AQUATRAN®

3/38

Operator's Manual

Revision G

mocon® / AMETEK®

Gas-Detection

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About This Manual

This manual explains how to set up and use the AQUATRAN 3/38 Water Vapor Transmission Rate System.

This manual is designed for viewing electronically. Most references to other sections or chapters in this document are hyperlinks which can be used to navigate to the referenced section.

Please use the following guide to get started with the system.

If You Want to Set Up the AQUATRAN 3/38

1. Prepare your test site.

   See Appendix A "Site Preparation Instructions" starting on page A-1 in this manual.

2. Install the AQUATRAN components.

   See Chapter 2 "Setting Up" starting on page 2-1 in this manual.

If You Want Some Background on How the System Works:

1. Get an overview of the system.

   See Chapter 1 "Introduction" on page 1-1 in this manual.

2. Learn how the AQUATRAN measures water vapor transmission.

   See Appendix D "Theory of Operation" on page D-1 in this manual.

3. Learn about the software.

   See Chapter 4 "Using the Instrument Software" starting on page 4-1 in this manual.

If You Want to Get Started Measuring Water Vapor Transmission Rate:

See Chapter 3 "Preparing for a Test" beginning on page 3-1, Chapter 6 "Testing Film Samples" on page 6-1.

If You Have Problems Operating the System:

1. If an error message appears on the instrument screen see Chapter 8 "Troubleshooting" beginning on page 8-1 in this manual.

2. If no error message appears but you have other problems, see Chapter 8 "Troubleshooting" beginning on page 8-1 in this manual.

SERVICE NOTE:

Please do not hesitate to call MOCON in the USA at (763) 493-6370. We want you to receive the best in product support services.

Safety Information

Be sure to read and understand this section and all other applicable chapters of the Operator's Manual and all on-product safety signs before setting up, operating, and maintaining this analyzer.

Safety signs appear in this manual and on the analyzer. All safety signs are identified by the words **WARNING** and **CAUTION**. These words signify the following:

- **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious personal injury.
- **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in moderate personal injury and/or possible damage to the analyzer and its components.

To avoid personal injury and equipment damage, observe the following precautions:

Installation Precautions

- Use appropriate precautions when lifting or moving the instrument. A two-person lift is recommended.
- The maximum pressure applied to the instrument from the Carrier Gas tank must not exceed 29 psi (2 bar), or damage to the instrument will occur.

Operating Precautions

- To avoid plumbing contamination use only specified gas type at recommended operating pressure.
- Use only HPLC-grade water in the humidity generator.
- Use care to avoid splashing the RH sensor with any salt solution. The RH sensor can be irreparably damaged by direct contact with salt solutions.
- Handle the RH probe carefully. The sensor housed in the probe is easily damaged.
- Do not expose the RH probe to an environment with RH greater than 90% RH.

Maintenance and Service Precautions

WARNING! HAZARDOUS VOLTAGES ARE PRESENT INSIDE THIS INSTRUMENT. SERVICE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

AVERTISSMENT: CET INSTRUMENT PRESENTE DES NIVEAUX DANGEREUX DE TENSION. L'ENTRETIEN DOIT ETRE EFFECTUE PAR UN PERSONNEL QUALIFIE UNIQUEMENT.

WARNING! Protection may be impaired if this device is not used in the manner specified.

- Maintenance and service should only be performed by qualified personnel.
- Make sure the instrument is powered OFF and unplugged from the power source before removing the covers to perform any internal maintenance or service. Failure to do so can result in electrical shock, which can cause injury or death.
- Failure to use proper safety equipment when mixing salt solution can result in frostbite or burn injuries. Salt solutions should be prepared only by qualified people with proper safety equipment.

Table of Contents

Figures

Tables

Chapter 1: Introduction

This chapter provides a brief overview of the AQUATRAN 3/38 Water Vapor Transmission Rate System.

Read this chapter to get an overview of:

- The features of the AQUATRAN 3/38 system
- A summary of basic steps in a permeation test
- A summary of how a Water Vapor Transmission Rate measurement is performed
- A summary of how Film and Package testing is performed

Figure 1-1: AQUATRAN 3/38 System

Features

The following features of the AQUATRAN 3/38 Water Vapor Transmission Rate System make it very versatile and easy to use:

- Fully automatic (Hands Off) testing.
- Pneumatically clamped Test Cartridges.
- Removable Dual-Film Test Cartridges for faster film mounting.
- Test Cartridges with TruSeal™ for increased performance.
- Automatic control of Pressure, Flow and RH.
- Automatic control of the Test Cell Temperature.
- QC Mode
- Advanced Gas Saver function reduces gas consumption.
- Automatically save and print Test Results.
- Internal storage of at least 100 Test Results.
- Integrated and intuitive touch screen operator interface.
- Remote Access and Control (requires optional Perm-Net Light software).
- Standard Ethernet port (100T).
- Dual USB 2.0 ports (for connection of keyboard, mouse or memory devices).

Permeation Test Overview

A "Permeation Test" consists of up to two phases that are performed using a Test Cell. The "Cell" contains the film sample. The Test Phase (always present) is used to measure the transmission rate of the test sample. The Individual Zero Phase is optional and may occur at the beginning or end of a Permeation Test. Each phase in the test consists of a series of discrete states. A Permeation Test may utilize all or only a subset of the possible test states. During a test the steps (or states) within each phase are executed in a fixed order. This order is called the "Test Sequence". A brief description of the phases and states within a permeation test are given below:

Individual Zero Phase

An Individual Zero Phase is used to determine the amount of water vapor that is present in the carrier gas from factors other than actual transmission through the sample. This amount is subtracted from the transmission rate obtained for each sample during testing. For more information on when and how to use an Individual Zero Phase see "Individual Zero Processing" in Chapter 3.

Conditioning the Sample

Almost every material requires a period of time to acclimate to the environment and reach equilibrium. A time period can be specified to allow the barrier to "Condition" to the test environment. The Conditioning Period when used will occur at the beginning of each test phase.

ReZero State

Periodically the instrument baseline must be measured so that any changes in the baseline will not affect the accuracy of your transmission rate data. This is done during a "ReZero State" by measuring the apparent water vapor transmission rate of the ReZero Cell.

Cell Examination State

The Cell Examination State is used to measure the transmission rate of the barrier sample. The carrier gas leaving the Test Cell is sent to the water vapor sensor where the amount of water vapor contained in the gas is measured to determine a transmission rate.

Bypass State

The Bypass State is used to minimize exposure of the water vapor sensor to excessive background levels of water vapor. The water vapor sensor is automatically placed in the Bypass State during conditioning, when tests are completed or when an excessively high level of water vapor is detected.

Test Completion

At some point sufficient measurements will have been made to accurately determine the transmission rate of the samples. A Permeation Test can be terminated manually by the user, after a fixed number of test cycles or using an automatic convergence process. When testing is complete, the cell is removed from the test sequence and no further transmission rate examination of that sample is performed. For more information on stopping a transmission rate test see "Determining When to Stop a Test" in Chapter 3.

Report Generation

You can request a report for one cell or any cell at any time until a new permeation test is started. See the instrument Help System for information on printing reports.

Measuring Water Vapor Transmission Rate

To make an accurate transmission rate measurement a known concentration Test Gas (usually 100% Water vapor) is applied to one side of the barrier material to be tested and the other side is swept with a water vapor free Carrier Gas (nitrogen). This is accomplished by mounting the sample in a device called a Diffusion Cell. For convenience a diffusion cell is often referred to as a "test cell" or as a "cell".

This process is illustrated in Figure 1-2 which is a simplified depiction of a film sample mounted in a diffusion cell. The Test Cartridge used in the AQUATRAN 3/38 contains two diffusion cells.

As shown in the illustration the film is mounted between two parts of the cell. The o-rings and sealing surfaces in the cell prevent outside air from affecting the measurement.

The Test Gas is continuously applied to bottom half of the cell. When performing a test using a 100% RH test gas, the water vapor is supplied by a saturated sponge. To perform a test using a Generated RH the sponge is removed and a gas at the specified RH is supplied to the Test Gas side of the cell.

The Carrier Gas (nitrogen) enters the top half of the cell. As water vapor permeates the sample barrier it mixes with the Carrier Gas. The output side (exhaust) of the test cell is routed to the water vapor sensor. The amount of water vapor in the carrier gas is measured using the water vapor sensor.

Seal leakage can be a significant source of error when measuring the transmission rate of a film sample. The TruSeal™ flush ring at the perimeter of the cell minimizes the effect of ambient water vapor on the measurement. During a test the TruSeal™ flush ring is purged with carrier gas minimizing the possibility of leakage past (or permeation through) the seals.

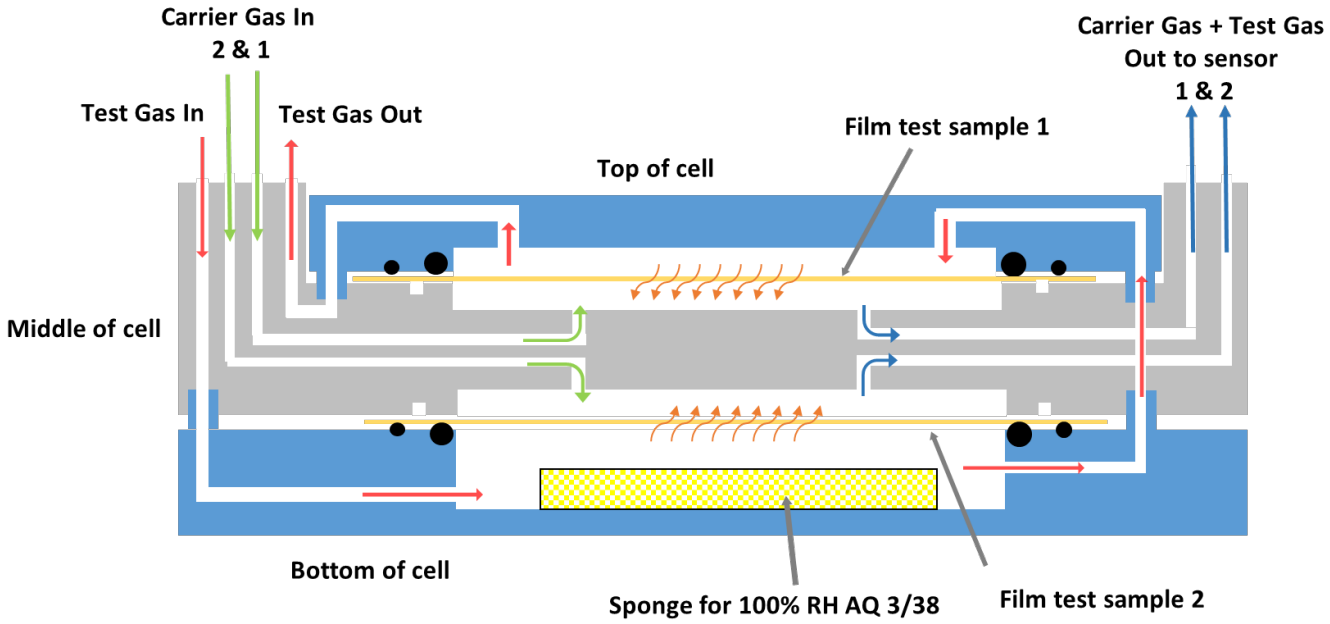


Figure 1-2: The AQUATRAN 3/38 - 100% RH Test Cell

Testing Samples

The AQUATRAN 3/38 is designed measure the Water Vapor Transmission Rate of film samples. The AQUATRAN 3/38 provides no capability for testing packages.

To test a film sample, it is prepared and mounted in a Test Cartridge. Both positions in the Test Cartridge (referred to as the top and bottom) must contain a film or foil. The test cartridge is used to maintain the film sample at the specified test conditions. For more information on testing Film Samples see Chapter 6.

Chapter 2: Setting Up

This chapter provides information on how to set up an AQUATRAN 3/38 and prepare it for use.

Read this chapter to learn about:

- Unpacking the System
- Preparing for System Installation
- Front Panel Parts and Controls
- Back Panel Parts and Controls
- Connecting the nitrogen gas line to the instrument

Unpacking the System

Each AQUATRAN 3/38 instrument is shipped in its own crate. Any optional kits or accessories may be shipped in the instrument crate or in separate cartons. A checklist will be included for the instrument and any of the optional kits you may have purchased.

If any components are missing or damaged, please call MOCON in the USA at (763) 493-6370.

Preparing for Installation

The Site Preparation Instructions (Appendix A) contain important information about preparing a location for the instrument and the facilities required for your new instrument. Please read Appendix A before proceeding with the installation of the AQUATRAN 3/38.

The ambient environmental conditions in which the instrument will be used must meet those specified on page 9-1 in Chapter 9.

The AQUATRAN 3/38 should be placed on a bench or table capable of supporting approximately 43 kg (95 lbs.). The work surface should be flat, clean and free of excessive vibration.

If installing a printer that will be directly connected to the AQUATRAN 3/38, place it next to the instrument. Read the manual that came with the printer for installation procedures.

Do not plug the instrument or printer into a power source until all components have been set up and connected.

Before proceeding with the setup or operation of the instrument familiarize yourself with the locations and names of the parts and controls on the front and rear of the instrument.

Front Panel Parts and Controls

The names and locations of the parts and controls located on the front of the instrument are shown in Figure 2-1, Figure 2-2 and Table 2.1.

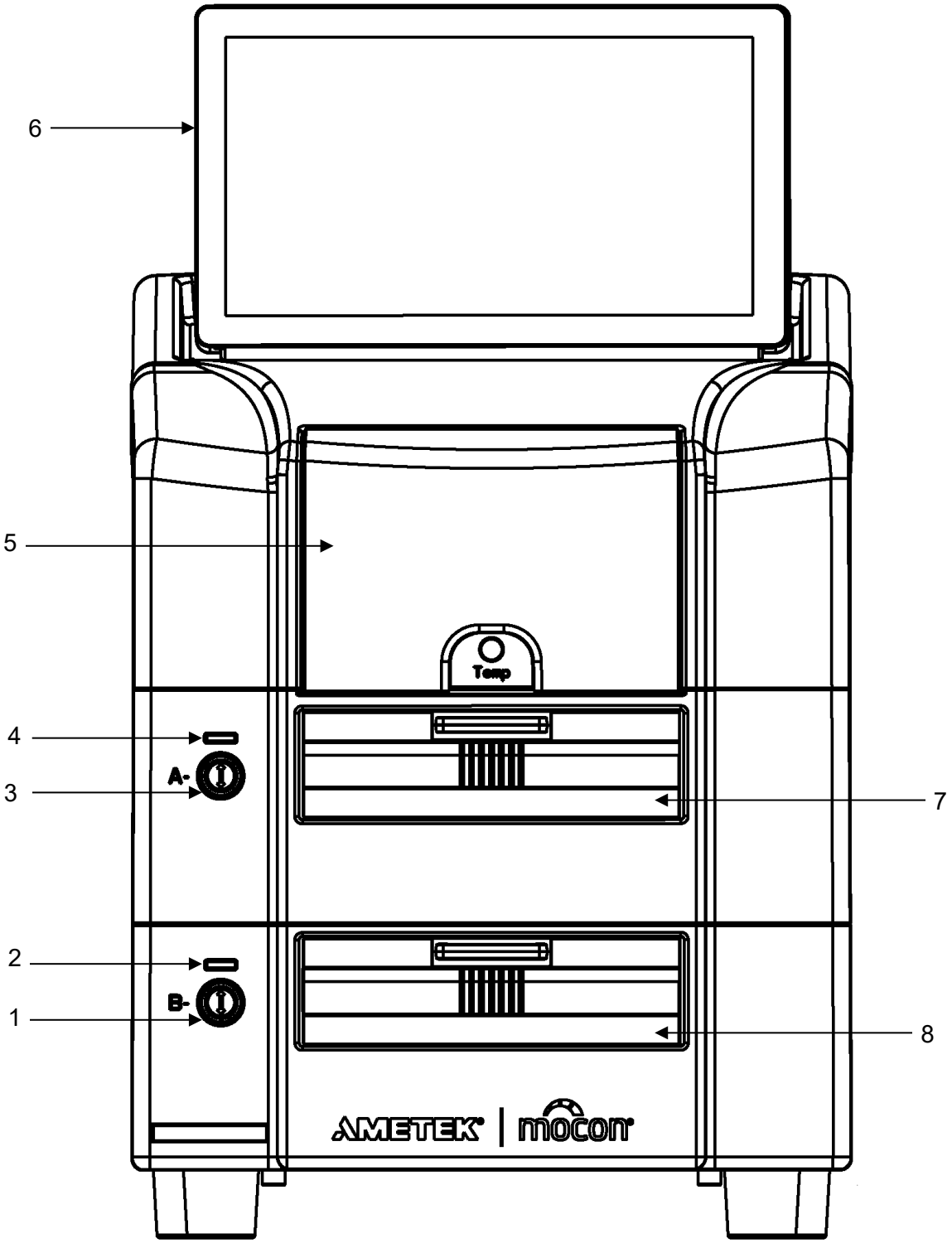


Figure 2-1: Front Panel Parts and Controls

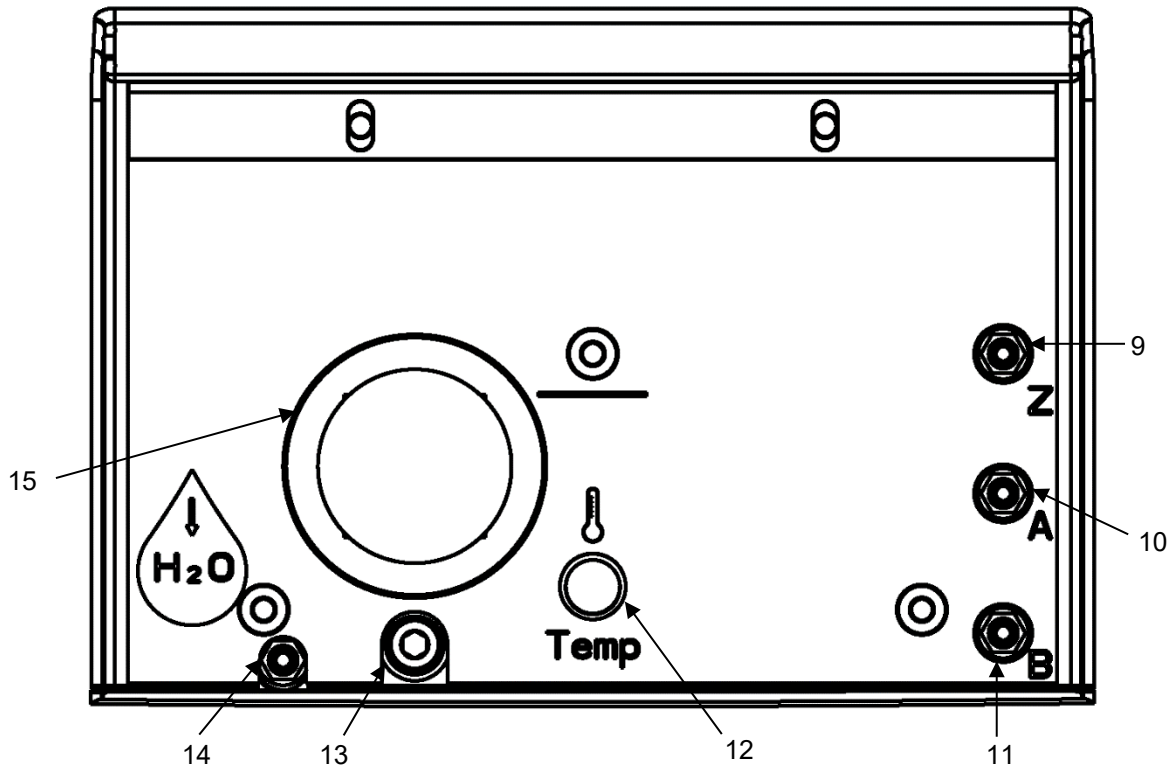

15
H2O
Temp
Z
A
B
9
10
14
13
12
11

Figure 2-2: Front Panel Parts and Controls

Item	Name	Description
1	Cartridge B Load/Unload button	This button is used to Load and Unload the Test Cartridge
2	Cartridge B Status Indicator	This indicator is used to show the Status of Cartridge B
3	Cartridge A Load/Unload button	This button is used to Load and Unload the Test Cartridge
4	Cartridge A Status Indicator	This indicator is used to show the Status of Cartridge A
5	Cover	The cover that is used to access the Humidifier and gas vents
6	Instrument Display	The color touch-screen display used for instrument control
7	Cartridge Drawer - Cartridge A	The drawer which contains Test Cartridge A
8	Cartridge Drawer - Cartridge B	The drawer which contains Test Cartridge B
9	ReZero Cell Vent	The carrier gas vent for the ReZero cell
10	Cartridge A Vent	The carrier gas vent for Test Cartridge A
11	Cartridge B Vent	The carrier gas vent for Test Cartridge B
12	Thermometer Well	A thermometer well for use with an external thermometer
13	Reservoir Fill/Drain Valve	The screw used to open & close the Reservoir drain
14	Reservoir Drain/Fill Port	The drain port for the Reservoir
15	Water Reservoir	Window showing the Reservoir water level

Table 2-1: Front Panel Parts and Controls

Back Panel Parts and Controls

The names and locations of the parts and controls located on the back of the instrument are shown in Figure 2-3 and Table 2.2.

