and analyze samples.
Using the QuickTrace™ M-7500

Summary of Gas and Liquid Flows for Analytical Ranges of the QuickTrace™ M-7500

**RANGE #1: ULTRATRACE SENSITIVITY**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow:</td>
<td>20 mL/min</td>
</tr>
<tr>
<td>Peristaltic Pump Speed:</td>
<td>100%</td>
</tr>
<tr>
<td>Sample Flow Rate:</td>
<td>~ 9 mL/min</td>
</tr>
<tr>
<td>Sample Time (for Liquid Uptake or Autosampler &quot;Sip&quot;):</td>
<td>90 s</td>
</tr>
<tr>
<td>Rinse Time:</td>
<td>160 s</td>
</tr>
<tr>
<td>Read Delay:</td>
<td>95 s</td>
</tr>
<tr>
<td>Replicate Read Time:</td>
<td>4 s</td>
</tr>
<tr>
<td>Replicates:</td>
<td>4</td>
</tr>
<tr>
<td>Baseline Correction Method:</td>
<td>2 point (10-20s &amp; 230-240s)</td>
</tr>
<tr>
<td>Oven Temperature Set Point:</td>
<td>60°C</td>
</tr>
<tr>
<td><strong>Expected Results:</strong></td>
<td></td>
</tr>
<tr>
<td>Detection Limit (nominal):</td>
<td>&lt; 0.0002 ppb</td>
</tr>
<tr>
<td>Sample Throughput Rate (minutes/sample):</td>
<td>4.10 min/sample</td>
</tr>
<tr>
<td>Dryer Cartridge Life:</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

**Expected Results:**

- 50 ppt | 7% HCl ~4000 uAbs
- Detection Limit (nominal): < 0.0002 ppb

**Table 4-1A. Parameters to Optimize Throughput vs. Sensitivity: UltraTrace**

**Figure 4-5A.** Typical Results from UltraTrace Settings.
**RANGE #2: HIGH SENSITIVITY**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow</td>
<td>40 mL/min</td>
</tr>
<tr>
<td>Peristaltic Pump Speed</td>
<td>50%</td>
</tr>
<tr>
<td>Sample Flow Rate</td>
<td>~5 mL/min</td>
</tr>
<tr>
<td>Sample Time (for Liquid Uptake or Autosampler &quot;Sip&quot;)</td>
<td>70 s</td>
</tr>
<tr>
<td>Rinse Time</td>
<td>140 s</td>
</tr>
<tr>
<td>Read Delay</td>
<td>85 s</td>
</tr>
<tr>
<td>Replicate Read Time</td>
<td>2 s</td>
</tr>
<tr>
<td>Replicates</td>
<td>4</td>
</tr>
<tr>
<td>Baseline Correction Method</td>
<td>2 point (18-28s &amp; 190-200s)</td>
</tr>
<tr>
<td>Oven Temperature Set Point</td>
<td>60°C</td>
</tr>
<tr>
<td><strong>Expected Results:</strong></td>
<td></td>
</tr>
<tr>
<td>Detection Limit (nominal)</td>
<td>&lt; 0.001 ppb</td>
</tr>
<tr>
<td>Sample Throughput Rate (minutes/sample)</td>
<td>3.30 min/sample</td>
</tr>
<tr>
<td>Dryer Cartridge Life</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

**Expected Results:**
- 500 ppt | 7% HCl ~20,000 uAbs
- Detection Limit (nominal): < 0.001 ppb
- Sample Throughput Rate (minutes/sample): 3.30 min/sample
- Dryer Cartridge Life: 3-6 months

**Table 4-1B.** Parameters to Optimize Throughput vs. Sensitivity: High Sensitivity

**Figure 4-5B.** Typical Results from High Sensitivity Settings.
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**RANGE #3: NORMAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow:</td>
<td>100 mL/min</td>
</tr>
<tr>
<td>Peristaltic Pump Speed:</td>
<td>50%</td>
</tr>
<tr>
<td>Sample Flow Rate:</td>
<td>~5 mL/min</td>
</tr>
<tr>
<td>Sample Time (for Liquid Uptake or Autosampler “Sip”):</td>
<td>30 s</td>
</tr>
<tr>
<td>Rinse Time:</td>
<td>70 s</td>
</tr>
<tr>
<td>Read Delay:</td>
<td>55 s</td>
</tr>
<tr>
<td>Replicate Read Time:</td>
<td>1.5 s</td>
</tr>
<tr>
<td>Replicates:</td>
<td>4</td>
</tr>
<tr>
<td>Baseline Correction Method:</td>
<td>1 point (26-30 s)</td>
</tr>
<tr>
<td>Oven Temperature Set Point:</td>
<td>70°C</td>
</tr>
<tr>
<td>Expected Results:</td>
<td>~85,000 uAbs</td>
</tr>
<tr>
<td>Detection Limit: (nominal):</td>
<td>≤ 0.010 ppb</td>
</tr>
<tr>
<td>Sample Throughput Rate (minutes/sample):</td>
<td>1.40 min/sample</td>
</tr>
<tr>
<td>Dryer Cartridge Life:</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

**Table 4-1C. Parameters to Optimize Throughput vs. Sensitivity: Normal**

**Figure 4-5C. Typical Results from Normal Settings.**
<table>
<thead>
<tr>
<th><strong>RANGE #4: HIGH THROUGHPUT / HIGH CONCENTRATION</strong></th>
<th><strong>1 - 50 ppb Hg</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow:</td>
<td>350 mL/min</td>
</tr>
<tr>
<td>Peristaltic Pump Speed:</td>
<td>50%</td>
</tr>
<tr>
<td>Sample Flow Rate:</td>
<td>~5 mL/min</td>
</tr>
<tr>
<td>Sample Time (for Liquid Uptake or Autosampler &quot;Sip&quot;):</td>
<td>10 s</td>
</tr>
<tr>
<td>Rinse Time:</td>
<td>40 s (Smart rinse disabled)</td>
</tr>
<tr>
<td>Read Delay:</td>
<td>44.5 s</td>
</tr>
<tr>
<td>Replicate Read Time:</td>
<td>0.3 s</td>
</tr>
<tr>
<td>Replicates:</td>
<td>4</td>
</tr>
<tr>
<td>Baseline Correction Method:</td>
<td>1 point (27-31 s)</td>
</tr>
<tr>
<td>Oven Temperature Set Point:</td>
<td>125°C</td>
</tr>
<tr>
<td><strong>Expected Results:</strong></td>
<td>50 ppb</td>
</tr>
<tr>
<td>Detection Limit (nominal):</td>
<td>&lt; 0.050 ppb</td>
</tr>
<tr>
<td>Sample Throughput Rate (minutes/sample):</td>
<td>0.50 min/sample</td>
</tr>
<tr>
<td>Dryer Cartridge Life:</td>
<td>3 – 6 months</td>
</tr>
</tbody>
</table>

**Table 4-1D.** Parameters to Optimize Throughput vs. Sensitivity: High Throughput

**Figure 4-5D.** Typical Results from High Throughput Settings.
4.10 Placing the QuickTrace™ M-7500 in Standby Mode

To prolong instrument life, it is not recommended to leave the system fully on (with lamp lit) overnight, or when not in use. However, to speed the next day’s startup, the QuickTrace™ M-7500 can be placed in Standby Mode overnight (See QuickTrace™ M-7500 Software Manual) without significantly shortening its life. When analysis is done for the day, rinse with 10% HNO₃ for several minutes through the reagent uptake tube. Then rinse with deionized water through the reagent uptake tube for several minutes.

**Note:**
Failure to perform this “shutdown rinse” may result in a system clog.

Next, withdraw the reagent uptake tube and using the QuickTrace™ M-7500 Software Controls withdraw the autosampler probe from the rinse station (See QuickTrace™ M-7500 Software Manual). Continue pumping until the drain tubing (Figures 3-8 and 3-10, AC) runs fully empty. Turn off the pump (See QuickTrace™ M-7500 Software Manual), unclamp all pump tubes and unhook them from one side of their tubing bridge. Turn off the gas (main supply) and disconnect the Hg vapor tube from the GLS.

