TM8 On-Line Gas Chromatography DGA Monitor Operation & Maintenance Guide Model TMx Series

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Product Overview

The TM8 On-Line Gas Chromatography DGA Monitor from Serveron Corp. is a remotely-deployed laboratory-grade gas chromatograph which can be safely installed onto an energized or non-energized transformer. The monitor is designed to detect and measure fault gases found in an electrical power transformer‘s insulating oil. It is designed and constructed to resist environmental conditions relevant to a transformer substation.

Serveron offers two versions of the TMx product. The TM8 measures eight IEEE-recommended fault gases: hydrogen (H_2), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), ethylene (C_2H_4), ethane (C_2H_6), and acetylene (C_2H_2). The TM3 measures the three Duval Triangle fault gases: methane (CH_4), ethylene (C_2H_4), and acetylene (C_2H_2). The monitor may be used on conservator or nitrogen-blanketed transformers. The sample of gas is extracted directly from the oil within the transformer.

Oil is circulated from transformer, to the monitor and then returned to the transformer through ¼-inch O.D. stainless-steel tubing. Stainless-steel tubing is used in conjunction with compression fittings to minimize the risk of leaks. The monitor is equipped with an internal gas extraction system which removes dissolved gases from the circulating transformer oil. Helium is used as a carrier gas to help transport the extracted sample gases through the gas chromatograph. The oil circulation and gas extraction paths in the monitor are shown below.

Data is collected in the monitor each time a gas chromatograph (GC) analysis is completed. The GC analysis takes approximately 45 minutes. Once an analysis has been completed, the TM View software can be used to view the monitor’s data. The monitor is set up to perform a sample analysis once every four hours by default. All data captured during an analysis is stored on compact flash memory within the monitor. The compact flash memory holds approximately (2) years of data. The TM View software will allow the end user to track the gas ppm levels over time and monitor the gas levels against user defined caution and alarm settings.

Optional LoadGuide® and Oil Moisture and Temperature sensors are available, along with 4-20mA inputs for use with other external devices. External sensor information can be correlated with fault gas information to allow a complete diagnostic overview of the transformer’s condition.

Product Symbols

The following symbols are used throughout the monitor or accessories. They are defined by the International Electrotechnical Commission, IEC 878 and IEC 417A. It is important for safety reasons to have an understanding of their representation.

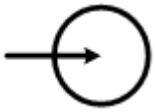
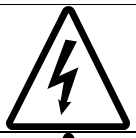
	Voltage Output
	Voltage Input
	High Voltage
	Caution: Refer to On-Line Transformer Monitor Installation Guide and accompanying documentation.
	Protective Earth (ground)
V~	Alternating Current and Voltage
H	Connect to mains live conductor (brown)
L	Connect to mains neutral conductor (blue)
__I__ **O**	The **I** position indicates the power switch is ON The **O** position indicates the power switch is OFF

Table 1: Product Symbols

WARNING statements in this manual identify conditions or practices that could result in personal injury.

CAUTION statements in this manual identify conditions or practices that could result in damage to the equipment or other property.

NOTE statements provide additional important information.

Operation

Once installed, the monitor requires very little setup before operation commences. To retrieve DGA data from the monitor, set caution and alarm levels, sampling schedules etc., use the included TM View software. Refer to the TM View Software User's Manual. For more information, manuals are available from the Qualitrol website (www.qualitrolcorp.com) or by contacting Serveron Technical Support at support@serveron.com

Calibration

Every Serveron monitor is calibrated at the factory. Following installation and commissioning, the monitor's auto-calibration feature verifies calibration automatically every three days. Serveron recommends confirming calibration of your monitor every six months by comparing the Verification Data graph in TM View to the PPM values on the calibration cylinder. Occasional re-calibration may be necessary as the monitor ages. This can be performed remotely, if remote communication to the monitor is available, or onsite at the monitor.

Alarm Settings

Following installation of the monitor and after an initial 48-hour stabilization period, the gas caution and alarm levels can be set, although it is recommended to wait a minimum of 7 days to allow the gas trends to be established. These levels can be set using the included TM View software.

