

ENMET Corporation
PO Box 979
Ann Arbor, MI 48106-0979

ISA-RAL-M
ISA-RAH-M
Operation and Maintenance
Manual

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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. 1910.134) 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-RAL-M (See Figure 1) monitors the carbon monoxide in compressed air used for human breathing. If the CO concentration exceeds any predetermined levels, the ISA-RAL-M will trigger audio-visual alarms and activates any associated equipment to alert personnel in potential danger.

NOTE: *All specifications stated in this manual may change without notice.*

1.1 Operation Principle

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

The ISA-RAL-M operates from single-phase 110 Vac, single-phase 220 Vac and/or 12 Vdc power and is equipped with relay contacts to provide additional alarm signals.

1.2 ISA-RAH-M High Pressure Monitor

The ISA-RAH-M is designed to monitor breathing air from cylinders at pressures up to 5000 psi. The equipment consists of an ISA-RAL-M with the addition of a high-pressure regulator at the sample air input as shown in Figure 2. The high pressure regulator must be plumbed into the high pressure line with an appropriate fitting; the output is connected to the ISA-RAL-M by means of a quick-release pneumatic fitting. The operation of the ISA-RAH-M is identical with that of the ISA-RAL-M, 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.

1.3 Hydrocarbon Filter

There are two versions of the ISA-RAL-M:

P/N 04526-001 is supplied with a hydrocarbon filter

P/N 04526-003 is supplied without a hydrocarbon filter

2.0 Upon Receipt

1. Unpack and inspect your new ISA-RAL-M for damage which might have occurred during shipment.
2. Make sure the instrument is calibrated according to your order.
3. Do not use damaged or incorrect equipment. If there is a problem, contact your distributor or ENMET personnel immediately.
4. Read this manual thoroughly to assure proper handling, operation, and maintenance of your ISA-RAL-M.

3.0 Features, Definition of Parts

3.1 Electronics Control Unit

Figure 1 shows the control unit which contains the electronics circuitry and controls. Main features are listed below.

Power Light (Green)	When this light is on, the unit is operating and is not in alarm. When this light is off, the unit is in alarm OR power to the unit has been interrupted.
Alarm Light (Amber)	Visual alarm (steady light). When this light is on, power to the unit is on and the unit is in low alarm.
Alarm Light (Red)	Visual alarm (steady light). When this light is on, power to the unit is on and the unit is in high alarm.
Audio Alarm	Audio alarm (2900 Hz, 95 dB at 2 ft.). The audio alarm is on when the unit is in alarm.
Meter	A carbon monoxide (CO) concentration meter. The scale is marked in parts per million (ppm) CO. This is a non-linear device. Do not infer exact readings from unmarked regions of the meter scale.
Operation Switch	A rotary switch, for OPERATE (normal operation), HORN OFF (disengage audio alarm) or PURGE ON (sensor temperature control). PURGE ON to clean (purge) sensor surface of adsorbed contaminants (sensor hot).
Switch Indicator Light (Red)	Indicates OPERATION SWITCH is not in OPERATE position.
Sensor Cable	Oiltight cable. Connects the sample head assembly to the control unit (length 8-10 feet). See Caution in section 4.0 Installation step 5.

