

# USER GUIDE

## **Zero Air Generator**



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# Guarantee

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This equipment is guaranteed against defects in materials and workmanship. This guarantee applies for 24 months from date of delivery. We will repair or replace products which prove to be defective during the guarantee period provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. Quotations for repairs can be given on request. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

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Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.



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# PLEASE READ FIRST

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## About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

<b>Area:</b> 1 in <sup>2</sup> (square inch) = 645 mm <sup>2</sup>	<b>Mass:</b> 1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
<b>Length:</b> 1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km	<b>Pressure:</b> 1 psi (lb/in <sup>2</sup> ) = 68.95 mb
	<b>Volume:</b> 1 UK pint = 568.3 ml 1 UK gallon = 4.546 litres 1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a “#” symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

## Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.



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# Precautions

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DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.** FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at [www.campbellsci.eu](http://www.campbellsci.eu) or by telephoning +44(0) 1509 828 888 (UK). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

## General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

## Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines.**
- Maintain a distance of at least one-and-one-half times structure height, or 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

## Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

## Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.





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# Zero Air Generator

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## 1. Introduction

The Zero Air Generator (pn #31022) provides a convenient source of zero air (air that contains no CO<sub>2</sub> or water vapour) for zeroing a gas analyser where normally a compressed-gas cylinder of zero air would be used. The Zero Air Generator effectively eliminates the need for a cylinder of compressed gas and the required pressure regulator and flow controller, making it extremely useful in zeroing open- or closed-path infrared gas analysers (IRGA) that are located in remote field sites.

## 2. Cautionary Statements

- READ AND UNDERSTAND the *Precautions* section at the front of this manual.
- WARNING
  - Do not connect the Zero Air Generator to any source of pressurized air, such as an external pump or a cylinder of compressed gas.
- CAUTION
  - Do not operate the Zero Air Generator pump with both outlets, **Out** and **Test**, plugged.

## 3. Initial Inspection

Upon receipt of the Zero Air Generator, inspect the packaging and contents for damage. File damage claims with the shipping company. Contact Campbell Scientific to facilitate repair or replacement.

The Zero Air Generator ships with the instrument, three sets of 1/4-in Swagelok<sup>®</sup> nuts and ferrules, and two 1.5V AA alkaline batteries.

## 4. Overview

The Zero Air Generator is a low-cost, handheld source of zero air (air that has been scrubbed of CO<sub>2</sub> and water vapour) intended for zeroing infrared gas analysers (IRGAs). The Zero Air Generator (shown in Figure 4-1) can be used to replace the traditional method of zeroing an IRGA requiring a cylinder of compressed gas with a pressure regulator and flow controller. A simpler source of zero air is particularly useful in remote field sites.

All IRGAs are subject to drift in the zero response due to aging over time, changes in temperature, window contamination, etc. An IRGA should undergo a zeroing procedure frequently to maintain peak accuracy. In many cases, IRGAs are zeroed infrequently because of the cost and difficulty of providing a source of zero air.



Figure 4-1. Zero Air Generator

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific®, Inc.) or the LI-7500 (sold by LI-COR®, Inc.), a zero/span shroud is also required. For these open-path analysers, the zero/span shroud is installed and the Zero Air Generator is connected in either an open- or closed-loop configuration. The small battery-powered pump in the Zero Air Generator circulates a low flow through a bottle filled with molecular sieve that removes CO<sub>2</sub> and water vapour, and pushes it through the zero/span shroud.

The Zero Air Generator may also be used to zero a closed-path IRGA such as the EC155 (sold by Campbell Scientific®, Inc.), or the LI-6262, LI-7000, LI-7200, or LI-840A (sold by LI-COR®, Inc.). Closed-path analysers do not require a zero/span shroud.

The Zero Air Generator includes a third connection that allows the user to assess the status of the molecular sieve. This gives an indication of when to replace the molecular sieve, ensuring that CO<sub>2</sub> and water vapour are always completely removed.

