ZERO-AIR™ GENERATOR

OPERATION AND
MAINTENANCE MANUAL

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Table of Contents Page

1. Introduction……………………………………………………………………….. 2

2. Description of Components…………………………………………………… 3
- 2.1 Perma Pure Dryer
- 2.2 Ultraviolet Lamp
- 2.3 Activated Carbon/Alumina Mixture
- 2.4 Carbon Monoxide Catalyst
- 2.5 1μ Particulate Filter

3. Start-Up Procedure……………………………………………………………. 4

4. Maintenance
- 4.1 Activated Carbon/Alumina Replacement ……………………………….…5
- 4.2 Final Filter Replacement ……………………………………………………. 6
- 4.3 Fuse Replacement ………………………………………………………….6

5. Spare Parts…………………………………………..……………………….8

6. Specifications……………………….…………………………………………8

Table of Figures Page

Figure 1 – ZAG Flow Schematic ……………………………………………… 2

Figure 2 – Perma Pure Nafion Membrane Dryer Schematic ……………………. 3

Figure 3 – Control Panel …………………………………………………………. 4

Figure 4 – ZAG Performance Curve ………………………………………………. 4

Figure 5 – Wiring Schematic…………………………………………………7

1 Introduction

The Zero-Air Generator (ZAG) is a simple, light-weight, self-contained system capable of producing high purity, particle free, dry air at up to 18 liters per minute. It is designed to replace gas cylinders as a source of calibration standard. The ZAG can be used with stationary analyzers, but its portability makes it especially well suited for use with remote monitoring sites and mobile testing facilities.

Operation is very simple. Ambient air is brought into the Zero-Air Generator where it is compressed and then purified using a combination of membranes, adsorbents, and filters. The only outside item that needs to be supplied is AC power.

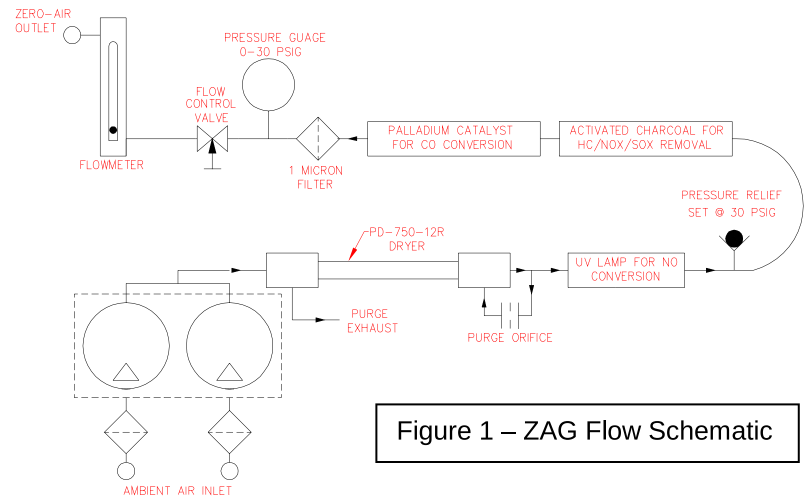

Figure 1 – ZAG Flow Schematic

Maintenance requirements are minimal and easy to perform. There are two desiccant canisters, one of which needs to be replenished periodically; under normal use, it will last up to six months. The other desiccant canister contains a catalyst that is not consumable. The only other regular maintenance is to replace the particulate filter periodically. All other components in the system are designed to provide years of trouble-free service.

The Perma Pure ZAG is ideal for use with the following monitors:

- Carbon monoxide
- Nitrogen oxides (NO_x)
- VOC's (except methane)
- Ozone
- Sulfur oxides (SO_x)

Consult Perma Pure for other monitoring applications.

The rugged design of the ZAG makes it ideal for field use. The components are protected inside a hard plastic enclosure, which is roughly the size and weight of a fishing tackle box. The ZAG takes up a minimal amount of space and is very easy to start up.