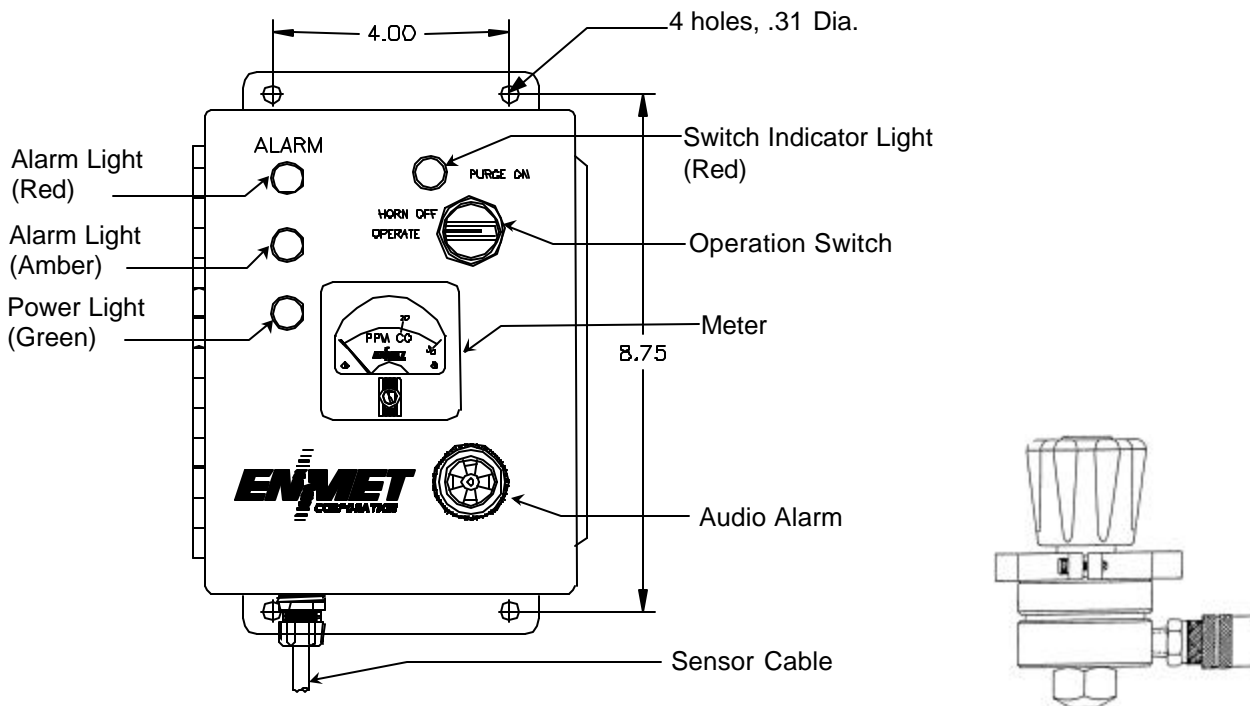


Figure 1: Electronics Control Unit

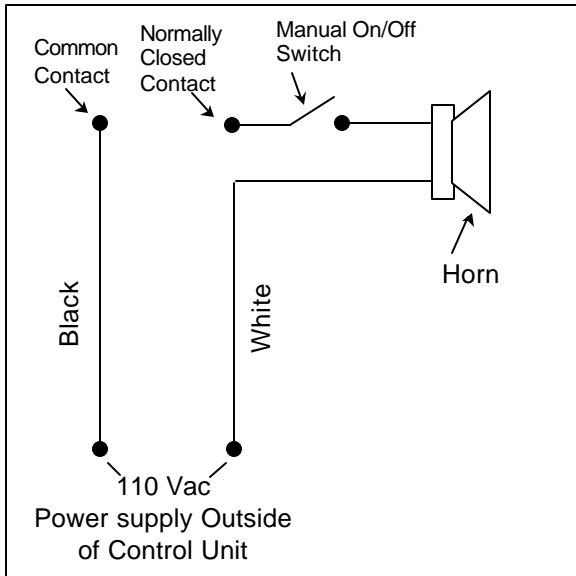
Figure 2: High Pressure Regulator

3.2 Internal Electronic Circuitry

Figure 5 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 signal when a hazardous CO level is detected, or when the ac or dc power is interrupted. These are double-pole relays with terminals normally open, normally closed and common (see Figure 3 for relay contact hook-up). There is one relay for each alarm level.
Potentiometers:	The unit has five potentiometers. Only 3 are used by the customer. These vary critical circuit resistances and are essential to calibration procedures. These potentiometers are described below.
Meter Adjust	To adjust and set the meter for appropriate gas response during calibration.
Low Level Set	To adjust the trip level of the amber gas alarm light and the audio alarm.
High Level Set	To adjust the trip level of the red gas alarm light and the audio alarm.

Suggested wiring configuration for Utilizing Relay Contacts (manual on/off switch is suggested; user supplied component)



Non-Latching Relay contacts:

Identified below is the non-powered (power to unit is off), alarm positions of the non-latching relay contacts.