There are no universal rules regarding the values at which to set the caution and alarm levels in the monitor. In the most general case, caution and alarm settings are disabled while the monitor runs for approximately thirty (30) days to establish gassing trends and a baseline PPM level for each of the eight gases. After the baseline PPM data has been established, you can use the history to set the caution and alarm levels directly.

The following IEEE guidelines may be useful for setting the initial gas caution and alarm levels. Keep in mind that these are recommendations. The appropriate caution and alarm settings for your transformer may vary from these recommendations.

New Transformers

Set the monitor caution level to 50% and the alarm level to 100% of the low-end CAUTION ppm limits proposed by IEEE PC57.104 Draft 11, published April 21, 2004; except acetylene, as noted below.

Gas	Caution PPM	Alarm PPM	Notes:
Hydrogen	50	100	
Methane	60	120	
Acetylene	2	5	**Per Draft 11**
Ethylene	25	50	
Ethane	33	65	
Carbon Monoxide	175	350	
Carbon Dioxide	1750	3500	
Oxygen	baseline+10%	Baseline+20%	above initial measured PPM

Table 2: Recommended caution / alarm settings for new transformers

Stable Transformers

Allow the monitor to operate and collect data for thirty (30) days in order to establish baseline levels of the eight fault gases. Set the monitor caution/alarm levels to the measured baseline levels + value (PPM) shown below.

Gas	Caution PPM +value (PPM)	Alarm PPM +value (PPM)	Notes:
Hydrogen	+50	+100	
Methane	+60	+120	
Acetylene	+2	+5	
Ethylene	+25	+50	
Ethane	+33	+65	
Carbon Monoxide	+175	+350	
Carbon Dioxide	+1750	+3500	
Oxygen	baseline+10%	Baseline+20%	above initial measured PPM

Table 3: Recommended caution / alarm settings for stable transformers

Gassing Transformers That Have Been Degassed

Set the caution level to 50% and the alarm level to 100% of the low-end CAUTION ppm limits proposed by IEEE PC57.104 Draft 11, published April 21, 2004; except acetylene, as noted below.

Gas	Caution PPM	Alarm PPM	Notes:
Hydrogen	50	100	
Methane	60	120	
Acetylene	2	5	**Per Draft 11**
Ethylene	25	50	
Ethane	33	65	
Carbon Monoxide	175	350	
Carbon Dioxide	1750	3500	
Oxygen	baseline+10%	Baseline+20%	above initial measured PPM

Table 1: Recommended caution / alarm settings for gassing transformers after degassing

Unstable Transformers (not degassed)

There are no pre-determined recommendations possible for transformers in this category. In order to establish the caution and alarm levels, it is recommended to allow the monitor to run for thirty (30) days to establish gassing trends and baseline measurements. After this data has been collected, you may consult with Serveron (support@serveron.com) to determine the appropriate caution and alarm settings for the transformer.

Viewing Monitor Data

The monitor data can be viewed using the supplied TM View software. A copy of the TM View software and user's manual can be found on the CD that shipped with the monitor. Alternatively, the monitor can present data to SCADA systems using DNP3, Modbus or IEC 61850 protocols. Please contact a Serveron representative for further information regarding integrating the monitor with a SCADA system.

Front Panel LED's

The monitor has three LED's located on the front panel. Their functions are described below:

Light	Notes:
Alarm	One or more gas PPM or rate of change (ROC) limits has been exceeded
Service	The service-required LED can be activated by any number of analyzer conditions. The specific cause can be determined by **TM View** (select the specific day on the Event History) or the optional internal display. **Note:** Depending on the cause for Service, the monitor may need to perform an analysis before the blue Service LED is turned OFF.
Power	Normal operation with no events occurring