Leave the system mains power on. The Hg lamp sent with the system has an operation life of ~5000 hours, but internal optical filter life may be substantially extended by turning off just the lamp whenever analyses are not being performed (See QuickTrace™ Software Manual). Leaving the main power on leaves the oven and lamp block heaters on, and consequently the lamp block, oven assembly, optical rail, detectors, and analog electronics remain thermally stable. To reactivate the instrument to “run” status, simply turn the lamp on again, re-establish appropriate gas and liquid flows and operate the instrument normally. The system will be stable and ready to run within 5-10 minutes.
4.11 Cold Shutdown

For a total system shutdown (to cold condition), prepare the pump tubing as described in Section 4.10 above, and turn off the Hg lamp, gas, ASX-520, pump, and QuickTrace™ M-7500 main power. Exit the QuickTrace™ M-7500 Software, shutdown windows and turn off the computer.

4.12 Summary of QuickTrace™ M-7500 Shut Down

Shutting down the QuickTrace™ M-7500, autosampler and autodiluter.

1. Prime the optional autodiluter three times with 10% HNO₃ and then twice with DI water. Then remove the diluent supply line from the water and prime so the ADX-500 syringe is left empty.
2. Place the reagent capillary in a beaker of 10% HNO₃ and cap the reagent bottle. Rinse the system for a minimum of ten minutes.
3. Place the reagent capillary in a beaker of DI water and rinse the system for one minute.
4. Raise sample probe via QuickTrace™ M-7500 controls (click probe up and autosampler pump off).
5. Remove reagent capillary from DI water.
6. Allow the drain and waste lines to run completely dry.
7. Turn off peristaltic pump.
8. Release peristaltic shoe clamps and release the pump tubing from the tubing bridge (release and relax peristaltic pump tubing).
9. Close vents on waste container.
10. Disconnect GLS exhaust line from GLS.
11. Turn off gas and lamp.
12. If you are going to use the instrument the next day or in the near future, leave the instrument in standby. It will then be ready for a warm start.
13. If you are not going to be using the instrument in the near future then exit the QuickTrace™ M-7500 Software and turn off the autodiluter, autosampler and QuickTrace™ M-7500.
Note:

Before shutting down the instrument to either Standby or Cold condition, remember to run 10% HNO₃ and deionized water through the SnCl₂ reagent lines. This will clean out any chemicals from the peristaltic pump and sample tubing and prevent residue encrustation in the Gas-Liquid Separator and its drain. Remember to pump all lines completely dry after rinsing.

CAUTION

Always remember to release all clamps and unhook the pump tubing from the peristaltic pump. Failure to release clamps and unhook the tubing when the pump is off, will cause tube fatigue and lead to poor results (bad % RSD) when used for analysis the next time.
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5.1 Daily Maintenance (Always Check Before Analysis)

- Ensure that the autosampler rinse bottle is rinsed with DI water and refilled with 1% HCl/HNO₃ v/v higher acid concentration should be used for standards and samples greater than 20 ppb. A 5% HCl/HNO₃ v/v should be sufficient. See Figure 5-1.

- Ensure that rinse bottle tubes (CA) in Figure 5-1 are completely submerged in rinse solution. The rinse station supply tubing should be at the bottom of the rinse bottle and the rinse station return tubing should be at the top of the rinse bottle. This will ensure that the rinse is a true recirculating rinse. Inspect the rinse station flow and ensure that the rinse is not removed via the sample probe faster than it is supplied. Replace the ASX rinse pump tubing periodically for best performance (See ASX Operator’s Manual).

- Inspect the sample peristaltic pump tubing for fatigue and wear (replace if too worn or fatigued).

- If the pump tubing was left clamped overnight, install new tubing.

- Pre-wet the GLS center post (See Section 4.8) and be sure it remains completely wet during operation.

- Check that the liquid flows, to and from the GLS, are smooth. Verify by close inspection the inlet to the GLS center post and drain exit points.

- Be sure the waste bottle will not overflow during the run. (Empty beforehand, if needed.)

- Check that the SnCl₂ reservoir is sufficiently full for the number of samples to analyze.

- Check that the SnCl₂ is fresh and not precipitated, crystallized, yellowed, or oxidized or that the small cap on reagent bottle was left open overnight. Replace if necessary.

- Ensure the "backup" glass ballast tank (Figure 4-4, J) is not full of liquid (pump empty by clamping drain peristaltic pump tubing only, starting the sample peristaltic pump, and initiating gas flow if the ballast tank is full).
For autosampler maintenance, see *ASX 520 Operator’s Manual.*

### 5.2 Weekly Maintenance

- Remove the GLS and clean if residue is building up. This is described later in section 5.10.
- Clean the SnCl₂ reagent bottle weekly or before refilling.
- Change the pump tubing if it is too worn, appreciably “flattened,” or left in place overnight.
- Empty the waste bottle. Cap all Lure fittings to carry this bottle.
- Check the cells and cell windows for cleanliness.

### 5.3 Monthly Maintenance

- Clean the GLS. See Section 5.10.
- Clean the cells and cell windows. See Sections 5.7 and 5.8.
- Remove, wash, dry and re-install the fan filter (BP) on the rear of instrument panel, see Figure 3-7.
- Replace the GLS inlet tubing and capillary insert. See Section 5.12.1.
- Replace the GLS drain tube if it is clogged or dirty. This is described in Section 5.12.2.
- Check that the Nafion® dryer cartridge is still good. A failing Nafion® cartridge may be indicated by loss of Mercury absorbance sensitivity and an increase in the baseline of more than 1000 μabs during a short run of 30 minutes or less. If the Mercury absorbance for a given standard solution drops to 50% or more of its original value, change the cartridge. See Section 5.13.
5.4 Yearly Maintenance

- Replace the Nafion® dryer cartridge bi-yearly or as needed (See Section 5.13). A failing Nafion® cartridge may be indicated by loss of Mercury absorbance sensitivity and an increase in the baseline of more than 1000μabs during a short run of 30 minutes or less. If the Mercury absorbance for a given standard solution drops to 50% or more of its original value, change the cartridge.

- Replace the 2-micron filter (See Figure 3-7, BL).

- Replace the external gas tubing (See Section 5.11).

5.5 ASX 520 Yearly Maintenance

- Replace the ASX-520 sample probe.

- Replace the ASX-520 rinse peristaltic pump tubing.

See the ASX 520-Autosampler Operator’s Manual.

5.6 Removal or Inspection of the Sample Cell

5.6.1 Opening the Oven Lid Door

The instrument is shipped with both the front access door (Figure 5-1, BF) and the oven lid (Figure 5-2, A) screwed tightly down.
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Figure 5-1. Front View of QuickTrace™ M-7500 Mercury Analyzer.

AA - Peristaltic Pump B - Rinse Tubes (ASX 520)
AB - GLS Drain Tubing to Pump
AC - Waste Tubing
AD - Drain Inlet “Tee”
AE - Sample Tube (from pump)
AF - Mixing “Tee”
AG - Drain Outlet “Tee”
AH - Tubing Bridge (outlet)
AI - Pump Power Switch
AJ - Tubing Bridge (inlet)
AK – Reagent Luer Fitting

AL - Reagent Sipper Tube
AM - Reagent Tube (from pump)
BA - GLS Drain Tubing
BB - Liquid Mix Tube (to GLS)
BC - M-7500 Base Unit
BD - Optical Cabinet
BE - Hinged Optical Door
BF - Locking Door Assembly
CA - Rinse Tubes (ASX-520)
CB - Autosampler Tray
CC - Rinse Station Fill Tube
CD - Rinse Overflow Tubing
CE - Rinse Station Overflow
CF - Rinse Station
CG - Sample Sipper Tubing
CH - ASX-520 Z-Axis Driver
CI - ASX-520 Autosampler
CJ - Sample Probe
CK - Standards Rack
CL - Sample Rack
CM - Sample Probe Guide
CN – ASX-520 Base

5–5
For continued protection against hazards indicated on the warning labels, always retighten these two metal screw-knobs securely.

Refer to Figure 5-1. For access to the oven interior, first turn off the main power. Next, read the warning label on the front of the oven (visible through the clear window). Use a flat-blade screwdriver to loosen the screw-knob (BF) on the optical cabinet door (BE). Pull the knob outward and upward, to open the front access door. Use a long-shank flat blade screwdriver to loosen optical cabinet lock down screws and snap off the optical cabinet cover.