## 4.1 Accessories

### 4.1.1 Other Accessories

#### Plastic tubing

Bev-A-Line IV plastic tubing with an outer diameter of 1/4 in and inner diameter of 1/8 in, is available as pn #7399. The tubing remains flexible even at cold

temperatures and holds up well in applications that require repeated handling and flexing. Campbell Scientific recommends this tubing for the plumbing connection between the Zero Air Generator and the instrument under test.

## 4.1.2 Replacement Parts

### AA alkaline cells

The power that operates the small pump of the Zero Air Generator is supplied by a pair of AA alkaline cells. Campbell Scientific offers pn #26064 which is a long-life 1.5 V, AA alkaline battery.

### Molecular sieve

The Zero Air Generator scrubs an air sample of CO<sub>2</sub> and water vapour with a 13X molecular sieve. The sieve requires periodic replacement. Campbell Scientific offers pn #27450, which is a bottle containing 250 g of 13X molecular sieve beads ranging from 1.6 to 2.5 mm diameter.

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**NOTE**

Two 250 g bottles are required to replace the sieve.

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### Filter

The original filter of the Zero Air Generator can be replaced by the filter available as pn #29998. The filter is an in-line, 2.5 cm (1.0 in) diameter, PTFE membrane filter of 3-micron pore size with Luer lock connections.



### Swagelok® plug

Spare 1/4-in Swagelok® plugs are available as pn #15891. This part is used to plug a fitting when the accompanying tube is disconnected. Plugging the fittings is necessary to keep the fittings clean and to avoid consumption of the molecular sieve during storage. It is strongly recommended to replace plugs in the event that those provided with the Zero Air Generator are lost or become damaged.



### Velcro® strap

A Velcro® strap is used as a lanyard to secure the Zero Air Generator to a crossarm or other support when it is used in the field. If this strap is lost or damaged it can be replaced with pn #4180, which is a 30 cm (12 in) length of 2.5 cm (1.0 in) wide Velcro® with a plastic loop. Longer or shorter straps are also available. Contact Campbell Scientific for details.



## 5. Specifications

<b>Dimensions</b>	
<b>Length:</b>	14.0 cm (5.5 in)
<b>Width:</b>	9.6 cm (3.8 in)
<b>Height:</b>	27.4 cm (10.8 in)
<b>Weight:</b>	1.16 kg (2.55 lb)
<b>Operating temperature range:</b>	-20 to 50 °C
<b>Capacity:</b>	750 ml (holds approximately 450 g molecular sieve)
<b>Flow rate:</b>	0.2 LPM (typical)
<b>Power:</b>	two AA batteries

## 6. Operation

### 6.1 Theory of Operation

In normal operation, ambient air enters the Zero Air Generator through an **In** port on the front of the module, flows through an inline filter, and is pushed by a small pump into the top of a bottle containing molecular sieve. The molecular sieve removes the CO<sub>2</sub> and water vapour from the air as it flows down the length of the bottle. Scrubbed air enters a tube at the bottom of the bottle and then emerges from the **Out** port at the front of the module.

The **Test** port provides scrubbed air pulled from the middle of the molecular sieve, whereas the **Out** port has zeroed air removed from the bottom of the molecular sieve. See Figure 6-1 for the configuration of the ports.