Terminal Block 2 see Figure 5	
Relay 1	High Alarm
Relay 2	Low Alarm

NOTE: N.C.= normally closed
N.O.= normally open

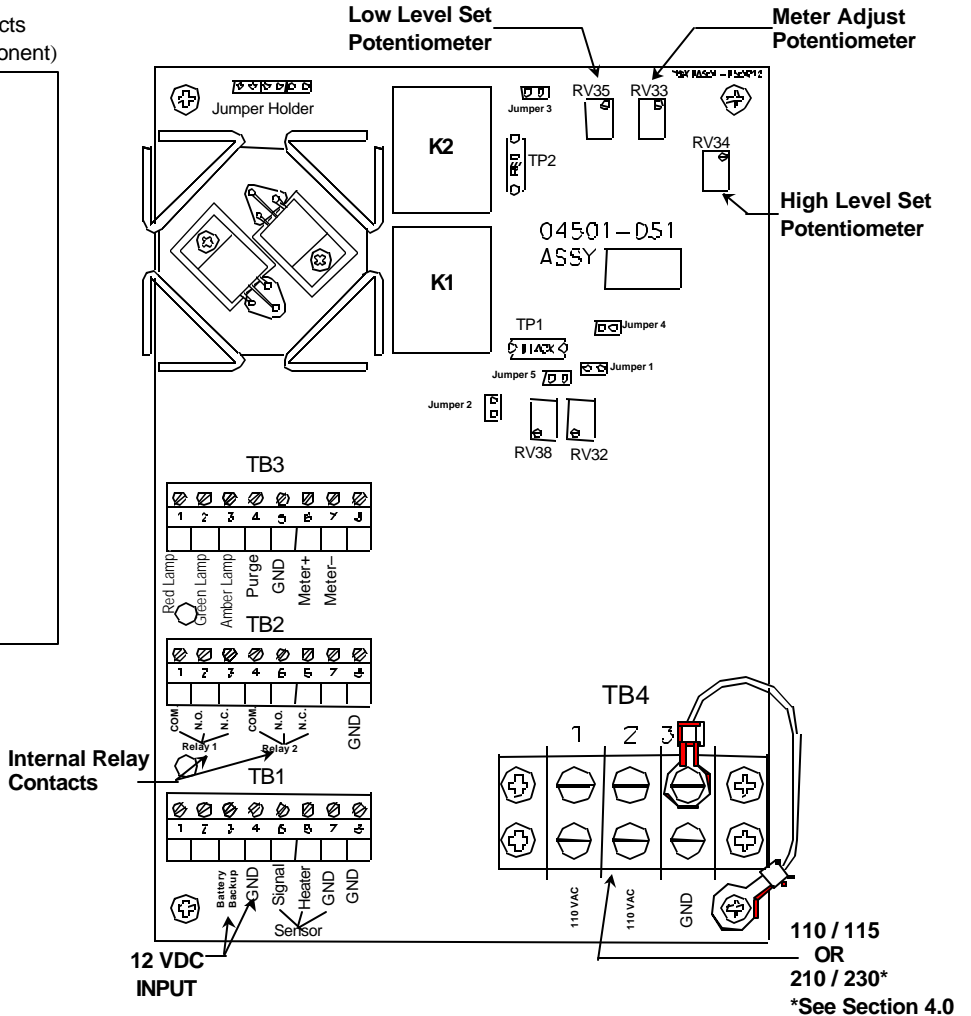


Figure 3: Utilizing the Relay Contacts

Figure 5: Internal Electronic Circuitry

3.3 Sample Head Assembly

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

Pressure Regulator	Reduces the pressure of a small sample of 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	For quick connect/disconnect; fits into the port of an
Pneumatic Fitting	Air line filter unit and ENMET calibration adapter (03605-001). Air inlet fitting is a Milton 727, compatible with Hansen 1000 series. If you substitute other fittings, the calibration fixture must also be changed.
Humidifier	Plastic bottle. This adds moisture to the air sample that passes over the sensor.
Metallic Oxide Semiconductor Sensor	Solid-state gas sensing element contained in 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 to ensure constant flow of air between the humidifier and pressure regulator.
Hydrocarbon Filter	To enhance low level calibrations by removal of hydrocarbon vapors from the air sample. Supplied on ISA-RAL-M P/N 04526-001.