Refer to Figure 5-2. Read the warning label on top of the oven lid (B). After reading the warning, use a flat-blade, offset screwdriver to loosen the metal screw-knob (A) on the top front edge of the oven lid. Once the screw-knob is loose, carefully open the oven lid as shown in Figure 5-2. It will stay open in this position.

Do not touch interior hot glass (C, D) or metal oven wall surfaces. Allow the oven to cool five minutes with the lid open and main power off before proceeding.

5.6.2 Removing the Sample Cell

Refer to Figure 5-2 and 5-3. The cells are designed for simple removal and cleaning. When removing the cells, be careful to not touch the cell windows at the ends of the optical cells. If the cells and cell windows are dirty, use a clean foam swab and isopropyl alcohol (spectrophotometric grade only) to clean the surfaces (See Section 5.7). If needed, the windows (D) can be taken out by removing the end caps (A) and the O-rings (B).

To remove the sample cell (after it cools five minutes), grasp the gas fittings on both ends and slowly raise the entire cell with tubes attached upward (as in Figure 5-2) and outward away from the instrument. Once out of the oven, disconnect the carrier gas lines from the cell end caps. Remove the cell end caps by holding the glass cell, pull, and rotate the end cap until it slides off the glass cell. Repeat this procedure for the reference cell. Inspect and/or clean the cell and its windows per the instructions in sections 5.7 and 5.8, or perform tubing maintenance as described in section 5.11.
5.7 Cleaning the Cell Windows

Refer to Figure 5-3. There are two ways to clean cell windows:

- **Quick Exposed Surface Cleaning (without dismantling)**
- **Dismantling for Total Cleaning**

The need for cleaning (or re-cleaning) is determined by close inspection of the window (D), visible through the hole in the window cap (A), while maintaining a low-angle total surface reflection of room light on the window. Any film, fingerprint, dust, or dirt will show up dramatically against the “white” background of a low-angle surface reflection of room light from the window.

**5.7.1 Quick Exposed Surface Cleaning**

Cleaning the exposed surface of the window requires the following: a clean foam swab, Kimwipes®, and a bottle of isopropyl alcohol (use only spectrophotometric grade).
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Note:

Do NOT use cotton swabs. They will leave small bits of lint, which can offset the absorbance baseline and add a great deal of noise, if the lint moves or flutters in the optical beam. Use only clean foam swabs. To pre-clean the foam swab, rinse in alcohol and dry with a Kimwipes®. Do not dip the swab in the alcohol supply (when new, the swabs may be dirty and contaminate the alcohol supply). Instead, squirt alcohol onto the swab with a wash-bottle that is for alcohol only and dry with the Kimwipes®. Rinse and only lightly blot the swab with Kimwipes® when cleaning, this will leave the swab moist with alcohol, which will be enough to clean the cell windows.

Using the pre-cleaned, alcohol-moistened swab, gently swab the outside of the cell window. Dry with a Kimwipe® followed by UHP Argon or Nitrogen at 20psi to remove lint. Re-check the surface reflection to see if the window is completely clean. If residue, fingerprints, or particles remain, repeat the process with another pre-cleaned alcohol-moistened foam swab until the windows are clean. If this quick procedure fails, it may be necessary to dismantle the assembly for more rigorous “total” cleaning, as described below.
5.7.2 Dismantling for Total Cleaning

Refer again to Figure 5-3. Total cleaning requires a small Phillips screwdriver, clean Kimwipes®, isopropyl alcohol, and a clean plastic forceps. Carefully pull the cell end caps (E) off the cell (F), using a twisting motion, next remove the Phillips screws (C) and the window caps (A). This will allow the sapphire windows to be removed. Grip the window (D) with the forceps or wear powder free gloves when cleaning. Squirt the window with alcohol or use an alcohol wetted foam swab, then rub the surface of the window clean with a Kimwipe®. Rotate the forceps to a different position on the window and repeat the cleaning. Dry with a Kimwipe® followed by UHP Argon or Nitrogen at 20psi to remove lint.

Clean the entire end cap (E) including the O-ring (B) and gas ports with alcohol. Do not handle the cleaned parts with your fingers; use clean forceps or powder free gloves. It will be necessary to blow dry the end cap; gas orifice and fitting with clean...
5.8 Cell Assembly

Reassemble the sapphire window (D), O-ring (B), and a window retainer (A) onto the cell end cap (E) with three flat-head Phillips screws (C), as shown in Figure 5-3. Be sure not to touch the clean O-ring (B). Handle it instead with clean forceps.

Grip the cell (F) near one end and insert the cell into the open end of the cell end cap (E) with a pushing twisting motion. From Figure 5-4, which shows the “open” end, note that each cell end cap has two imbedded O-rings (A, B). Firmly push (with twisting motion) the cell into the open end of the cell end cap and continue pushing until both O-rings (A, B) are fully engaged.

Figure 5-4. Open end of cell end cap.
A - O-ring \hspace{1cm} B - O-ring

Inspect the assembled cell to determine that both O-rings (A, B) are fully engaged as shown in Figure 5-5. In Figure 5-5, shown without the window and cell cap, area “C” reveals no O-ring gap. This indicates that both O-rings A and B of Figure 5-4 are fully engaged.

gas before assembly. Be sure not to touch the windows after cleaning. Fingerprints will send the absorbance to full scale (over-range).
engaged. Figure 5-6, shown with window and cell cap, also reveals no O-ring gap at point “C” (the boundary between the cell end (E) and the cell end cap.)

![Engaged O-ring](image)

*Figure 5-5.* Engaged O-ring. Shown without the window and cell cap.

C - No gap visible
Figure 5-6. Engaged O-ring. Shown with the window and the cell cap.

C - No O-ring visible  D - Window O-ring  E - Cell

Note:
The O-ring “D” visible in Figure 5-6 seals against the cell window.

If a O-ring is NOT engaged, as in Figure 5-5, the O-ring “B” figure 5-7 is visible in the gap immediately at the end of the glass cell “E” figure 5-7. This should look, instead like region “C” in Figures 5-5 and 5-6. If the O-rings are not engaged correctly (as in Figure 5-7), then the system may drift, and perform poorly. Assemble and attach the remaining cell end cap to the other end of the glass cell.
An alternate means of checking complete engagement of all O-rings in both cells is to measure the overall length of the fully assembled cell with a ruler. If the overall assembled cell length is 8 29/32 inches (226.5 mm) then both O-rings are engaged, 8 31/32 inches (228 mm) indicates one O-ring is not engaged, 9 1/32 inches (229.5 mm) indicates that two O-rings are not engaged (one in each end).
Note:

The glass tubing is sufficiently thick-walled that there is almost no danger of breakage (provided you have gripped near the end being inserted). However, to error on the side of caution, grip the glass tube with a sufficient thickness of cloth or paper towel to protect your hands in the unlikely event of glass breakage. Never insert or try to use a cracked or chipped glass tube.

Once the cell has been completely assembled, with both O-rings fully engaged, place the cell on a flat surface with both cell end cap “flats” facing downward. Rotationally adjust the cells until both “flats” are flat against the surface and parallel with each other. Recheck O-ring engagement (as above) and reinspect both windows under low-angle reflection illumination to verify that no residual dust, lint, fingerprints, or other smudges exist on the windows. If both windows are “clean,” attach the appropriate Viton® interconnect tubing and reinstall the cell into the oven.

To reinstall the clean (and/or re-tubed) sample cell, first check that the two cell holder “flats” are parallel to each other. A simple check will reveal both cell end cap flats to be completely “tight down” against a flat surface with no gap visible between the end cap and the flat surface, when parallel. Lift the assembled cell and lower it gently into the oven (with the sample cell holder "flats" facing inward - next to the reference cell holder "flats", Figure 5-2). Verify that the glass cell rests in the mating "W-shaped" (Figure 5-9, AA) cell holders immediately outside each end of the oven.

5.8.1 Closing the Oven Lid Door

Refer again to Figure 5-2. Carefully pull the oven lid (B) downward (don't let it fall) until its compression angles (Figure 5-8, W) rest on the glass cells. Press downward on the oven lid (B) while simultaneously tightening the screw knob (A).