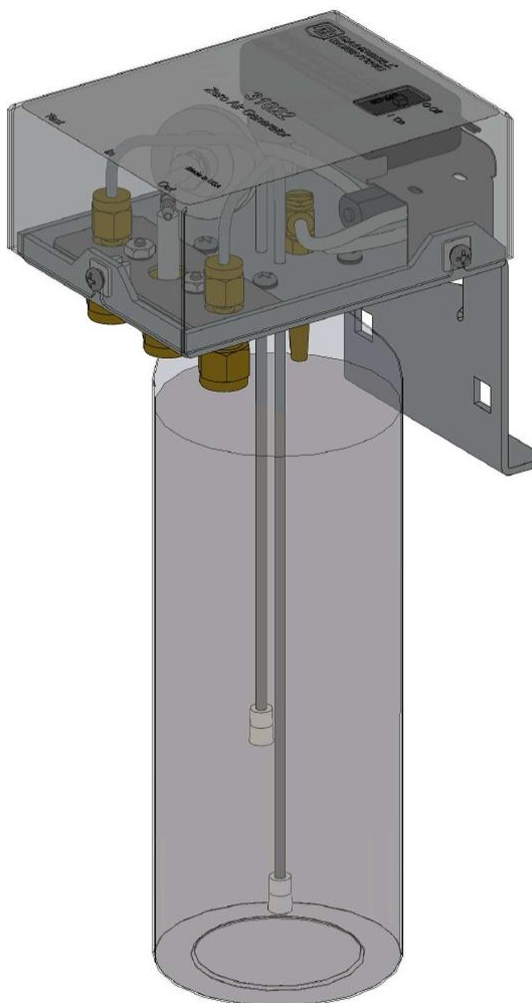


Figure 6-1. Zero Air Generator port configuration

The **Test** connection pulls air from two inches above the bottom of the bottle of molecular sieve. This air sample is used to monitor the effectiveness of the molecular sieve scrubbing the air. Because unscrubbed air enters at the top and flows downward, the molecular sieve will be consumed from the top down. Measuring the CO<sub>2</sub> and water vapour from this **Test** port and comparing the values to the readings from the bottom of the bottle shows when the molecular sieve at the top of the bottle has been consumed. If air from the **Test** port contains more CO<sub>2</sub> or water vapour than the air exiting the **Out** port, the molecular sieve should be replaced. Molecular sieve 13X with 1.6 – 2.5 mm bead diameter is recommended. Approximately 450 g is needed to refill the bottle (see Section 4.1.2, *Replacement Parts* (p. 3)).

The **In** port should either be connected to the exhaust side of an IRGA zero/span shroud or sample cell, left capped (a tee-connection allows entry of ambient air from under the Zero Air Generator cover, see Figure 6-2), or left uncapped. If the Zero Air Generator is used in recirculating mode, the open port of the tee will keep the IRGA near ambient pressure. The **Out** port or **Test** port should be connected to the intake side of the IRGA zero/span shroud or sample cell. All connections should be made via tubing with 1/4-in Swagelok® connectors.

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**NOTE**

Do not operate the Zero Air Generator with both outlets, **Out** and **Test**, plugged.

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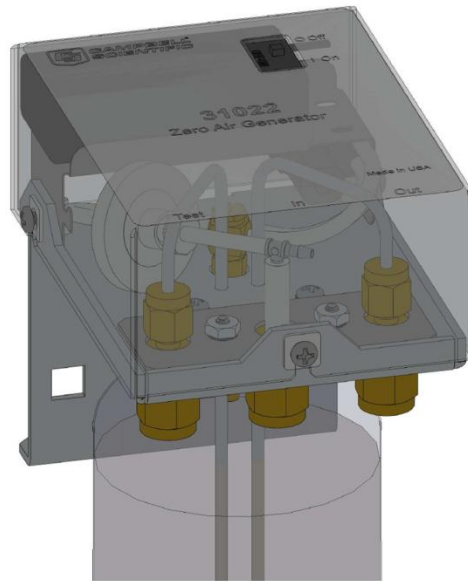


Figure 6-2. Internal connections of Zero Air Generator

## 6.2 Zeroing an Open-Path IRGA

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific<sup>®</sup>, Inc.) or the LI-7500 (sold by LI-COR<sup>®</sup>, Inc.), a zero/span shroud is required. Install the zero/span shroud according to the manufacturer's instructions.

Secure the Zero Air Generator to the crossarm or other structure using the Velcro<sup>®</sup> strap. Connect the Zero Air Generator to the IRGA zero/span shroud in either an open-loop or a closed-loop configuration. Figure 6-3 shows the zero/span shroud connected to an LI-7500 in an open-loop configuration. Figure 6-4 shows the Zero Air Generator connected to an IRGASON in a closed-loop configuration. Either configuration will give good results.

The closed-loop configuration will exhaust the molecular sieve more slowly, which may be important if the Zero Air Generator is used extensively. The instrument will operate for many hours in an open-loop configuration. Normally, the batteries will have to be replaced a few times before the molecular sieve must be replaced, even in open-loop operation.