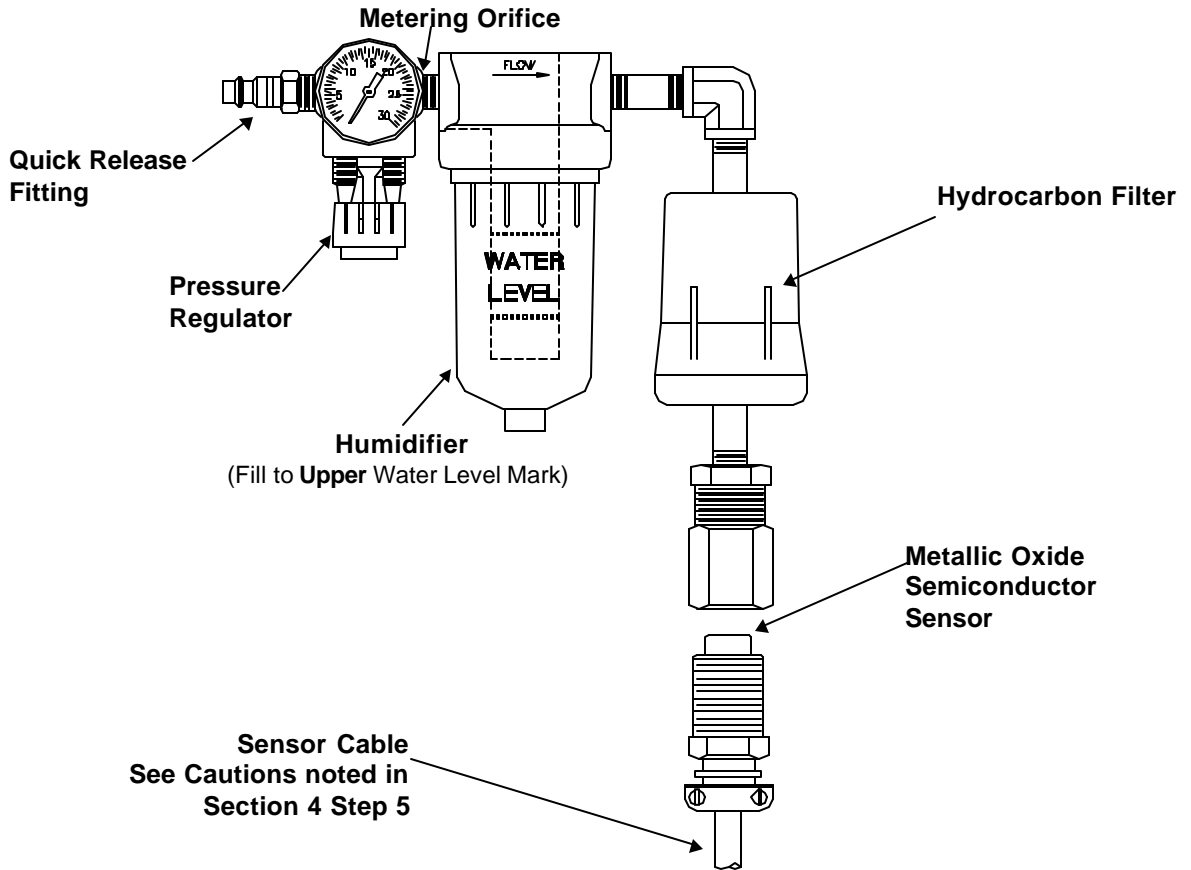


Figure 4: Sample Head Assembly

4.0 Installation

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

CAUTION: Neither the ISA-RAL-M control unit nor its sensor are rated for explosionproof environments. Take caution that neither one is installed in an explosionproof-rated area.

1. Choose an appropriate location for mounting the electronics control unit and sample head assembly. The mounting dimensions are given in Figure 1. Locate the sampling point upstream from the workers such that the respiratory air reaches the carbon monoxide sensor **before** it reaches the workers. Locate the control unit, or an auxiliary visual alarm actuated by the instrument's relay contacts, in an area where it can easily be seen by workers using the breathing air.

NOTE That the flow rate of the sample air to the sensor head is approximately 1 SCFH (Standard Cubic Feet per Hour).

2. A 110 Vac line cord is supplied, plug this into an appropriate outlet.
3. If conduit is preferred, remove the terminal strip cover from TB4 inside the control unit (simply pull the cover off its holding prongs). Apply 110 Vac power to the appropriate terminals. Refer to Figure 5.

NOTE Utilizing 220 Vac power requires a change in the transformer hook-up by a competent electrician or electronics technician; but this change is best done at ENMET. 12 Vdc may be used as a primary source (refer to Figure 5) or as an emergency back-up power source, both ac and dc power can be applied at the same time. Current flows from the ac source; dc current will flow only when the ac power is interrupted.

4. Run the relay contact leads through the same oiltight fitting as the power supply leads or out through a second fitting.

NOTE When the power supply is interrupted, the relays switch to the same position as for a true gas alarm condition, and the power light goes off. *Do not* connect the unit to other voltage supply lines. The ISA-RAL-M is completely oiltight. Use the correct oiltight fitting for the cord or conduit when supplying power to the unit.

5. Connect regulator/humidifier and hydrocarbon filter (if supplied) to the sensor head assembly. Attach this assembly to a 50 – 250 psi compressed air line (see Figure 6).

CAUTION: • **DO NOT** use a rubber hose to connect regulator to air line. This may cause inaccurate meter readings and false alarms.

- **DO NOT** locate the sample point on a low spot in the line. Water condensation may clog or damage the regulator or sensor assembly.
- **DO NOT** modify or extend the sensor cable without first contacting ENMET customer service personnel for instructions regarding heater voltage and adjustment.

The instrument can be installed directly on an ENMET AFP-82 or AFP-40 air filtration panel if the work location is suitable. In the event that the work environment is *unsuitable* for the installation of the ISA-RAL-M, it should be installed in a suitable location in the air line, upstream of the work environment.

6. Add tap water to the *upper* Water Level mark. Replace bowl, ensure water does not go higher than the upper edge of the bowl.
7. Adjust the pressure regulator to between 7 and 12 psi.
8. Replace terminal strip cover on TB4 inside the control unit.
9. Proceed to Section 5.0 for initial warm-up and operating procedures.