Table 5: Front-Panel LED's

Examples of Service-Required Conditions

Error Message	Description
02 - persistent GC analysis failure	A sample run has not occurred in the last 24 hrs
03 - helium tank empty	incoming helium pressure is below 70 psi
04 - calibration tank empty	cal gas delivery pressure is below minimum level
05 - extractor shutdown	monitor's extractor subsystem has stopped operation
06 - faulty rotary valve	monitor's 6-port or 10-port rotary valve has failed
07 - heater shutdown	monitor's heater subsystem has stopped operation
09 - calibration tank date expired	verification cylinder has reached expiration date
10 - enclosure fan stalled	monitor's enclosure fan has stopped turning
13 – 24 volt supply out of range	24V supply to system board from power supply
14 – 5 volt supply out of range	system board 5V supply out of range
15 - system board analog 5 Volt out of range	5V analog supply on system board out of range
16 - 6.8 Volt supply out of range	6.8V supply out of range
17 - 15 Volt supply out of range	15V supply out of range
18 - analog board analog 5 Volt out of range	5V analog supply on analog board out of range
19 - 12 Volt supply out of range	12V supply out of range
20 - system board DAC voltage out of range	system board D-to-A converter voltage out of range
21 - analog board DAC voltage out of range	analog board D-to-A converter voltage out of range
22 - sample schedule disabled	user has disabled the monitor's sampling schedule
23 - persistent oil over / under temp	incoming oil temp is above 60C or below 0C
24 - persistent oil over-pressure	excessive oil return-line pressure
25 - persistent oil sampling failure	not enough oil has not passed through the extractor
26 - gases not calibrated	one or more gas peaks were not detected
28 - persistent oil path restriction	oil supply path is restricted
29 - extractor oil purge over pressure	excessive oil return-line pressure during purge
30 – extractor gas blowout stopped, EPC pres low	EPC2 pressure low for extractor blowout

Table 6: Service-Required Conditions

Monitor Shut-Down

CAUTION: Ensure helium is always being supplied to the monitor. Do not leave helium inputs exposed to the atmosphere for extended periods of time

CAUTION: If the monitor will be powered-down for more than 24 hours, follow the appropriate shut-down procedure

NOTE: If your monitor incorporates an extractor pressure-relief device, follow the steps for the Standard Shut-Down procedure. If there is no pressure-relief device installed, then follow the steps for the Revised Shut-Down procedure.

Standard Shut-Down Procedure

1. Power-off the monitor at the power switch on the power supply.
2. Close all Serveron oil supply and return valves (yellow, black and dark-green).
3. Close the helium and calibration gas cylinder valves.
4. Install the brass vent tube caps on the hot zone (**fig 4**).

Revised Shut-Down Procedure

1. Power-off the monitor. Close the Serveron secondary shut-off valve (dark-green) and the Serveron oil return valve (black).

2. Disconnect the oil supply line from the secondary shut-off valve as shown (**fig 1**) and the oil return tubing from the oil return valve as shown (**fig 2**). Place a container under these fittings to catch any oil. Use absorbent rags / pads as necessary.

Fig 1

Fig 2

3. Power the monitor on and allow it to pump the oil out of the extractor until there is no longer any flow (about 10 minutes).
4. Power–off the monitor, re-attach the oil supply and oil return tubing to the fittings disconnected above.
5. If the monitor will be off for more than 72 hrs, remove the black tubing from the hot zone vent tubes and re-install the brass caps (**fig 4**).
6. Close the helium and verification gas supplies.

Start-Up After Shut-Down

From Standard Shut-Down

1. Remove the brass hot zone vent tube caps (if previously installed) and install the black vent tube exhaust lines (orientation is not important).
2. Open the helium and calibration gas cylinder valves (if previously closed).
3. Ensure that all oil supply and return valves are open.
4. Power-on the monitor at the power switch on the power supply.

From Revised Shut-Down

1. Open helium and verification gas supplies (if previously closed).
2. Remove the brass caps from the hot zone vent tubes (if re-installed) and re-connect the black tubing to the vent tubes.
3. Ensure that all valves are closed initially, including the transformer oil return valve.
4. Remove the brass cap from the top of the bleed fixture and attach a bleed tube (**fig 3**). Have a container ready under the tube to catch the oil.
5. Ensure that the transformer supply valve and Serveron oil-supply valve (**yellow handle**) are open.
6. Ensure that the Serveron secondary shut-off valve (**dark-green handle**) is open and the manual sample port (**light-green handle**) is closed.
7. Ensure that the transformer return valve is closed and that the Serveron oil-return valve (**black handle**) is open.
8. Turn the power on to the monitor and wait for oil to exit the bleed tube into the container. This will take about 10 minutes, depending on the length of the supply and return tubing and the ambient temperature.

Figure 3: Bleed Tube

9. When bubble-free oil is coming out of the bleed tube, power-off the monitor. Close the Serveron oil-return valve (**black handle**). Remove the bleed tube and replace the brass cap. Open the Serveron oil-return valve (**black handle**) and the transformer return valve.