Follow the manufacturer's instructions to zero the specific IRGA. To ensure the molecular sieve is removing all of the CO<sub>2</sub> and water vapour, compare the IRGA readings by using the **Test** outlet.





Figure 6-3. Zero Air Generator connected to LI-7500 in open-loop configuration



Figure 6-4. Zero Air Generator connected to IRGASON in closed-loop configuration

### 6.3 Zeroing a Closed-Path IRGA

The Zero Air Generator may also be used with a closed-path IRGA in either an open-loop or a closed-loop configuration. Figure 6-5 shows the Zero Air Generator connected to an LI-840A (sold by LI-COR<sup>®</sup>, Inc.) in a closed loop configuration. Connect the **Out** port to the LI-840A **IN** port and the LI-840A **OUT** port to the Zero Air Generator **In** port. Turn the pump on to start the flow of zero air. Follow the recommendations of the IRGA manufacturer for the zero procedure.



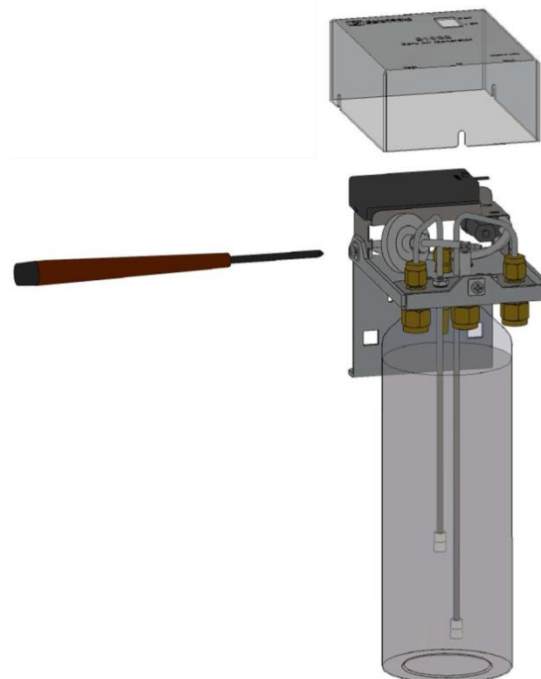
Figure 6-5. Zero Air Generator connected to LI-840A

## 7. Maintenance

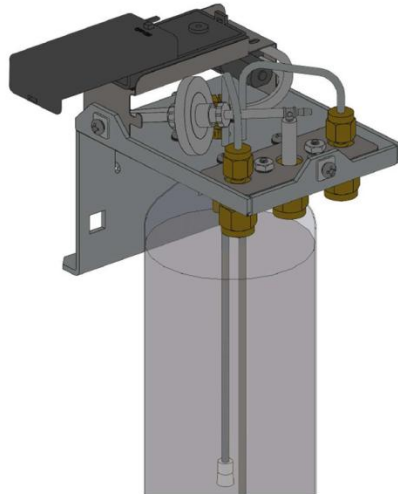
### 7.1 Replacing Batteries

The Zero Air Generator ships with two AA alkaline cells. Refer to the following instructions and figures to replace the batteries.

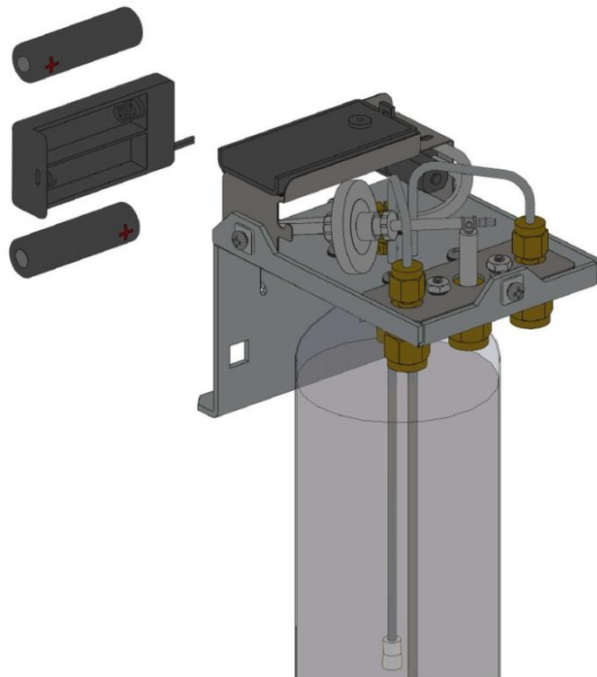
1. Make sure the switch is in the “OFF” position as shown on the lid of the Zero Air Generator.
2. Loosen the three screws that attach the lid and remove the lid as shown.



