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ISA-44RAL-OD
ISA-44RAH-OD
Operation and Maintenance
Manual

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Reference information:

NOTE: [important information about use of instrument – if not followed may have to redo some steps.]

CAUTION: [affects equipment – if not followed may cause damage to instrument, sensor etc...]

WARNING: [affects personnel safety – if not followed may cause bodily injury or death.]

1.0 Introduction

Sandblasting, welding and spray painting are examples of activities that create potentially hazardous environments. Such environments contain toxic gases, dust and fumes. An air compressor system with hoods or masks supplies clean breathing air to workers and minimizes the risk of injury or death; however, carbon monoxide (CO) can contaminate the air in a compressor system. Carbon monoxide contamination can occur either when the intake air itself is contaminated, or when the compressor breaks down and overheats. Because of this hazard, Federal OSHA regulations (Sec. 1910.34) require monitoring of CO in compressed air systems. In addition, the Compressed Gas Association has set up guidelines governing maximum tolerable levels of CO and other contaminants (Spec. G-7.1) to ensure the health and safety of persons who use respiratory air lines.

The ENMET ISA-44RAL-OD monitors the carbon monoxide and oxygen levels in compressed air used for human breathing. If the CO concentration exceeds any predetermined levels, the ISA-44RAL-OD will trigger audio-visual alarms and activate any associated equipment to alert personnel in potential danger. In addition, if the oxygen concentration falls below a predetermined level, the instrument will again alarm in the same manner.

This instrument is designed to operate continuously; there is no on/off switch. Therefore, the ISA-44RAL-OD should be left on 24 hours a day. The instrument should not be unplugged at night or at the end of a workshift. In addition, air must flow over the sensors continuously whenever the unit is in operation.

1.1 Operating Principle

The ISA-44RAL-OD is an all solid-state electronic gas-detecting instrument designed to continuously monitor the carbon monoxide and oxygen levels in compressed air. The CO sensing element is a gas-sensitive metallic oxide semiconductor (MOS sensor). A regulator humidifier assembly collects and humidifies a small air sample from the respiratory air line and passes it over the sensor. If the level of CO in the air passing over the sensor increases to preset value, the ISA-44RAL-OD alarms with audio (audio alarm) and/or visual (light) signals.

The sensor for the oxygen channel is a micro-fuel cell. It employs a galvanic reaction to emit a steady current. This current indicates the presence of oxygen to the circuitry. If the oxygen level drops, the current emitted also drops proportionally. When the current from the cell falls below a predetermined safe level, the alarm circuitry triggers.

The sensing elements of the ISA-44RAL-OD are sensitive to large scale temperature changes. Although this is usually not a problem with compressed air lines, if the air sample which passes over the sensors is subject to large temperature changes, the ISA-44RAL-OD may go into false alarms.

The percent oxygen (% oxygen) meter is a linear device. All regions of the meter scale represent approximate concentrations. It differs from the ppm carbon monoxide (ppm CO) meter, which is not linear.

The ISA-44RAL-OD operates from single-phase 115Vac and/or 12Vdc power and is equipped with relay contacts to provide additional alarm signals. Operation on single-phase 220 Vac requires several circuitry changes. Contact ENMET or your distributor for this information.

1.2 ISA-44RAH-OD

The ISA-44RAH-OD is designed to monitor breathing air from cylinders at pressures up to 5000 psi. The equipment consists of an ISA-44RAL-OD with the addition of a high pressure regulator at the sample air input as shown in Figure 1a. The high pressure regulator must be plugged into the high pressure line with an appropriate fitting; the output is connected to the ISA-44RAH-OD by means of a quick release pneumatic fitting. The operation of the ISA-44RAH-OD is identical with that of the ISA-44RAL-OD, and calibration is also identical; the high pressure regulator is removed from the sample input and the calibration procedures given in this manual are employed.

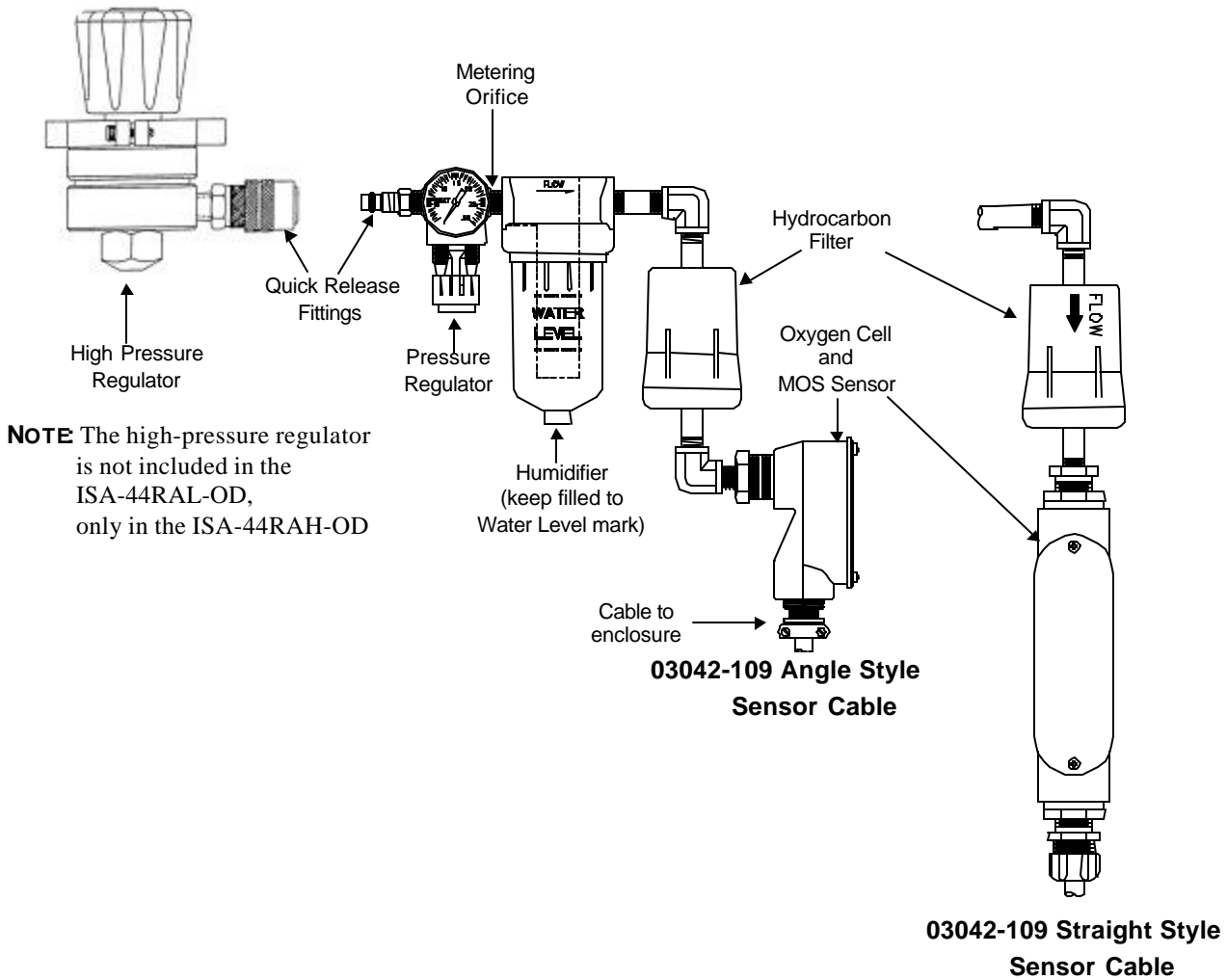


Figure 1a: Sample Head Assembly, Typical High Pressure Hook-up

2.0 Upon Receipt

2.1 Unpack

Unpack the ISA-44RAL(RAH)OD and examine it for shipping damage. If such damage is observed, notify both ENMET customer service personnel and the commercial carrier involved immediately.

Regarding Damaged Shipments

NOTE: It is your responsibility to follow these instructions. If they are not followed, the carrier will not honor any claims for damage.