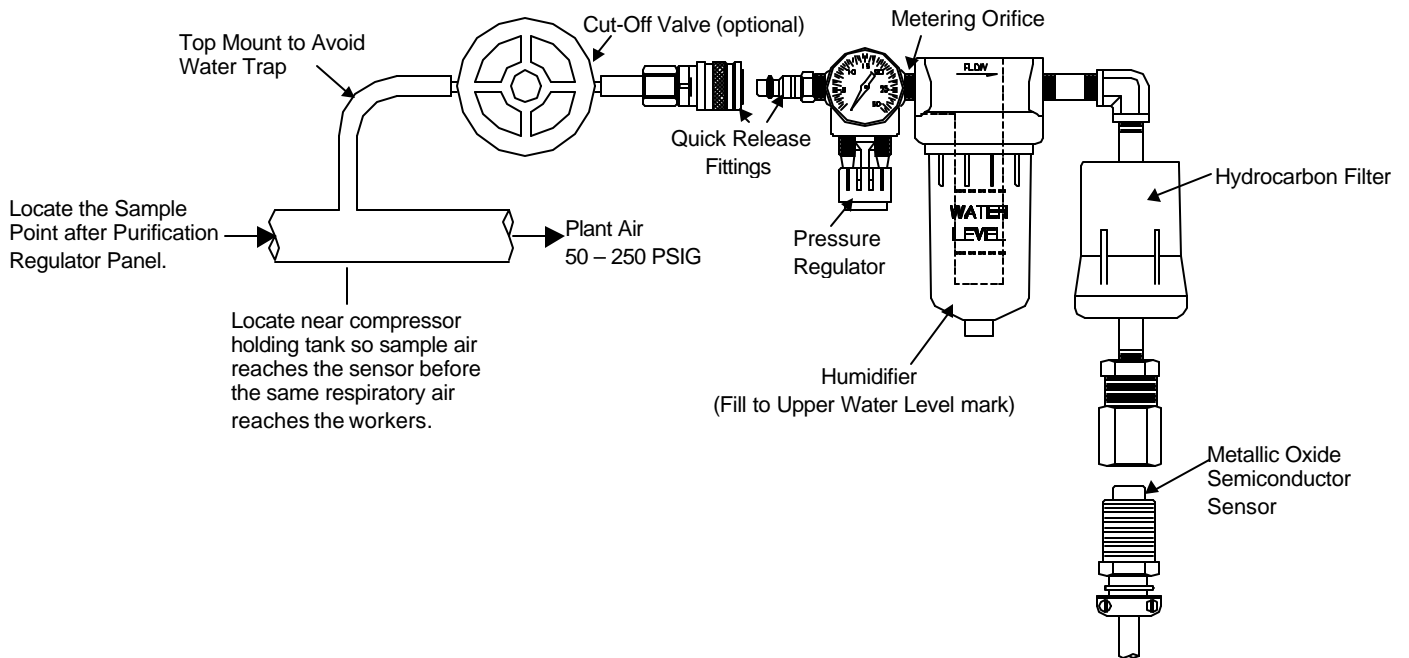


Figure 6: Connecting to Compressed Air Line

5.0 Initial Warm-Up and Operation

The ISA-RAL-M incorporates a Metallic Oxide Semiconductor (MOS) sensor to detect carbon monoxide. During periods of inactivity, contaminants may build up on the sensor element that need to be cleaned off. It is normal for the instrument to go into an alarm condition when first powered up after a time of storage or after power has been disconnected for some time.

CAUTION: Do NOT operate the ISA-RAL-M without air passing over the sensor. The absence of air flow over the sensor when the instrument is in operation can permanently damage the sensor!!!

You need a voltmeter for this procedure.

1. Mount and install the ISA-RAL-M as outlined in section 4.0.

NOTE: This unit has no ON/OFF switch for the power; this safety monitoring device is designed to operate continuously. Turn the Operation Switch to HORN OFF to silence the audio alarm during warm-up.

2. Turn the operation switch to PURGE ON. The alarm light will go on; don't worry, this is normal.
3. Open the control unit. With a voltmeter, check the voltage across terminals 6 and 7 on TB1 (terminal 6 is positive, terminal 7 is negative). The voltage must be 1.60 Vdc within a 0.07 Vdc range. This voltage is not adjustable, if it is not within this range, contact your local distributor.
4. Let clean air pass over the sensor for at least one hour to purge (clear) the sensor of contaminants. CLEAN AIR MUST PASS OVER THE SENSOR. If you suspect contaminated air (or really dirty conditions) in your compressor, use bottled clean air. Do not operate the unit without air passing over the sensor. If you do, you are likely to contaminate the sensor.

NOTE: After long periods of storage (several days or more), extend the purge operation to several hours; or operation switch may be left set to PURGE ON overnight.

5. Purging is complete when the red alarm light goes out, and the meter stabilizes at a low reading.
6. Turn the operation switch to HORN OFF. Some meter drift is normal. Open the control unit and measure the voltage across terminals 6 and 7 of TB1 (terminal 6 is positive, terminal 7 is negative). The voltage must be 0.86 Vdc within a 0.07 Vdc range. This voltage is not adjustable, if it is not within this range, contact your local distributor.
7. Turn the operation switch to OPERATE .

Reference: State of Operation of ISA-RAL-M, ISA-RAH-M	
Normal Operation: No alarms. Green light is on. Enclosure feels warm to the touch.	Alarm State: Green light is off. Amber light or red light/audio alarm on. Relay contacts in alarm position.

If pressure is applied to the regulator input, and air is not bubbling through the humidifier, check to see that the regulator is adjusted to between 7 and 12 PSI. If this is not the problem, then the metering orifice is probably plugged; you must replace it. See section 7.1 for part number.