3. Slide the battery holder off its lid. The lid is held captive by a strip of Velcro®. The battery holder is captive to the pump by wires.



4. Insert two AA cells into the battery holder, taking care to put them in the proper orientation as indicated.



5. Replace the battery holder and lid in the reverse order.

Batteries will typically last approximately 45 hours of operation. The pumping speed will depend on the charge state of the batteries, as shown in Figure 7-1. Replace the batteries if the pump seems to be running slower than normal, or if it does not run at all. Replacement batteries can be obtained from Campbell Scientific as pn #26064, but can usually be sourced locally. Any type of AA cells may be used: rechargeable or disposable.

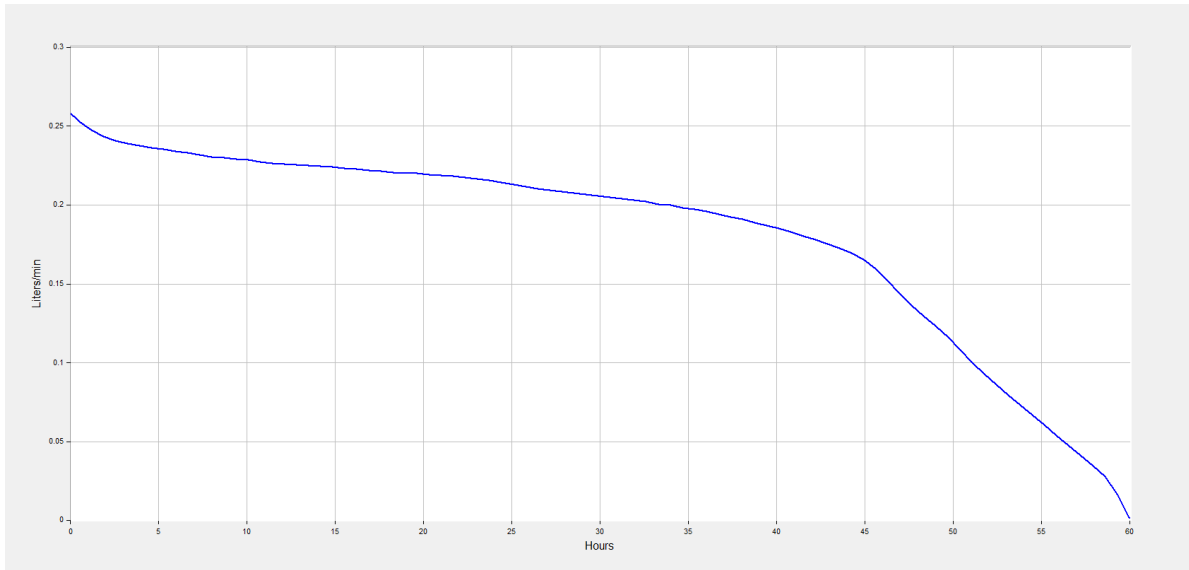
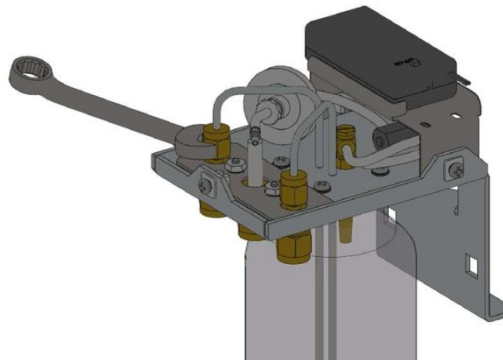


Figure 7-1. Pumping speed relative to hours of use, indicating time for battery replacement