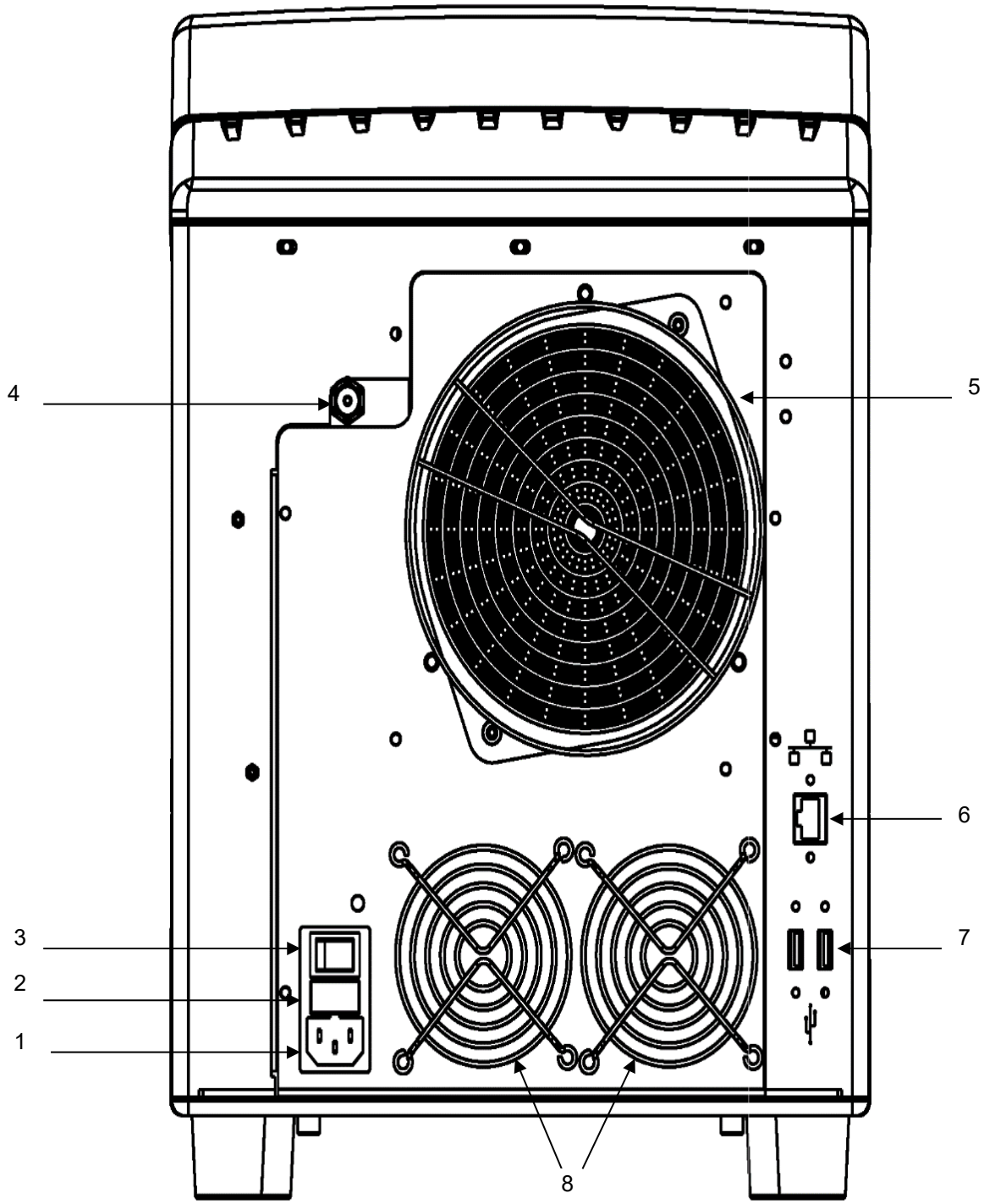


Figure 2-3: Back Panel Parts and Controls

Item	Name	Description
1	Power In	The connector the power cord attaches to.
2	Fuse Holder	The fuse holder contains the fuses used to protect the instrument.
3	Power Switch	The switch that is used to turn the instrument on and off. I is ON O is OFF
4	Carrier Gas Inlet Port	The fitting that connects the carrier gas supply to the instrument.
5	Cooling Fan	The fan that supplies cooling air to the sample heating/cooling system.
6	Network Port	A 10/100T Ethernet port for connection to a network.
7	USB Ports	USB 2.0 Ports for connection of USB devices (keyboard, mouse).
8	Enclosure Fans	The fans that supply cooling air to the instrument enclosure.

Table 2-2: Back Panel Parts and Controls

Carrier Gas (Nitrogen)

The AQUATRAN 3/38 requires a Carrier Gas that is 99.7% nitrogen. A standard T size cylinder will typically provide sufficient gas to operate a single instrument for several weeks.

Gas Distribution System

Each instrument ships with a local regulator/isolation device (called a Regulator Tee) that can be used to connect the instrument to a common Carrier Gas distribution system. Figure 2-4 illustrates how a gas distribution system for multiple instruments can be created using the provided Regulator Tee.

When using compressed gas cylinders, consideration should be given to the impact cylinder replacement will have on operational efficiency. Interruptions to the gas supply when a cylinder is changed (or goes empty) will have an adverse effect on any active tests. Cylinder manifolds that provide an uninterrupted gas supply during cylinder replacement are available from many gas suppliers.

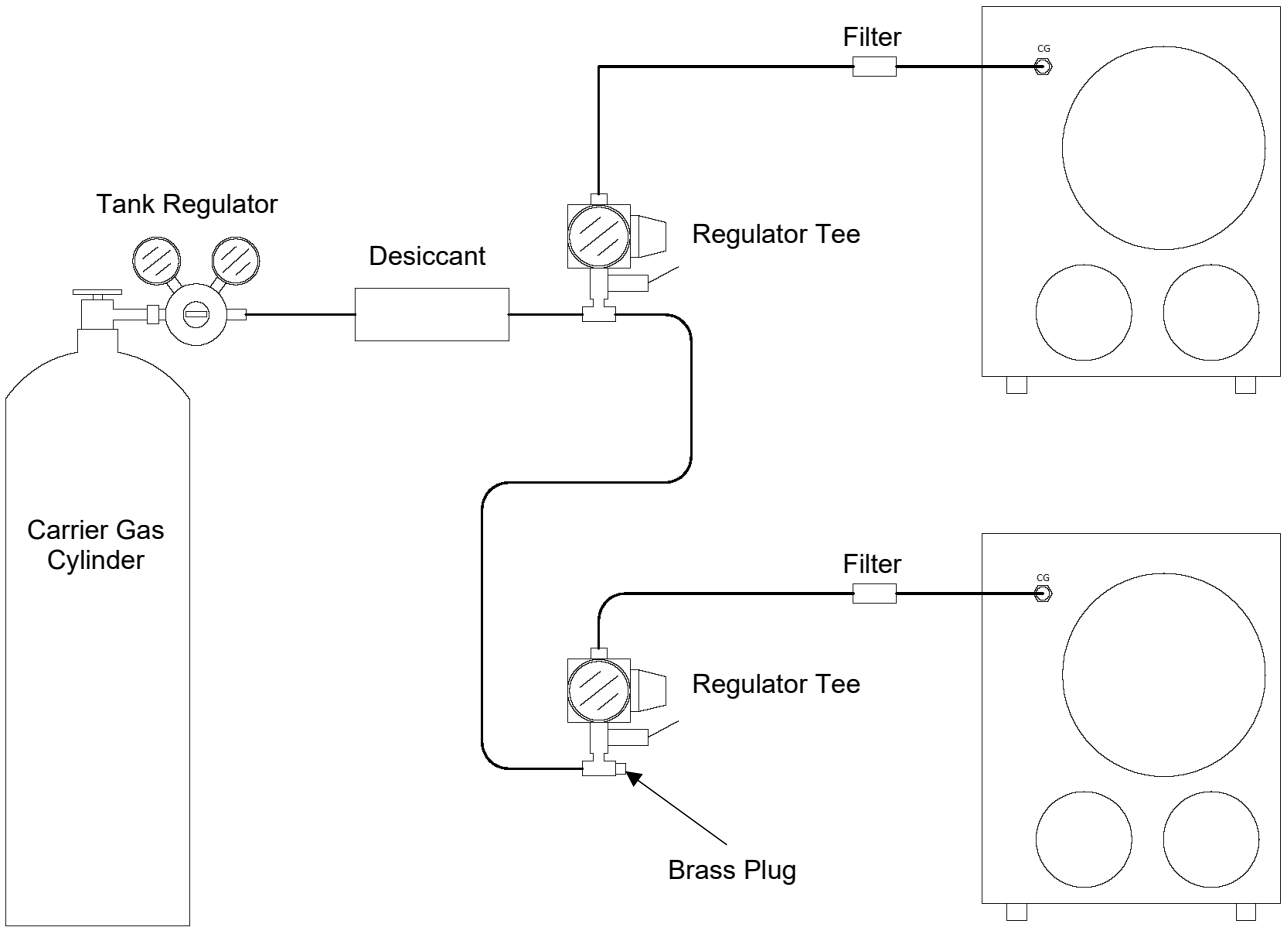


Figure 2-4: System Plumbing Connection Diagram

Connecting the Gas Lines

The AQUATRAN 3/38 has a gas inlet for connection of the Carrier Gas (nitrogen) supply. This compression fitting is intended for use with 1/8" copper tubing. Refer to Figure 2-3 and Figure 2-4 for the location of the fitting and an example of plumbing system diagram.

The optional Starter Kit (054-161) contains 50 feet (14 meters) of tubing in addition to extra compression nuts, ferrules and grease.

Follow these steps to connect the gas supply lines:

1. Remove the brass plug from the Carrier Gas fitting on the instrument back panel. Save this plug as it will be needed later.

2. Cut a piece of tubing approximately 6 inches in length (15 cm).

3. Cut a piece of tubing approximately 10 inches in length (25 cm).

4. Apply a thin coating of High Vacuum grease to four compression ferrules.

5. Connect the Carrier Gas fitting on the instrument back panel to one side of the particulate filter (051-791) using the shorter piece of tubing and two nuts and ferrules.

6. Connect the other side of the particulate filter to the output fitting on a regulator tee using the longer piece tubing and two nuts and ferrules.

7. Cut a piece of tubing to connect the Desiccant Tower to the Carrier Gas (Nitrogen) supply.

8. Apply a thin coating of High Vacuum grease to a compression ferrule.

9. Connect the inlet fitting on the Desiccant Tower to the Carrier Gas (Nitrogen) supply regulator using a nut and a ferrule. The inlet fitting on the Desiccant Tower is on the end of the chamber containing the cover. Make sure the tube is inserted all the way into the fitting on the Desiccant Tower before tightening the knurled nut.

10. Cut a piece of tubing to connect the regulator tee to the Desiccant Tower.

11. Apply a thin coating of High Vacuum grease to a compression ferrule.

12. Connect the inlet fitting on the regulator tee to the output fitting on the Desiccant Tower using the tubing a nut and a ferrule. Make sure the tube is inserted all the way into the fitting on the Desiccant Tower before tightening the knurled nut.

13. If there are no additional instruments to be connected skip to step 17. If there are additional instruments to be connected, repeat steps 2 - 6 and 14 - 16 for each instrument.

14. Apply a thin coating of High Vacuum grease to two compression ferrules.

15. Cut a piece of tubing to connect the regulator tee on the previous instrument to the regulator tee on the next instrument.

16. Connect the previous Carrier Gas regulator tee to the next Carrier Gas regulator tee using two nuts and ferrules.

17. Using the plug removed in step one, cap the open port on the last regulator tee assembly.

Setting the Gas Supply Pressure

Set the Gas Supply Pressure as follows:

1. Set the Carrier Gas cylinder or main line supply regulator pressure to 35 psi.

2. Set the pressure on the Carrier Gas regulator-tee so that the gauge reads 29 psi.

Caution:	**The maximum Carrier Gas pressure to the instrument must not exceed 32 psi. Input pressures greater than 32 psi (2.2 Bar) will damage the system.**

Note: When using compressed gas cylinders, the tank must be replaced when the pressure falls below 300 psi (on the first stage of the regulator).

System Outgassing

Before the system can be used any air trapped in the gas lines and instrument must be purged out. After purging the carrier gas supply system, the instrument must be outgassed. After the initial purge residual water vapor may still be present in the seals and void spaces within in the instrument. Out-gassing removes this residual water vapor from the system.

To out-gas the system follow these steps:

1. Verify the Gas Supply Pressure is set correctly; see setting the Gas Supply Pressure on page 2-9.

2. Turn the instrument on.

3. Mount a film in the Test Cells, for more information see "Mounting Samples" on page 6-7.

4. Load and Clamp the Test Cells, for more information refer to "**Error! Reference source not found.**" on page **Error! Bookmark not defined.**.

5. Let the system out-gas for at least one hour before starting a test.

Chapter 3: Preparing for a Test

This chapter provides information on how to prepare for a permeation test.

Read this chapter to learn about:

- Testing Basics
- How Barrier Properties Affect Testing
- Developing Test Methods for Films and Packages
- Developing a Temperature Profile

Testing Basics

A permeation test is comprised of a series of discrete actions or events. Some of these steps require human thought, action or intervention. Some of the steps are performed by the instrument and will be discussed elsewhere. The most important part of the process is the planning and preparation that occurs before the actual testing begins. Inadequate planning or preparation may result in an inaccurate measurement. This chapter contains information on the factors that should be considered when planning for a permeation test.

How Barrier Properties Affect Testing

A good understanding of the barrier material properties for the samples to be tested is very helpful when preparing for a permeation test. The transmission rate of the sample and the conditions at which it will be tested may require changes to the test methodology.

Any sample with a transmission rate within the range of the instrument (as specified in Chapter 9) can be tested. Additional consideration is advised when setting up tests for samples that have a transmission rate within 25% of the upper or lower end of the instruments test range.

Use caution when testing at the upper end of the instruments test range, an excessively high transmission rate will over-range the water vapor sensor. Common poor barrier materials include polyethylene, polycarbonate and acrylic.

The possibility of an over-range condition can be reduced by; lowering the water vapor concentration (RH) of the Test Gas, using a mask to reduce the area of the film samples or increasing the Carrier Gas flow rate. Using any or all these methods will reduce the amount of water vapor in the carrier gas, reducing the possibility of an over range condition.

Testing Mixed Barriers

Simultaneously testing barriers with widely divergent transmission rates is not recommended. The data for some samples may not be accurate when there is a large difference in the transmission rates. If during a test there is a large difference in the transmission rates, set the divergent cell (or cells) to Idle and continue testing the remaining cell (or cells). You may want to determine which samples will condition more rapidly and test those samples first.

Testing Moisture Sensitive Barriers

With some materials such as nylon, cellophane and ethyl vinyl alcohol, variations in the amount of water vapor absorbed from the test gas will significantly affect the Water Vapor Transmission Rate.

Some hydroscopic materials expand or swell when water is absorbed into the polymer or fiber structure. The extent of this swelling depends largely on the solubility factors of the polymer or fiber. If swelling is severe enough, the film may droop or dome, causing the gas ports (ingress or egress) to be covered. This will result in erroneous data.

To prevent this blockage, always precondition hygroscopic films in a hydrator or container over either distilled water (100% RH) or a salt solution (see Appendix F) that will give the desired RH. If several RH levels will be used during testing, always precondition at the highest RH anticipated before mounting the sample in the cell.

Developing Test Methods for your Films and Packages

Choosing the appropriate test conditions and methodology is one of the most important preparatory tasks. Inaccurate test results and "Failed" tests are commonly caused by inappropriate methodology. A good understanding of the characteristics of the barrier sample will be very helpful in choosing an appropriate methodology. For specific information on how to set or adjust the Test Method parameters discussed in this section please refer to the Instrument Help System.