- This shipment was carefully inspected, verified and properly packaged at our company and delivered to the carrier in good condition.
- When it was picked up by the carrier at ENMET, it legally became your company's property.
- If your shipment arrives damaged:
 - Keep the items, packing material, and carton "As Is." Within 5 days of receipt, notify the carrier's local office and request immediate inspection of the carton and the contents.
 - After the inspection and after you have received written acknowledgment of the damage from the carrier, contact ENMET Customer Service for return authorization and further instructions. Have your Purchase Order and Sales Order numbers available.
- ENMET either repairs or replaces damaged equipment and invoices the carrier to the extent of the liability coverage, usually \$100.00. Repair or replacement charges above that value are your company's responsibility.
- The shipping company may offer optional insurance coverage. ENMET only insures shipments with the shipping company when asked to do so in writing by our customer. If you need your shipments insured, please forward a written request to ENMET Customer Service.

Regarding Shortages

If there are any shortages or questions regarding this shipment, please notify ENMET Customer Service within 5 days of receipt at the following address:

ENMET Corporation
680 Fairfield Court
Ann Arbor, MI 48108
734-761-1270 734-761-3220 Fax

2.2 Check Order

Check the contents of the shipment against the purchase order. Verify that the ISA-44RAL-OD / ISA-44RAH-OD is received as ordered. If there are accessories on the order, ascertain that they are present. Check the contents of calibration kits. Notify ENMET customer service personnel of any discrepancy immediately.

2.3 Serial Numbers

Each ISA-44RAL-OD / ISA-44RAH-OD is serialized. These numbers are on tags on the equipment and are on record in an ENMET database.

3.0 Features / Definition of Parts

3.1 Electronics Control Unit

3.1.1 Carbon Monoxide Detection Channel

Refer to Figure 1

FEATURE	DESCRIPTION
POWER LIGHT (GREEN)	Light on: Channel operating Light off: Alarm condition or power interrupted.
ALARM LIGHTS	Visual alarms (steady lights). AMBER: unit in low level alarm. RED: unit in high level alarm.
AUDIO ALARM	Audio alarm: activates when high alarm level is exceeded.
METER	A CO concentration meter. The scale is marked in parts per million (ppm) CO. This is a non-linear device. <i>Do Not Infer Exact Readings From Unmarked Regions Of The Meter Scale.</i>
OPERATION SWITCH*	A rotary switch. Operate: normal MOS sensor operation Purge: Purges (cleans) MOS sensor by heating it to very high temperatures. Sensor inoperative as a CO detector. Horn Off: Deactivates audio alarm during calibration and maintenance.
CABLE	Oiltight. Connects the sample head assembly to the control unit.

3.1.2 Oxygen Detection Channel

Refer to Figure 1

FEATURE	DESCRIPTION
POWER LIGHT (GREEN)	Light on: channel operating. Light off: alarm condition or power interrupted.
ALARM LIGHT (AMBER)	Visual alarm (steady light). Light on: channel in alarm.
AUDIO ALARM	Audio alarm; activates when oxygen channel goes into alarm (amber light).
METER	Oxygen concentration meter. The scale is marked in % oxygen. The oxygen meter scale is linear - the points on the meter accurately correspond with the oxygen concentration in the monitored air
OXYGEN GAIN ADJUST	Rotary component which adjusts the meter reading during calibration, testing or sensor replacement.
OPERATION SWITCH*	Same as for CO channel.
CABLE	Same as for CO channel.

* Older equipment has separate PURGE and HORN OFF switches.

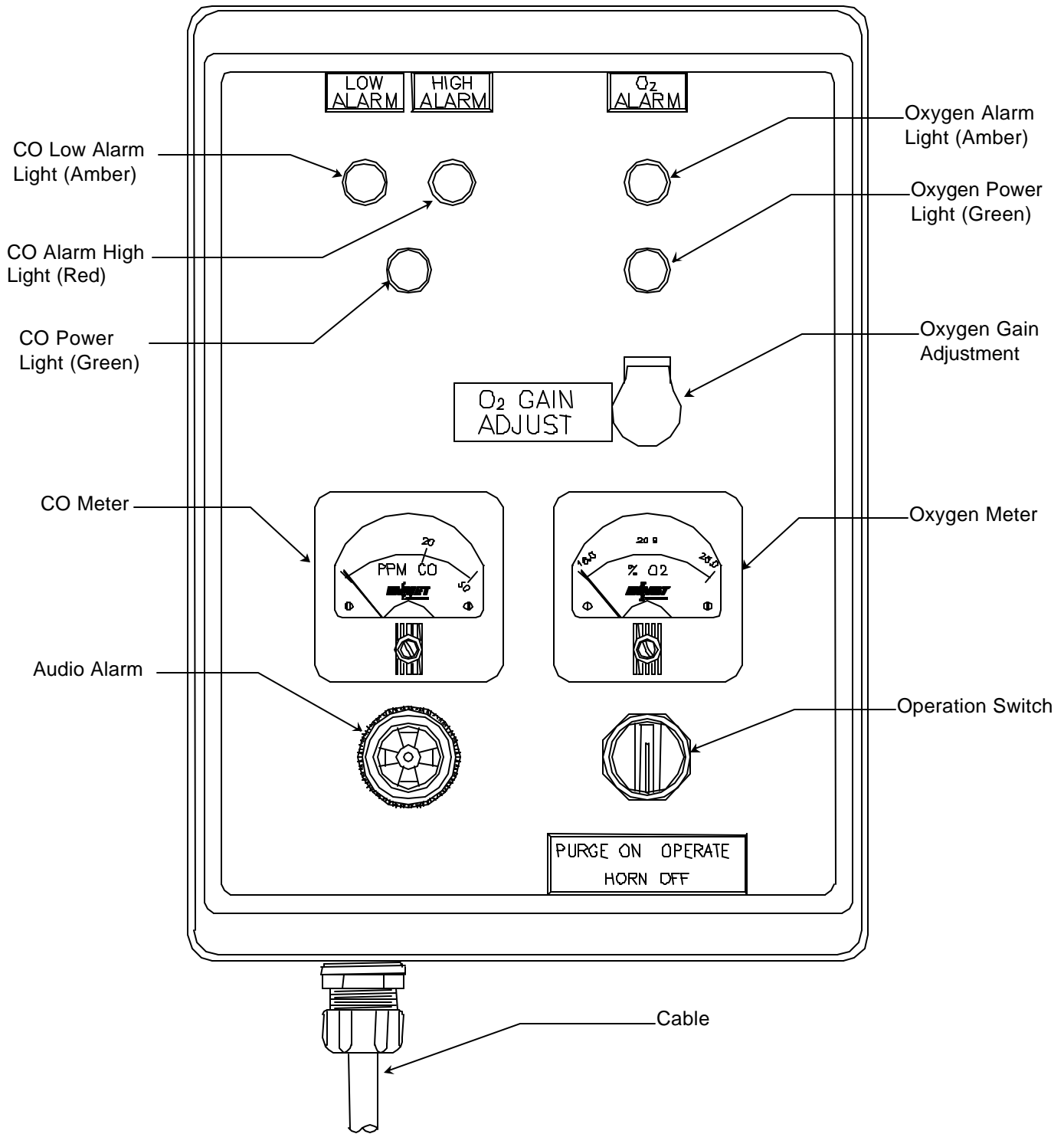


Figure 1: Control Unit Features

3.2 Internal Electronic Circuitry

Figure 2 shows the circuit board and terminal blocks housed inside the hinged oiltight control unit. Specific relays and adjustments are defined:

INTERNAL RELAY CONTACTS: Relays can be used to activate an external remote alarm system when a hazardous CO level is detected. These are double-pole relays (Figure 2 upper right) with terminals "normally open"(N.O.), "normally closed"(N.C.), and "common"(COM.) (See Figure 3 and Section 4.0 for relay contact hook-up). There is one relay for each alarm level (2 alarm levels for CO, 1 for oxygen).

NOTE: Relay contacts are shown in the de-energized state (power off).

NOTE: If you want the relays to activate auxiliary equipment when the power to the control unit is interrupted, you must connect the relays to an external power source. See Figure 3a.