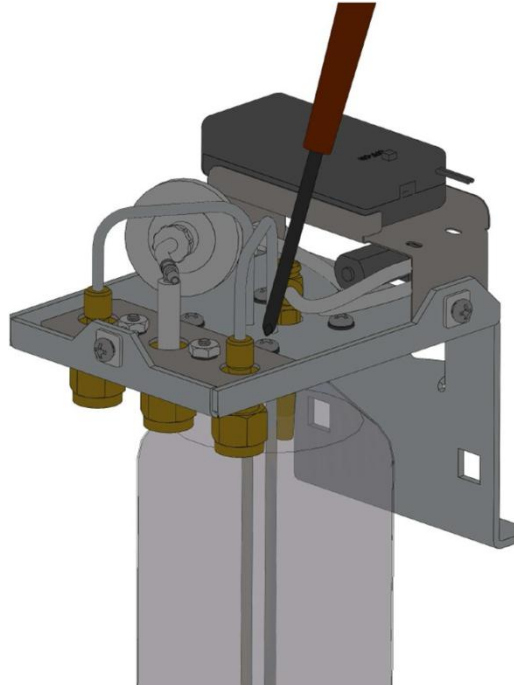
## 7.2 Replacing Molecular Sieve

The molecular sieve in the Zero Air Generator requires periodic replacement. Time for replacement can be determined by comparing the values of an air sample taken from the **Test** port to those of an air sample taken at the **Out** port as described in Section 6.1, *Theory of Operation* (p. 4). Two bottles of pn #27450 are needed to fill the bottle when replacing the molecular sieve material as described in the following steps and illustrations.

1. Loosen the three screws that attach the box lid as shown in step 1 of Section 7.1, *Replacing Batteries* (p. 8), and remove the lid.
2. Unscrew the two 1/8-in Swagelok® nuts.



3. Loosen the four screws that clamp the bottle cap to the bracket approximately one turn.



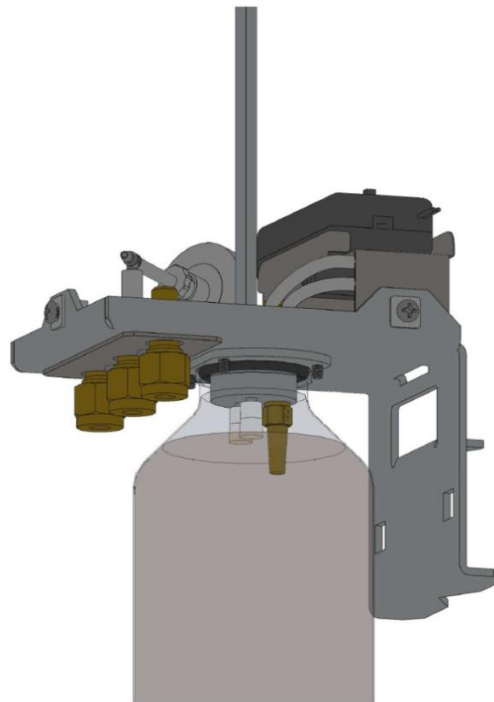
4. Slide tubes out until filters touch the bottle cap.

**NOTE**

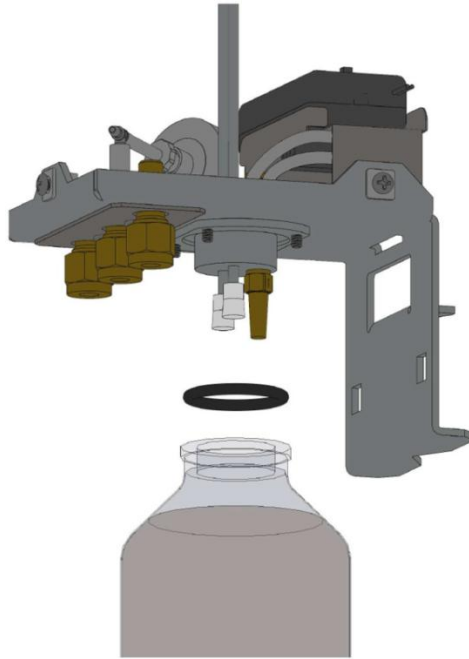
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Pull gently at first increasing force just until the tubes begin sliding out. Stop pulling when you feel the filter touch the bottle cap. Pulling too hard will pull the filter off the end of the tube.