The Examination Time

The Exam Times specifies how long (in minutes) the Test Cell (containing the sample) will be examined to determine the water vapor transmission rate. During this examination time the carrier gas (along with any water vapor that has permeated the sample) is routed to the sensor. For some barriers you may need to increase the examination time. This is because the sensor approaches its final value at an exponential rate. For some barriers the sensor may not properly stabilize within the default examination time. For most barriers the small increase in water vapor transmission rate caused by increasing the examination time is insignificant.

The ReZero Frequency

The baseline of the instrument can shift slightly during testing due to such changes as ambient temperature. The ReZero process adjusts for these small shifts in the instrument baseline.

The ReZero function can be turned on and off. The default is on with a new zero taken every two cell examination periods (equivalent) to one pass for each cell. The default values were chosen to provide optimum conditions when testing very good barriers. This means that a new baseline (the ReZero value) will be established after every cell examination.

The Sample Conditioning Time

When you condition a sample in the test cell, carrier gas and test gases are routed to the test cell as they are during testing. However, the carrier gas is not routed to the water vapor sensor. This conditioning period allows a sample barrier to acclimate to the conditions within the test cell.

When you use individual zero processing the sample will be conditioned twice, once with no water vapor present in the Test Gas before individual zero testing and once using water vapor before the transmission rate test.

A Very Good barrier material may take a long time to reach equilibrium, conditioning can be used to limit the number of transmission rate values that appear on a printed report.

The amount of time in hours that the sample is conditioned can be specified. After the specified conditioning period the system will automatically begin testing or individual zero processing.

Individual Zero Processing

Adjusting the ReZero frequency will compensate for small shifts in the baseline zero. It may also be necessary to compensate for individual variations such as edge leaks in the test cells. This is done with Individual Zero Processing.

During individual zero processing the Permeant Driving Force is deliberately reduced to negligible levels. The Permeant Driving Force is reduced by inserting a blocking foil in the cell. Any water vapor that is picked up on the carrier gas side is thus due to factors other than permeation.

The instrument automatically subtracts this Individual Zero value from the water vapor transmission rate value to produce a very accurate result.

Whenever you test a Very Good barrier you should perform individual zero processing. The settings for the Individual Zero fields are explained below.

Individual Zero - Off/On	When set to Off an Individual Zero phase will not be performed. When set to On an Individual Zero phase is performed as specified by the Individual Zero Mode control. The default mode is off.
Beginning/End	When using these options, the individual zero value for the cell is measured. This value is subtracted from the measured transmission rate to give a corrected transmission rate value. The "Beginning" and "End" settings indicate when the Individual Zero phase will be performed at the Beginning or at the End of the test.
Last Individual Zero	In this mode the latest individual zero value measured is used. This value is subtracted from the measured transmission rate to give a corrected transmission rate value. The mode is useful if making many tests on the same type of material and the user is confident that edge leakage is not a problem and every sample barrier is mounted the same.

Determining When to Stop a Test

The setting used for the "Test Mode" parameter determines how and when a transmission rate test is stopped (Test Completion). Four different methods of stopping a transmission rate test are provided. The four methods are: "Continuous", "Standard", "Convergence By Cycles" and "Convergence By Hours".

The **Continuous** mode executes until manually stopped by an operator. The **Standard** mode executes for the number of cell examination cycles specified by the "Number of Cycles" parameter. The **Convergence** modes execute until equilibrium is achieved as defined by the convergence parameters.

Unless the characteristics of the test sample are well understood, the continuous mode should be used. If the test is stopped prematurely the transmission rate reported will not reflect the true transmission rate for the material. For more detailed information on the "Test Mode" parameter see the Instrument Help system.

Choosing a Test Method

There are three different ways to specify the parameters that determine how a permeation test is to be performed. These "Test Methods" are described briefly in the following section. For more detailed information see the Instrument Help system.

The Advanced Test Method

The Advance Test Method allows the user to specify all the parameters and conditions used to perform a permeation test. An Advanced Test Method allows the most flexibility in determining how a permeation test will be executed. The Advanced Test method also allows Test Sequencing.

Saved Test Methods

Saved Test Methods are Advanced Test Methods that have been saved and can be recalled for later use. Saved test methods are accessed using the "Methods" control displayed at the bottom of any Advanced Test Method screen.

QC Mode

The QC Mode allows the user to specify all the parameters and conditions used to perform a permeation test. The QC Mode also allows user to enter pass/fail criteria for easy identification of good and bad barriers.

Chapter 4: Using the Instrument Software

This chapter provides an overview of the software system used to operate the AQUATRAN 3/38. Detailed information on how to use the instrument software can be found in the Instrument Help System.

Read this chapter to learn about:

- The Features and Capabilities of the Instrument Software
- The Structure and Organization of the Instrument Software
- Accessing the Screens and Functions in the Instrument Software

The instrument software is used to control and monitor all instrument functions and test activity. The only activities that require operator intervention are loading/unloading the test cartridges, filling the water reservoir, setting the initial test conditions and starting tests.

The operator has full control of all test parameters when the "Advanced Test" function is used. As the test progresses data is collected and logged.

The resulting data is made available in tables and charts. The information (displays and reports) is available in both tabular and graphical formats. A Diagnostic interface is included for instrument maintenance and calibration.

Software Features

- Stored Test Methods
- Multiple Test Strategies
- Manual Test Parameter Selection
- Test setup using "Saved Test Methods"
- Independent Cell Level Test Parameters
- Real Time Graphical Display of Test Status
- Real Time Tabular Display of Test Status
- Automatic Reporting and Archival of Test Results
- Manual Reporting and Archival of Test Results
- Optional FDA CFR 21 Part 11 Compliant Operation

Instrument Software Structure and Organization

All the User Interface and Instrument Control functions of your permeation system are accessed through the Instrument Software. The User Interface consists of a Title bar, an Icon bar, and the Workspace

The "Title" bar is a fixed region at the top of the screen that shows the users login status, the name of the current screen displayed in the workspace, an icon for printing a screen image, an icon for accessing the Help System and a "close" button. The "Icon" bar is the fixed region below the Title bar containing seven icons. The "Workspace" occupies the remaining space below the Icon bar.

The various functions and screens that appear within the workspace are accessed using the icons in the Icon bar. Selecting one of these icons displays a screen in the workspace or a menu from which additional choices can be made.

When the instrument is started the Home screen is automatically displayed in the workspace. The application contains eighteen additional screens, which are organized according to their primary function or task. These functions can be described as belonging to one of the following six categories:

- Test Setup
- Starting and Running Tests
- Monitoring Test Activity
- Reporting Test Results
- Maintenance and Diagnostics
- Help

The functions in the first four categories listed above are organized into nine different screens. Each of these screens when "opened" replaces the one previously displayed in the workspace. Seven of the remaining screens are accessed using "Tools" icon.

The two remaining screens are accessed using the "Help" icon. The first Help menu item is used to display the Instrument Help System. The help system is displayed in the workspace below the Icon bar and contains two panes. There is a navigation\search pane on the left and a topic pane on the right. The help system contains detailed information on all the features, functions and fields in the instrument software.

The "About" menu item is used to display information about the instrument that may be needed when requesting service or support.

Chapter 5: Permeant Sensor Calibration

You will need to calibrate the system to ensure accuracy in determining water vapor transmission rates. Calibration also ensures proper automatic compensation in the transmission rates when environmental and other factors cause the system to drift. Such factors include:

- Ambient temperature fluctuation
- Excessive vibration from traffic, machines, etc.

To achieve the best possible results, you will need to make sure that your AQUATRAN 3/38 remains properly calibrated. You will need to manually calibrate the instrument after one or more of the following conditions occur.

- Set up of the system for the first time
- Changes of the nitrogen supply tank
- Changed the location of the modules
- Shut down of the system
- Suspect your data is not correct

Permeant Sensor Accuracy Check

The accuracy of the permeant sensor can only be checked by using a film to generate a reference transmission rate. The transmission rate of this film must be known to a high degree of accuracy. In addition, it is highly desirable that the film have NIST traceability. MOCON strongly discourages using any material that does not meet these conditions.

MOCON strongly advises using only our Certified Films to check the accuracy of the Permeant Sensor. Refer to the "Permeant Sensor Calibration Test Setup" in this chapter for information on setting up a test to check the accuracy of the permeant sensor.

NOTE: MOCON has available sets of certified NIST traceable films that cover the usual testing range. A third certified NIST traceable film is available for low transmission rate testing. Call MOCON in the USA for more information at (763) 493-6370.

Performing a Permeant Sensor Calibration

Calibration of the permeant (water vapor) sensor is a two-step process. First, a film sample with a known transmission rate must be tested. Refer to the "Permeant Sensor Calibration Test Setup" in this chapter for information on setting up a film test. The data from the test can then be used to adjust the permeant sensor.

After suitable data is available the "WVTR Calibration" screen can be used to adjust the output of the Permeant Sensor. Refer to the Instrument Help System for more information on performing a WVTR Calibration.

After a WVTR Calibration has been made and saved it can be viewed and recalled using the Calibration History screen. Refer to the Instrument Help System for more information on using the Calibration History screen.

Permeant Sensor Calibration Test Setup

To calibrate an instrument to a standard reference film or a certified film use the following procedure:

NOTE: MOCON has available Certified NIST Films that cover the usual testing range. Call MOCON in the USA for more information at (763) 493-6370.

NOTE: MOCON Certified NIST Films, if not damaged, should last for a year. Do not use the film if it is wrinkled, punctured or contaminated with grease or fingerprints.

NOTE: Certified films should be stored in a manner that will keep them clean and free from wrinkles. MOCON Certified NIST traceable films should be stored in the provided case.

NOTE: MOCON is not responsible for problems resulting from improper calibration or use of an inadequate transmission rate reference material.

1. Select a Certified Film or reference film that most closely approximates the transmission rate of the film samples you will be testing.

2. Unclamp and remove the Test Cartridge from the instrument.

3. Mount the Certified Film (or reference film sample) in the Test Cell. For information on mounting films see "Mounting Samples" on page 6-7.

4. Replace the test cartridge and clamp it in place. For information on installing and clamping the Test Cell see "Loading and Unloading the Test Cartridge" on page **Error! Bookmark not defined.**.

5. The Calibration Film Test Procedure should be performed using an "Advanced" Test Method. For information on how to set up an Advanced Test see the instrument Help System.

6. Verify the following Instrument Level parameters have been correctly assigned:

Cell Temperature:	If using certified films, the test temperature must be 37.8 °C. If calibrating with another known film, use the temperature at which the transmission rate for the film was measured.
Instrument ReZero:	Enabled
ReZero Frequency:	1
ReZero Exam Minutes:	Set appropriately for the sample being tested. At least 30 minutes is recommended. The test period may need to be longer depending on the time the film takes to reach equilibrium.

NOTE: Use of the "Test ID", "Sample ID" and "Material ID" fields is advised to document the all the relevant information on the specific material used to perform the test.

7. Verify the following Cell Level parameters have been correctly assigned:

   Area/Cell: Verify the area is set correctly if not using a Certified film.

   Package/Film selection: Verify that Package is selected if using a Certified film. If using another film, set the Package/Film buttons to the appropriate selection for the method used to establish the reference transmission rate.

8. Verify the following Test Level parameters have been correctly assigned:

   Test Mode: Verify the Test Mode parameter is set to continuous mode.

   Exam Minutes: Set the examination time appropriately for the sample being tested. At least 20 to 30 minutes is recommended.

   Individual Zero Mode: Determine if an "Individual Zero" phase was used to create the reference sample. If an "Individual Zero" phase was used set the Individual Zero control to the "On" position. Set the Individual Zero Mode parameter to "Beginning".

9. After the film has been mounted and test parameters correctly assigned, start testing the reference sample.

10. Monitor the progress of the test using the "Cell Status" and "Instrument Status" screens. When the reference sample has reached equilibrium, advance the cell to the "Test Complete" state. The sample is usually considered to be at equilibrium when there is no discernable trend in the data.

NOTE: Do not advance the test to the Test Complete state unless the certified film is at equilibrium.

11. Adjust the output of the Permeant Sensor using the "WVTR Calibration" screen. Refer to the Instrument Help System for more information on performing a Calibration.

NOTE: Calibration films should be stored in a manner that will keep them clean and free from wrinkles. MOCON Certified NIST Films should be stored in the provided case. You will need to use these films again whenever a module needs re-calibration.

Chapter 6: Testing Film Samples

This chapter contains information on how to test flat film samples. Suggestions on how to maximize the accuracy of your results and procedures describing how to perform the test are discussed.

Read this chapter to learn about:

- Testing Suggestions
- Preparing for a Film Test
- Sample Size
- Using Masks
- Sample Orientation
- Preparing the Samples for Testing
- Filling the Humidifier
- Filling the Humidifier during a Test
- Conducting a Film Test

Testing Suggestions

The following information will assist you in the day to day operation of your instrument.

- Test duplicate samples whenever possible.
- Use good samples. Pinholes and creases can contribute to false readings.
- Use caution when recording data for a new or unknown specimen. Some materials approach equilibrium slowly. When in doubt repeat the test.
- If the test is to be run under precise RH conditions, make sure that the humidifier has sufficient water in it.
- If no testing will be performed for a significant period (overnight or weekend) no special precautions are needed. The Gas Saver function will automatically be activated (when enabled) whenever both test cells are in the "Idle" state.

  Turning off the power and gas supply to instrument is not recommended. If the instrument is shutdown you will need to wait for it to outgas before testing can resume.

Preparing for a Film Test

Before a test can be conducted there are a number of tasks that must be performed: The samples to be tested must be prepared. The samples must be mounted in a Test Cartridge and Loaded into the instrument. Finally, if the test requires a Generated RH the Humidifier must be checked and filled if necessary.

For information on preparing the film samples refer to the sections on "Sample Size", "" and "Loading and Unloading the Test Cartridge" in this chapter.

For information on mounting samples and loading the test cartridge refer to "Mounting Samples" and "Loading and Unloading the Test Cartridge" in this chapter

For information on fill the Humidifiers refer to "Filling the Humidifier" in this chapter

Sample Size

The film sample should be approximately 4" x 4" (10.16 x 10.16 cm), with a thickness not exceeding 2 mm (0.08 inches). Smaller samples can be masked to allow them to be mounted, see the following section on "".

The film must be cut to a specific size and shape so it will fit in the Test Cartridge. MOCON provides a film template (available as part of optional Starter Kit 054-161) as an aid to cutting your film samples.

Special Cartridge for Thick Samples

For samples with thickness up to 1/8", a specially designed cartridge with two side-by side 10cm^2 cells, or with two side-by-side 5cm^2 cells can be used. Refer to a separate User Guide 054-641 for details.

Using Masks

A foil mask should be used if any of these conditions exist:

- You are testing a material with a transmission rate near or exceeding 100 g / (m^2 • day) (such as nylon or polycarbonate). If such materials are tested as full size samples, the sensor may over range.

  Using a 5 cm^2 mask will reduce the amount of water vapor sent to the sensor by a factor of 10 allowing a sample with an un-masked (50 cm^2 area) transmission rate of 1000 g / (m^2 • day) to be tested safely.

- The test material is not available in pieces large enough to mount in the cell.

- The test material is too fragile to support itself across the full cell area.

NOTE: Some materials may fail to adhere fully to the masks, and thus give erroneous and/or highly variable sample-to-sample transmission rates. Always check the compatibility and seal of your sample to the mask adhesive to determine if these problems exist.

When using a mask, specify the mask open area before starting the test. The mask reduces the area of the test sample (from the standard unmasked 50 cm^2 area). To correctly calculate transmission rate, the instrument must compensate for the difference between the masked and unmasked areas.

If your sample is thin (less than 5 mils), you need only mask one side. Mount the sample in the test cell with the film side facing up.

If your sample is thicker than 5 mils, mask both sides. Be sure the mask apertures are accurately aligned and the edges around the foil aperture are tight against the film.

Orienting the Sample

When mounting test samples, orientation can be important. Edge leakage or oxidation on some materials can affect the test result. It is important to place the "barrier side towards the carrier". Follow the guidelines below to minimize edge leakage and oxidation effects.

Homogeneous Materials

If you are testing a homogeneous, one-layer sample, the orientation of the sample in the cell is not critical.

Multi-Layered and Laminated Materials

Install a multilayered film or laminate with the barrier coating or laminate, toward the Film Mounting Plate. For example, a one-sided, PVDC-coated paper should be mounted with the PVDC side facing the Film Mounting Plate, placing the PVDC towards the carrier gas.

Metalized Materials

Mount the film in the test cartridge with the metalized side towards the carrier gas to prevent oxidation.

Using a 100% RH Test Gas

The AQUATRAN 3/38 has the capability of using a 100% RH Test Gas. A saturated sponge is used to generate a 100% RH Test Gas. The saturated sponge is placed in a cavity in the bottom Test Gas plate and the "Run at 100%" control is set to the ON position.

For information on properly saturating the sponges refer to following section "Using Saturated Sponges".

Using Saturated Sponges for testing at 100% RH

The sponge used for 100% RH testing should be refilled weekly, unless experience dictates refilling more often when testing high transmitters. Sponges should be very moist, but not dripping.

Caution:	**You must use HPLC-grade water in the AQUATRAN 3/38. HPLC-grade water (1 megohm or better) is preferred and can be obtained through local suppliers. If you do not use HPLC-grade water, scale is likely to form. If this occurs, expensive repairs will be necessary to fix the problem.** **In addition, the use of de-ionized water may result in the inability to achieve the desired RH.**

Using a Generated RH Test Gas

The AQUATRAN 3/38 has the capability of generating a controlled RH from 5 to 90% for the Test Gas. A Generated RH Test Gas is created by moving pressurized gas through a humidifier filled with HPLC-grade water and mixing the wet gas with a dry gas in the appropriate ratios.

To use a Generated RH the sponge (when present) is removed from the cavity in the bottom Test Gas Plate and the Test Gas RH controls on the Instrument tab of the Test screen are set as required.

Filling the Humidifier

Before starting a test requiring RH generation the level in the humidifier should be checked and filled if necessary. Follow these steps to fill the humidifier:

Note: Refer to Figure 6-1 for the location of the referenced controls.

1. Open the door on the instrument to access the Humidifier.
2. Check the water levels to determine if there is sufficient water to perform the test.
3. Fill a syringe with HLPC-grade water and attach short piece of tubing to the luer fitting.
4. Push the end of the tubing onto the Fill/Drain Port fitting.
5. Open the Fill Valve by turning it 2-3 turns counterclockwise.
6. Push in the plunger on the syringe to force the water into the reservoir.
7. Close the Fill Valve and remove the syringe.

Filling the Humidifier during a Test

During a long test requiring RH generation the level in the humidifier should be checked periodically and filled if necessary. Follow these steps to fill the humidifier during a test:

Note: Refer to Figure 6-1 for the location of the referenced controls.