Important: When replacing the orifice, use teflon thread to seal the connections.
 Do Not use joint sealing compound.

5.1 Quick Field Tests

To verify the instrument's response capability:

Use a cylinder of high-level CO/air mixture (i.e., 200 ppm CO for a 20 ppm calibrated unit) with a quick-disconnect gas fixture.

- 1a. Remove the compressed air line and insert the test gas.
- 2a. Let a little gas flow over the sensor. You may need to adjust the regulator.
- 3a. Meter should move up-scale in less than 20 seconds and read full-scale within one minute.

OR

- 1b. Unscrew the sensor head assembly.
- 2b. Give the sensor a quick exposure to a bottle cap from an alcohol solution.

NOTE Alcohol is heavier than air. Hold the cap over the sensor so vapors float down over it. Purge the sensor after this test.

Whenever you use a test gas containing a level of gas greater than the high alarm level, the meter swings up-scale, green power light goes out, amber and red alarm lights go on and relay contacts close to trigger remote alarms.

This test is to verify response capability. If it does not bring the unit into alarm, contact ENMET personnel.

CAUTION: Do not repeatedly blow smoke on the exposed sensor heat. Do not squirt pure gases or liquid hydrocarbons (butane, propane, gasoline etc.) directly on the sensor.

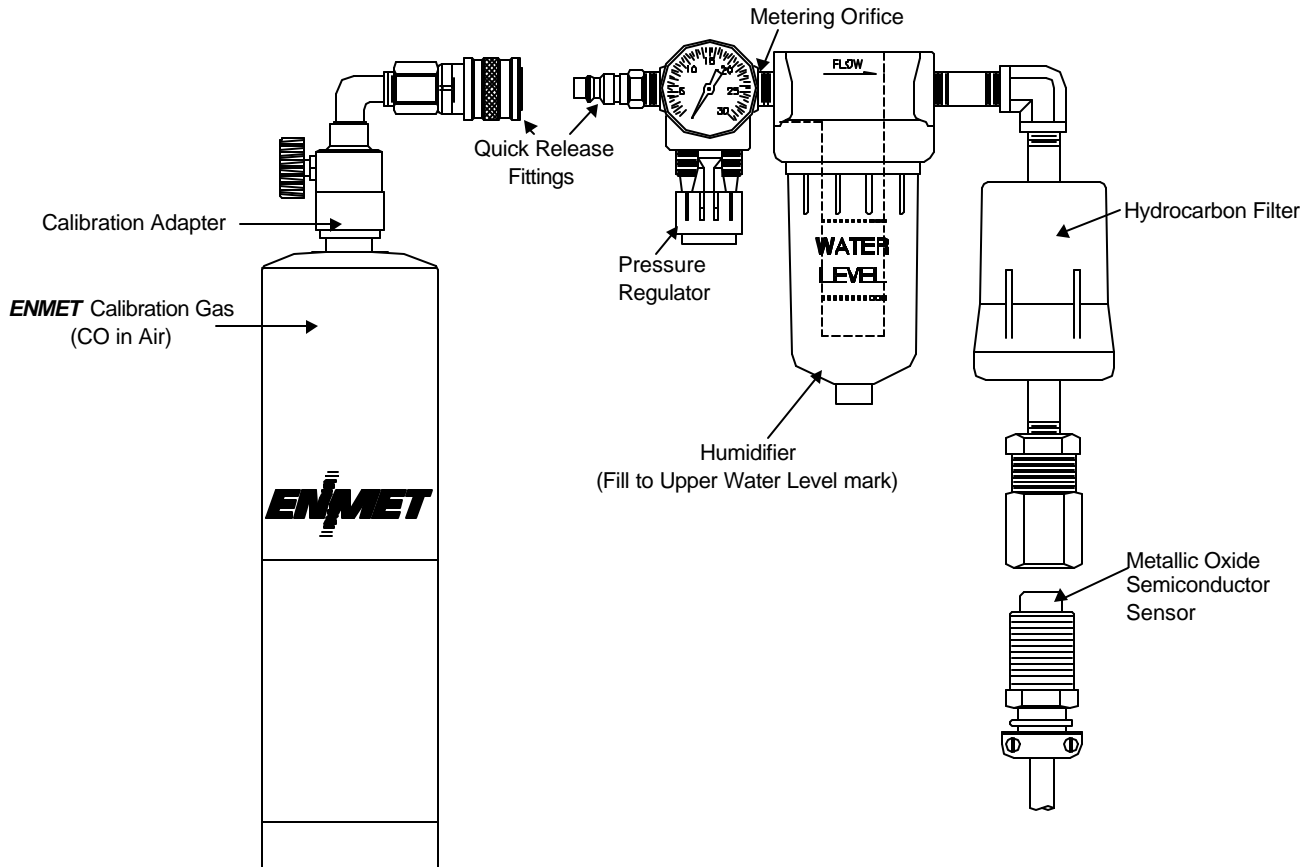


Figure 7: Calibration Adapter and Gas

6.0 Calibration

The following procedure is for checking the calibration level and for recalibrating the ISA-RAL-M.