WARNING

For continued protection against skin burns, tighten the oven lid screw-knob (Figure 5-2, A) and obey all warning labels on the front and top of the oven.
Note:

Except for a few difficult to reach, and otherwise shielded exterior oven parts, only the interior surfaces of the oven will be very hot. All of the easily accessible exterior oven surfaces are double-wall shielded and are merely warm to the touch. However, for continued protection against skin burn, read and obey all posted warning labels, and secure all metal screw-knobs tightly.

Finally, snap the optical cabinet cover in place and close the optical cabinet front door (Figure 5-1, BE) and, for continued hazard protection, secure the screw-knob fastener (BF) tightly.

5.9 Cell Oven

Refer to Figures 5-8 and 5-9. The oven (G) and cells (H) are designed to fit together without any user adjustment. The “W-shaped” (AA) cell holders will immobilize the sample and reference beam cells in perfect optical alignment, so no adjustment is required.

CAUTION

Do NOT tighten or adjust the screws found atop the two ends of the oven lid. When the oven lid is closed, these screw heads normally rise off the oven lid slightly, leaving a small "gap" under the screw head. This gap is normal, and it maintains proper spring tension on the glass cells inside the oven. Do NOT attempt to eliminate this gap by tightening the screws. (The gap is normal and necessary for proper optical alignment and system stability.)
Figure 5-8. QuickTrace™ M-7500 Optical System.

A - Optical Rail  I - Cell End Cap  Q - Detector Housing
B - Binocular Camera (Lens Plate)  J - Window O-Ring  R - Analog to Digital Converter
C - EOFM Angle Plate  K - Sapphire Window  S - Detector Electronics Cover
D - Lamp Block  L - Window Cap  T - Detector Electronics Base
E - Detector Bracket  M - Gas Liquid Separator  U - Oven Lid
F - Oven Door Pin Nut  N - Glass Ballast Tank  V - Oven Lid Screw
G - Oven Base  O - Drying Cartridge  W - Cell Compression Angle
H - Glass Cells  P - Lamp Housing
5.10 Cleaning the Gas-Liquid Separator

Periodically it will be necessary to clean the Gas-Liquid Separator (Figure 5-8 (M). Try pumping 10% HNO₃ through the system for 30 minutes continuously, followed by a deionized water rinse. For more aggressive cleaning, disconnect all tubing from the GLS. Be careful not to pull hard on the tubing; this can break the glass side arms off. Instead, use a fingernail to gently work the tubing off the glass arms. Refer to Figure 4-4. Loosen the white plastic retainer screw (C), and carefully remove the GLS by...
rotating the vapor outlet to the front and slide the GLS down through the clamp and exiting at the clamp bottom. (If the GLS is too long to remove in this manner, restore it to normal position, snap off the front cover, and repeat the removal steps).

Once the GLS is removed from the optical rail, place the stripped GLS in a beaker containing 50% HNO₃ v/v in DI water. If an ultrasonic bath is available, place the beaker in the bath and sonicate for 30 minutes. Otherwise, let the GLS soak for two hours in the 50% HNO₃. If excessively dirty immerse the GLS in a mixture of 20% nitric and 20% sulfuric acid and heat on a hot plate for several hours or until clean.

Next, rinse with DI water and dry. Reassemble GLS as in section 5-12. Tighten the plastic screw (C, Figure 4-4) finger tight only.

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**Note:** Cleaning procedure may need to be repeated with fresh acid for optimal results.

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**CAUTION**

Do not over-tighten the plastic screw C (Figure 4-4), as this may crack the GLS.

**WARNING**

Hot concentrated acids may cause severe burns, severe fume inhalation trauma and/or death. They should be handled only by professionally trained chemists, who employs proper safety precautions and equipment (hoods, goggles, gloves, tongs, etc.).

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### 5.11 Changing the External Gas Tubing

Once each year, replace the external liquid and gas tubing. To do this, begin by pulling the instrument forward on the bench, and remove the optical front cabinet.

Next, replace the tubing as shown in Figures 5-10, 5-11, and 5-12. The replacement tubes, which are in the external tubing kit, are labeled and precut to length. See Figure 5-10 for label designations, lengths, and tube material type. Match these numbers and letters with Figures 5-10, 5-11 and 5-12 and the existing tubing, to see where each labeled tube should go. It is best to replace one tube at a time.

In Figure 5-10 connect the number printed on each tube end label (See “Tubing Label Schedule”) to the same circled number in Figure 5-10 diagram. The tubing length (in inches) is indicated for each tube in the diagram, and the tubing material is designated by letters. Refer to Figures 5-11 and 5-12 to see the exact tube routing.
Figure 5-10. Tubing Diagram and Connection Table.

To remove an old tube from a plastic connector, grip it near its connector and pull firmly. For glassware, it is better to slit the old tube with a razor blade or sharp knife, before removing. Alternatively, you may use the edge of a fingernail to ease the tube off its glass arm.

A simple way to avoid making wrong connections is to remove only one tube at a time, and replace this tube with the appropriate, labeled new one, before proceeding to the next tube.

Drying cartridges are replaced as assemblies (replacements with tubing already attached).
Figure 5-11. External tube routing (front view).
See Figure 5-10 (tubing labels and routing diagram).

Figure 5-12. External tube routing (bottom view).
See Figure 5-10 (tubing labels routing diagram).
When finished, be sure the tubing under the optical rail, or exiting the optical cabinet are positioned so they will not interfere with snapping the optical cabinet back into place. If they are pinched it will be will cause the system to fail or perform poorly. Refer to Figures 5-11 and 5-12. Check that the dark Viton® tube, which runs from 9 to 10, is routed above the drain tube (3) as shown in the figures.

Replace the Tygon® drain waste as described in Section 3.16.5.

Sample in and drain lines need to be replaced monthly, and Viton® gas lines need replacement annually. A tubing kit is available from CETAC with the correct labeled tubing included, pre-cut to correct length. To replace the tubing follow the instructions included with the kit, or in the section above.

**Note:**

Do not use waste tubing other than that provided by CETAC. The ID and length (three feet) of the drain tube (See Section 3.16.5) are optimized for maximum system stability, and should not be altered. Other tubes are similarly optimized and substitutions/alterations should not be made.

### 5.12 Retubing the Gas-Liquid Separator

This procedure should be followed about once a month, unless the samples are excessively "dirty," in which case the procedure should be followed more often, as needed.

#### 5.12.1 GLS Inlet

Refer to Figures 5-13. Note tubing routing and then remove all tubing, drain sleeve (J), inlet capillary (C) and Silicone® sleeve (D) from the GLS using the same procedure as for Viton® tubing above.
Select a new translucent white silicone inlet sleeve (D), and push it down over the glass sample inlet guide (E) until ≈6mm (1/4 inch) of Silicone tubing protrudes above the top of the glass inlet guide (E).
Select a replacement GLS Teflon® inlet capillary assembly, (C). Carefully direct the capillary end of the insert into the top protruding end of the silicone tube (D), and GENTLY push "straight" down.

The capillary insert (C) should go down inside the inlet guide (E). Continue pushing gently downward until the exposed capillary end (C) protrudes below the glass guide (E). Stop pushing when the bottom edge of the capillary is about 0.5 mm (range of 0.3 - 0.6 mm) above the top of the GLS frosted center post (G). The two parts should never touch! Finally, select a replacement liquid mix tube (A). Carefully slide the end of the Viton® liquid inlet tube labeled "2 <-- Liq. Mix <--" onto the protruding upper end (yellow heat-shrink, B) of the GLS inlet insert assembly. Continuously watch the lower end of the insert, to be sure that it’s position does not change. Finally, check that the lower end of the insert is still spaced 0.3 - 0.6 mm above the frosted center post (G).

Install the assembled GLS into its holder on the front of the optical rail and gently tighten the GLS screw clamp (Figure 4-4, C) Do not over-tighten, or the GLS may crack. Connect the drain tube and route the drain and liquid mix tubes in their appropriate tubing clamps. The above procedure may be done with the GLS in its holder, if caution is used so the fragile glass ports are not broken.

### 5.12.2 GLS Drain

Select a new GLS drain tube. Prior to installation, the Teflon® drain tube should be pushed all the way into the silicone drain tube-sleeve. Do not kink the Teflon® drain tube. To install, line up the end of the assembly against the glass drain and push. Refer again to Figure 5-13. The Silicone® tube-sleeve (J) should automatically slide over the outside of the glass tube, and the Teflon® drain tube (I) should slide inside the glass drain tube as seen in Figure 5-13. Keep pushing until the Teflon® tube is approximately flush with the interior wall curvature of the GLS, or about 2mm withdrawn from this point.