POTENTIOMETERS: The unit has 9 potentiometers. These adjust critical circuit resistances and are essential to calibration procedures.

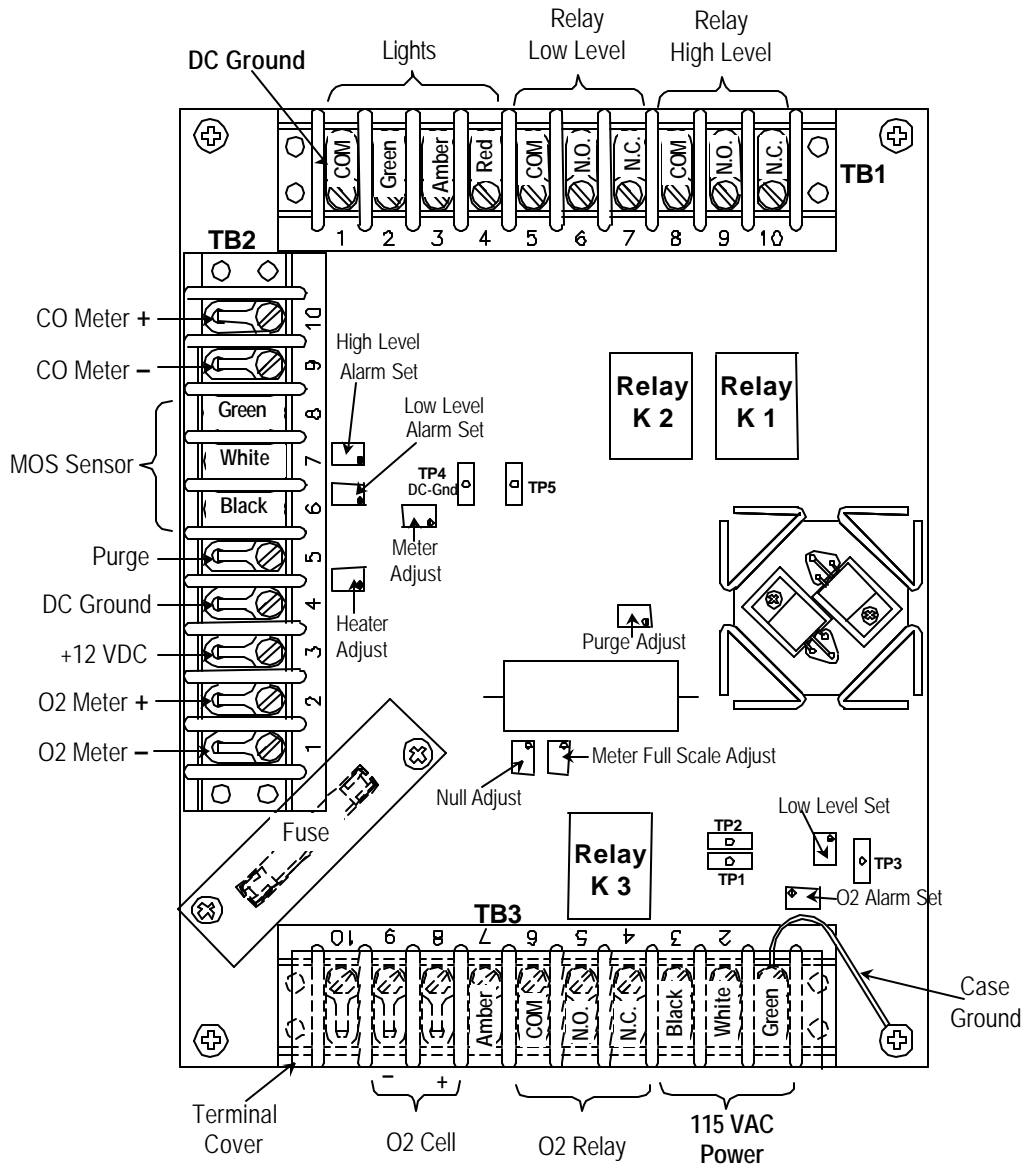


Figure 2: Circuit Board with Terminal Blocks

3.2.1 CO Circuit

Refer to Figure 2

PURGE ADJUST POTENTIOMETER	Adjusts purge voltage. Operation switch must be in purge position to adjust purge voltage.
HEATER ADJUST POTENTIOMETER	For adjusting the MOS sensor heater operating voltage. DO NOT adjust this potentiometer unless a voltage reading indicates that an adjustment is necessary. (May need adjusting after replacing sensor cable assembly). Voltage: .86 Vdc + .03 Vdc
METER ADJUST POTENTIOMETER	To adjust and set the meter for appropriate gas response during calibration.
LOW LEVEL ALARM SET ADJUST POTENTIOMETER	For adjusting the trip level of the CO low level alarm light.
HIGH LEVEL ALARM SET ADJUST POTENTIOMETER	For adjusting the trip level of the CO high level alarm light and the audio alarm.

3.2.2 Oxygen Circuit

Refer to Figure 2.

OXYGEN ALARM SET	For adjusting the trip level of the audio alarm and the amber oxygen alarm light.
NULL ADJUST	For adjusting oxygen circuit voltage during calibration.
METER FULL SCALE ADJUST	For adjusting full scale meter reading during calibration.
LOW LEVEL SET	For adjusting oxygen circuit voltage during calibration.

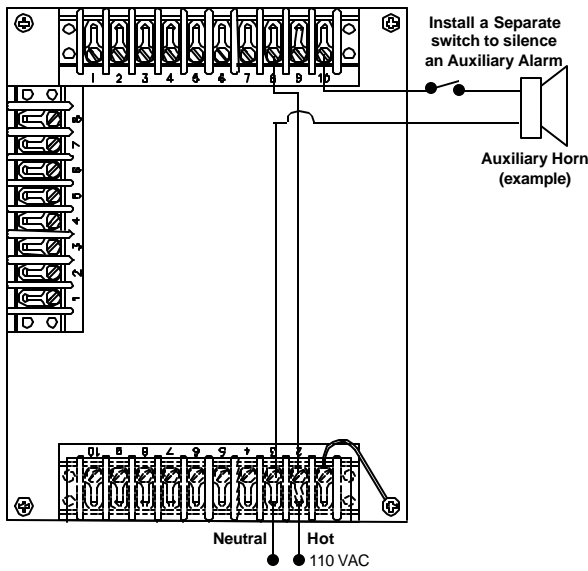


Figure 3: Relay Hook-up, Internal Power

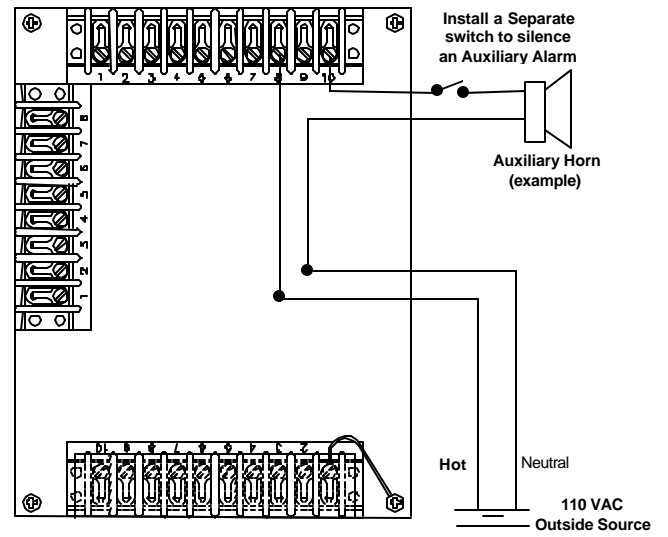


Figure 3a: Relay Hook-up, External Power

Figure 3: Relay Hook-up, Power Internal and External

3.3 Sample Head Assembly

The sample head connects to a compressed air line. This unit continuously monitors the respiratory lines for carbon monoxide and oxygen. Figure 4 illustrates this unit. Assembly parts are listed and defined below:

PRESSURE REGULATOR:	Reduces the pressure of sample air from the compressed air line before passing over the sensor. It includes a meter to measure the pressure in pounds per square inch (psi) at the regulator exit.
QUICK RELEASE PNEUMATIC FITTING:	For quick connect/disconnect; fits into the port of an air line or filter unit and an ENMET calibration gas fixture. Air inlet fitting is a Milton 727, which is compatible with Hansen 1000 series. This fitting also connects with the exit fitting of the high pressure regulator on an ISA-44RAH-OD. If you substitute other fittings, the calibration fixture must also be changed.
HUMIDIFIER:	This adds moisture to the air sample that passes over the sensor, which is a requirement for correct sensor operation.
METALLIC OXIDE SENSOR (MOS Sensor):	Solid-state gas sensing element, contained in the sensor housing. When the amount of CO in the air passing over the sensor increases to a preset level, the equipment alarms and relays activate.
METERING ORIFICE:	This replaceable assembly has a tiny orifice (hole) to ensure constant flow of air between the humidifier and pressure regulator.
ELECTROCHEMICAL SENSOR:	Oxygen sensing element, contained in the sensor housing.
Hydrocarbon Filter	To enhance low level calibrations by removal of hydrocarbon vapors from the air sample.