In addition to its convenience, the ZAG is also a safe and cost-effective source of high purity air. Gas cylinders are heavy, bulky, and under high pressure. Extreme caution must be exercised when working with them. In addition, these cylinders are very expensive and can cause storage problems. The only operating costs associated with the ZAG are electricity (about $75/year if run continuously) and replacement desiccant. Depending on zero air consumption, it will normally pay for itself within 12 months.

2 Description of Components

2.1 Perma Pure Dryer

Water vapor and certain polar organic compounds (i.e. alcohols, ketones) are removed here. A bundle of Nafion® tubes is housed inside the dryer shell. As the wet compressed air flows through the tubes, the water vapor is absorbed through the membrane and carried off by a counter-current purge air flow at a reduced pressure. The driving force for this process, known as *permeation distillation*, is the difference in partial vapor pressure of water between the product and purge gas flows. In this system, a portion of the dried air is expanded and used as the purge gas.

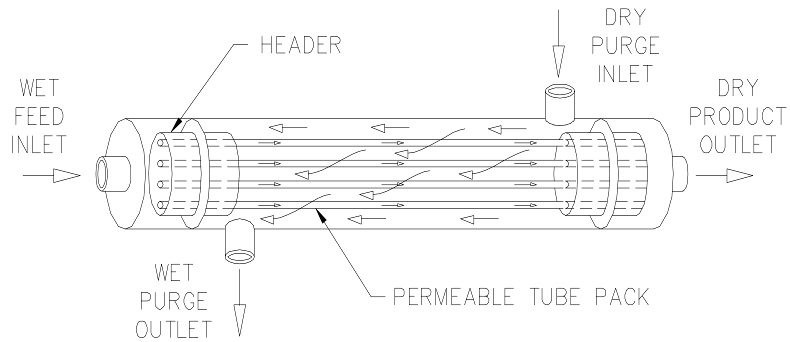

Figure 2 – Perma Pure Nafion Membrane Dryer Schematic

2.2 Ultraviolet Lamp

Used for the destruction of bacteria into carbonaceous by-products. The lamp produces approximately 1-3 PPM of ozone (O_3), which then breaks down microorganisms into carbon compounds that are removed further downstream. The lamp also oxidizes NO to NO_2, which is readily removed by system adsorbents.

2.3 Activated Carbon/Alumina Mixture

This is a blend of high performance activated carbon and impregnated alumina pellets. This mixture will remove trace quantities of chlorine (Cl_2), hydrogen fluoride (HF), hydrogen sulfide (H_2S), nitrogen oxides (NO_x), ozone (O_3), sulfur dioxide (SO_2), sulfur trioxide (SO_3), and general hydrocarbons (HC). In addition to removing these substances, the mixture changes from purple to brown, indicating the need for replacement.

2.4 Carbon Monoxide Catalyst

Palladium impregnated alumina pellets are used to convert low levels of CO to CO_2. This catalyst is not consumable, and should last for the lifetime of the unit.

2.5 1µ Particulate Filter

The last stage of purification is the particulate filter. This filter has an absolute retention rating of 1 micron, and a 93% rating for particles down to 0.1 micron. The disposable filter is housed in a transparent plastic housing, allowing easy visual determination of the filter's condition.

3 Start-Up Procedure

1. Place the ZAG on a level, dry surface.
2. Check to make sure the power switch is in the 'off' position.
3. Plug the unit into a standard 110V electrical outlet.
4. Open the flow control knob fully (turn the knob counter-clockwise).
5. Connect the calibration gas line to the 1/4" tube compression fitting located on the top panel of the generator.
6. Turn the power switch to the 'on' position.
7. Adjust the flow control valve to the desired air output. Maximum capacity is 18 lpm.
8. High purity air will be produced within 2 minutes after start-up.