Inspect the drain area closely. If the liquid pulsates or segments immediately prior to the Teflon® drain tube end, then try a different position for this tube end. Try it further inserted (about 1mm into the chamber), or try it with less insertion (several mm withdrawn from the chamber). Select the position that eliminates or minimizes segmentation and/or pulsation of the flow at the entry point of the Teflon® insert. A steady, high-speed stream of tiny bubbles should form within the Teflon® drain tube, and larger bubble segments should emerge from the remote end, where a longer Silicone® tube is attached.
5.13 Replacing the Nafion® Dryer Cartridge

Replace this cartridge if mercury absorbance diminishes to less than 50% of original value. Refer to Figures 5-14, 5-10, 5-11, and 5-12, which show a replacement Nafion® cartridge and its installation.

1. Pull the instrument forward on the bench and remove the optical front cabinet for easy access.

2. To remove the old Nafion® Dryer cartridge, refer to Figures 5-10, 5-11 and 5-12. Disconnect the following tubes: “11->Hg Vapor->12” from the GLS arm (11), “->Sample Gas->14” from the sample cell (14), and “<-Dryer Supply<-5A”, from the dryer gas supply port (5A). Unhook “->Sample Gas->14” from the two tubing clips on the optical rail.

3. Carefully unhook the remaining Nafion® dryer tube, “13A<-Dryer Exhaust.” Detach the Nafion® dryer from the two black clamps (Figure 5-9, KK); pull cartridge forward, and set aside.

4. Install a new Nafion® dryer cartridge and reattach tubes described above. (When reconnecting Luer lok fittings, be careful not to kink the tubing, which could cause gas flow constriction.) Remember to route the tube 13A (“13A<-Dryer Exhaust”) down (front) / under and then up / behind the optical rail before exiting through the optical cabinet cover cut out.

Figure 5-14. Nafion® Dryer Cartridge.
5.14 Recovery from an Unlikely GLS Overflow Accident

Observation of a full or overflowing GLS, absorbance over-range, loss of gas flow or liquid in the sample cell may indicate a GLS overflow accident. This could happen if the sample probe is left in the park position for an extended period and rinse siphons into the GLS. The sample probe, when not in use should not be submerged in the rinse station. In addition, during operation if the overflow sensor were not functioning properly an overflow might occur. The latter could occur if the GLS drain outlet-tubing clogs from non-filtered digested samples during unattended operation. In addition, it may occur if the waste pump tubes fail, or the clamp tension is too loose and or not clamped. When any of the above symptoms occur, liquid may have overflowed the Nafion® dryer cartridge into the optical sample cell, and possibly beyond.

If an overflow happens, liquid has been introduced into the Nafion® dryer and possibly, the optical sample cell and beyond. If the overflow is discovered quickly, it is possible that the Nafion® dryer can be cleaned and dried (See step 11) before the membrane pores become saturated and enlarged, which may render the dryer useless.

Follow the steps below to correct the problem and bring the instrument performance back to normal. Also, refer to section 5.7.2.

1 Shut off the instrument main power and unplug the QuickTrace™ M-7500.

2 Snap-off the front optical cabinet, open the oven door, and allow system to cool five minutes. While cooling, inspect the sample cell (in place) and judge whether any liquid is likely to have passed through the sample cell to the "gas exhaust." If there is room, push the instrument back from the bench top edge.

3 Remove the internal plastic drip tray from the optical cabinet and place the tray on the lab bench in front of the QuickTrace™ M-7500 (or beside it). Remove the sample cell, GLS, and Nafion® dryer cartridge (with all tubing still attached). Place all parts in the plastic drip tray.

4 Dismantle the sample cell completely over the plastic drip tray. See Sections 5.7.2.
Do NOT remove the cell window blocks over the optical rail if the cell is wet or full of water. Do this instead outside the instrument to avoid spillage onto the optical components and the oven heater. Remove the internal plastic drip tray from the optical cabinet and place this under the cell to contain the water/brine when the sample cell end caps are removed.

5 Dump out all water and brine from the sample cell glass tube.

6 Rinse the sample cell glass tube with deionized water and oven dry. Alternatively, dry by rinsing with alcohol (recommended spectrophotometric isopropyl alcohol (isopropanol)) and blowing dry with clean air or Nitrogen.

7 Rinse and dry all remaining cell holder parts, fittings and transfer tubing by steps similar to five and six. However, do not oven dry; use the alcohol rinse/blow-dry procedure, instead. Inspect closely to be sure all water, and/or all residual alcohol is completely eliminated from all fittings, tubes, parts, and gas ports.

8 Clean the sapphire window first with water and then as described in Section 5.7.2.

9 Reassemble the window and cell end caps. Handle the window with clean forceps or hold by the edge with fingertips while wearing cloves (verify cleanliness by inspection with low-angle room light reflection).

10 Install the glass tube into the cell end caps, and seat firmly to fully engage both O-rings.

11 For Nafion® dryer cartridges that have gotten wet, if not already disconnected, disconnect the cartridge “sample gas” from sample cell. Attach a 10mL Luer lock syringe filled with DI water to tube 14 and gently push the water through the Nafion® dryer cartridge. The water will exit through the cartridge at tube 11 (Figure 5-4, tube numbered 11). Hold tube 11 so it is positioned over an empty beaker (do not pull on tube 11 it may disconnect from the cartridge and render it useless). Reconnect tube 11 to the GLS. Turn on the QuickTrace™ M-7500 and initiate the software. Next, initiate 40mL/min-gas flow and allow GLS and cartridge to blow dry for one hour with flowing gas. Be sure the peristaltic pump clamps engage all peristaltic pump tubes before initiating gas flow (otherwise the gases will leak out the pump tubing and bypass the Nafion® dryer cartridge).

12 Turn off gas! Reattach cartridge sample outlet tube to the sample cell and reinstall the sample cell into the QuickTrace™ M-7500, close oven door, and reattach all tubes except for the final tube end labeled “16 ←GAS EXHAUST ←.”
13 Determine whether any rinse solution (acidic stannous chloride dissolved in water) got past the sample cell (during the original accident), and into any portion of the remaining gas exhaust lines and KMnO₄ trap. Determine this by dismantling all fittings "en route" and inspecting for the presence of any liquid or salt encrustation in any of the fittings or tube ends. Especially check the dark purple potassium permanganate powder to see if it is wet and/or no longer "free flowing" in any part of the trap tube.

If no undesirable condition is found in the above plumbing inspection, reconnect all the system plumbing and check the gas flow, following the procedure in the QuickTrace™ M-7500 Mercury Analyzer Software Manual. Be sure all peristaltic pump tubes are engaged by their clamps before checking gas flow (otherwise the gases will leak out the pump tubing and bypass the flowmeter).

If ANY undesirable condition was found during the above plumbing inspection proceed to step 14. Otherwise, skip to step 25.

14 Remove the potassium permanganate Mercury trap from the rear of the instrument. If it is completely dry and simply set it aside. If the vapor trap is wet, empty the KMnO₄ and dismantle the trap. Remove the glass wool plugs; rinse all parts, fittings and tubes with deionized water and then Hydroxylamine Hydrochloride. The Hydroxylamine Hydrochloride will clean any remaining purple color from the vapor trap. Dry by means of rinsing with alcohol and blowing dry with clean air or Nitrogen. Reinstall loose glass wool plugs into the endcaps, install one cap, and refill tube body with potassium permanganate powder (crystals). Install the remaining end cap and set the trap aside. Do not reinstall the permanganate trap on the QuickTrace™ M-7500 Instrument at this time.

15 Follow procedures in steps 15 – 24 to rinse residual acidic stannous chloride brine out of remaining internal gas exhaust tubing. Pump deionized water through the Gas-Liquid Separator (GLS) until only deionized water remains in the tubing. Do this with the ASX sample probe in a 50mL test tube filled with DI water and the reagent capillary placed in a beaker of DI water. Refer to the QuickTrace™ M-7500 Mercury Analyzer Software Manual for use of the QuickTrace™ M-7500 Instrument controls to place the autosampler sample probe in 50mL tubes of
deionized water located in standard positions. Stop all pump flow and disconnect tube end labeled "16←Gas Exhaust←."