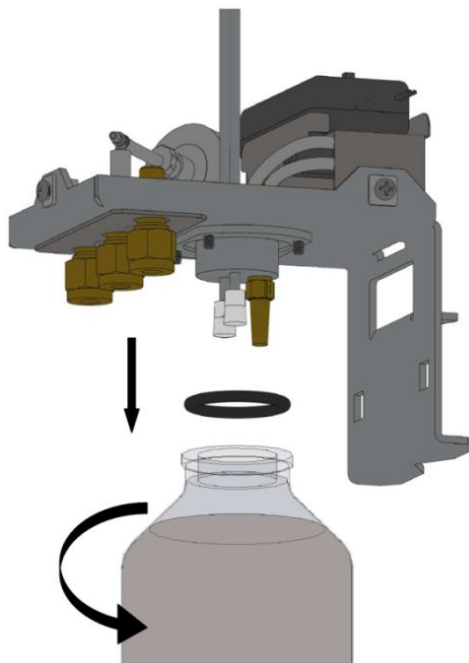
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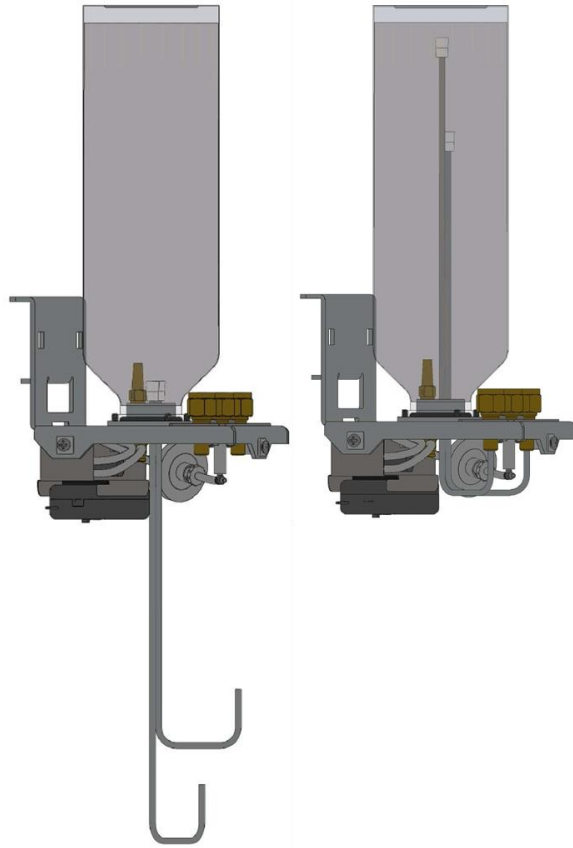
5. Remove the bottle, keeping it upright to avoid spilling the contents, and set the O-ring aside for reassembly.



6. Empty the old molecular sieve into a disposal container and dispose according to local regulations.
7. Fill the bottle with new molecular sieve until the sieve is mounded as much as possible. Jiggle the bottle slightly to settle the beads and make room for the tubes and filter.
8. Place O-ring on top of the bottle and secure the cap tightly to the bottle.



9. Invert the bottle assembly so the tubes can be more easily pushed in to the molecular sieve.



10. Tighten the two 1/8-in Swagelok® nuts.
11. Tighten the four screws that clamp the lid to the bracket.
12. Reattach the box lid and tighten the screws until snug.

### 7.3 Replacing Filter

The Zero Air Generator's inlet filter is likely to last several years with normal usage. Heavy use in dirty environments may eventually clog the filter causing a reduction of air flow. If the inlet filter becomes plugged it may be replaced with pn #29998 through the following steps.

1. Loosen the three screws and remove the box lid.
2. Twist the fittings on each side of the filter to remove the filter.
3. Replace the filter with pn #29998.
4. Tighten the fittings securely to avoid leakage.
5. Reattach the box lid and tighten the screws until snug.

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