Perform A Complete Recalibration Periodically (At Least Every 90 Days) And:

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

MATERIALS:

- Cylinders of calibration gas of known CO concentration in air corresponding with the alarm level of the unit, for example, 20 ppm CO in air.

CAUTION: Do not use CO in a pure inert carrier gas, such as nitrogen or argon.

- Calibration adapter, ENMET part no. 03605-001.
- Small screwdriver for potentiometer adjustment.

PROCEDURE:

1. Turn the switch to **PURGE ON**. The alarm lights go on; this is normal.
2. Leave switch in the **PURGE ON** position for at least one hour. Air must be flowing through the humidifier and over the sensor during this time. Remember, if you suspect contaminated air in your compressor system, use clean bottled air.
3. After at least one hour, turn the switch to **HORN OFF**. Allow the sensor to stabilize for 30 minutes before continuing.

NOTE: Some compressor installations produce very clean air during normal operations. A medical air system is an example of such an installation. In such situations, the purge operation before calibration can usually be eliminated. The sensor requires purging only when the meter needle does not return to the normal “zero” area within 30 minutes after the calibration gas is removed. If this occurs, purge and stabilize the sensor as described above, then recalibrate. Of course, always purge the sensor after sensor replacement or heavy sensor contamination due to severe conditions.

4. Be sure the humidifier bottle is filled with tap water to the *Upper Water Level* mark.
5. Remove the compressed air line and insert the calibration adapter (Figure 7).
6. Open the regulator on the top of the calibration gas cylinder. This brings the gas into the sampling assembly.
7. Regulate the flow of calibration gas to between 7 and 12 psi on the pressure regulator dial. Adjust flow using only the valve on the calibration adapter.
8. Let the calibration gas flow into the system for 5 minutes. This assures a full and balanced response from the sensor.
9. With the gas still flowing, adjust the Meter Adjust potentiometer (Ref figure 5 RV33; ccw to increase, cw to decrease meter reading) with a small screwdriver. You want to have the meter pass through the low level alarm point, verify that the alarm light triggers at the 10 ppm point. If it does not, set the meter to the 10 ppm mark and adjust RV35 (low level alarm pot) turn the switch to **OPERATE** for a second to verify the horn is operational. Then adjust the meter gain pot to pass through the 20 ppm point, verify that the alarm light triggers at the 20 ppm point. If it does not, set the meter gain to the 20 ppm adjust RV34 to trigger the alarm light. Turn the switch to **OPERATE** for a second to verify the horn is operational. This sets the alarm points (Refer to Figure 5). *Do Not* adjust for instantaneous alarm when test gas is first released. If you do, the calibration is inaccurate, and the sensor is overly sensitive.
10. Shut off the calibration gas flow at the valve on the gas cylinder.
11. Allow pressure to equalize - wait until the pressure meter on the humidifier-regulator assembly reads zero, then remove the calibration adapter from the input of the sample head.

CAUTION: If you disassemble the calibration unit before the pressure is equalized, you may cause a back flow of water from the humidifier. This damages the regulator valve.

12. Remove the calibration gas, reconnect the unit to the air line, the flow of clean air should clear the unit from its gas alarm state in less than one minute. After the alarms have cleared, turn the switch to **OPERATE**
13. Clean compressed air results in a meter reading from 0 - 1/3 full scale, Green power light indicates a clean condition.

7.0 Maintenance

Since the ISA-RAL-M carbon monoxide monitor is a safety instrument, it requires periodic testing and recalibration. Refer to Operation (Section 5.0) and Calibration (Section 6.0) sections of this manual for testing and recalibration procedures. In addition, perform the following:

7.1 Routine Maintenance

1. Check the unit for mechanical damage or simple malfunctions, such as burned out lamps.
2. Periodically check the water level inside the humidifier and add water to the high WATER LEVEL mark.
3. With the unit operating, make sure that the regulated air pressure is between 7 and 12 PSI on the gauge.
4. When power to the unit has been disconnected for more than a few hours, purge the sensor upon reapplication of power. It may be necessary to periodically purge the sensor of a unit monitoring an airline that has a high level of contamination. The interval between purges depends on the level of contamination. With the unit operation, turn the switch to PURGE ON and leave for half-hour, then return the switch to OPERATE.

7.2 Sensor Cable Replacement

If the sensor no longer responds properly to calibration gases (see section 6.0, Calibration), the entire sensor cable assembly must be replaced.