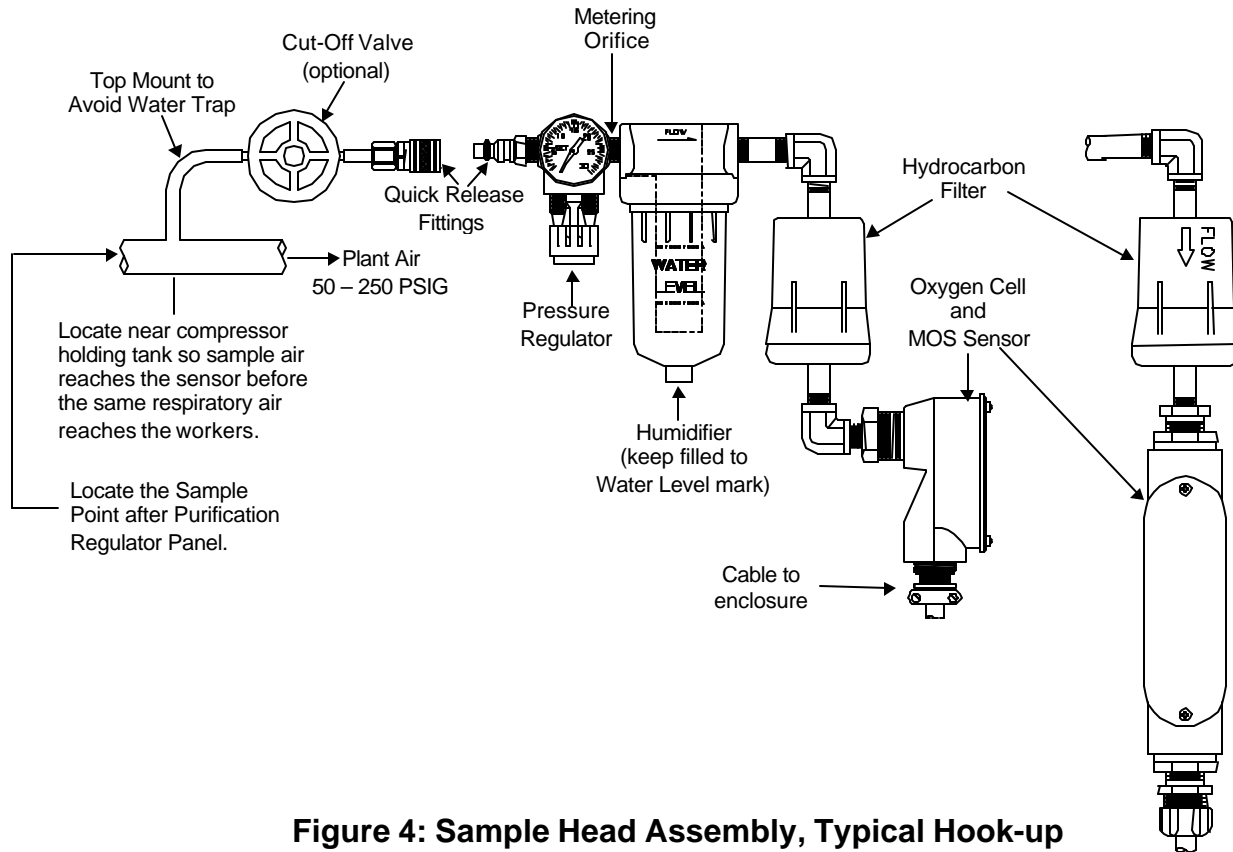


Figure 4: Sample Head Assembly, Typical Hook-up

4.0 Installation

After becoming familiar with the main parts and their functions, follow the installation procedure as outlined below:

1. Choose an appropriate location for mounting the electronics control unit. Do not locate the sampling head assembly in an area where quick temperature changes are likely to occur, like near an outside door. The oxygen cell is sensitive to temperature and the circuitry for this cell cannot track rapid changes in temperature. A rapid change in temperature may cause nuisance alarms, especially for those units calibrated to alarm at a percent near the normal fresh air volume (20.9%).
2. The three terminal block positions shown in Table 1 below (TB3-4, TB3-5, TB3-6) are attached to relay K3 (see Figure 2) and are available as a switch to activate any remote alarms or equipment when the oxygen alarm triggers. This relay has a rating of 2 amps continuous, 5 amps surge at 110Vac. When power is interrupted, this relay switches to the same position as in an oxygen-deficient situation.

Table 1: Oxygen Alarm Relay Contacts

Position	Function	Relay
TB3-4	Normally Closed	K-3
TB3-5	Normally Open	K-3
TB3-6	Common	K-3

3. The six terminal block positions shown in Table 2 below (TB1-5 - TB1-10) are attached to the two CO alarm relays, K-1 and K-2 (see Figure 2). These positions are available as switches to activate any remote alarms or equipment when either the CO low alarm or CO high alarm triggers. These relays have the rating of 2 Amps continuous, 5 Amps surge at 110Vac. When power is interrupted, these relays switch to the same position as in a gas alarm situation.

NOTE: K-1 is the relay for the CO low alarm.

K-2 is the relay for the CO high alarm.

Table 2: CO Alarm Relay Contacts

Position	Function	Relay
TB1-5	Common	K-2 CO low alarm
TB1-6	Normally Open	K-2 CO Low alarm
TB1-7	Normally Closed	K-2 CO Low alarm
TB1-8	Common	K-1 CO High alarm
TB1-9	Normally Open	K-1 CO High alarm
TB1-10	Normally Closed	K-1 CO High alarm

4. Run the relay contact leads through the oiltight fitting for the power supply leads. If you want to run the relay contact leads through another part of the enclosure, drill a hole in the side or bottom of the enclosure and use a NEMA 4X oiltight fitting.

NOTE: The ISA-RAL-OD is completely oiltight. Use the correct oiltight fitting for the cord or conduit when supplying power to the unit.

NOTE: The ISA-44RAL-OD is engineered for respiratory air lines having 50 - 250 PSI. If your air line has a higher pressure, you must use the ISA-44RAH-OD (see Section 1.2).

NOTE: If used in conjunction with an ENMET air filtration panel, the ISA-44RAL-OD can be mounted on the air filtration panel mounting plate. Attach the RAL-OD assembly to the quick disconnect fitting on the air filtration unit.

- Apply 115 Vac and/or 12 Vdc power to the appropriate terminals (refer to Figure 2). As an emergency back-up power source, both ac and dc power can be applied at the same time. Current will flow from the ac source. DC current will flow only when the ac power is interrupted.

NOTE: 220 Vac power requires a change in the transformer hook-up. This change is best done at ENMET or an ENMET service center.

- Attach the sample head of the ISA-44RAL-OD to the respiratory air line so that the sample air reaches the sensors before the same respiratory air reaches the workers. If you have any problems involving the location of the unit, contact your distributor or ENMET personnel. A technician will analyze the problem and provide recommendations for a location.