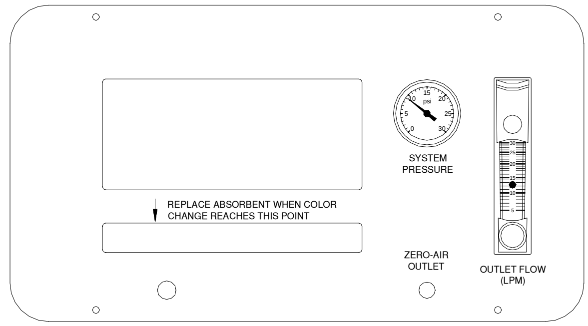

Figure 3A – ZAG Top Panel

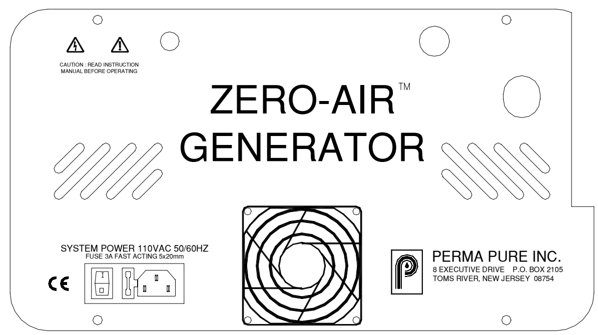

Figure 3B – ZAG Bottom Panel

Note: There is a trade off between air pressure and flow. High air volumes will result in lower air pressure, and vice versa. If low pressure, low flow applications are encountered, a pressure regulator should be connected between the instrument and the Zero-Air Generator.

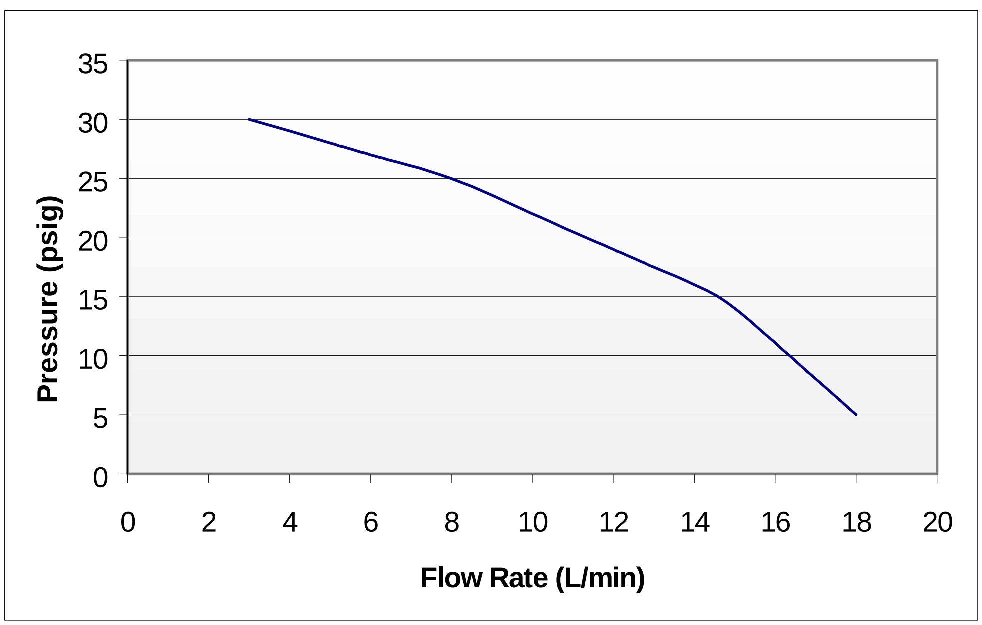

Figure 4 – Zero-Air Generator Performance Curve

4 Maintenance

Routine maintenance on the ZAG consists of periodic carbon replacement and outlet filter replacement. Under normal, intermittent use, the desiccant should last at least six months.

WARNING!! De-pressurize and unplug the ZAG before attempting any maintenance or removing the top or bottom panels!

4.1 Activated Carbon/Alumina Replacement

The activated carbon canister is located behind the top panel. The top half of the canister is exposed to allow visual inspection of the mixture. As the mixture is used, its color changes from purple to brown. When ¾ of the canister has changed to brown, replace the mixture. The mixture can not be regenerated and must be discarded.