1. Open the door on the instrument to access the Humidifier.
2. Check the water levels to determine if there is sufficient water to perform the test.
3. Put the instrument in ByPass using the GoTo control.
4. Fill a syringe with HLPC-grade water and attach short piece of tubing to the luer fitting.
5. Push the end of the tubing onto the Fill/Drain Port fitting.
6. Open the Fill Valve by turning it 2-3 turns counterclockwise.
7. Slowly push in the plunger on the syringe to force the water into the reservoir.

8. Close the Fill Valve and remove the syringe.

9. Start a ReZero examination using the GoTo control.

Humidifier Ports and Controls

The ports and controls used to fill the Water Reservoir used for Generated RH testing are illustrated in the figure and table below.

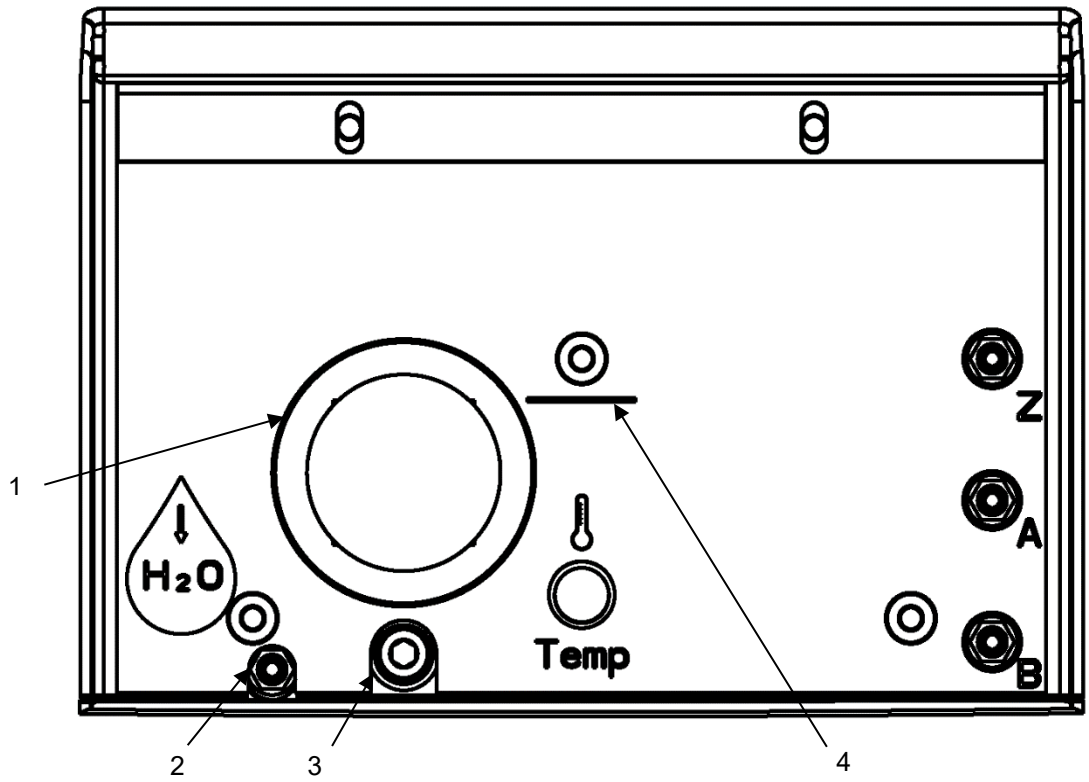


Figure 6-1: Humidifier Fill Ports

Item	Name	Description
1	Water Reservoir - Test Gas	Window showing the Test Gas Reservoir water level
2	Water Fill/Drain Port - Test Gas	The fill port for the Test Gas Humidifier
3	Water Fill/Drain Valve - Test Gas	The knob used to open & close the Test Gas fill port
4	Reservoir Fill Line	The maximum level to which the reservoir should be filled.

Table 6-1: Humidifier Ports and Controls

Mounting Samples in the Test Cartridge

Follow the instructions below to mount film samples in the Test Cartridge:

Note: Both positions (Top & Bottom) must contain a film or foil. If both positions are not required, a Foil may be mounted in the unused position.

Note: For information on cutting and preparing the film samples refer to the sections on "Sample Size", "" and "Loading and Unloading the Test Cartridge" in this chapter.

1. Remove the Test Cartridge from the instrument, see "Loading and Unloading the Test Cell" in this chapter.

2. Separate the top and bottom plates from the Film Mounting Plate (middle part).

3. Remove the old film samples from both sides of the Film Mounting Plate.

4. Clean the film sealing surfaces of the Film Mounting Plate to remove the old grease.

5. Apply new High Vacuum grease to the sealing surfaces on the Film Mounting Plate.

6. Inspect the TruSeal flushing ring and ports, remove any excess grease.

Mounting a Sample in the bottom Test Cartridge position

1. Place the Film Mounting Plate on a clean flat surface with the bottom mounting surface up.

2. Place the film on the greased sealing surface, remove any wrinkles as necessary.

3. Verify the inner and outer O-Rings are properly seated in the bottom Test Gas Plate.

4. When testing at 100% RH place a saturated sponge in the bottom Test Gas Plate cavity.

5. Install the bottom Test Gas plate on the Film Mounting Plate.

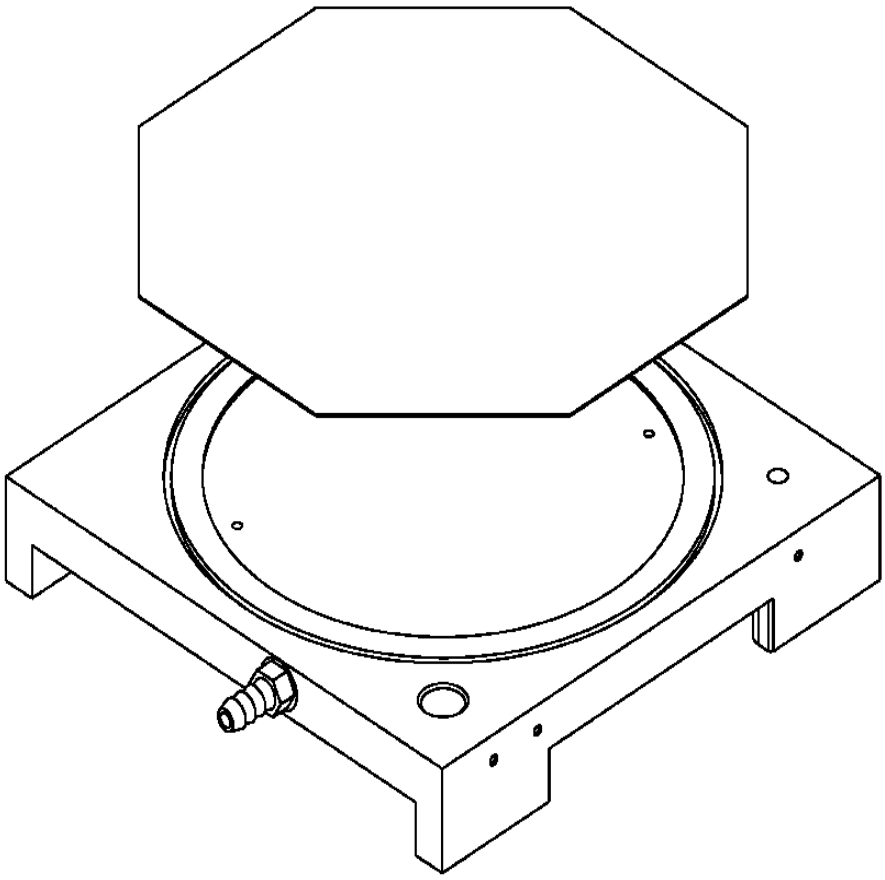


Figure 6-2: Mounting a Film Sample (Bottom Position)

Mounting a Sample in the top Test Cartridge position

1. Place the partially assembled Test Cartridge on a flat surface with the top mounting surface up.

2. Place the film on the greased sealing surface, remove any wrinkles as necessary.

3. Verify the inner and outer O-Rings are properly seated in the top Test Gas Plate.

4. Install the top Test Gas plate on the Film Mounting Plate.

Note: Inspect the gap between the top and bottom Test Gas Plates and the Film Mounting plate. If the gap is not even on all four sides one of the O-Rings may not be properly seated.

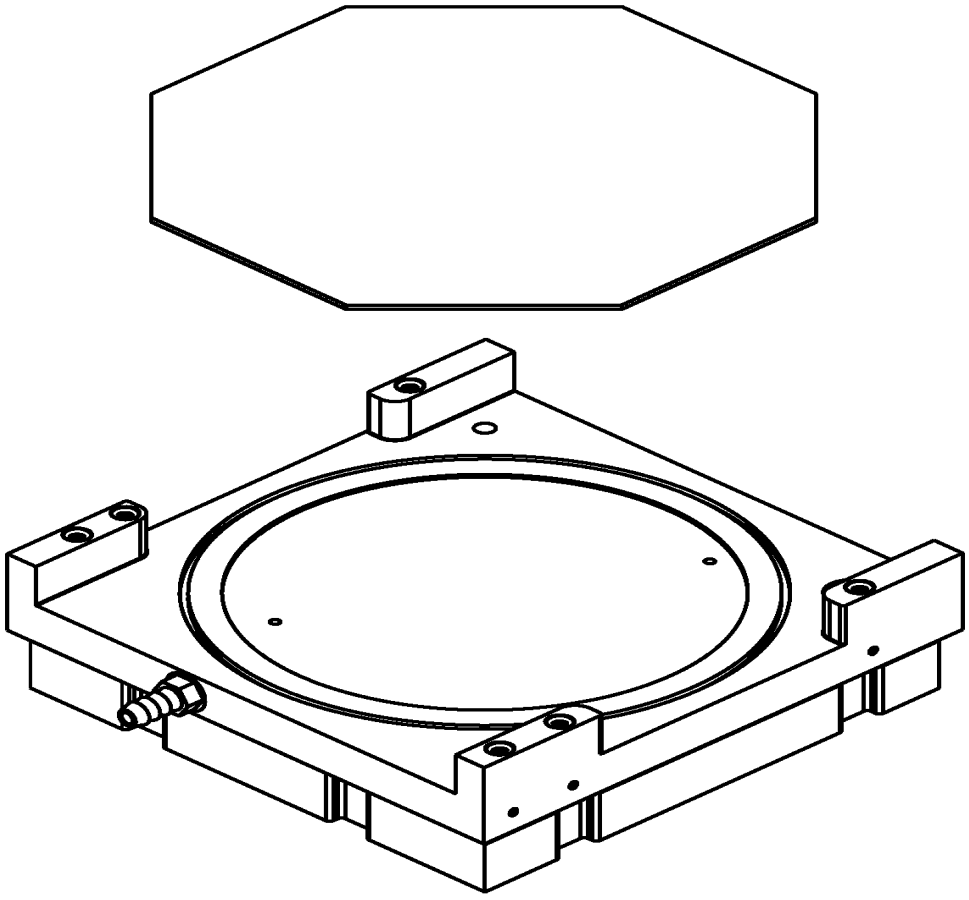


Figure 6-3: Mounting a Film Sample (Top Position)

Loading and Unloading the Test Cartridge

The AQUATRAN 3/38 uses a pneumatic system to clamp and unclamp the Test Cartridge. The Test Cartridge must be manually loaded and unloaded from the instrument.

To Unload the Test Cartridge from the instrument, follow the instructions below (refer to Figure 6-4):

1. Press the Cartridge Load/Unload button on the front of the instrument (see Figure 2-1).

2. Open the Cartridge Tray completely by gently pulling straight back from the front panel.

3. Grasp the Test Cartridge by the front and back edges and lift straight up.

To Load the Test Cartridge into the instrument, follow the instructions below (refer to Figure 6-4 and 6-5):

1. Grasp the Test Cartridge by the front and back edges and lower it straight down.

2. Close the Cell Cartridge completely by gently pushing straight towards the front panel.

3. Keep your finger holding the tray at its closed position.

4. While holding the Cell Tray, press the Cell Load/Unload button to clamp the cell (see Figure 6-4).

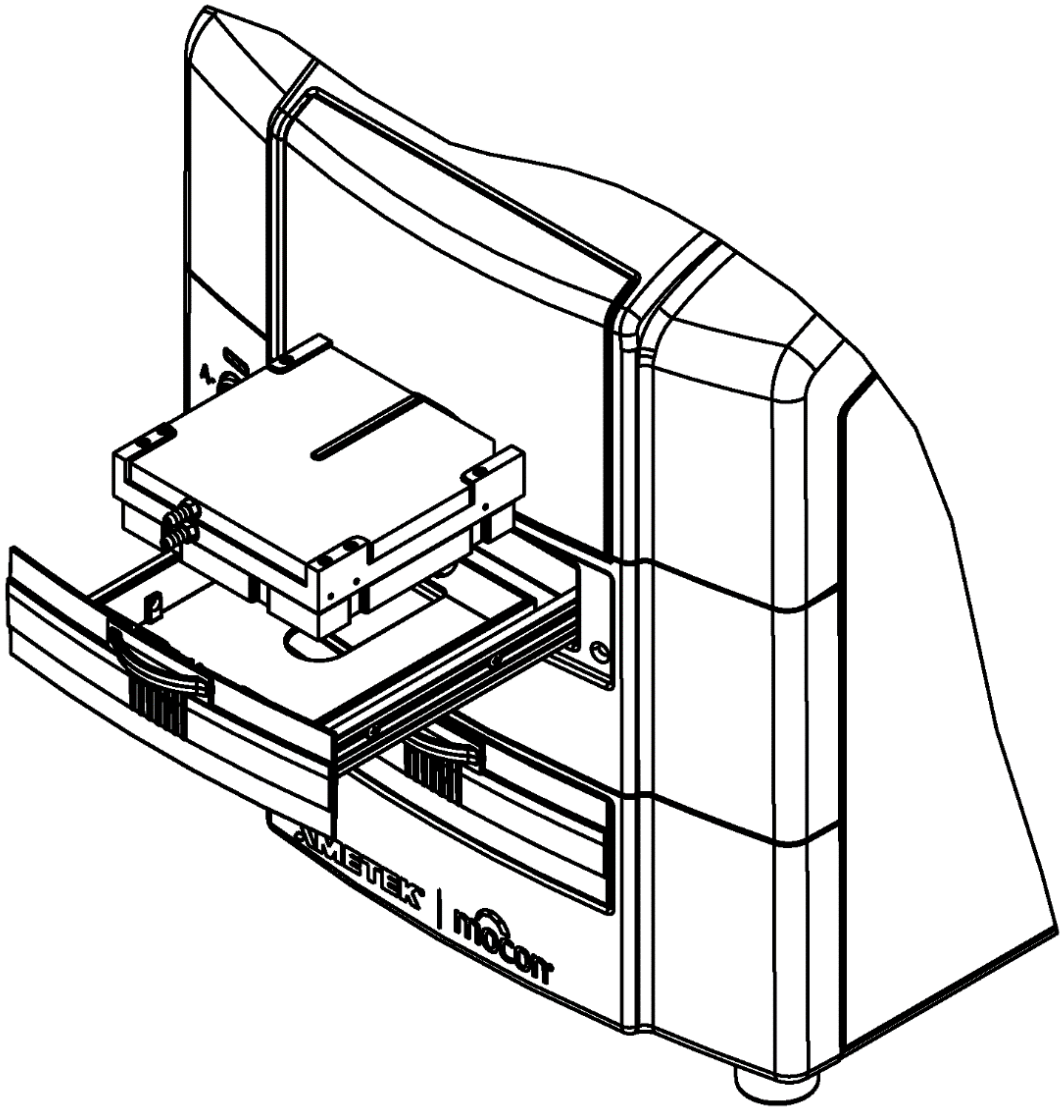


Figure 6-4: Loading the Test Cartridge

Figure 6-5: Press Load/Unload Button While Holding the Tray

Setting Up and Starting a Film Test

After the samples are loaded and the instrument is ready there are a number of test parameters that must be set. There are two types of test parameters, cell parameters and instrument parameters. Cell Parameters are specific to each cell (Sample ID, Sample Thickness). Instrument parameters are common for all cells (Cell Temperature and Test Gas RH). The "Test" icon is used to access the screens and controls required to set up the test conditions and start a test.

There are two methods that can be used to setup a permeation test. A test can be setup using the "Advanced Test" screen or a "Saved Test Method" can be recalled.

The "Advanced Test" screen allows the operator total control of all test parameters. An Advanced Test is setup and started by selecting the Test icon to display the "Advanced Test" screen. The "Cell", Instrument" and "Test" screens are used to specify the entire set of test conditions prior to starting a test on the desired Test Cell. The entire set of parameters (called the Test Method) can be saved, recalled or exported using the "Method" and "Save Method" controls.

A permeation test can be setup using a "Saved Test Method" by selecting the "Methods" control displayed at the bottom of the Advanced Test Method screens.

For more information on setting up and starting a test see the Instrument Help system.

Monitoring and Controlling a Film Test

The status of an active test can be monitored and controlled using the "Home", "Cell Status" and "Instrument Status" screens. These screens are accessed by selecting the "Home" and "Status" icons.

As each phase or state in a test is completed the test will automatically be advanced to the next step as specified by the currently executing test method. The operator can control (override) the execution of the test using the Abort, Advance and GoTo controls.

Test data can be viewed, and reports created (in graphical or tabular form) using the controls on the Cell and Instrument status screens.

For more information on setting up, starting tests and generating reports see the Instrument Help system.

Chapter 7: Maintenance

This contains information on how to clean and maintain the AQUATRAN 3/38.

Read this chapter to learn about:

- Cleaning the Instrument
- Cleaning the Test Cell
- Cleaning the Air Filters
- Maintaining the Test Cells
- System Standby
- System Shutdown, Relocation and Storage

The following information will assist in the daily operation and maintenance of the AQUATRAN 3/38 system. Included are answers to the questions most commonly asked of the MOCON Technical Services Group.

Cleaning the Instrument

The AQUATRAN 3/38 is housed in a painted metal and plastic case that is easy to clean and maintain. Periodically wipe the case with a damp cloth and mild detergent solution.

> **Warning!**
>
> **Turn OFF the instrument and unplug it from its power source before beginning these procedures. Failure to do so can result in electrical shock, which can cause injury or death.**

Some important precautions to follow:

- Leave the instrument covers on while cleaning; do not get liquids in the instrument.
- Never use alcohols or solvents on the instrument case. These chemicals could damage the instruments as well as the case.

NOTE: There are no user serviceable parts inside the AQUATRAN 3/38. A MOCON service representative should perform all other internal maintenance and adjustments.