16. Next, disconnect the "low" end of the liquid waste tubing from the large waste bottle; by means of the Luer disconnect fitting.

17. With the front optical cabinet removed, pull the instrument forward to the edge of the lab bench, so that the optical rail hangs out past the bench.

18. Refer to Figure 5-10 and 5-12. Locate the "gas exhaust" fitting (16) on the electrical cabinet front panel.

19. Connect the liquid waste tube (From step 16) to the "gas exhaust" fitting.

20. Place a waste receptacle (>100 mL) immediately under the other "gas exhaust" fitting on the rear of the instrument. Alternatively, use the appropriate Luer fittings and hook another transfer tube from the rear gas exhaust fitting to the drain bottle on the floor.

21. Pump 100mL of deionized water through the GLS, until it all passes through to the waste collection receptacle. Refer to the QuickTrace™ M-7500 Mercury Analyzer Software Manual for use of the QuickTrace™ M-7500 Instrument controls to place the autosampler sample probe in 50mL tubes of deionized water located in standard positions. This will wash all residual perchlorate salt encrustation and/or acidic stannous chloride brine out of the internal gas exhaust lines and fittings.

22. Using QuickTrace™ M-7500 Instrument controls, lift the autosampler sipper tube out of the deionized water tube and allow the peristaltic pump to push air through the system, until no more water enters the waste receptacle.

23. Unhook the waste tube end from fitting 16 (Figure 5-12) and restore it to its normal drain bottle fitting.

24. Reconnect the tube end labeled "16←Gas Exhaust←" to the "gas exhaust" port on the lower left side (under the optical rail) of the electrical cabinet front panel.

25. Reinstall all covers, close all doors.

26. Initiate a reasonable gas flow using QuickTrace™ M-7500 Software, pump rinse solution through the GLS continuously, and let the system "purge," "dry" and thermally stabilize for a period of 90 minutes.

27. Reinstall the permanganate trap onto the back of the instrument.
5.15 Replacing the Hg Lamp Bulb

The effect of lamp current on data quality (absorbance and noise) is minimal over the range 6-13 mA. When a lamp is new, the normal operating lamp current is 6.5 – 8.5 mA. As the lamp ages, the lamp current will automatically adjust to maintain constant emission intensity reaching the EOFM filter/detector. See Figure 5-9, HH.

Use the QuickTrace™ M-7500 Software to check the lamp current. Wait until the lamp current reaches 15 mA to order a new lamp. At this point, use a dentist mirror and flashlight to check that the EOFM filter (HH) is not "smudged" (Refer to Figure 5-9). If it's clean, order a replacement lamp. If the EOFM filter, (HH) is dirty, clean in place using the cell cleaning procedure. After cleaning, recheck the lamp current. Install the new lamp when the current of the old lamp reaches 15 mA, or if you need greater absorbance sensitivity than the old “high current” lamp can provide.

To maintain the best possible detection limits (e.g. for critical work in the range <0.2 - 100 ppt). Order a replacement lamp when the lamp current reaches 10 mA (check first that the EOFM filter is not "smudged"), and install it when the current reaches 13 mA.

To change the bulb, turn off the main power, unplug the QuickTrace™ M-7500 completely. Disconnect all power and communication cables and cords to the ASX-520. Remove the ASX-520 from atop the QuickTrace™ M-7500 and set the ASX-520 to one of the sides. Remove the nine cabinet screws from the electrical cabinet cover of the QuickTrace™ M-7500 and remove the cover. Allow the instrument to cool five minutes. Locate the "heavy" yellow/orange colored lamp cord, on the left-hand side of the cabinet interior. Trace the cord backward and unplug it from the lamp controller board. On the top surface of the lamp block, push the edge of the gray foam toward the front of the instrument. Under the edge of this foam is a small "Allen" set screw. Insert a 0.050 inch Allen wrench into the setscrew head and loosen the screw.

Grab the old bulb where it attaches to its yellow cord and pull straight back (toward the rear of the instrument). The bulb will slide out easily. Clean the new bulb by wiping clean with a Kimwipe® or optical tissue moistened with high purity (spectrophotometric grade) isopropanol, and allow to air dry (or blow dry with clean gas). Don't touch the bulb face, once it is clean.

Holding it by the base, carefully insert the bulb into the lamp block until it stops. Rotate the bulb base until the scratch mark scribed on the lamp body faces upward and lines up exactly with a matching scratch mark on the lamp block housing. This scratch mark may be an arrow or a date on the yellow power cord. Hold this position carefully while tightening the Allen set screw. Check that the two scratch marks match up after
Maintaining the QuickTrace™ M-7500

the setscrew has been tightened. Plug the yellow lamp cord into the lamp controller board. This plug only inserts one way into the socket. Re-install the cabinet cover and screws, and reposition the ASX-520.

Turn on the unit; allow a 90 to a 180-minute warm-up. Check the lamp current on the QuickTrace™ M-7500 instrument controls menu. If the current is not in the range 6 – 8.5 mA, call CETAC Service. If the lamp current is in the range of 6 – 8.5 mA, operate the instrument normally.

5.16 Optional ADX-500 Autodilutor Maintenance

Troubleshooting the QuickTrace™ M-7500
6 Troubleshooting the QuickTrace M-7500

6.1 Fuses and Power

Disconnect the input power cord before attempting any fuse servicing.

There are two mains fuses located in the small fuse drawer at the top of the input power module on the QuickTrace™ M-7500 (Figure 6-1, BH). Remove the fuse drawer by raising the latch tab with a fingernail or non-metallic tool until it releases.

Please note that on the QuickTrace™ M-7500 there are four additional screwdriver accessible fuses (Figure 6-1, BJ).

Contact CETAC Customer service and support regarding suspected difficulty with these four fuses.

For 220-240V Operation of the QuickTrace™ M-7500:

- Mains: Use GMC - 5 x 20-mm, 1.5 A, 250-v, time-delay.
- F1: 1.5 A Slo-Blo.
- F2: 0.75 A Slo-Blo.
- F3: 2.5 A Slo-Blo.
- F4: 1.25 A Slo-Blo.

For 100-120V Operation of the QuickTrace™ M-7500:

- Mains: Use GMC - 5- x 20-mm, 2.5 A, 250-v, time-delay.
- F1: 1.5 A Slo-Blo.
The ASX-520 Autosampler, peristaltic pump and optional ADX-500 Autodilutor also employ fuses. The fuses are located in the sealed 24VDC power supplies, and are not user serviceable.

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**WARNING**

Replacement with higher-rated fuses is not recommended. Violation voids the warranty and will be solely at the user's risk. Blown fuses indicate an abnormal condition, and replacement should be uncommon. Call CETAC Customer Service and Support if repeated fuse blowing occurs.
Figure 6-1. Locations of fuses in the QuickTrace™ M-7500.

BH - QuickTrace™ M-7500 Mains Fuse
BJ - Fuses F1, F2, F3 and F4
6.2 Cannot Zero Instrument (Log 100 Error)

Perform the following steps:

1. Check that the Hg lamp is on in the software and that the main power switch on the back of the instrument is in the on position (up). Verify the yellow light on the front panel (Figure 5-11, A) is on.

2. Be sure instrument is fully warmed up (See “warm-up times” in Section 4.7).

3. Check that both cells (sample & reference) and cell end caps are clean and "dry" (no liquid or dried stannous chloride obstructing the gas flow or the optical beam. If so, see Section 5.7).

4. Check that both cell windows are clean (See Section 5.6.2).

6.3 Drifting Baseline

The system might not be thermally stable because of insufficient warm up time. Wait longer.

- Check that gas pressures are stable and correct. Variable gas flow can cause the baseline to drift. Check that no stannous chloride encrustation exists in gas lines/fittings after a GLS overflow accident in the unlikely event of an overflow protection failure. See Section 5.6.2.

- Check that the gas hoses are not pinched between the front cover and the main electrical cabinet.

- Check the cleanliness of the cell windows and cells.
Check that the lamp block heater works. The lamp block should be hot (50°C) to touch. Turn the lamp power off. Remove lamp housing cover and touch the lamp block momentarily to verify that it is hot.