CAUTION: Do not use a rubber hose to connect regulator to air line. This will cause inaccurate, upscale meter readings.

CAUTION: Do not locate the sample point on a low spot in the line. Water condensation may clog or damage the regulator or sensor assembly. If you must locate the sample point at a low spot, install a water trap between the air line and the sample head assembly.

NOTE: Because the ISA-44RAL-OD will be operating continuously, make sure that air is flowing over the sensors continuously. Sensors exposed to stagnant or non-moving air may overheat or become contaminated.

NOTE: If pressure is applied to the regulator input, and air is not bubbling through the humidifier, the metering orifice is probably plugged; you should replace it (Section 7.1).

- Add tap water to the humidifier up to the Water Level mark.
- Adjust the pressure regulator to align the gauge needle with the black dots marked "...SET" or between 7 – 12 PSI on the dial.
- Proceed to Section 5.0.

5.0 Initial Warm Up and Operation

5.1 Carbon Monoxide Detection Channel

Mount and install the ISA-44RAL-OD as outlined in Section 4.0.

NOTE: The unit has no ON/OFF switch. This safety monitoring device is designed to be powered and on at all times.

- Rotate the operation switch to PURGE ON. This will silence the audio alarm, both alarm lights may go on soon; don't worry, this is normal. They will turn off after awhile.
- While operation switch is in PURGE ON position, measure purge voltage across TB2-6 and TB2-7. It should be 1.6 Vdc +/- .03 Vdc. If not 1.6 Vdc +/- .03 Vdc, adjust Purge Adjust Potentiometer (see Figure 2) until desired reading is shown. Turn operation switch to HORN OFF position and measure sensor heater voltage across TB2-6 and TB2-7. It should now read 0.86 Vdc +/- .03 Vdc. If not 0.86 Vdc +/- .03 Vdc, adjust Heater Adjust Potentiometer (see Figure 2) until desired reading is shown. Turn operation switch back to PURGE ON position.
- Let clean air pass over the sensors for at least one hour. *Clean Air Must Pass Over The Sensor.* If you suspect contaminated air or dirty conditions in your compressor, use bottled clean air. DO NOT operate the unit without air passing over the sensor. If you do, you may contaminate or burn out the sensor.
- The sensor is purged when the amber alarm light goes out, and the meter has stabilized.
- Turn operation switch to HORN OFF position. Some meter drift is normal. The unit may show both green and red lights momentarily at this point. This is also normal. After the sensor becomes stable, the red light will deactivate and the green light will remain on, which is the normal operating state.
- Turn the operation switch to OPERATE position.

Table 3: Reference, State of Operation of ISA-44RAL-OD / ISA-44RAH-OD

Normal operating state	<ul style="list-style-type: none"> No alarms Green light on
Alarm state	<ul style="list-style-type: none"> Green light off Amber light (low level alarm) or Amber light, Red light and Audio Alarm (high level alarm) Appropriate relay contacts in alarm position
Sensor fault or disconnected	<ul style="list-style-type: none"> Green and red light on together.

5.2 Oxygen Detection Channel

After installation is completed, the oxygen meter must be adjusted to a clean air reference point of 20.9% oxygen by volume. The equipment necessary for this is included in a calibration kit for ISA-44RAL-OD / RAH-OD units, ENMET part number 03430-001.

1. Turn operation switch to **HORN OFF** position.
2. Connect the calibration fixture to the bottled clean air (20.9% oxygen) and attach the calibration fixture to the quick-release fitting on the low pressure regulator. If you have an ISA-44RAH-OD unit, first disconnect the high-pressure regulator attached to the incoming air line until you are finished.
3. Open the small regulator on the calibration fixture to release clean air into the sampling head assembly. Keep opening the small regulator until the needle on the pressure gauge rises to the "...SET" mark or between 7 – 12 PSI.
4. After exposing the oxygen cell to clean air for 3-5 minutes (use bottled 20.9% oxygen if necessary), dial down the oxygen Gain Potentiometer on the front panel of the unit so that the meter needle passes the alarm point. At that point, the amber light should go on. If the alarm does not go on at the specified oxygen alarm point, recalibrate the oxygen channel (Section 6.2). In addition, while the unit is in alarm, turn the horn switch on briefly to verify that the audio alarm works.
5. Dial the oxygen Gain Potentiometer up again and leave the meter at 20.9%. Before closing the small regulator on the calibration fixture and detaching it from both the low pressure regulator and the clean air cylinder, make sure the pressure is equalized (regulator for sample head reads zero). If you do not wait until the pressure is equalized, the pressure will cause a backflow of water from the humidifier, which will damage the sensor.
6. The initial adjustment is complete. Turn the audio alarm back on and reattach the high pressure regulator if you have one.

5.3 Quick Field Tests

5.3.1 Carbon Monoxide Detection Channel Field Test

To Verify The Instrument's Response Capability. Use a cylinder of high-level CO/air mixture (for example, 200 ppm CO for a 20 ppm CO calibrated unit) with a quick-disconnect gas fixture. See Figure 5.

1. Turn operation switch to **HORN OFF** position.
2. Remove the compressed air line from the sample head assembly. Insert the test gas.
3. Open the small regulator on the calibration fixture to release clean air into the sampling head assembly. Keep opening the small regulator until the needle on the pressure gauge rises to the "...SET" mark or between 7 – 12 PSI.
4. Meter should move upscale in less than 20 seconds and read full-scale within one minute.

Whenever you use a test gas containing a level of gas greater than the calibration level, the meter swings upscale, green power light goes out, red alarm light goes on, and relay contacts "close" to trigger any remote alarms being used.

This Test Is To Verify Response Capability; It Does Not Imply Correct Calibration. If The Test Does Not Bring The Unit Into Alarm, Contact ENMET Personnel Or An Authorized Service Center.

5.3.2 Air Quality and Pressure Adjustments

For the OXYGEN DETECTION CHANNEL: Atmospheric conditions and conditions inside your air compressor are constantly changing. In order to maintain a clean oxygen reading of 20.9% oxygen the oxygen Gain Potentiometer must be adjusted periodically. Check the oxygen meter daily. If it continually shows a percentage other than 20.9% for 15 minutes in the presence of compressor air, double check that the compressor air is really clean by exposing the cell to bottled clean air from a pressurized cylinder. During exposure to bottled air, if the meter still does not read 20.9% (especially if it is higher), adjust the oxygen Gain to reference clean air.

The electrochemical oxygen cell current output is directly proportional to the partial pressure of the oxygen in the atmosphere surrounding the cell. The partial pressure of oxygen is a function of the percent by volume of oxygen in the air and the air pressure.

Air pressure varies as natural weather systems move through the area, causing changes in barometric pressure as well as oxygen content. The barometric pressure changes cause a relatively small change in oxygen content indication; for example, if the gain is set to give an oxygen content meter indication of 20.9% oxygen when the barometric pressure is 29.9 inches of mercury, normal variations of barometric pressure cause variations in meter readings of + 0.25%, from 20.75% to 21.15%.

If the gain is set during a normal high pressure weather cycle, the variation is 0.50% downscale; conversely, if the gain is set during a normal low, the variation is upscale.

This response to atmospheric pressure is not distressing when understood. The variation of the alarm point by + 0.25% is not significant when the liberal safety factor between the alarm point, usually 19.5%, and the point at which oxygen deficiency first emphatically affects human performance, approximately 16%, is taken into consideration.

PRECAUTIONS

DO NOT: expose the oxygen cell to temperatures below 32 F (0 C) or above 130 F (55 C).

NEVER: adjust the oxygen cell when the air passing over it may be oxygen deficient. Always adjust the cell in the presence of CLEAN AIR.

AVOID: gross exposure to toxic gases. Pure gases, liquid hydrocarbons (butane, propane, gasoline etc.), lacquer fumes, and cigarette smoke should be kept away from the oxygen cell.

If you wish to recalibrate to a different alarm point, consult an authorized ENMET service center or ENMET personnel directly.