Cleaning the Air Filters

Periodically the air filter on the back of the instrument should be removed and cleaned. The recommended interval is twice a year (or whenever there is a significant buildup of dust).

If the filter is not cleaned on a regular basis air will not circulate properly through the cooling system. The performance of the temperature control system for the Test Cells may be affected and the instrument safety systems may prevent the system from being used.

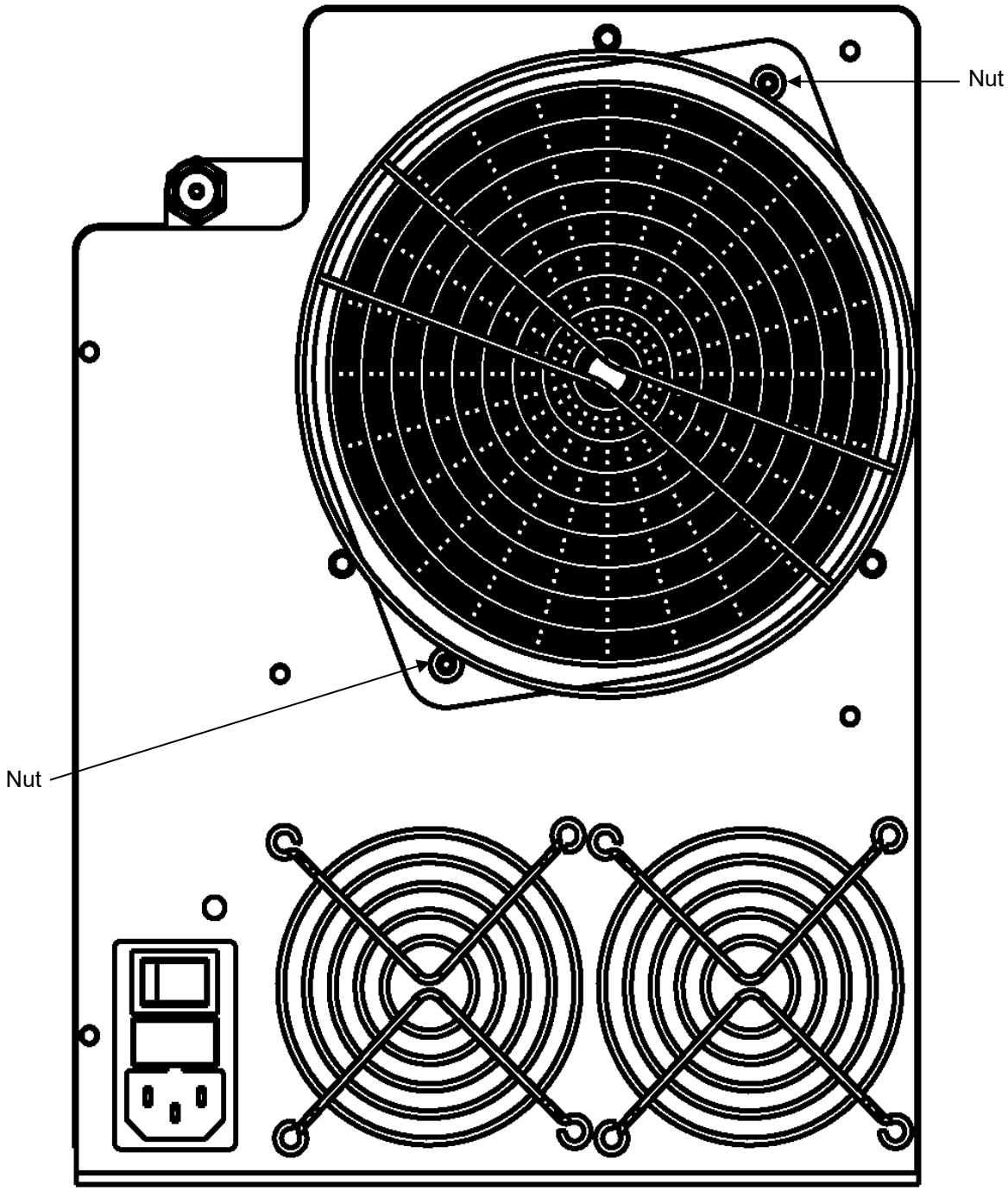


Figure 7-1: The Air Filters

To remove the cooling system air filter, remove the two nuts shown in Figure 7-1 above.

Cleaning the Test Cells

Periodically the test cells should be cleaned to remove any excess buildup of grease. Alcohol can be used to remove any residue from the High Vacuum grease.

Inspect the gas ports and TruSeal flush ring and remove any grease that could obstruct the flow of gas.

Maintaining the Test Cells

Periodically the test cells should be examined and any damaged, deformed, cracked or brittle o-rings replaced. The parts of the test cells are illustrated in Figure 7-2; the associated part numbers are shown in Table 7.1.

Inspect the film sealing surface of the top half of the test cell for nicks and scratches. Dragging a fingernail across a nick or scratch is a simple way to estimate the depth of the flaw. Nicks and scratches deep enough to feel may cause errors in the transmission rate due to leakage.

Drying Out the Humidifier

Before shutting down the instrument for long term storage or repair the Humidifier must be drained and the chamber dried out to prevent any corrosion from occurring during storage or transport.

To prepare the Humidifier for storage or transport follow the procedure below:

1. Advance all active tests to the Idle state.
2. Open the cover on the front of the instrument to access the Drain Port and Drain Screw. For more information see Figure 6-1and Table 6.1 for the location of the drain port and screw.
3. While holding a container under the drain port, open the drain screw for the humidifier.
4. The pressure of the Carrier a gas will force all the water out of the humidifier.
5. After the humidifier has been drained allow gas to vent out the drain port until all residual water that is visible has been removed.
6. Tighten the drain screw.

Test Cartridge Components and Part Numbers

The parts of the test cartridge are shown in Figure 7-2 below. Refer to Table 7.1 for the associated part numbers and the quantity used. To order replacement parts contact MOCON in the USA at (763) 493-6370.

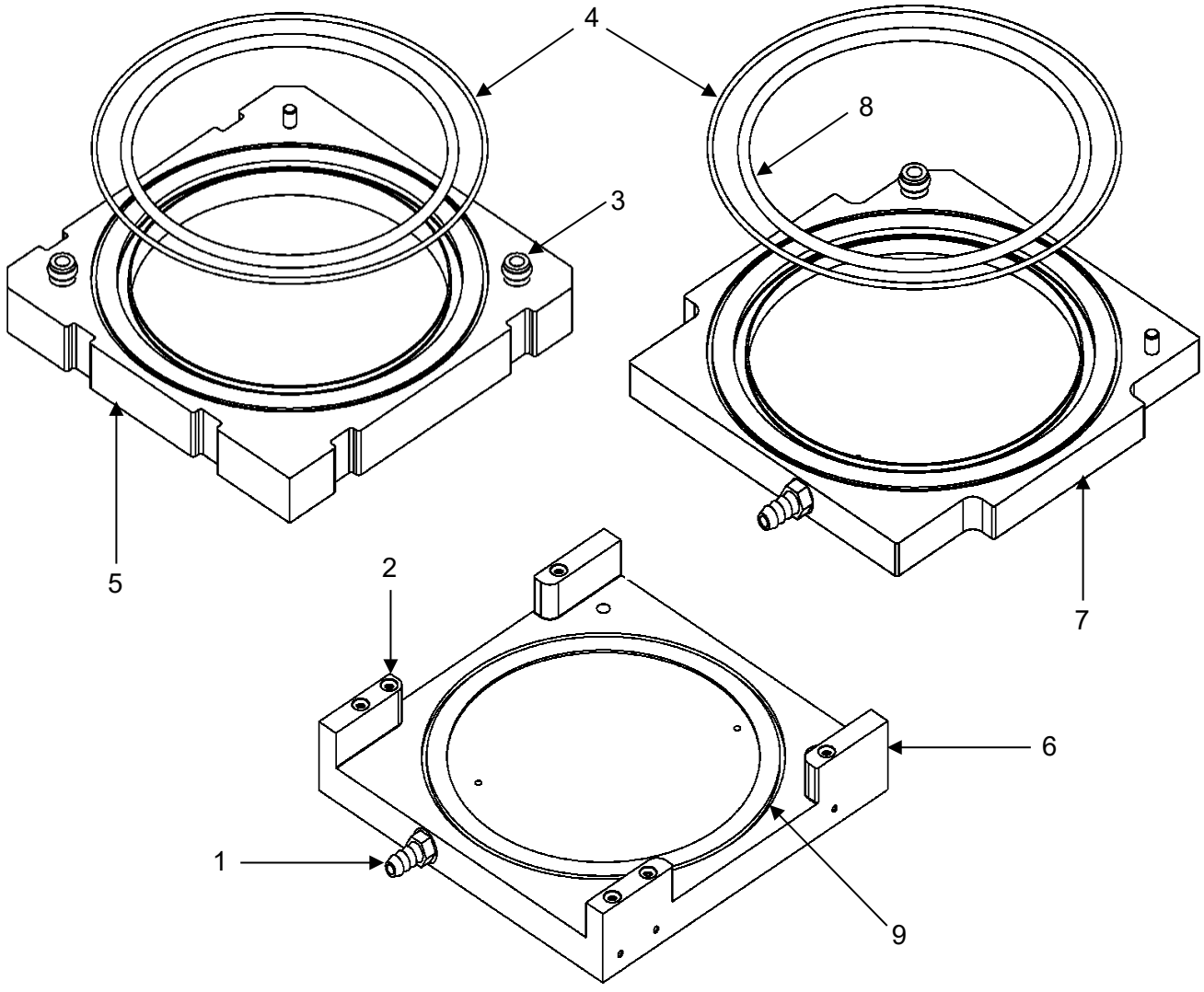


Figure 7-2: Test Cartridge Components

Item	Quantity	Part Number	Description
1	2	031-070	Barb, Hose, 10-32, Nickel-Plated Brass
2	6	033-613	O-Ring, 0.087 ID X 0.040 CS, Buna N, 70 Durometer
3	3	050-112	O-Ring, 0.145 ID X 0.070 CS, Viton
4	2	052-185	O-Ring, 3.661 ID X 0.050 CS, Buna-N
5	1	054-070	Cell, Test, Bottom, HT
6	1	054-071	Cell, Test, CG, HT
7	1	054-072	Cell, Test, Top, HT
8	2	054-079	O-Ring, 3.000 ID, 0.103 CS, Buna-N
9	N/A	N/A	TruSeal Ring
Not Shown	1	028-538	Sponge, Test Head

Table 7-1: Test Cartridge Part Numbers

Changing the Desiccant

The desiccant chamber is located in-line between the regulator tee assembly and the nitrogen tank. Change the desiccant whenever the blue indicator starts to turn pink. Refer to Figure 7-3 and follow the directions below to change the desiccant:

Warning! **The desiccant chamber contains high pressure and will cause personal injury if the nitrogen gas supply is not turned OFF before detaching the gas lines.**

1. Turn off the nitrogen tank gas flow by turning the knob all the way clockwise.
2. Detach the gas lines (copper tubing) from each end of the desiccant chamber.
3. Remove the cover end of the chamber. The cover end is the end connected to the nitrogen supply. Refer to Figure 7-3.
4. Remove the glass wool, aluminum screen, spring and o-ring from the chamber.
5. Empty the desiccant from the chamber.
6. Clean the chamber thoroughly with water and let it dry.
7. Fill the chamber slightly less than halfway with molecular sieve. (Do not use a substitute for the molecular sieve.) Molecular sieve is available from MOCON in 2.2 kg cans.
8. Pour one inch of blue indicator pellets into the chamber. The blue indicator pellets are available from MOCON.
9. Fill the chamber with molecular sieve to within one inch (2 to 3 cm) below the connector fitting.
10. Replace the glass wool.
11. Replace the aluminum screen and then the spring.
12. Lubricate the o-ring with high vacuum or silicon grease and insert it into the metal cap.
13. Close the chamber cover tightly.
14. Inspect the o-rings on the chamber fittings and replace them if worn or cracked.
15. Reconnect the gas lines. Make sure to connect the tube from the nitrogen supply to the cover end of the desiccant chamber.
16. Turn on the nitrogen tank valve and readjust the regulator pressure, if necessary.

Caution: To eliminate the possibility of gross leaks, you should make sure the copper tubing is fully inserted into the desiccant chamber fittings and that the o-ring and ferrule are installed and positioned correctly (see Figure 7-3).

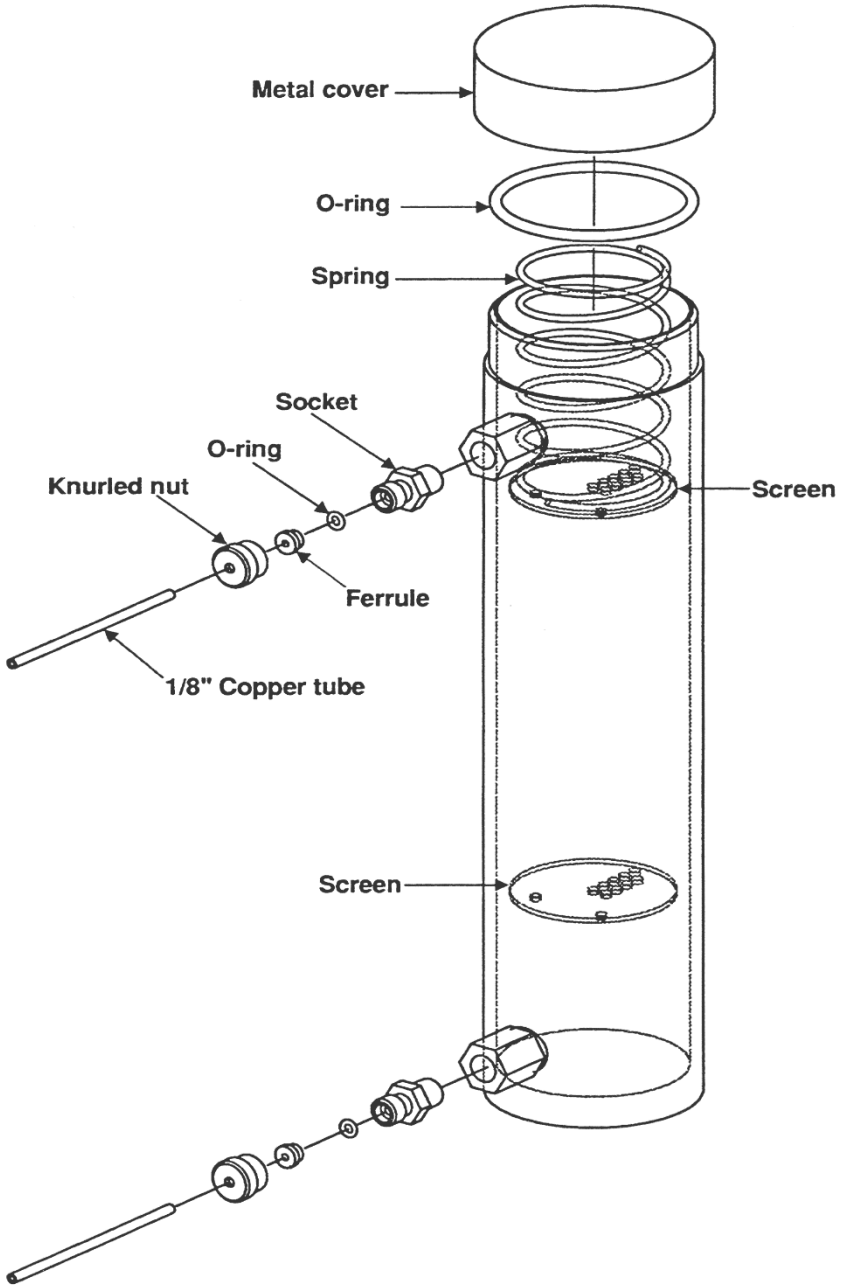


Figure 7-3: The Desiccant Chamber

System Standby

When a test series is complete, the instrument sets the sensor to the Bypass state. In this position the sensor is isolated and protected from inadvertent exposure to large amounts of water vapor.

If no testing will be performed for an extended period of time (overnight or weekend) leave a film mounted and clamped in the test cells. Turning off the power and the gas supply to instrument is not recommended. If instrument is shutdown you will need to wait for it to outgas before testing can resume.

When all cells are in the "Idle" state, the instrument will activate the "Gas Saver" function which automatically reduces the gas consumption by 25 to 50%.

System Shutdown for Storage or Repair

When shutting down the instrument for relocation, long-term storage, or if the instrument is to be sent for factory repairs, follow these instructions:

1. End all active tests and verify that the sensor is set to Bypass.

2. Set the Temperature Set Point to the approximate ambient temperature and allow the instrument to come to ambient temperature.

CAUTION:	**The instrument's testing temperature must be at ambient temperature with the gases flowing before turning the instrument off for a long period of time. If the temperature is not at ambient, condensation may form and damage to the instrument is likely.**

3. Remove the water from the Humidifiers see "Drying Out the Humidifier" in this chapter.

4. Turn off power to the instrument.

5. Disconnect the gas lines at the rear of the module and use the brass fitting plugs (025-382) to seal the gas connections fittings on the rear of the instrument.

Chapter 8: Troubleshooting

This chapter contains information to assist you in solving problems that may occur during the operation of the instrument.

Read this chapter to learn about:

- Error Messages and Warnings
- Solving Operational Problems
- Sensor Over-Range Recovery
- Power Fail Recovery

Error Messages and Warnings

The instrument software is continually checking for errors. When an error is detected, an Error Message dialog will be displayed. Select the "Dismiss" button to close the dialog. If a condition that could cause damage is detected, any active tests will automatically be "Failed" and the sensor will be placed in the By-Pass state.

For additional information on any error messages that may occur, their cause and possible solutions please consult the Instrument Help System.

NOTE: If you encounter an error message and are unable to resolve the problem, write down both the error code and the message. This will help MOCON service representatives diagnose the problem. Contact MOCON in the USA at (763) 493-6370.

Troubleshooting Testing Problems

The following may assist in identifying and correcting problems that occur during instrument operation.

Symptom: Abrupt changes in display readings or long-term cyclic oscillations.

Comment: Unwanted data fluctuations observed during a test cycle may be caused by abrupt changes in the carrier gas flow rate. Such a transient symptom can be produced by a temporary restriction in a gas line, or gas usage by another system.

Regular, cyclic data fluctuations may also be observed in connection with ambient package tests where the test packages are exposed to ambient temperature fluctuations caused by frequent on/off heater and air conditioner cycles.

Solution: An Environmental Chamber (MOCON P/N 001-001) can be used when testing packages to reduce or eliminate this problem.