With the Hg lamp off, check that the EOFM filter is not dirty (inspect it with a dentist’s mirror and low angle flashlight).

Check that the lamp current is not too high using the QuickTrace™ M-7500 Instrument controls. High current indicates a worn-out lamp, if all the windows and optics are clean.

Replace the Nafion® dryer cartridge.

6.4 Low Absorbance or No Mercury Response

Check that the Hg lamp is on.

Check all liquid uptake rates and gas flow. If there is no liquid or gas flow, see Section 6.5 below.

- Ensure the reagent tube is in the reagent bottle.
- Check that SnCl₂ is active, not empty, not oxidized or precipitated.
- Ensure the standards have the correct Hg concentrations in them.
- Check the liquid lines for kinks or clogs.
- Ensure the standards have 7% HCl in them.
- Check the gas flow at the GLS outlet.
- Check the gas flow at the sample cell outlet.
• Check that the gas flow at the KMnO₄ trap outlet; does not drop in pressure or flow, this indicates an upstream block or a leak.

• Check all plumbing connections for correct location and proper seal.

• Replace the Nafion® dryer cartridge.

• Mechanically block the sample beam optical path (e.g. with a business card) and see if absorbance goes full scale (≥ 1,050,000 μabs).

• Reboot the system: shut down the software, and power down the QuickTrace™ M-7500 and ASX-520. Restart, and check the signal.

6.5 No Liquid or Gas Flow

6.5.1 If No Sample or Rinse Flow

• Increase the tension on the sample pump tubing to start flow.

• Be sure the sample, SnCl₂, and “Liq. Mix” tubes are not pinched off anywhere and restricting flow.

• Check especially that neither tube is pinched behind the “snap-on” optical cabinet or under the autosampler foot.

• Check that the rinse station is filled with 1% HCl/HNO₃ v/v.

• Ensure all pump tubing is centered in clamps.

• Check for clogs in sample tubing.

• Check for kinks in the ASX-520 sample probe and sipper tube.

• Check for excessive pump tubing wear. Replace if needed.
6.5.2 If No SnCl₂ Flow

• Increase tension on the reagent pump tubing to start flow.

• Check to see that no precipitate has formed and clogged the reagent sipper and/or pump tubing.

• Check for excessive pump tubing wear. Replace if needed.

6.5.3 If No Drain Flow

• Increase tension on the drain pump tubing to start flow.

• Check that there is no clogging of the drain outlet tubing of the Gas-Liquid Separator. If clogged, clean or replace the drain outlet tubing.

• Be sure the drain tube is not pinched off and restricting flow. Check especially that it is not pinched behind the “snap-on” optical cabinet or under the autosampler foot.

• Ensure the vent port on the waste bottle is open, and that the bottle is not overflowing.

6.5.4 No Gas Flow or Low Gas Flow

• Check that the in-line gas filter is not clogged. Remove the threaded connection downstream from the filter and check for gas flow at the filter outlet.

• Ensure all gas supply lines are connected correctly.

• Check that no gas tube is kinked or pinched.

• Be sure that the KMnO₄ trap is not packed too tightly (with either the glass wool plugs or the reagent crystals) and restricting flow. Repack if too tight.
• Check for leaks/clogs throughout the gas system, especially after a GLS overflow accident. Check flow after each fitting/component to isolate the bad section.

6.6 Double Peak With Low Absorbance

This may indicate a problem with not enough (or none at all) reagent (stannous chloride) uptake. Check the following items:

• The reagent sipper tube is in the reagent bottle (rather than sitting in a deionized water container or loose in air).

• There is liquid in the reagent bottle.

• The sipper tube is submerged below the liquid level.

• The liquid is 10% stannous chloride solution in 7% HCl.

• The reagent is not "old," precipitated, yellowed or otherwise oxidized (for example, by leaving the bottle open overnight).

• There is no clog, kink, pinch, or other obstruction in the reagent tubing pathway.

• The reagent liquid uptake rate is at least 1.5 mL/min at 50% pump speed.

• The ASX-520 sipper tube is the right size, no longer than 3.5 feet and no smaller than 1.0mm i.d.

• The sample uptake is at least 4 mL/min at 50% pump speed.

• The ASX-520 probe, reagent sipper tube, QuickTrace™ M-7500 mixing tee and GLS liquid/mix capillary inlet is not under pressure from a partial clog.
6.7 Poor Reproducibility

- Always be sure to matrix match standards and samples as closely as possible (excluding the 7% HCl in the standards), and rinse solution should also be 1% HCl/HNO₃.

- Inspect the liquid flow into and out of the Gas-Liquid Separator. If either the sample in or waste out is pulsing, adjust the clamp tension on the corresponding tubing in the peristaltic pump to smooth out flows. If unable to stop the pulsing, check to see if the pump tubing is worn out. If so, replace the pump tubing. Be sure to check all the pump tubes.

- Check that the center post is fully “wet.” If partially dry anywhere on post surface, wet the post see section 4.8.

- Check to see if the reagent tube is in the reagent bottle.

- Ensure that the stannous chloride has not been emptied or oxidized. Old SnCl₂ can lead to poor results. Replace if yellow, precipitated, or just too old.

- Ensure that the ASX-520 rinse station and rinse bottle are filled with 1% HCl/HNO₃.

- Inspect both cell windows for fingerprints, films, or debris. If dirty, clean the windows following the procedure outlined in Section 5.7.

- Check that gas pressure to the QuickTrace™ M-7500 is at 120 psig.

- Check the output gas flow after the KMnO₄ gas trap with a flow meter (to check this flow, all pump tubes must be clamped or plugged). This gas flow should be the same as set in the software. Check all the seals and recalibrate if necessary. Note calibration and flow stability.

- Check the gas flow at the GLS exit.

- Check the gas flow at the sample cell exit.
• Check that the optimal instrument settings are employed. See the *QuickTrace™ M-7500 Mercury Analyzer Software Manual* and chapter four of this manual for details.

• Check that the peristaltic pump rollers are not severely worn. Inspect all rollers with tubing removed. Roller facets should not be “grooved”. All rollers should spin freely when turned by sliding your thumb quickly across them. None should feel “gritty” or slow in spinning. Replace the head if any one of the 12 rollers are grooved or fail to move freely.

• Check that the baseline is not drifting severely (See Section 6.3).

• Check that the raw analog system noise is $\leq 10 \ \mu Abs$. If not, call CETAC Support.

### 6.8 Noisy Baseline

• Check that flows into and out of the Gas-Liquid Separator are not pulsing. Pulsation indicates improperly adjusted pump clamps.

• Check that gas pressures are correct.

• Be sure the SnCl$_2$ is fresh and not oxidized or precipitated.

• Check that the cell windows are clean.

• Check that the EOFM filter is clean. Turn the Hg lamp off and check that the EOFM filter is not dirty (inspect it with a dentist’s mirror and low angle flashlight).

• Check that nothing has been spilled on the binocular camera lenses. Turn the Hg lamp off and check that the camera lenses are not dirty (inspect them with a dentist’s mirror and low angle flashlight). Call CETAC Customer Service and Support if the camera lenses are dirty.
• Check that the lamp current is not excessive (>15 mA). Do this with the QuickTrace™ M-7500 Software. For more information see Section 5.15.

• Check cleanliness of the cell windows and cells.

### 6.9 Bad DL

• Check low absorbance. See Sections 6.4 and 6.6.

• Check noisy baseline. See Section 6.8.

### 6.10 Sudden Standard Absorbance Rise During Run

• Ensure the rinse bottle has 1% HCl/HNO₃.

### 6.11 Poor Accuracy

• Verify good reproducibility (e.g. ~1 % RSD on standard replicates).

• If reproducibility is poor, see Section 6.7.

• Ensure the standards contain 7% HCl (v/v).

• Check that samples are properly digested.

• Utilize an appropriate process standard to validate digestion and container storage.

• Check process (digestion blanks, containers, and rinse solution) for Mercury contamination.
• Check standard solution accuracy, and all gravimetric/volumetric process steps and equipment for accuracy and calibration.

• If very low samples are run immediately following high samples or standards, the rinse time may not have been long enough and the result may be reading low. (Increase rinse times when sample and/or standard concentrations are widely spread).