5.4 Humidifier

Periodically check the humidifier water level, and add water when required to maintain proper water level. Operating the equipment with a dry air sample and no water in the humidifier bowl renders the carbon monoxide sensor ineffectual.

6.0 Calibration

6.1 Carbon Monoxide Detection Channel Calibration

The following procedure is for checking the calibration level and for recalibrating the Carbon Monoxide Channel of the ISA-44RAL-OD. Refer to Figure 5 and Figure 2.

Perform A Complete Recalibration Periodically (at least monthly) and:

- When you replace the sensor.
- When the sensor encounters severe conditions (i.e., gross exposure to smoke or liquid hydrocarbon).

MATERIALS

- Cylinders of calibration gas of known CO concentration in air (i.e. 20 ppm and 50 ppm CO in air.).
DO NOT use CO in an inert carrier gas, such as nitrogen or argon.
- Calibration gas fixture (with quick-disconnect fitting – ENMET part number 03605-001)
- Small screwdriver (for potentiometer adjustment)
- dc voltmeter

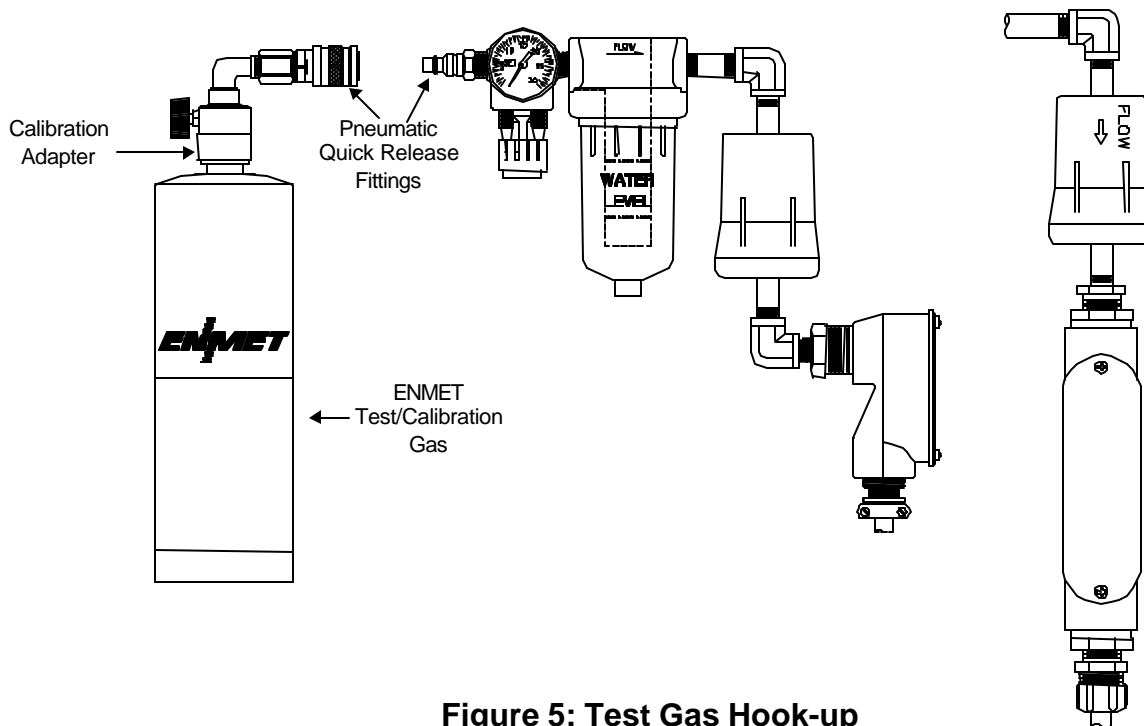


Figure 5: Test Gas Hook-up

PROCEDURE

1. Turn operation switch to **HORN OFF**. Be sure humidifier bottle is filled with tap water to Water Level mark.
2. Turn operation switch to **PURGE ON**. Measure purge voltage across TB-6(+) and TB2-7(-). It should be 1.6 Vdc +/- .03 Vdc. If not 1.6 Vdc +/- .03 Vdc, adjust Purge Adjust Potentiometer (see Figure 2) until desired reading is shown. Turn operation switch to **HORN OFF** and measure sensor heater voltage across TB2-6 and TB2-7. It should now read 0.86 Vdc +/- .03 Vdc. If it is not 0.86 Vdc +/- .03 Vdc, adjust Heater Adjust Potentiometer (see Figure 2) until desired reading is shown.
3. Turn operation switch back to **PURGE ON**. Purge at least one hour, up to overnight.

REMEMBER: If you suspect contaminated air in your compressor system, use clean bottled air to supply the sensors with a continuous airflow.

4. After purging, turn operation switch to **OPERATE**. Allow 30 minutes to stabilize.
5. Remove the compressed air line and insert the calibration apparatus (see Figure 5).

6. Turn operation switch to **HORN OFF**. Open the regulator on the top of the high-level calibration gas cylinder. This brings the gas into the sampling assembly.
7. Regulate the flow of calibration gas according to the "...SET" mark or between 7 – 12 PSI on the pressure regulator dial.
8. Let the high-level calibration gas flow into the system for 5 minutes. This assures a full and balanced response from the sensor. During this time, the meter should have risen above the low-level alarm point and the amber light should have gone on.
9. With the gas still flowing, adjust the Meter Adjust Potentiometer with a small screwdriver (adjust this pot CCW to increase, CW to decrease meter reading). You want to have the same meter reading as the calibration gas concentration. This sets the alarm point. Refer to Figure 2.

Note: Do not adjust for instantaneous alarm when test gas is first released. If you do, the calibration will be inaccurate, and the sensor will be overly sensitive.

10. Adjust the High Level Alarm Set Adjust Potentiometer CCW until the red alarm light is just barely triggered. At this point, verify the audio alarm is operational by turning the operation switch to **OPERATE** momentarily.

NOTE: If red alarm light is on prior to the potentiometer adjustment, adjust this pot. cw until the light deactivates, then readjust CCW until the light just barely activates.

11. Shut off the calibration gas flow (at the regulator on the gas cylinder).
12. Allow pressure to equalize – wait until the pressure meter on the humidifier-regulator assembly reads zero. Remove calibration fixture, and reconnect humidifier-regulator assembly to compressed air line. Allow air to flow over sensor for 10 minutes to clear the sensor.
13. In a similar manner, apply the low level calibration gas for five minutes
14. While the gas is still flowing, adjust the Low Alarm Set Adjust potentiometer CCW until the amber alarm light just activates.

NOTE: If amber light is on prior to pot. adjustment, adjust this pot. CW until light is off, then readjust CCW until light just activates.

IMPORTANT: The meter may not display the exact low level alarm.

DO NOT change the low level alarm meter reading unless grossly off (four meter needle widths or more). If far off, recalibrate the high alarm, meter reading (step 9).

15. Repeat step 11.
16. Repeat step 12.
17. Reconnect the sample head to the air line.
18. The flow of clean air should clear the unit from its gas alarm state within 3-5 minutes. After 5 minutes, turn the operation switch to **OPERATE**.
19. Clean compressed air lines will show a meter reading from 0 – 1/3 full scale. Green power light will indicate a clean condition.
20. Carbon Monoxide Detection Channel Calibration is complete.

Verify the operation switch is in the **OPERATE** position.

6.2 Oxygen Circuit Calibration

Refer to Figure 2

This procedure is given in reference to an S-2 cell, which is ENMET P/N 67013-008 as furnished as a replacement cell.