When testing packages, this effect can also be minimized by placing a loose-fitting plastic bag over the specimen, or by placing the specimen in an insulated box.

Recovering from a Sensor Over-Range Condition

A severe over range condition will terminate the test sequence on both cells.

If you see a red Cartridge Status indicator (on the front of the instrument), the test has failed due to a permeant sensor over-range condition. In addition to the red Cartridge Status indicator, an error indicator may be displayed on the Home screen.

Examine the data on the Cell Status screen to determine the cause of the over-range condition. The Cell (or Cells) that caused the over-range will be "Failed". If the ReZero Cell failed due to an over-range condition all active tests will be failed.

Possible causes may be:

- The sample has a high transmission rate. To correct the problem testing can be done using a lower water vapor concentration test gas or a foil mask.
- The sample has pinholes, cracks or a poor-sealing surface.
- The cartridge is installed and clamped but no barrier is present.
- The o-ring seals on the top of the Test Cell are missing or damaged.

After correcting the cause of the malfunction restart the test on the failed cell (or cells).

Recovering from a Power Failure

The instrument software records data at periodic intervals. This data is used to assist in recovering from power failures and instrument restarts.

If testing is interrupted after the instrument has restarted testing will resume from the point at which it was interrupted.

Chapter 9 Specifications

This chapter contains the specifications of the AQUATRAN 3/38.

Read this chapter for details about:

- Physical specifications
- Environmental requirements
- Electrical requirements
- Gas Supply requirements
- Operational capabilities

Physical Specifications

	Height	Width	Depth	Weight
Uncrated	15.5 inches (39.4 cm)	12 inches (30.4 cm)	23 inches (58.0 cm)	95 pounds (43.1 kg)
Crated	25 inches (63.5 cm)	19 inches (48.3 cm)	37 inches (94 cm)	115 pounds (52.2 kg)

Table 9-1: Physical Specifications

Environmental Requirements

Temperature	Operation	22 °C ± 2 °C
	Storage	10 °C to 30 °C
Humidity	Operation	20% to 80% RH (non-condensing)
	Storage	5% to 85% RH (non-condensing)
Barometric Pressure	Operation	400 to 850 mmHg (522 to 1133 millibar)
Elevation (Maximum)	Operation*	2500 Meters (8202 Feet) above sea level

Table 9-2: Environmental Requirements

* The instrument may not comply with all agency ratings when operated above the maximum specified elevation.

Electrical Requirements

Voltage	100 - 240 VAC 50/60 Hz
Maximum Power Draw	700 VA
Current Draw at 100 VAC 50 Hz	1.80 A nominal
Current Draw at 120 VAC 60 Hz	1.50 A nominal
Current Draw at 220 VAC 50 Hz	0.82 A nominal
Current Draw at 240 VAC 50 Hz	0.75 A nominal

Table 9-3: Electrical Specifications

Gas Supply Requirements

Carrier Gas	Gas Composition	Nitrogen (99.7% N_2 or better)
	Supply Pressure, Nominal	29 PSI, (2.0 Bar), (200 kPa)
	Supply Pressure, Maximum	32 PSI, (2.2 Bar), (220 kPa)
	Supply Pressure, Minimum	26 PSI, (1.8 Bar), (179 kPa)
	Flow Rate, Maximum	555 cc/minute (Test Active 100cc/min)
	Flow Rate, Minimum	75 cc/minute (Test Active 10cc/min)

Table 9-4: Gas Supply Specifications

Operational Capabilities

Temperature Control Range	20 °C to 40 °C ± 0.2 °C
Time to Reach a Heated Temp (from ambient)	Approximately 60 minutes to reach 99% of a 40 °C setting
Humidity Control, Film Cell, Test Gas	100% and 50% to 90% RH ± 3 RH
RH Film Cell-to-Cell Uniformity	± 3 RH
Time to Reach Humidity Setting	Approximately 3 hours to reach 99% of RH setting
Test Range, Film, Unmasked	0.05 to 100 g/(m^2 • day) 0.003 to 6.45 g/(100in^2 • day)
Test Range, Package	0.00025 to 0.50 g/(pkg • day)
Resolution, Film	0.0001 g/(m^2 • day) 0.000006 g/(100in^2 • day)
Resolution, Package	0.0000005 g/(pkg • day)
Repeatability, Film	0.05 g/(m2 • day) or 2% whichever is greater
Repeatability, Package	0.00025 g/(m2 • day) or 2% whichever is greater

Table 9-5: Operational Capabilities

Transmission Rate Range and Repeatability Capabilities

Testing Range	Carrier Flow	Minimum Exam Time Required	Calibration Standard	Repeatability
2.5 to 100 gm/(m^2-day) 0.161 to 6.45 gm/(100^2-day) 0.0125 to 0.50 gm/(pkg-day)	100 sccm	25 minutes	Certified Film P/N 054-162 (yellow)	+/- 2.0% of Reading
0.05 to 2.5 gm/(m^2-day) 0.0032 to 0.161 gm/(100^2-day) 0.00025 to 0.0125 gm/(pkg-day)	100 sccm	25 minutes	Certified Film P/N 054-163 (Red)	+/-0.05 g/(m^2 • day)
0.05 to 10 gm/(m^2-day) 0.0032 to 0.645 gm/(100^2-day) 0.00025 to 0.05 gm/(pkg-day)	10 sccm	45 minutes	Certified Film P/N 054-164 (Blue)	+/- 2.0% of Reading or +/-0.05 g/(m^2 • day) whichever greater

Table 9-6: Range and Repeatability Capability

Notes:

1. The ReZero Frequency must be set to one.
2. When testing samples in both cells the transmission rates must be within a factor of 5.
3. Calibration will be performed at the flow rate the samples were tested at.
4. Testing performed at 37.8 Degrees Centigrade.
5. The Repeatability specifications assume the use of a 100% RH Test Gas.
6. Repeatability is based on a film area of 50 cm^2.

Appendix A: Site Preparation Instructions

P/N 140-223

(See next page)

mocon / AMETEK

P/N 140-223
Revision A

7500 Mendelssohn Avenue North
Minneapolis, MN 55428 U.S.A.
Telephone 763-493-6370
Web Site: www.ametekmocon.com

SITE PREPARATION INSTRUCTIONS IMPORTANT! REQUIREMENTS FOR THE START-UP OF THE AQUATRAN® 3/38 SYSTEM

The following must be furnished by the customer before a new AQUATRAN 3/38 can be set up. If a MOCON technical representative will be setting up your system these items must be on site before we can arrange to visit your plant.

1. **SPACE REQUIREMENTS** - Each AQUATRAN 3/38 instrument requires 18 to 24 inches (46 to 62 cm) of bench space. The instrument is 23 inches (58 cm) deep. The bench should provide additional space to allow for the required electrical and plumbing connections. The instrument weighs 95 pounds (43.1 kilograms) the bench should provide adequate support for the instrument.

   A printer requires approximately 24 inches (62 cm) of bench space. Benches should be sufficiently large and strong to accommodate the instrument and printer in close proximity.

2. **ENVIRONMENTAL REQUIREMENTS -** The AQUATRAN 3/38 should be operated in an environment with a stable room RH between 20% and 80% non-condensing, and at an ambient temperature of 22 °C ± 2 °C. It is important to locate the instrument in a relatively stable environment free from drafts and temperature fluctuations.

3. **POWER REQUIREMENTS** - The AQUATRAN 3/38 requires 100 - 240 VAC ± 10% at 50/ 60 Hz. Maximum power consumption for each instrument is 700 VA (maximum surge). The instrument must be provided with a quiet computer grade electrical circuit with an isolated ground and an appropriate grounded receptacle. In the USA a duplex NEMA 5-15R receptacle must be provided for each instrument.

   NOTE: MOCON only provides power cords with instruments configured for 120V.

See the last page of these instructions for details and cautions on

"RECOMMENDED ELECTRICAL INSTALLATION"

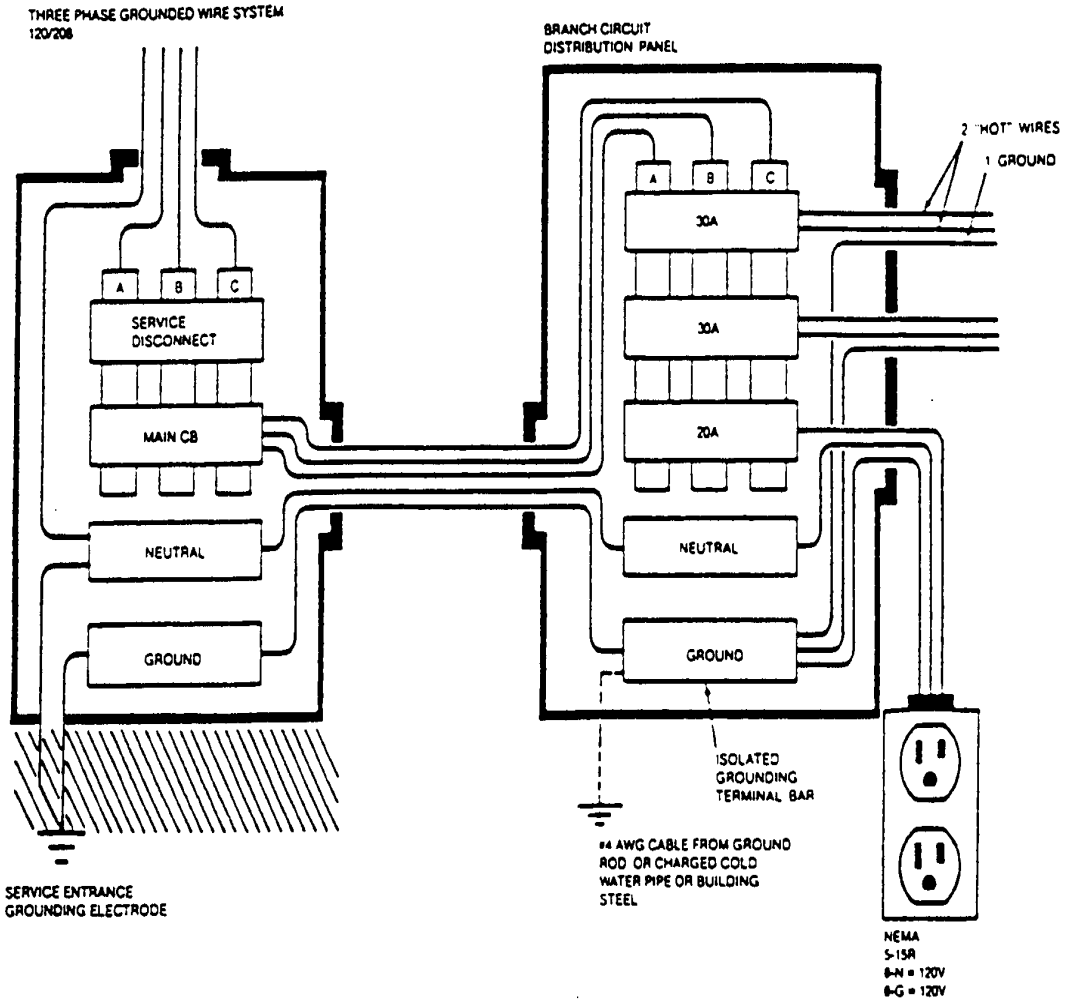
4. **NITROGEN** - The required carrier gas is extra dry nitrogen (99.7% or better). A standard "T" size cylinder will typically provide several weeks of operation. MOCON requires that the tank regulator be a two stage model.

5. **DISTILLED WATER** - You should use HPLC grade water for relative humidity generation. Obtain this water through a local supplier.

6. **REGULATOR ASSEMBLY** - If the customer chooses to purchase the optional regulator, then the gas cylinder is the only item that must be supplied by the customer. The regulator assembly contains everything else that is needed.

7. **COPPER TUBING -** Metallic tubing is required for connecting the nitrogen supply to the rear panel of the instrument. Desiccated and sealed (D&S), refrigeration-grade copper tubing (1/8 OD x 0.030 WL/3.175 mm OD x .762 mm WL) is required. This tubing can be purchased through MOCON by calling MOCON in the USA at (763) 493-6370, or through your local tubing supplier.

RECOMMENDED ELECTRICAL INSTALLATION



NOTES

1. The impedance of the equipment ground path from receptacle being utilized back to main service entrance where equipment ground and neutral are connected together must be one ohm or less.

2. Machinery and air conditioners can generate a large amount of electrical interference on the AC power lines. These disturbances can interfere with the operation of the system unless steps are taken to isolate the power disturbances from the power lines serving the instrument. Electrical noise can sometimes be eliminated by repair, replacement, relocation or electrical filtering of the originating device. If not, a suitable power line conditioner may have to be installed in the AC line to the system by a qualified electrician. A noisy circuit or improper grounding will cause adverse performance and possible damage to the system.

WARNING! The installation of the appropriate electrical circuit and receptacle requires the skill and knowledge of a qualified electrician. Do not attempt to test the electrical current in your facility or to wire or fabricate the electrical power circuit without the services of a qualified electrician.

The MOCON AQUATRAN 3/38 system will provide years of useful life provided these requirements are observed. Please contact MOCON in the USA at (763) 493-6370 with any questions regarding these Site Preparation Instructions.

Appendix B: Spare Parts

The following is a list of the spare parts that are available for the AQUATRAN 3/38. To order, contact MOCON in the USA at (763) 493-6370.

Part Number	Description	Quantity	Unit of Measure
024-180	Thermometer, 4 inch Long, 0 °C to 50 °C	1	EA
024-383	Tubing, Tygon, 1/4 OD X 1/8 ID, Clear	1	EA
024-517	Assy, Desiccant Chamber	1	EA
025-382	Plug, Fitting, 1/8 Tube, Brass, 7/16 Hex	1	EA
025-600*	Mask, Aluminum Foil, 5 X 5, Blank	10	EA
027-240	Tubing, Copper, 1/8 OD X 0.030 Wall, Desiccated and Sealed	50	FT
027-326	Kit, Knife with Cutting Mat	1	EA
027-343	Regulator Tee, Tested	1	EA
027-790	Regulator, N2-HE. Two Stage, High Purity, CGA 580	1	EA
028-538	Sponge, Test Head	10	EA
030-802	Flask, Erlenmeyer, 250 ml, Narrow Mouth, Heavy Duty Rim	1	EA
030-803	Stopper, RH Calibrator	1	EA
030-804	Stopper, EPDM, Red, Tapered, 70 Durometer	1	EA
033-613	O-Ring, 0.087 ID X 0.040 CS, Buna N, 70 Durometer	10	EA
050-112	O-Ring, 0.145 ID X 0.070 CS, Viton	10	EA
051-918	Fuse, 8A, 250V, 5 X 20 mm, T-LAG Glass	10	EA
052-185	O-Ring, 3.661 ID X 0.050 CS, Buna-N	10	EA
052-720	Syringe, Disposable, 60 ml, Luer	1	EA
054-079	O-Ring, 3.000 ID X 0.103 CS, Buna-N	10	EA
054-080	Assy, Cartridge, Film Test, 2/28, 3/38	1	EA
054-113	Assy, Template, Trimming, Film	1	EA
054-162	Certified Film, #1, 3/38	1	EA
054-163	Certified Film, #2, 3/38	1	EA
054-164	Certified Film, #3, 3/38	1	EA
105-259	Mask, Aluminum Foil, 4X4, Blank	10	EA

Part Number	Description	Quantity	Unit of Measure
130-015	Mask, Alum Foil, 5 CM^2, 4 X 4, 0.994 Hole, No Mounting Holes	10	EA
143-216	Manuscript, AQUATRAN, 3/38, On Flash Drive	1	EA
210-017	Cord, Power, 125V, 18/3, SVT, IEC, Unshielded, 7 1/2 FT	1	EA
310-027	Nut, 1/8 Tube, Brass	10	EA
310-051	Ferrule, 1/8 Tube, Brass	10	EA
930-009	Molecular Sieve, 5 Lb. Can	5	LB
930-010	Desiccant, Anhydrous Calcium Sulfate, Indicating Drierite	1	LB
930-022	Grease, High Vacuum, Clear, 150 Gram (5.3 Oz.) Tube.	1	EA

Appendix C: Warranty and Service Policies

Part Number: 032-846, Warranty Policy
Part Number: 032-847, International Service Policy
Part Number: 032-848, Domestic Service Policy

(See next pages)

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Telephone 763-493-6370
Web Site: www.ametekmocon.com

Part Number 032-846
Revision G

WARRANTY POLICY
STATEMENT OF LIMITED WARRANTY

MOCON, Inc. warrants that any part of any MOCON instrument or accessory ("Instrument") which proves to be defective in material or workmanship during the warranty period will be repaired by MOCON "certified" service personnel only, or at MOCON's option replaced, free of charge: FCA designated MOCON location.
Please consult the MOCON technical services department to determine which warranty statement applies to your instrument. This warranty applies to the original purchaser only, and is subject to the following terms and conditions:

1. Units or systems with MOCON offered field training, either purchased as an option or included in the purchase price.
   - If field training is performed by MOCON personnel or "certified" representatives the warranty period is:
     - One year from date of shipment from MOCON's factory for the Instrument.
     - Coulox® and IR Sensors in the following Instruments have an extended warranty as defined below:
       - AQUATRAN 2/22, 2/28, 2/40, 2/48,
       - PERMATRAN-W 3/34
       - PERMATRAN-C 4/30
       - AQUATRAN 3/38, 3/40 (together, the 'Extended Warranty Instruments")

     The extended warranty is defined as a Four-Year Pro Rata Warranty for the Coulox® and IR Sensors (the "Sensor(s)") installed by the factory in the Extended Warrant Instruments. If a Sensor is determined to be defective during the applicable warranty period, the sole and exclusive remedy shall be a discount, based on the table below, towards the purchase of a replacement Sensor or replacement of a Sensor at MOCON designated facility, FCA.

Time after Shipment	Sensor Replacement Cost Discount
Less than one year	100% off replacement cost at time of replacement
Greater than 1 year but less than 2 years	75% off replacement cost at time of replacement
Greater than 2 years but less than 3 years	50 % off replacement cost at time of replacement
Greater than 3 years but less than 4 years	25% off replacement cost at time of replacement
Greater than 4 years	No Discount

   - If field training is not purchased, the warranty period is Ninety days from date of shipment from MOCON's factory.

2. Units or systems without MOCON offered field training.
   - One year from date of shipment from MOCON's factory.

3. Spare parts, repairs and accessories when purchased separately and not a part of a new instrument order.
   - Ninety days from date of shipment from MOCON's factory.

4. This warranty covers normal use only. It does not cover damage that results from alteration, accident, misuse, abuse, neglect, or failure to follow assembly, installation, operational, or other MOCON instruction.