• Be sure that the rinse solution contains 1% HCl/HNO₃. If it only contains deionized water, very low samples (acidified) may read erroneously high if they immediately follow the high standard or a high sample, regardless of allocated deionized water rinse time. The problem is avoided by a 1% HCl/HNO₃ solution in the rinse solution bottle.
Glossary
Glossary

This manual frequently uses the following terms:

A  Amperes, Electrical Current
AAS Atomic Absorption Spectrometry
Abs Absorbance (-log₁₀ T or 2-LOG₁₀ %T)
ADC or A/D Analog-to-Digital Converter
ADX-500 Optional Autodilutor Accessory
ASX-520 The ASX-520 Autosampler
Bar Unit of Pressure. 1 bar = 100 kPa ≈ 14.5 psi
Ar Argon Carrier Gas, Chemical Formula
CH₃HgCl Methyl Mercuric Chloride (or “Methyl Mercury”), Chemical Formula of a Common Organo-Mercurial
CLP Contract Laboratory Protocol (Analysis Protocol of U.S. EPA)
cm Centimeter (10⁻² meter), Unit of Length
Cold Vapor Direct AAS or CVAAS Direct Atomic Absorption Spectrometric Analysis (at 253.652 nm) of “head-space” gas from a stannous chloride or stannous sulfate reactor using neither flame, nor plasma, nor furnace nor any other electro-thermal atomizer. CVAAS works only for the element mercury (Hg).
DBA Doing Business As
Dia. Diameter
DL Detection Limit. Smallest statistically detectable concentration, where the absorbance, Abs (produced by that concentration), equals three times the standard deviation σ of the blank Abs.
DSP Digital Signal Processor
ea. Each
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>EOFM</td>
<td>Electro-Optic Feedback Module; Used to stabilize the Hg lamp.</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>EPA-245.1</td>
<td>The standard EPA Method of water quality analysis for measuring mercury (Hg).</td>
</tr>
<tr>
<td>ETFE</td>
<td>Ethylenetetrafluoroethylene (Tefzel®), A polymeric tubing material.</td>
</tr>
<tr>
<td>g</td>
<td>Gram, unit of mass or “weight.”</td>
</tr>
<tr>
<td>GCU</td>
<td>Gas Control Unit, Sets and regulates carrier gas flow rate</td>
</tr>
<tr>
<td>GLS</td>
<td>Gas-Liquid Separator</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrochloric Acid, Chemical formula</td>
</tr>
<tr>
<td>Hg</td>
<td>Mercury, Chemical symbol</td>
</tr>
<tr>
<td>Hg⁰</td>
<td>Mercury, Elemental (reduced) state</td>
</tr>
<tr>
<td>Hg²⁺</td>
<td>Mercuric ion, Mercury in +2 (oxidized) state, Typically HgCl₂</td>
</tr>
<tr>
<td>HgCl₂</td>
<td>Mercuric Chloride, Chemical formula</td>
</tr>
<tr>
<td>HNO₃</td>
<td>Nitric Acid, Chemical formula</td>
</tr>
<tr>
<td>i.d.</td>
<td>Inside Diameter</td>
</tr>
<tr>
<td>IDL</td>
<td>Instrument Detection Limit. DL in ultra-clean, high purity acid media (e.g. 7% HCl, “Ultrex II” grade). IDL is generally measured under “favorable” operating conditions and does not involve sample digestion or preparation steps. IDL indicates what the instrument is capable of doing, if not subjected to contamination, digestion loss, storage loss, or other sample collection/preparation errors or limitations</td>
</tr>
<tr>
<td>KMnO₄</td>
<td>Potassium permanganate, Chemical formula of oxidizing reagent, and Mercury Exhaust Trap agent</td>
</tr>
<tr>
<td>L</td>
<td>Liter, Unit of volume</td>
</tr>
<tr>
<td>LED</td>
<td>Light-Emitting Diode</td>
</tr>
</tbody>
</table>
Glossary

**QuickTrace™** Specifically the CETAC Mercury Analyzer instrument that sits below the ASX-520 Autosampler.

**QuickTrace™** Specifically the entire Mercury analyzer system including the QuickTrace™, ASX-520, Peristaltic Pump, etc.

**mA** Milliamperes ($10^{-3}$ amperes), electrical current

**MDL** Method Detection Limit; DL measured under actual reagent purity, sample preparation, and storage conditions for samples, reagents, and containers in question. Calibration standards are generally prepared in the sample media and are carried through all sample digestion/preparation, storage and transfer steps, etc., as are samples. In the presence of significant contamination, small concentration detectability gets worse and the actual MDL should be redefined as $1/3$ the contamination, but not less than the statistical MDL!

**mL** Milliliter (cubic centimeter, cc, $10^{-3}$ L), Unit of volume

**mm** Millimeter ($10^{-3}$ meter), Unit of length

**MSDS** Material Safety Data Sheet specifying chemical hazard type and level.

**N₂** Nitrogen Carrier Gas, Chemical formula

**Nafion®** Registered trademark of DuPont (E.I. du Pont de Nemours and Company), which trademark is licensed to Perma Pure, Inc. and used (with permission) herein by SD Acquisition, Inc. DBA CETAC Technologies. The trademark is descriptive of DuPont/Perma-Pure’s porous membrane which passes water vapor, but not Hg vapor.

**nm** Nanometer ($10^{-9}$ meter), Wavelength unit

**ng** Nanogram ($10^{-9}$ gram), Mass or weight unit

**o.d.** Outside Diameter

**P** Transmitted Radiant Power, photon flux at sample detector (after passing through sample).
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₀</td>
<td>Incident Radiant Power, Photon flux at reference detector (before passing through sample).</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PEEK</td>
<td>Polyetheretherketone; A machined polymeric construction material.</td>
</tr>
<tr>
<td>pg</td>
<td>Picograms (10⁻¹² g), Mass or weight unit.</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional Integral Differential. Description of a type of precision heater control device.</td>
</tr>
<tr>
<td>ppb</td>
<td>Parts Per Billion (ng/mL, 10⁻⁹ g/mL, μg/L, 10⁻⁶ g/L), concentration unit.</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts Per Million (μg/mL, 10⁻⁶ g/mL, mg/L, 10⁻³ g/L), concentration unit.</td>
</tr>
<tr>
<td>ppt</td>
<td>Parts Per Trillion (pg/mL, 10⁻¹² g/mL, ng/L, 10⁻⁹ g/L), concentration unit.</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds Per Square Inch. Pressure. 1 psi ≈ 0.068 bar. 1 bar = 100 kPa.</td>
</tr>
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</table>
psig  Pounds Per Square inch.  *Gauge* reading (above atmospheric pressure).

PTU  Precision-Timed Uptake

Pump or PP  Peristaltic Pump

P-P  Peak to Peak. A description of how signal noise is measured (One method).

RMS  Root Mean Square. A description of how signal noise is measured. RMS = 0.707 of peak amplitude (another method), approximately one standard deviation unit.

RSD  Relative Standard Deviation. A measure of data precision or reproducibility.

SCR  Stannous Chloride Reactor

Sn  Tin, Chemical Symbol. Typically as SnCl₂ reagent.

SnCl₂  Stannous Chloride, Chemical formula of reducing agent.

SRM  Standard Reference Material, Containing a certified, known Mercury level.

T  Transmittance (P/P₀), Often %T or percent transmittance (P/P₀ x 100%)

TC  “To Contain” Designation of a type of volumetric flask calibrated to accurately contain a specified volume of liquid.

TD  “To Deliver” Designation of a type of volumetric flask or pipet calibrated to accurately deliver a specified volume of liquid.

UHP  Ultra High Purity

UV  Ultraviolet; Short wavelength region of spectrum below 370 nm (e.g. 253.7 nm)

VAC  Volts Alternating Current
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>VDC</td>
<td>Volts Direct Current</td>
</tr>
<tr>
<td>XS</td>
<td>A substantial concentration “Excess” of one chemical reactant (over another).</td>
</tr>
<tr>
<td>μg</td>
<td>Micro-gram (10⁻⁶ g), Unit of mass or weight</td>
</tr>
<tr>
<td>μL</td>
<td>Micro-liter (10⁻⁶ L), Unit of volume</td>
</tr>
<tr>
<td>μAbs</td>
<td>Micro-absorbance units. (10⁻⁶ Abs)</td>
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</table>