10. Power-on the monitor. After the monitor has temperature-stabilized, it will resume its normal sampling schedule.

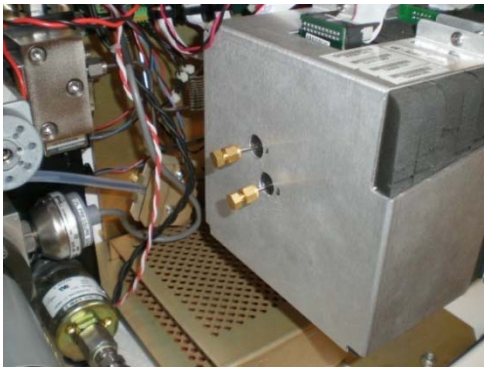


Fig 4: Hot Zone Caps

Manual DGA Sampling

A manual sample port (optional - **fig 5**) can be installed in-line with the monitor oil supply tubing. Serveron recommends this port for manual sampling to better correlate monitor data to manual DGA data. The sample port includes a ¼-in locking valve with a ¼ -in FNPT fitting. The manual sampling procedure is as follows:

1. Close the secondary shut-off valve (dark green / black handle) to the monitor.
2. Connect the manual sample device.
3. Open the manual sample port (light green handle) to draw the manual sample
4. Close the manual sample port and secure the locking device with a lock, bolt or tie wrap.
5. Open the secondary shut-off valve to the monitor.

NOTE: Leaving the secondary shut-off valve closed will result in improper operation of the monitor.

Figure 5: Manual Sample Port

Maintenance

The TMx Monitor has been designed to require very little maintenance. After the first continuous month of use, follow the schedule below (or adapt to your current schedule).

Frequency	Maintenance Step
Every three months	**Check all gas and oil fittings for leaks**
Every six months	**Inspect / clean oil filter(s)**
Every four years (or eight years for the Amplify high-capacity cylinder)	**Replace helium cylinder**
Every four years	**Replace hot zone, if degraded**
Every five years	**Replace Verification Gas cylinder**

Table 7: Scheduled Maintenance

Helium

The proper grade of helium used with the monitor is extremely important **(**Serveron **minimum** specs: **99.9995% purity, ≤ 0.5 ppm H20)**. **Chromatographic** or **Research-Grade** is recommended. A full, standard-size (49L) cylinder will last approximately 4 years, based on the default, four-hour sampling interval, provided the system is leak-free (the larger-capacity **Amplify** cylinders will last approximately 8 years). It is important that all of the helium fittings are inspected quarterly with a leak-check solution, such as Snoop.® The helium cylinder should be replaced when the high-side regulator gauge (right gauge) reads approximately **150 psi**.

CAUTION: The use of helium with a lower-purity or higher moisture content will result in reduced monitor performance and early degradation of the GC subsystem.

WARNING: When full, the standard helium cylinder is pressurized to greater than 2000 psi (138 bar). Always follow Compressed Gas Association (CGA) guidelines when handling and transporting compressed gases.

Helium Cylinder Replacement

Required Tools: adjustable wrench

Follow the steps below to replace the helium cylinder:

1. Close both the helium cylinder valve and the black regulator knob clockwise to the fully OFF position.
2. If a helium dryer is present, it can be removed completely, as it is no longer required, as long as the proper grade of helium is in use. If there is enough helium tubing remaining, it can be connected directly from the regulator to the helium input on the right-side of the monitor. The dryer and small 10” section of helium tubing can be discarded.

CAUTION: Avoid leaving the monitor’s helium input exposed to the atmosphere for an extended period, as moisture can enter the GC through this path if left open.

3. Remove the regulator from the cylinder with a suitable wrench. Be sure to properly support the regulator when removed from the cylinder, so the stainless helium line is not damaged.

4. Remove the strap (if present) from around the cylinder and replace the cylinder. Position the new cylinder in the bracket, making sure the cylinder valve is properly positioned. Secure the strap to the cylinder (if present).
5. Re-install the regulator onto the cylinder valve and tighten. Re-position cylinder if necessary.
6. Open the helium cylinder valve fully counter-clockwise then open the black regulator knob fully.
7. Check for leaks with a leak-check solution.