Replacing the mixture

1. Disconnect the three (3) air lines by loosening the ¼" compression nuts with a 9/16" wrench. Hold the bulkhead nut with a 5/8" wrench to prevent turning.
2. Remove the four (4) panel screws using a 1/8" Allen wrench and pull the top panel out.
3. Remove the black plug from the bottom of the canister using a 15/16" wrench.
4. Pour the pellets out, tapping the canister lightly to remove any that may remain inside.
5. Re-fill the canister by slowly pouring in the fresh activated carbon/impregnated alumina mixture. Tap the side of the canister while filling to settle the mixture and reduce air pockets.
6. Apply Teflon® tape to the plug and replace in the bottom of the canister tightening fully.
7. Replace the top panel using the panel screws.
8. Re-connect the three (3) air lines to the bulkead fittings, making sure to re-connect to the proper ports. Once again, hold the bulkhead nuts in place using a 5/8" wrench.

4.2 <u>Final Filter Replacement</u>

The final filter should be replaced each time the activated carbon/alumina is changed. The filter is located immediately after the outlet of the CO catalyst canister.

1. Remove the four (4) panel screws using a 1/8" Allen wrench and pull the top panel out. Note the position of the filter so that you can install the replacement in the same way.

2. Loosen the 1/4" compression nuts on either end and pull the filter from the tubing.

3. Remove the nuts from the old filter and place them on the new filter.

4. Install the new filter with the standoff end (visible inside the housing, supporting the filter element) connected to the catalyst canister outlet.

5. Firmly tighten the compression nuts on the inlet and outlet tubing.

4.3 <u>Fuse Replacement</u>

If the unit fails to run when plugged in and turned on, first check the fuse.

1. Disconnect the power cord from the power input module on the bottom panel of the unit.

2. Using a slotted tip screwdriver, pry up at the slot located about ¼" below the surface of the power input module, inside the cord entry socket. This will pull up the fuse carrier that holds the fuse on the bottom and a spare.

3. Inspect the fuse to see if it is blown. If so, remove it and replace it with the spare fuse.

4. If the fuse is in good shape, re-install and plug the system back in.

- If the unit still does not work, unplug the unit again and remove the four socket head screws located on the corners of the bottom panel. Pull the bottom panel out and inspect the wiring connections to make sure they are secure. If any loose wires are evident, tighten the connection if possible. Refer to the wiring schematic for details if necessary.