MATERIALS

- digital voltmeter
- small screwdriver

PROCEDURE

1. Turn operation switch to HORN OFF position.
2. Null Adjust
 - a. Disconnect the oxygen cell from the circuit by disconnecting leads at TB3-8 (+) (terminal block 3-position 8) and/or TB3-9 (-). Removing one lead is sufficient to break the circuit. See Figure 2.
 - b. Connect negative (-) voltmeter lead to TP-1 (test point one) and positive (+) voltmeter lead to TP-2 in the oxygen circuit. These are in the lower right hand corner of the printed circuit board.
 - c. Adjust the Null Adjust potentiometer to read 0.00 Vdc between TP-1 and TP-2.
3. Low Level Set:
 - a. Reconnect the oxygen cell to TB3-9(-) and TB3-8(+).
 - b. Make sure the oxygen cell is properly connected by measuring the voltage between TB3-9 and TB3-8. Voltage should read between .043 and .09 Vdc. Allow oxygen cell to stabilize for 15 minutes.
 - c. Connect negative lead of voltmeter to TP-1 and positive lead to TP-3 in the oxygen circuit.
 - d. Adjust the Low Level Set potentiometer to read .766 Vdc.
4. Full Scale Adjust:
 - a. Leave negative lead of voltmeter at TP-1 and connect positive lead of voltmeter to TP-2 in oxygen circuit.
 - b. Adjust oxygen gain potentiometer (on front panel of unit) so the voltmeter reads 1.24 Vdc.
 - c. Adjust Meter Full Scale Adjust potentiometer on circuit board so the meter on the front panel reads full scale (26%). Adjust this potentiometer cw to increase, ccw to decrease meter reading.
 - d. Verify that the oxygen alarm comes on at the predetermined alarm point (19.5%) on the meter. If it does not, repeat steps a. and b. in this section. If the oxygen alarm still does not come on, repeat the entire recalibration procedure checking terminal connections, testpoints and voltage settings very carefully. Contact your local Authorized ENMET Service Center if problems persist.
 - e. Adjust and leave the oxygen gain potentiometer at a meter reading of 20.9% (setpoint).
5. The oxygen cell calibration is now complete. Turn the operation switch to OPERATE

7.0 Routine Maintenance

Since the ISA-44RAL-OD/RAH-OD is a safety instrument, it requires periodic testing and recalibration. Refer to Operation and Calibration sections of this manual for testing and recalibration procedures.

AT REGULAR INTERVALS:

1. Rotate operation switch to PURGE ON. This interval varies with the amount of contaminants present in the air system, but purge for at least 10 minutes. Rotate operation switch to OPERATE when purging is complete.
2. Check the unit for mechanical damage or obvious malfunctions (i.e. burned-out lamps).
3. Check the oxygen channel response periodically.
4. Check the water level and verify air bubbles.
5. If the unit will not operate, check the fuse (See Figure 2). If this fuse is cracked or broken, replace it (ENMET part no. 64004-001). If the instrument remains inoperative after this fuse is replaced, send the instrument in for repair.

7.1 Replacement Parts

Table 4: Replacement Part Numbers

Description	ENMET Part #
Metering Orifice Assembly (s/n below 2311)	03415-000
Orifice	03415-001
Pressure Regulator	73089-000
Humidifier RAL Regulator Assembly	03406-000
Male Coupler Plug (quick-release fitting)	73061-000
Gauge (0 - 30 psi)	73089-003
Red, Lamp/LED-for units with s/n 2271 and below	52006-003 *
Green, Lamp/LED-for units with s/n 2271 and below	52006-001 *
Amber, Lamp/LED-for units with s/n 2271 and below	52006-002 *
Lamp-for units with s/n 2283 and above	63001-002
Lens, Red-for units with s/n 2283 and above	62012-001
Lens, Green-for units with s/n 2283 and above	62012-002
Lens, Amber-for units with s/n 2283 and above	62012-003
5 wire RAL-OD Cable Assembly (without oxygen cell)	03042-109
CO Meter	03411-000
Oxygen Meter	03411-005
Oxygen Cell, S-2	67013-008
Hydrocarbon Filter with hardware	73089-060
Fuse 1 Amp	64004-001

* Replaces 12RC lamps will appear different

7.2 Calibration Equipment

Table 5: Calibration Gas Part Numbers

Description	ENMET Part Number
10 ppm CO in air	03219-010
20 ppm CO in air	03219-020
50 ppm CO in air	03219-050
200 ppm CO in air	03219-200
20.9% oxygen in nitrogen	03296-209
17.0% oxygen in nitrogen	03296-170
Calibration Gas Fixture	03605-001
Carry Case	73083-000

7.3 Oxygen Cell Replacement

The oxygen fuel cell has a six-month warranty. The average lifetime of the cell is twelve months. Replace the cell when you can no longer adjust the oxygen gain potentiometer, outside on the front panel, so that the oxygen channel meter reads 21%. An oxygen circuit that is in constant alarm is a good indication that the oxygen fuel cell is either expired or grossly contaminated. See Figure 6

MATERIALS

- screwdriver

PROCEDURE

1. Obtain a new oxygen cell, ENMET P/N 67013-008.
2. Do not open the sealed package as soon as you receive it. Wait until you are ready to use the cell. The cell is packaged in nitrogen and begins its useful lifespan as soon as it comes into contact with oxygen.
3. Remove the two screws from the sensor housing cover.
4. Unpackage the new oxygen cell. Remove the "shorting clip" before installation. Your unit goes into alarm when you disconnect the oxygen cell, if it isn't already in alarm. The absence of a signal from the oxygen cell makes the circuitry react as if there is not enough oxygen in the air. Turn the operation switch to HORN OFF before disconnecting the oxygen cell.
5. Carefully unplug the old oxygen cell from the printed circuit board. Install the new cell (it may be necessary to clip off approximate 1/2 of the gold pins on the back of the new oxygen cell to make sure that the pins on the cell do not puncture the gasket on the sensor housing). See Figure 6. The alarm should shut off immediately after the new oxygen cell is plugged in. If it doesn't, you may have plugged in the oxygen cell backwards.
6. Replace the enclosure cover and screws.
7. Wait at least four hours for the oxygen cell to stabilize. Having been packaged in nitrogen, the cell must adjust to an environment with oxygen in it. The meter reading will be much higher than normal until the cell stabilizes. Don't bother adjusting the meter now; it will drift.
8. After at least four hours, verify the alarm point by adjusting the oxygen gain potentiometer (front panel of control unit) down to trigger the alarm.

NOTE: If, after following these steps, you are unable to trigger an oxygen alarm by adjusting the oxygen gain, check the voltage between the oxygen cell pins. It should be between .043 to .09 Vdc. If not, you have a defective oxygen cell. If the oxygen cell voltage is good and the alarm still does not trigger, contact your area's authorized ENMET service center or ENMET personnel directly.