Helium Pressure Adjustment

Required Tools:

3/16” or ¼” Allen wrench

Laptop computer (if available) with Serveron-supplied serial cable and RJ45-to-DB9 adapter

If the helium regulator requires adjustment, first determine which type of regulator is present, **Concoa** (**fig 6**) or **Airgas** (**fig 7**). For the **Concoa** version, lift up the black **Concoa** label and use a 3/16” Allen wrench to turn the hex screw clockwise to increase the pressure and counter-clockwise to decrease. The low-side pressure (left gauge) should be adjusted to **82** psi. For the **Airgas** version, remove the ¾” cap nut to expose the hex screw and use a ¼” Allen wrench to adjust the pressure in a similar manner to **80** psi on the left gauge.

Figure 6: Concoa regulator

Figure 7: Airgas regulator

If a laptop is available with Hyperterminal (or another terminal-emulation application), connect to the monitor’s service port at **J11** on the system board with the serial cable and adapter and establish a CLI session (Command-Line Interface) with the monitor. After logging in, issue the command **pres** to start a scrolling, real-time readout of the helium pressure. Watch the left-hand column (helium delivery pressure) as you turn the Allen wrench to increase or decrease the pressure. The change

in pressure will be more immediate when you increase the pressure and take longer to bleed off when you decrease it. Press **Ctrl + C** to stop the scrolling, then type **exit** if you are finished with the CLI session.

If your Concoa regulator has only one gauge or the monitor's firmware is **lower** than version **3.9.11**, contact Serveron Support (**+1 866 273 7763** support@serveron.com) if assistance is required to adjust helium pressure.

Verification Gas

The verification cylinder contains a NIST-certified mixture of gases used by the monitor for automatic calibration. The contents of the cylinder are certified for **five (5) years** from the analysis date on the cylinder label, based on the default three-day verification run schedule, provided the system is leak-tight. The gauge on the regulator should be checked quarterly and the gas system checked for leaks quarterly with a leak-check solution, such as Snoop®. The verification cylinder should be replaced when the regulator gauge reads **25 psi** (1.72 bar). Replacement verification cylinders must be ordered from Serveron.

Verification Cylinder Replacement

Required Tools: 9/16" wrench

CAUTION: The use of any other calibration gas mixtures not approved by Serveron will result in poor monitor performance and potential damage to the GC subsystem.

WARNING: When full, the verification cylinder is pressurized to more than 500 psi (34 bar). Always follow Compressed Gas Association (CGA) guidelines when handling and transporting compressed gases.

Follow the steps below to replace the verification cylinder:

1. Close the valve on the calibration gas cylinder fully clockwise and loosen the 9/16" nut that secures the cylinder to the regulator. Remove the empty cylinder.
2. Install the new cylinder into the Velcro® loop and secure to the 9/16" nut on the regulator. Open the valve on the cylinder fully counter-clockwise. Check for leaks with a leak-check solution, such as Snoop®.
3. The analysis date and gas concentrations from the new cylinder must be input to the monitor's configuration and a purge of the verification gas line performed. This can be

accomplished by any of the following methods: TM View (**ver 4.X and higher**), Hyperterminal or the TM Configuration Utility.

TM View

1. While in TM View, right-click the TM8 icon in the navigation tree (you may need to be on the Verification Data tab, depending on your version) and select **New Verification Gas Cylinder.**
2. Enter the analysis date and gas concentrations from the cylinder label into the table and select **OK** to start a gas line purge.

Hyperterminal

1. Once the CLI connection to the monitor is established, log in with **Distributor** for the username and **Distributor** for the password.
2. Issue the following commands with the cylinder concentrations and the expiration date, which is three years from the analysis date:

co set cal.h2 XXX	**co set cal.co2 XXX**
co set cal.o2 XXX	**co set cal.c2h4 XXX**
co set cal.ch4XXX	**co set cal.c2h6 XXX**
co set cal.co XXX	**co set cal.c2h2 XXX**
co set cal.expd YYYY-MM-DD	***Ar value not needed**

Then issue the command **cal.purge** to purge the verification gas line.