Materials Needed:

- ISA-RAL-M sensor cable assembly, ENMET part no. 03035-109
- Flat-headed screwdriver
- Two adjustable wrenches (adjust to approx. 1")

Procedure:

1. Disconnect power to the control unit to prevent electrical shock.
2. Unscrew the two front panel latches on the right side of the control unit. Open up the control unit front panel.
3. Locate TB1-5, TB1-6 and TB1-7 inside the control unit (see Figure 5). Unscrew the sensor cable leads from these terminals.
4. Unscrew the rounded housing of the strain relief fitting in the bottom of the control unit, and draw the sensor cable and terminal leads out through the fitting.
5. Empty the water from the humidifier bottle of the sample head assembly.
6. Using the adjustable wrenches, unscrew the brass bushing which connects the sensor cable to either the regulator/humidifier or the hydrocarbon filter. Insert the bushing of the new sensor cable and tighten with wrenches using hand pressure only.
7. Insert leads of new cable assembly through strain relief fitting located at bottom of enclosure. Tighten rounded housing of fitting.
8. Attach colored leads of cable to TB1-5 (green), TB1-6 (white) and TB1-7 (black). Tighten terminal screws gently but securely.
9. Close front panel of control unit, and replace and tighten latches.
10. Fill humidifier bottle of sample head assembly halfway with clean water and replace.
11. Apply power to instrument and allow to operate overnight with air flowing through bubbler and over sensor. Then calibrate the instrument (see section 6.0).

7.3 Replacement Parts

Description of Part	Part Number
Metering orifice assembly	03415-000
Metering orifice*	03415-001
3-wire RAL cable assembly (with sensor)	03035-109
Pressure regulator	73089-057
Hydrocarbon filter assembly	73089-060
Hydrocarbon Filter Element*	73089-061
Humidifier assembly	03406-000
Male coupler plug (quick release fitting)	73061-000
Gauge (0 - 30 psi)	73089-058
Meter	03411-000
Lamp body	62012-010
Lens, red	62012-011
Lens, green	62012-012
Lens, amber	62012-013
Control unit light bulb	63001-002
Calibration kit	03414-000
Cylinder of 20 ppm CO in Air	03219-020
Calibration adapter	03605-001

***NOTE** For instruments S/N 634 and above, only the element needs to be replaced. For instruments with serial numbers below S/N 634, the replacement assembly (73089-060) should be used to obtain the proper fitting. Contact ENMET customer service for additional information.

8.0 Specifications

ENCLOSURE:	NEMA-12 enclosure
SIZE:	Approximately 6" h x 8" w x 4" d
WEIGHT:	Approximately 10 lbs.
CABLE LENGTH:	Between box and air inlet: 8 - 10 ft.
AUDIO ALARM:	2900 Hz, 95 decibels at 2 ft.
MAXIMUM POWER:	117 Vac - 60 Hz - 25 watts 12 Vdc - 25 watts
RELAY CURRENT:	2 amp steady, 5 amp surge
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 psi
SAMPLE FLOW RATE:	Approximately one cubic foot per hour

NOTE: *All specifications stated in this manual may change without notice.*

8.1 Typical Calibrations

Hazardous Gas	Low Alarm	High Alarm
Carbon monoxide	10 ppm	20 ppm

8.2 Options and Variations

Options:

- 220 Vac power input connection
- NEMA-4X fiberglass enclosure

Variations:

- Available in an explosion-proof instrument housing, Models ISA-44RALE and ISA-44-RAHE. With this, the equipment is suitable for operation in Class I, Division I, Groups 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-RAL-M where you are required by the National Electrical Code or local codes to use an explosionproof variety.
- ENMET Filtration Panels filter oil, water and solid particles from compressed air. AFP-40: equipped to distribute air to three respirators. AFP-82: equipped to distribute air to six respirators.
- Units that also monitor for oxygen deficiency in breathing air are available; consult a distributor or the factory.

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. 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.

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.

9.1 Repair of Certain Units

The warranty does not apply to equipment returned in either of the conditions defined below. These are not the result of defective workmanship or material. We will renovate and return at owner's expense.

- a) **Gross Recalibration:** We calibrate all ISA-RAL-M's according to the customer order before shipping. Changing the potentiometers voids the warranty, except when following the calibration procedures (Sec. 6.0). When we receive such a unit for repair, and no defects exist, we will diagnose the problem and recalibrate the unit according to the original order.
- b) **Gross Sensor Contamination:** The MOS sensor is durable. It can be purged of normal contaminants by operating the unit in the PURGE mode for a sufficient length of time. Gross contamination usually occurs during misuse. Here are three examples of gross sensor contamination:

Close exposure to an open gas flame.

Dipping the sensor in lacquer.

Continuous exposure to heavy concentrations of industrial vapors.

A grossly contaminated sensor must be replaced. If we receive such a unit, we will diagnose the problem, replace the sensor and recalibrate the unit.

WHEN YOU RETURN A UNIT TO THE FACTORY FOR SERVICE:

Warranty or otherwise:

- Be sure to include paperwork.
- A purchase order, return address and telephone number will assist in the expedient repair and return of your unit.
- Include any specific instructions.
- For warranty service, include date of purchase.
- If you require an estimate, please contact ENMET Corporation.