9. Leave the meter set at 20.9%.
10. This procedure is now complete. Turn operation switch to OPERATE.

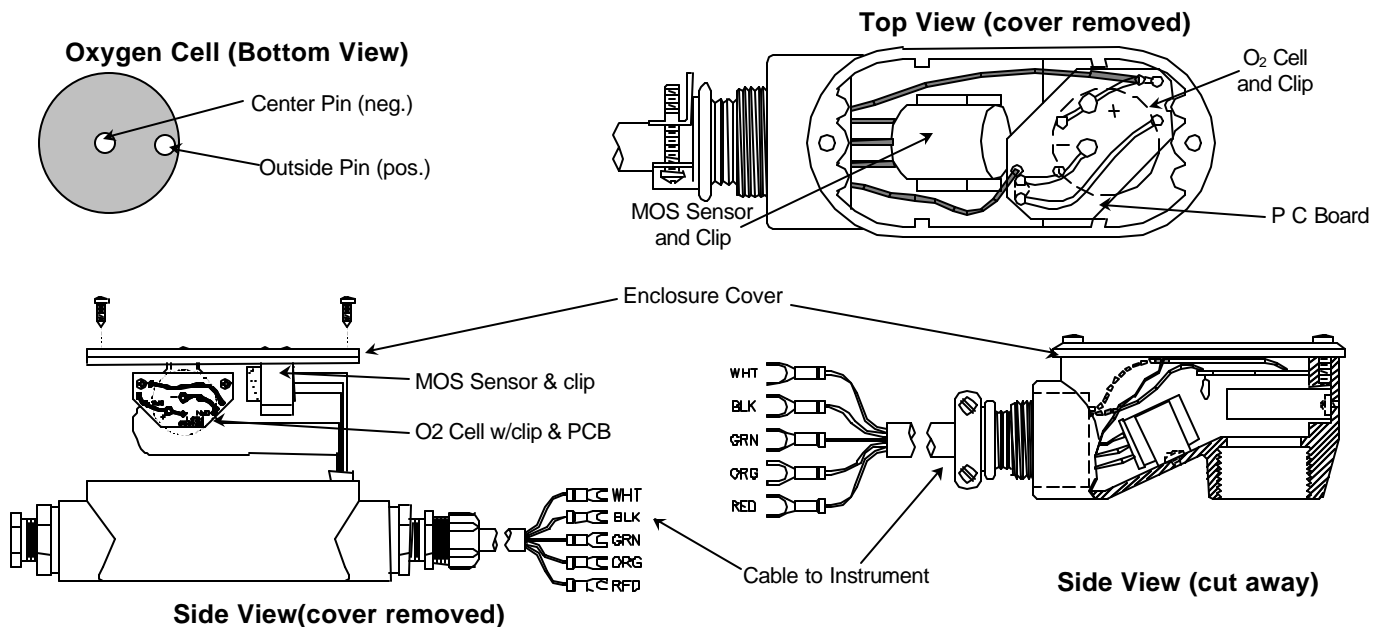


Figure 6: Housing, Oxygen Cell and MOS Sensor

7.4 Hydrocarbon Filter Replacement

The charcoal absorption filter for hydrocarbons will need periodic replacement. The length of time between replacement depends on the instrument usage and VOC (Volatile Organic Compounds) level in the breathing air supply. For ISA-RAL monitors that are in continuous air streams, 24 hours, 7 days a week 365 days a year it is recommended that the filter be replaced when any of these conditions occur:

- At least annually
- Any time fluid is found inside the filter
- Any time the filter is damaged
- If any odor is detected in the breathing mask

8.0 Specifications

Specifications are subject change without notice

MAXIMUM POWER	<ul style="list-style-type: none"> ◆ 117 Vac, 60 Hz, 25 watts ◆ 12 Vdc, 25 watts 	
RELAY CURRENT	2 amp steady, 5 amp surge @ 110Vac	
MOS SENSOR LIFE	Up to 3 years in clean air (no oil)	
RESPONSE TIME	Up to 5 minutes for low-level carbon monoxide gas calibrations	
MAXIMUM AIR		
LINE PRESSURE	250 PSIG (ISA-44 RAL-OD)	
SAMPLE FLOW RATE	Approximately .4 SCFH (Standard Cubic Foot Hour)	
OXYGEN MICRO-FUEL CELL		
OUTPUT	linearity error (0 – 100 % oxygen)	less than 0.5%
	at 0% oxygen	less than 2.0 ua
	nominal (in air @ 25 degrees C)	175 ua
	variation from nominal	+20%
RESPONSE TIME @ 25 DEGREES C (TYPICAL) 90%	30 seconds	
OPERATING TEMPERATURE RANGE	32 - 125 degrees F	
EXPECTED LIFE	up to 12 - 14 months in air	
ENMET WARRANTY	6 months	

8.1 Typical Calibrations

Hazardous Gas	Low Level Alarm Threshold	High Level Alarm Threshold
Carbon Monoxide	10 or 20 ppm	20 or 50 ppm
Oxygen Deficiency	19.5%	

8.2 Options and Variations

OPTIONS

- ◆ 220 Vac power input connection

VARIATIONS

- a) Available in an explosion-proof instrument housing, Models ISA-44-RALE-OD and ISA-44AHE-OD. With this, the equipment is suitable for operation in Class I, Division I, Group C and D atmosphere, as defined in the National Electrical Code. Units for Group B are available upon special order. DO NOT use the standard ISA-44RAL-OD where you are required by the National Electrical Code or local codes to use an explosion-proof variety.
- b) ENMET Filtration Panels filter oil, water and solid particles from compressed air.
 - AFS-50: equipped to distribute air to four respirators.

Ask for product bulletin on air purification and monitoring systems.

9.0 Warranty

ENMET warrants new instruments to be free from defects in workmanship and material under normal use for a period of one year from date of shipment from ENMET. The warranty covers both parts and labor; however, oxygen cells are limited to a warranty period of six (6) months from date of shipment from ENMET. Equipment believed to be defective should be returned to ENMET within the warranty period (transportation prepaid) for inspection. If the evaluation by ENMET confirms that the product is defective, it will be repaired or replaced at no charge, within the stated limitations, and returned prepaid to any location in the United States. ENMET shall not be liable for any loss or damage caused by the improper use of the product. The purchaser indemnifies and saves harmless the company with respect to any loss or damages that may arise through the use by the purchaser or others of this equipment.

Material shipped to ENMET for warranty evaluation must be packed so it is not damaged in shipping. This applies particularly to oxygen cells, which must be packed so that the connector pins cannot damage the membranes of adjacent cells, and cells cannot be damaged by the movement of other cells or items in the shipment. We strongly suggest that oxygen cell pins be protected with a small piece of styrofoam, that individual cells be placed in small plastic bags, and that adequate packing material be used to constrain the movement of the cells and other items during shipment. Material damaged in shipment is not covered by warranty.

This warranty is expressly given in lieu of all other warranties, either expressed or implied, including that of merchantability, and all other obligations or liabilities of ENMET which may arise in connection with this equipment. ENMET neither assumes nor authorizes any representative or other person to assume for it any obligation or liability other than that which is set forth herein.

There are Return for Repair Instructions and Form on the last pages of this manual. This Form can be copied or used as needed.

Notes:



PO Box 979
680 Fairfield Court
Ann Arbor, Michigan 48106-0979
734.761.1270 Fax 734.761.3220

Returning an Instrument for Repair

ENMET instruments may be returned to the factory or any one of our Field Service Centers for regular repair service or calibration. The **ENMET** Repair Department and Field Service Centers also perform warranty service work.

When returning an instrument to the factory or service center for service, paperwork must be included which contains the following information:

- A purchase order number or reference number.
- A contact name with return address, telephone and fax numbers
- Specific instructions regarding desired service or description of the problems being encountered.
- Date of original purchase and copy of packing slip or invoice for warranty consideration.
- If a price estimate is required, please note it accordingly *and be sure to include a fax number.*

Providing the above information assists in the expedient repair and return of your unit.

Failure to provide this information can result in processing delays.

ENMET charges a one hour minimum billing for all approved repairs with additional time billed to the closest tenth of an hour. All instruments sent to **ENMET** are subject to a minimum \$30 evaluation fee, even if returned unrepaired. Unclaimed instruments that **ENMET** has received without appropriate paperwork or attempts to advise repair costs that have been unanswered, after a period of 60 days, may be disposed of or returned unrepaired COD with the evaluation fee.

Service centers may have different rates or terms. Be sure to contact them for this information.

Repaired instruments are returned by UPS/FedEx Ground and are not insured unless otherwise specified. If expedited shipping methods or insurance is required, it must be stated in your paperwork.

Note: Warranty of customer installed components.

If a component is purchased and installed in the field, and fails within the warranty term, it can be returned to **ENMET** and will be replaced, free of charge, per **ENMET**'s returned goods procedure.

If the entire instrument is returned to **ENMET** Corporation with the defective item installed, the item will be replaced at no cost, but the instrument will be subject to labor charges at half of the standard rate.



Repair Return Form

Mailing Address:
ENMET Corporation
PO Box 979
Ann Arbor, Michigan 48106

Shipping Address:
ENMET Corporation
Attn: Repair Department
680 Fairfield Court
Ann Arbor, Michigan 48108

Phone Number: 734.761.1270
FAX Number: 734.761.3220

Your Mailing Address:

Your Shipping Address:

Contact Name: _____ Your Phone: _____

Your PO/Reference Number: _____ Your FAX: _____

Payment Terms: COD
(Check one) VISA / MasterCard _____
Card number Expiration

Return Shipping Method:

- UPS: Ground 3 Day Select Next Day Air ND Air Saver 2-Day Air
- Federal Express: Ground Express Saver P-1 Standard 2-Day Air
- FedEx Account number: _____

Would you like ENMET to insure the return shipment?

No Yes Insurance Amount: \$ _____