TM Configuration Utility

Once the application is open, select the activity **Replace Verification Gas Cylinder.** Enter the analysis date and gas concentrations from the cylinder label. After selecting **Continue**, the monitor will perform a gas line purge.

Verification Gas Regulator Adjustment

NOTE: This adjustment requires CLI (Command Line Interface) access to the monitor in Hyperterminal or another terminal-emulation application at the monitor's service port.

The regulated delivery pressure for the verification gas is **8 psi ± 2 psi**. If the pressure for your monitor is outside this range, the regulator should be adjusted. There are two different types of regulator for the verification gas: **Concoa** and **Scott**. The adjustment is slightly different for each one. Follow the steps below, after determining the particular type of regulator on your monitor.

Concoa

Required Tools: 3/16” Allen wrench

1. Connect to the monitor in CLI and determine the current verification gas delivery pressure by issuing the command **cal.purge**.
2. If the pressure is outside the range of **8 psi + 2 psi**, lift the Concoa label to expose the hex adjustment screw and turn the screw clockwise to increase the pressure or counter-clockwise to decrease the pressure.
3. Use small adjustments at first and issue the **cal.purge** command after each one to check the pressure. Once the desired pressure is achieved, exit the CLI session by typing **exit**.

Scott

Required Tools: 5/64” Allen key

1. Connect to the monitor in CLI and determine the current verification gas delivery pressure by issuing the command **cal.purge**.
2. If the pressure is outside the range of **8 psi + 2 psi**, loosen the two set screws (they are 180 degrees apart) on the regulator body as indicated (**fig 8**). If desired, you may completely remove the least-accessible of the two screws and discard it.
3. Increase or decrease the delivery pressure with the knob and then issue the **cal.purge** command again to check the pressure (**fig 9**). Repeat as necessary.
4. When the adjustment is complete, tighten the set screw(s) on the regulator body, being careful to not over-tighten. Exit the CLI session with the monitor by typing **exit**.

Figure 8: Scott regulator set screw

Figure 9: Adjustment knob

Gas Separation Columns (Hot Zone)

The hot zone contains the gas separation columns that separate and quantify the gases after they are extracted from the oil. Although the hot zone is not considered a consumable item, it does degrade over time. Mechanically, the hot zone is very easy to replace. However, it does require system calibration after replacement. Training is available for this replacement and system calibration. Please contact Serveron Support at **+1 (866) 273-7763** or Support@Serveron.com for information on training.

Oil Filter Inspection / Cleaning

The oil filter for the incoming oil supply uses a 230-micron screen to filter any debris from the incoming oil. The filter should be inspected every six months. Older monitors may have two filters for both the oil supply and return lines. Both filters should be inspected at the same time. Follow the steps below to inspect / clean the oil filter:

Required Tools: adjustable wrenches (2), wire brush, rags

1. Power-off the monitor at the switch on the power supply. Close the Serveron secondary shut-off valve (**dark green handle**) and the Serveron oil-return valve (**black handle**).
2. While supporting the filter body with one wrench, loosen the filter cap with the other wrench. Unscrew the cap and remove the screen by pulling out (**fig 10**). Have a rag available to clean any residual oil
3. Remove any debris present with a wire brush. Do not use any solvents or cleaners, as these will get into the oil.
4. Replace the screen and filter cap and tighten. Open the two valves closed previously and power-on the monitor.

Figure 10: Oil Filter

Bleeding Air From Oil Lines

Required Tools: Piece of Tygon® tubing to attach to Bleed Fixture, container to catch oil

If any part of the oil supply or return line is disconnected for any reason, air may be introduced into the lines and will need to be bled-out before the monitor is returned to service.

1. Ensure that all valves are closed initially.
2. Ensure that the helium supply is connected to the monitor and that the regulator and helium cylinder valve are open.
3. With the monitor powered off, remove the cap from the top of the bleed fixture and attach a bleed tube. Have a container ready under the tube to catch the oil.
4. Ensure that the transformer supply valve and Serveron oil-supply valve (**yellow handle**) are open.
5. Ensure that the Serveron secondary shut-off valve (**dark-green / black handle**) is open and the manual sample port (**light-green handle – if present**) is closed.
6. Ensure that the transformer return valve is closed and that the Serveron oil-return valve (**black handle**) is open.
7. Power the monitor on and wait for oil to exit the bleed tube into the container. This will take about 10 minutes, depending on the length of the supply and return tubing and the ambient temperature.
8. When bubble-free oil is exiting the bleed tube, power the monitor off. Close the Serveron oil-return valve (**black handle**). Remove the bleed tube and replace the cap. Open the Serveron oil-return valve (**black handle**) and the transformer return valve.
9. Power the monitor on. After the monitor has temperature-stabilized, it will resume its normal sampling schedule.