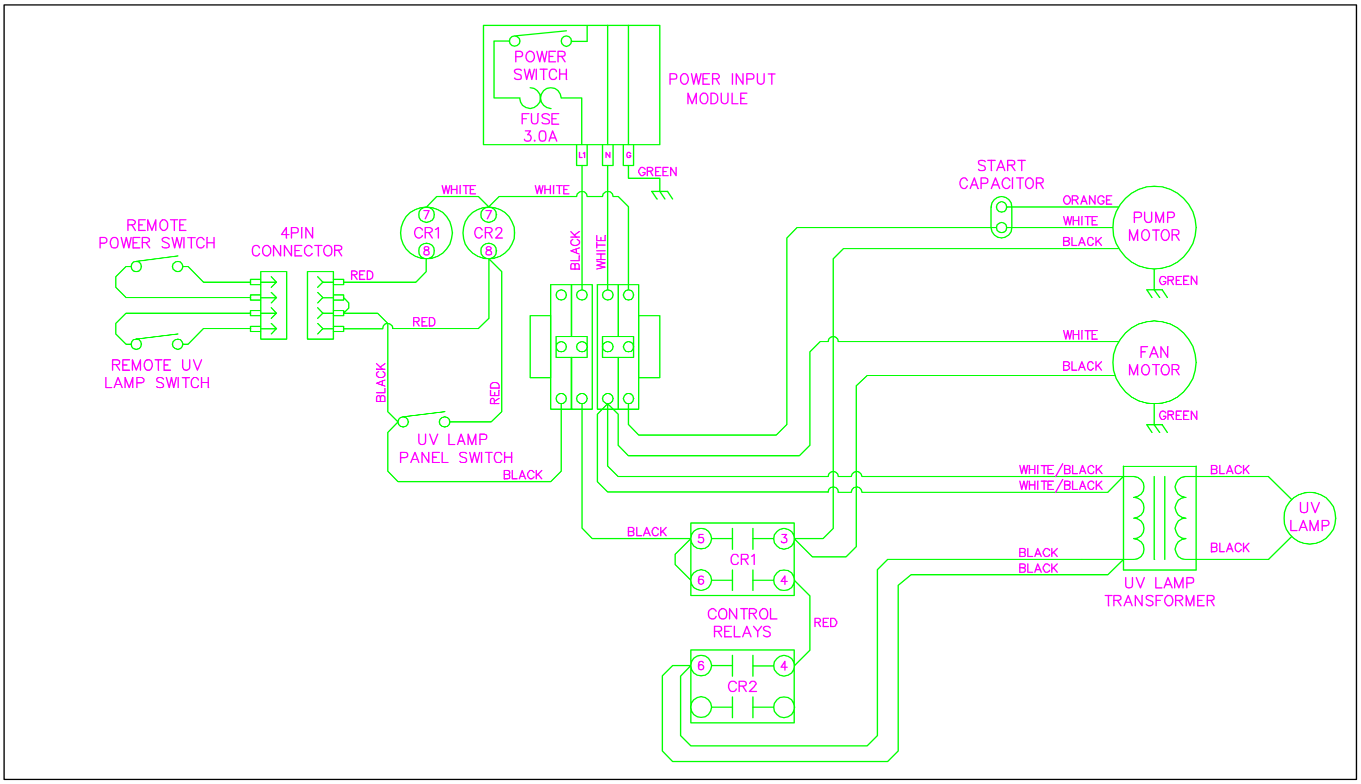

Figure 5 – ZAG Wiring Schematic

- If the unit still does not run after re-installing the panel and connecting power, it may be necessary to return it to Perma Pure for maintenance. Please contact Perma Pure to arrange any returns for maintenance.

The following items do not require any routine maintenance:

- The Pump
- UV Lamp
- Perma Pure Dryer

If performance of any of the non-maintenance components begins to degrade, contact Perma Pure for assistance.

5 Spare and Replacement Parts

The following spare parts are recommended for each maintenance period. All maintenance should be performed each time the activated carbon/alumina canister changes color from purple to brown along 3/4 or more of its length.

1) Activated Carbon/Impregnated Alumina Blend - Purafil® CP Blend

Purafil, Inc.
P.O. Box 1188
Norcross, Georgia 30091

Approximately 0.7 lb. required per adsorbent change.

2) Outlet Filter - 1µ absolute particulate filter available from:

Headline Filters Inc.
27610 College Park Drive
Warren, MI 48093
Phone: (810) 773-9111
Fax: (810) 773-9357

One (1) filter is required per maintenance period.

Please note that all maintenance items are also available from Perma Pure directly.

6 Specifications

PUMP	Dual Head Diaphragm, up to 30 PSIG, 18 SLPM
INLET FILTER	Sintered SST,10 Micron Porosity
DRYER	PD-750-12PR Nafion Gas Dryer
STERILIZER	Ultraviolet Light Chamber, 254 nm peak wavelength
NO_x, SO_x, HC SCRUBBER	Activated Carbon, Indicating Catalyst Blend
CO CATALYST	Palladium Impregnated Alumina
FINAL FILTER	0.1µ Glass Fiber Particulate Filter
OVERALL DIMENSIONS	8.5"W x 10"H x 16.5"L (216 x 254 x 419 mm)
WEIGHT	27 Pounds (12.3 kg)
POWER REQUIREMENT	2.5A @ 110 VAC, 1.25A @ 220 VAC, 50/60 Hz
FUSE REPLACEMENT	2.5A/110 VAC, 1.25A/220 VAC Fast Acting, 5x20mm
OPERATING ENVIRONMENT	-20°C To +40°C 0 to 95% RH