5. All warranty repair items are to be shipped at purchaser's expense, to and from MOCON

6. MOCON software is provided "as is" and MOCON makes no warranty as to the software, including up time. In no event shall MOCON be liable for any damages in excess of the price paid for software including, but not limited to, direct, consequential (including, without limitation, lost profits), special, exemplary, incidental and indirect damages, arising out of or in connection with the use, the results or the inability to use the software, and imposed under any cause of action whatsoever, including contract, warranty, strict liability, or negligence, even if MOCON has been notified of the possibility of such damages.

MOCON will also not be liable under any circumstances for Product replacement or associated labor, loss of use, loss of profits, or for any other indirect, incidental, collateral, exemplary, punitive, consequential or special damages, or losses arising out of the purchase of the Product and/or out of this limited warranty, even if MOCON or its' designated representative have been advised of the possibility of such damages or claims. To the extent such claims are not excludable as adjudged by a court of competent jurisdiction, you agree to accept as sole and exclusive remedy, a payment equal to the original purchase price for the product adjudged to be defective. This warranty gives you specific legal rights and you might also have other rights that vary from country/region to country/region, state to state, or province to province.

SOME COUNTRIES, REGIONS, STATES OR PROVINCES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF REMEDIES OR OF INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, OR THE APPLICABLE TIME PERIODS, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU. EXCEPT TO THE EXTENT LAWFULLY PERMITTED, THIS LIMITED WARRANTY DOES NOT EXCLUDE, RESTRICT OR MODIFY, AND IS IN ADDITION TO THE STATUTORY RIGHTS APPLICABLE TO THE SALE OF THIS PRODUCT TO YOU.

EXCEPT FOR THIS LIMITED WARRANTY, AND TO THE FULLEST EXTENT ALLOWED BY LAW, NEITHER MOCON NOR ANY AUTHORIZED DISTRIBUTOR MAKES ANY OTHER WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. MOCON DOES NOT OFFER, ASSUME OR AUTHORIZE THE OFFER OR ASSUMPTION OF LIABILITY FOR IT OR FOR ANY OTHER WARRANTY, EITHER EXPRESS OR IMPLIED BY ANY AUTHORIZED DISTRIBUTOR OR OTHER INDEPENDENT THIRD PARTY.

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Part Number 032-847
Revision D

INTERNATIONAL SERVICE POLICY

MOCON offers a complete range of service options to purchasers of MOCON instrumentation and systems.

♦♦♦SERVICE PERFORMED WITHIN THE WARRANTY PERIOD♦♦♦

LOCAL SERVICE (IF AVAILABLE)

A request may be made for your local representative to visit your facility. If a special trip to your location is required, you will be billed for time, travel expenses, and parts. Once the representative arrives at your plant, parts (if covered by warranty) are free of charge. Contact your representative for labor rates. If you are unsure of whether you have a local representative, please contact MOCON and we will direct you to the location nearest you.

RETURN UNIT TO MOCON U.S.A.

If replacing the part appears to be beyond the local representative's capability or if no local representative exists, the customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, U.S.A., for repairs. In this case, the Customer is responsible for round trip freight, insurance, and duties, with MOCON providing all labor and materials free of charge, subject to warranty restrictions. Our Service Department will keep turnaround time to a minimum.

U.S.A. SERVICE PERSONNEL

When the malfunction is considered by MOCON to be an emergency, MOCON service personnel can be dispatched from the U.S.A. to visit your facility and to correct the problem you are experiencing. The charges for this service include travel expenses incurred and portal-to-portal travel time at prevailing labor rates. Labor and parts expended while on your premises are free of charge, subject to warranty restrictions.

PART REPLACEMENT

If a local service representative is not available in country and if a defective part can be determined by the Customer's maintenance personnel, a free replacement part can be shipped collect to the customer for installation by the Customers maintenance personnel.

♦♦♦SERVICE PERFORMED AFTER THE WARRANTY PERIOD♦♦♦

LOCAL SERVICE (IF AVAILABLE)

A request may be made for your local representative to visit your facility. If a special trip to your location is required, you will be billed for time, travel expenses, and parts. If you are unsure if you have a local representative, please contact MOCON and we will direct you to the location nearest you.

RETURN UNIT TO MOCON U.S.A.

If replacing the part appears to be beyond the local representative's capability or if no local representative exists, the Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, U.S.A., for repairs. The Customer is responsible for round trip freight, insurance and duties, and will be billed for parts and labor required to accomplish the repair. If the required parts are in stock, turnaround time is minimal.

U.S.A. SERVICE PERSONNEL

When the malfunction is considered by MOCON to be an emergency, MOCON service personnel can be dispatched from the U.S.A. to visit your facility and to correct the problem you are experiencing. The charges for this service include travel expenses incurred, portal-to-portal travel time at prevailing labor rates, and parts expended.

PART REPLACEMENT

If a local service representative is not available in country and if a defective part can be determined by the customer's maintenance personnel, a replacement part can be shipped collect to the customer for installation by in-house maintenance personnel. Charges will include the cost of the parts plus shipping.

Part Number 032-848
Revision G

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DOMESTIC SERVICE POLICY

MOCON offers a complete range of service options to purchasers of MOCON instrumentation and systems.

♦♦♦SERVICE PERFORMED WITHIN THE WARRANTY PERIOD♦♦♦

RETURN UNIT TO MOCON

The Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, for repairs. In this case, the Customer will pay the charge for round trip freight and insurance, with MOCON providing all labor and materials free of charge subject to warranty restrictions.

SERVICE REPRESENTATIVE VISIT

If malfunction is considered by MOCON to be an emergency, a MOCON service representative will be dispatched from MOCON to visit the Customer's facility to correct the problem. The charges for this service include all travel expenses and the service technician's portal-to-portal travel time at the prevailing labor rates. Labor and parts expended while on the Customer's premises are free of charge, subject to warranty restrictions.

♦♦♦SERVICE PERFORMED AFTER WARRANTY PERIOD♦♦♦

In the event that repairs are required after the warranty period, the Purchaser again has several alternatives.

PREVENTIVE MAINTENANCE CONTRACT

Preventive maintenance contracts are available. MOCON recommends the instruments sold by MOCON have preventative maintenance performed yearly to facilitate calibration and reduce the likeliness of unexpected failures and downtime. If it is found during the PM visit that repairs are needed, repairs may be able to be performed during the PM visit if time in the schedule permits. Additional labor charges may apply for repairs conducted during the PM visit.

RETURN UNIT TO MOCON

The Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, for repairs. The Customer is responsible for the cost of round-trip freight and insurance. The Customer will be billed for parts and labor required accomplishing the repair.

SERVICE REPRESENTATIVE VISIT

If malfunction is considered by MOCON to be an emergency, a MOCON service representative will be dispatched from MOCON to visit the Customer's facility to correct the problem. The charges for this service include all travel expenses, the service technician's portal-to-portal travel time at prevailing labor rates, parts used, and on-stie labor at the prevailing labor rates to repair the equipment.

♦♦♦GENERAL TERMS AND CONDITIONS♦♦♦

- Invoices are due NET 30 days (with approved credit) and are billed and payable in U.S. dollars.
- All parts are shipped EXW MOCON factory Minneapolis, Minnesota; freight and Insurance will be billed separately.
- MOCON insures all shipments unless advised otherwise.
- All repairs after the original instrument warranty period are warranted for 90 days on parts and labor, EXW. MOCON factory.

Please refer to the latest version of MOCON's Warranty Policy sheet for warranty information.

Appendix D: Theory of Operation

How the Water Vapor Transmission Rate is measured

When a film is installed in a Test Cartridge, it is exposed to a continuous flow of dry nitrogen gas across the one side (the Carrier Gas side) and an RH on the other (the Test Gas side). The gas leaving the cell via the exhaust port consists of a mixture of nitrogen and water vapor in a ratio determined by the nitrogen flow rate through the cell and the rate of the water vapor transmission through the film barrier.

With the nitrogen flow rate set to a constant value, the resulting water vapor density at the Carrier Gas side of the cell will be determined by the water vapor transmission rate of the film barrier. The water vapor density of the Carrier Gas is measured by routing the cell exhaust to a Water Vapor Sensor.

How the Water Vapor Sensor Works

The Water Vapor Sensor in the AQUATRAN 3/38 uses a pressure modulated Infrared Detector. The measurement system consists of a bellows pump, a sensing chamber, an infrared source, a 2.6 micrometer infrared filter, a lead sulfide photo detector and an amplifier.

The pump varies the pressure and the density of the gas mixture in the sensing chamber. As pressure and density of the gas mixture varies, the absorption rate of infrared energy by water vapor also varies. The Infrared Detector senses the change in infrared energy reaching it and produces a low-level electrical signal. The Infrared Detector is connected to a low noise amplifier.

The signal from the detector is amplified, filtered, and converted to a DC signal which is directly proportional to the water vapor in the exhaust of the cell. The signal is therefore proportional to the water vapor transmission of the barrier material.

Water Vapor Sensor Calibration Theory

The AQUATRAN 3/38 is a relative (not absolute) water vapor transmission rate (WVTR) measurement system. To achieve accurate results, the instrument must be calibrated using a reference material with a known water vapor transmission rate. In other words, the WVTR of the test cells must be calibrated to a known constant of WVTR prior to testing.

Room temperature and humidity are just two of many factors that can marginally affect test results. Consequently, a piece of film with a known WVTR will test higher or lower.

Any reference film, whose WVTR has been established, may be used for calibration. A reference film at any arbitrarily constant test flow will produce an arbitrary constant amount of water vapor in the carrier gas. The infrared sensor/amplifier produces a DC output proportional to the amount of water vapor. The DC output is converted to a value and transmitted to the computer.

The computer subtracts the ReZero value from the DC output value. The result is converted to units of Water Vapor Transmission Rate (WVTR) using a scaling factor determined by the nitrogen gas flow rate.

Factors that Affect the Transmission Rate of a Barrier Material

The water vapor transmission rate of barrier materials is affected by several factors:

- Barrier test temperature
- Test Gas (water vapor) concentration effect on driving force
- Barometric pressure effect on measured transmission rate
- Relative humidity

Barrier Temperature

The temperature at which the barrier is tested has a great effect (usually logarithmic) on transmission rate. This makes temperature one of the most important test conditions for most barrier materials. Many barriers exhibit a 6% to 15% rise in water vapor transmission rate for each degree C rise in temperature.

Test Gas Driving Force

The driving force of the test gas has a direct effect on the water vapor transmission rate. The driving force of the test gas is affected by the water vapor concentration (RH) of the test gas and the ambient Barometric pressure.

Barometric Pressure

Barometric pressure influences the output of the water vapor sensor. The water vapor sensor vents to the atmosphere. The pressure in the water vapor sensor is affected by changes in the barometric pressure.

The instrument automatically compensates all transmission rate data to eliminate the effect of barometric pressure on the reported transmission rate.

Relative Humidity

The amount of water vapor some materials (such as nylon, cellophane and ethyl vinyl alcohol) are exposed to significantly affects the water vapor transmission rate of the barrier. The barrier properties of some of these materials can be permanently affected by prolonged exposures to significant amounts of water vapor.

The AQUATRAN 3/38 provides the capability to test these types of materials in a controlled "wet" test environment. A Relative Humidity for the Test Gas between 0% and 90% RH can be specified.

How a Humidified Test Gas is Generated

A Humidified Test Gas is created by moving pressurized gas through a humidifier filled with HPLC-grade water and mixing the wet gas with a dry gas in the appropriate ratios.

A mixing valve is used to "mix" the saturated gas (~100% RH) with the dry gas. A mix-ratio of 50% yields a gas with an RH of approximately 50%.

A RH sensor is used to measure the actual RH delivered to the Test Cell. The instrument uses the measured RH value to adjust the mixture ratio to maintain the RH of the gas delivered at the specified value.

The RH that the sample will be tested at can be changed by simply changing the RH set point. The "Sequential Test" feature can be used to automatically perform a sequence of tests at different RH levels.

How the ReZero Cell Works

The transmission rate measured for samples mounted in a test cell is the sum of the transmission rate due to permeation through the barrier material and all other sources of water vapor ingress. This includes the system baseline. If the system baseline can be measured, subtracting it from the apparent transmission rate of the test cell will give a more accurate representation for the transmission rate of the barrier material.

During a ReZero State the instrument routes carrier gas (which is at the same temperature as used in the Test Cells) to the water vapor sensor. The instrument components used to perform this function are referred to as the ReZero Cell. The ReZero Cell is different from a test cell in that it does not contain a barrier material that is exposed to a Test Gas. This means that any residual water vapor in the carrier gas is not due to permeation through the barrier materials mounted in the test cell. The residual water vapor measured in the ReZero State is therefore considered to be a good representation of the system baseline.

Periodically the instrument baseline is measured using the ReZero Cell. The ReZero Interval and Examination Time is determined the by currently active Test Method. The resulting data is used to correct the transmission rate data for any active tests. This ensures that changes in the baseline do not affect the accuracy of the transmission rate data.

Appendix E: Electrical and Plumbing Diagrams

Title	Part Number
Plumbing Diagram, AQUATRAN 3/38	051-953
Electrical Diagram, AQUATRAN 3/38	051-954