Vacuum-Filling the Transformer

WARNING: If a transformer will have a vacuum applied to it during filling with oil, the monitor **MUST** be isolated from this vacuum by closing the Serveron oil supply valve (**yellow handle**) and the Serveron oil return valve (**black handle**). Additionally, there must not be any residual vacuum on the transformer supply and return valves after the filling operation is completed. **Failure to properly isolate the monitor from vacuum may permanently damage the extractor membrane, requiring monitor replacement.**

Storage of Spares

Many of the spare parts for the TM8/TM3 can be stored for several years. However, special care must be taken for the storage of **hot zones** (gas separation column set) and **sled assemblies**. Both of these assemblies should be kept in their original shipping containers until the time of use. Additionally, they should be kept in a dry environment, at a standard temperature, due to the nature of their sensitive electronics. It is not advisable to store the Verification Gas cylinders as spares, as they are life-limited by their expiration from the **Analysis Date** on the label.

Monitor Cleaning

Internal – No internal cleaning of the monitor is required. Doing so may cause damage to the monitor's internal components.

External – No external cleaning of the monitor is required. If external cleaning is desired, use only water. However, avoid the direct spray of any high-pressure water around the door seal, LED's, cable glands or helium / oil fittings.

Fuse Replacement

The monitor utilizes an auto-switching power supply rated to receive an input of **115VAC ± 15% or 230VAC ± 15%.** Current draw is **6A max. at 115VAC** and **3A max. at 230VAC**. There are two **4A** fuses installed for the power supply (grey fuse holders) and two **2.5A** fuses for the analyzer's enclosure heater (black fuse holders).

CAUTION: Replace fuses with same type and rating only.

Returning Material to Serveron

An RMA number must first be issued by Serveron prior to any monitor or part being returned. To receive an RMA number, please email: support@serveron.com. Returned items should be shipped in the original packaging or like-packaging to avoid shipping damage. Please mark the shipment with the RMA number and return to:

Serveron

13550 SW Karl Braun Dr.

Beaverton, Oregon 97077

WARNING: Shipping the analyzer without installing the internal foam support (PN 010-0038-XX, fig 11) can cause damage to the analyzer. If you need to return a monitor to Serveron and do not have the proper packaging material, contact Serveron Support to have this packaging sent to you.

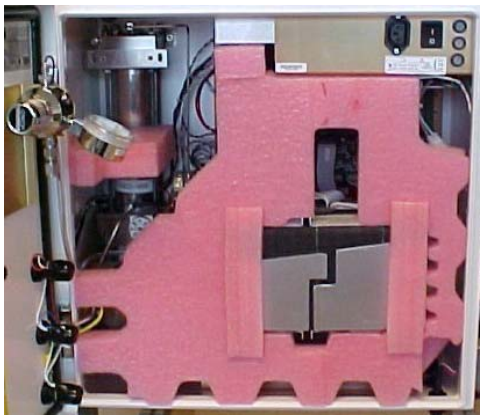


Figure 11: Internal Foam Support

Serveron® Field Services

Serveron provides on-site commissioning, start-up and comprehensive maintenance contracts to all customers worldwide. To further improve reliability, an extended warranty is available on selected products commissioned by Serveron.

Serveron® Educational Services

Serveron professional training (designed to achieve hands-on performance based objectives) prepares operations, maintenance, and engineering personnel to install, test, configure, operate and maintain Serveron products.

Serveron® Accelerated Delivery

Serveron provides accelerated delivery on many products and services including replacements, spare parts and repairs.

About Serveron®

Serveron transformer condition assessment and management tools are critical to utilities in improving grid reliability while optimizing the management and economics of their asset base. We are a leader in on-line DGA monitoring of power transformers with solutions across the entire power transformer fleet. Serveron is a QUALITROL Company.