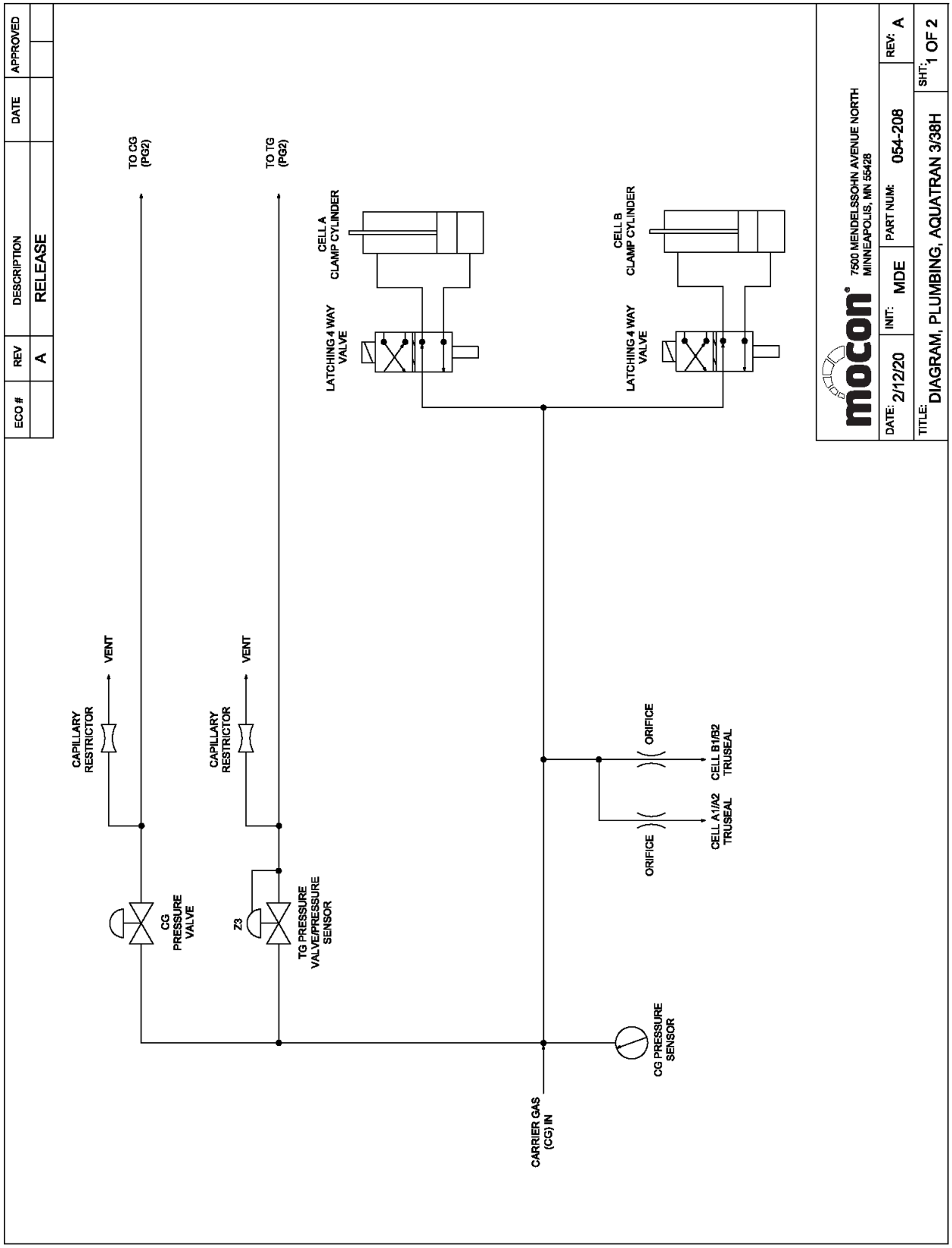

Figure 9-1: Plumbing Diagram Page 1

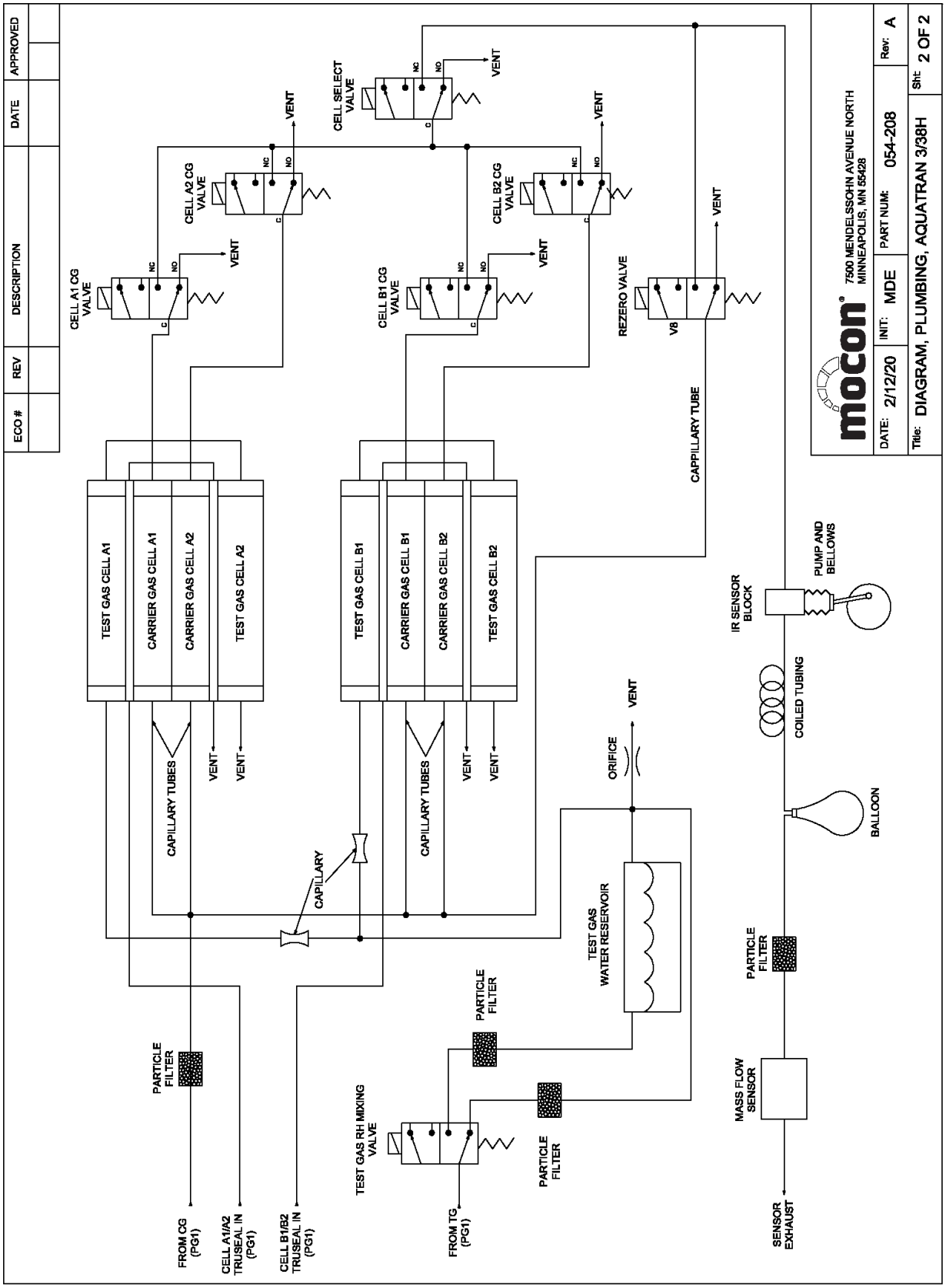

Figure 9-2: Plumbing Diagram Page 2

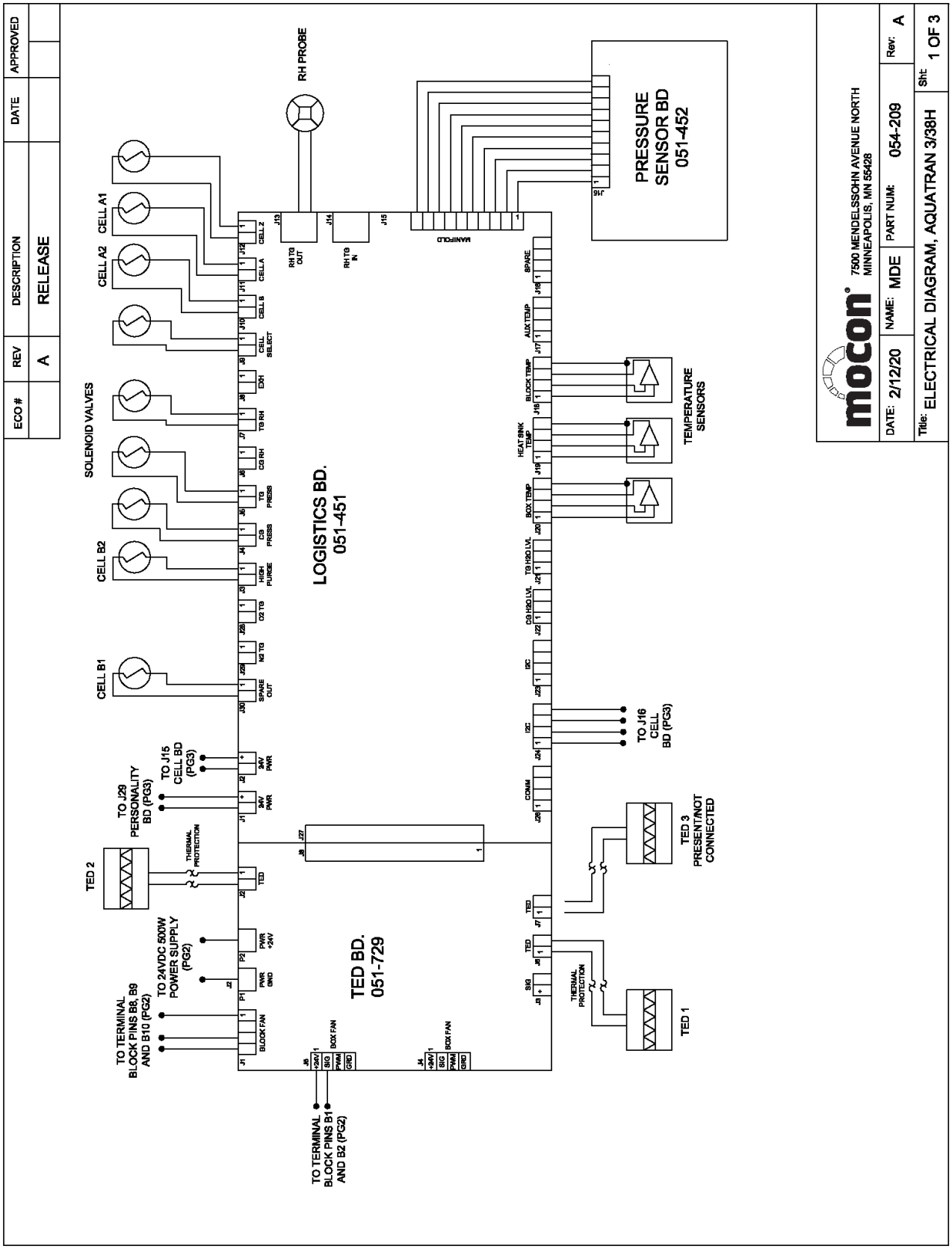

Figure 9-3: Electrical Diagram Page 1

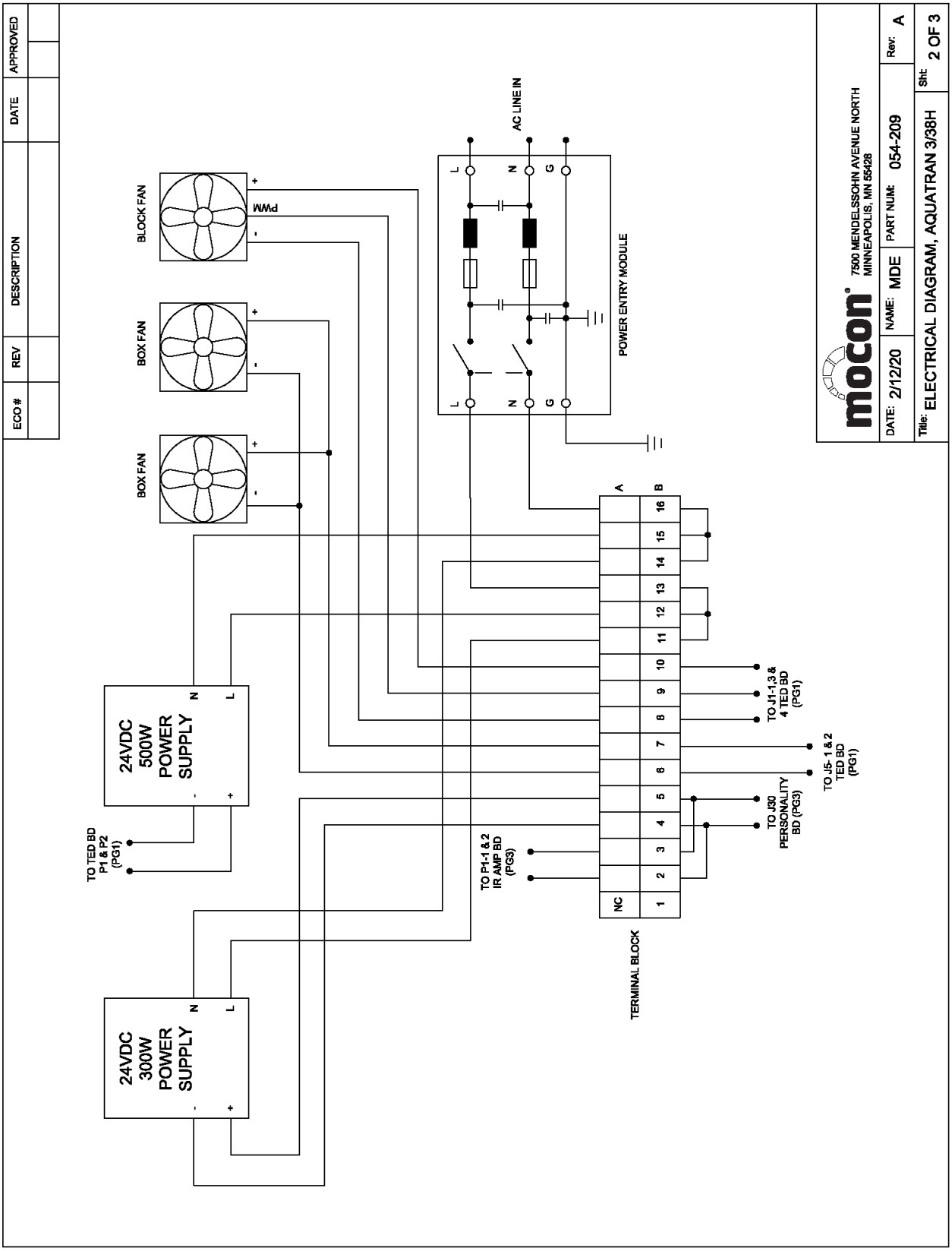

Figure 9-4: Electrical Diagram Page 2

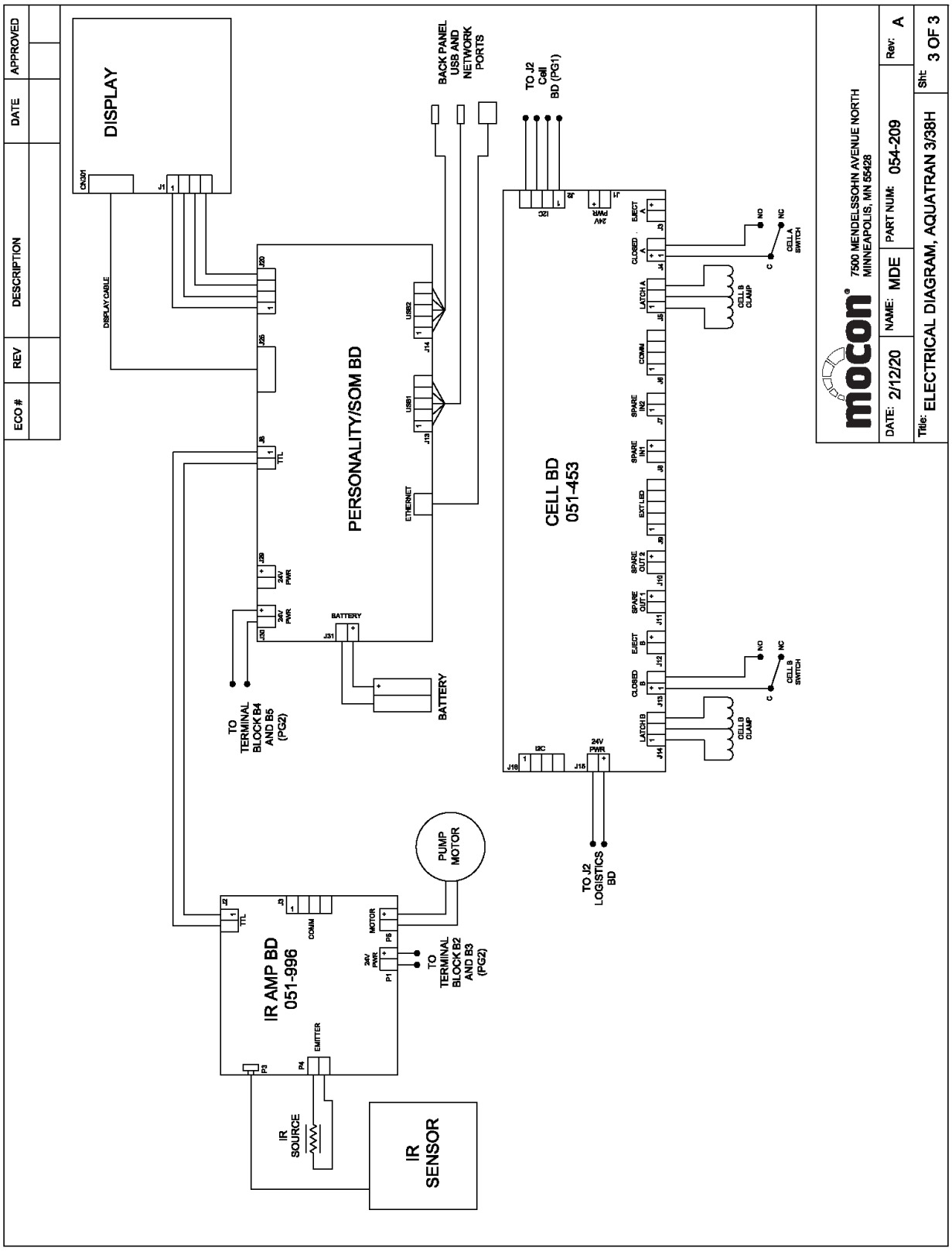

Figure 9-5: Electrical Diagram Page 3

Appendix F: Preparing RH Calibration Standards

To calibrate or check the RH probes used in the AQUATRAN 3/38, requires RH reference values (or standards). A RH Calibration Standard consists of a saturated salt solution or molecular sieve in a "Calibration Flask". Calibration Standards should be kept tightly sealed using the "Flask Stopper" when not in use. The molecular sieve should be regularly replaced.

RH Calibration Equipment

MOCON has available the following materials to facilitate the preparation of RH reference standards suitable for the calibration of the RH Probes in the AQUATRAN 3/38.

- Calibration Flask MOCON Part Number 030-802
- RH Probe Stopper MOCON Part Number 030-803
- Flask Stopper MOCON Part Number 030-804

Choosing a Salt Solution

> **Warning!** Some salts will produce exothermic or endothermic reactions when mixed with water. Failure to use proper safety equipment when mixing salt solution can result in frostbite or burn injuries. Salt solutions should be prepared only by qualified people with proper safety equipment.

RH sensor calibration will be performed at a specific temperature. A salt must be chosen that will produce the desired RH at that temperature.

For most salt solutions the RH produced by the solution is dependent on temperature. To choose the correct salt solution for your application, consult one of the following resources:

- Table F.1, Salt Solution Humidity Standards in Percent RH shown below.
- Handbook of Chemistry and Physics.
- The National Bureau of Standards.

Salts	15 °C	20 °C	25 °C	30 °C	35 °C
Lithium Bromide	6.86	6.61	6.37	6.16	5.97
Lithium Chloride	11.30	11.31	11.30	11.28	11.25
Potassium Acetate	23.40	23.11	22.51	21.61	21.61
Magnesium Chloride	33.30	33.07	32.78	32.44	32.05
Potassium Carbonate	43.15	43.16	43.16	43.17	43.17
Potassium Iodine	70.98	69.90	68.86	67.89	66.96
Sodium Chloride	75.61	75.47	75.29	75.09	74.87
Ammonium Sulfate	81.70	81.34	80.99	80.63	80.27
Potassium Chloride	85.92	85.11	84.34	83.62	82.95
Ammonium Monophosphate	93.85	93.32	92.65	92.00	91.42
Potassium Nitrate	95.41	94.62	93.58	92.31	90.79

Table 9-7: Salt Solution Humidity Standards in Percent RH

Preparing a High-Level Calibration Standard

A High-Level RH Calibration standard can be prepared using a salt solution as follows:

1. Chose the appropriate salt for the calibration standard. See "Choosing a Salt for a Calibration Standard" in this appendix.
2. Prepare a saturated salt solution. See "Preparing a Saturated Salt Solution" in this appendix.
3. Thoroughly clean a calibration flask and flask stopper. Rinse the calibration flask and flask stopper using distilled water.
4. Thoroughly dry the calibration flask and flask stopper before proceeding to the next step.
5. Fill the flask ¼ to ½ full using the salt solution.
6. Add several grains of the salt used in the solution to the filled flask. This will provide a nucleation point to prevent super-saturation.
7. Tightly seal the flask using the Flask Stopper.
8. Wait four to six hours to allow the solution to come to equilibrium at the desired temperature before use.

Preparing a Low Level Calibration Standard

A Low Level RH Calibration standard can be prepared using a molecular sieve as follows:

1. Thoroughly clean a calibration flask and flask stopper. Rinse the calibration flask and flask stopper using distilled water. They must be completely dry before use.
2. Fill the flask ¼ to ½ full with the molecular sieve. Molecular sieve (part number 930-009) is available from MOCON.
3. Tightly seal the flask using the Flask Stopper.
4. Wait 2 to 3 hours before use.

Preparing a Saturated Salt Solution

1. Fill a clean glass beaker with distilled water. Leave enough room in the beaker so the water will not overflow when the salt is added to the beaker.
2. Place the beaker on a hot plate. The hot plate should be held at a temperature of 5 °C (10 °F) above the temperature at which it will be used.
3. Slowly add small amounts of the appropriate salt to the water.
4. Stir gently until no more salt will dissolve in the water when stirred. At that point, the water is saturated. There should always be some un-dissolved salt in the solution.
5. Remove the salt solution from the heat.

Appendix G: Compliance

Declaration of Conformity

Manufacturer: AMETEK MOCON.
7500 Mendelssohn Avenue North
Minneapolis, MN 55428 USA
(763) 493-6370
www.ametekmocon.com

Type of Equipment: Electrical Equipment for measurement, Control and Laboratory Use

Model(s): AQUATRAN 3/38 H

Application of Council Directive(s):

2014/35/EU	Low Voltage Directive
2014/30/EU	EMC Directive
2011/65/EU	RoHS Directive

Standard(s) to which conformity is declared:

IEC 61010-1:2010 Third Edition
EN 61326-1:2013

Class A Radiated & Conducted
Basic Immunity Test Requirements

EN 61000-3-2:2006, A1:2009, A2:2009
EN 61000-3-3:2013

This declaration is based on an understanding of the materials used and information provided by third-party suppliers. AMETEK MOCON proactively manages the supply chain to ensure information pertaining to composition of the materials used is accurate. AMETEK MOCON has not and does not conduct destructive testing or chemical analysis to verify material composition.

Place of Issue: Minneapolis, MN USA

Date of Issue April 7th, 2022

Hasan Akhtar
Global Director, Quality and Safety