



CMS 1 CARBON MONOXIDE MONITOR

O. M. 23301

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WARNING

Do not proceed with these instructions until you have READ the orange cover of this MANUAL and YOU UNDERSTAND its contents. * These WARNINGS are included for the health and safety of the operator and those in the immediate vicinity.

***If you are using a Clemco Distributor Maintenance and Part Guide, refer to the orange warnings insert preceding the Index before continuing with the enclosed instructions.**

Electronic files include a Preface containing the same important information as the orange cover.

© 2013 CLEMCO INDUSTRIES CORP.
One Cable Car Dr.
Washington, MO 63090
Phone (636) 239-4300
Fax (800) 726-7559
Email: info@clemcoindustries.com
www.clemcoindustries.com



WARNING

- Employers are responsible for identifying all job site hazards, educating and training all persons who will operate and maintain these products, and ensuring that all blast operators and their assistants understand the warnings and information contained in these instructions relating to safe and proper operation and maintenance of this equipment.
- Serious injury or death can result from failure to comply with all Occupational Safety and Health Administration (OSHA) regulations and all manufacturer's instructions.
- This equipment is not intended for use in any area considered hazardous per National Electric Code NFPA 70 2011, Article 500.
- Read this document and follow all instructions before using this equipment.

OSHA regulations relating to abrasive blasting are contained in the Code of Federal Regulations, Title 29 (29 CFR 1910 General Industry; 1915 Maritime; 1926 Construction). The most pertinent include: 1910.94 Ventilation, 1910.95 Occupational Noise Exposure, 1910.132 Personal Protective Equipment, 1910.133 Eye and Face Protection, 1910.134 Respiratory Protection, 1910.135 Head Protection, 1910.244 (b) Remote Controls. Consult www.osha.gov for complete information.

NOTICE TO PURCHASERS AND USERS OF OUR PRODUCTS AND THIS INFORMATIONAL MATERIAL

Clemco proudly provides products for the abrasive blast industry and is confident that industry professionals will use their knowledge and expertise for the safe and efficient use of these products.

The products described in this material, and the information relating to these products, are intended for knowledgeable, experienced users.

No representation is intended or made as to: the suitability of the products described here for any purpose or application, or to the efficiency, production rate, or useful life of these products. All estimates regarding production rates or finishes are the responsibility of the user and must be derived solely from the user's experience and expertise, not from information contained in this material.

It is possible that the products described in this material may be combined with other products by the user for purposes determined solely by the user. No representations are intended or made as to the suitability of or engineering balance of or compliance with regulations or standard practice of any such combination of products or components the user may employ.

Abrasive blast equipment is only one component of an abrasive blasting job. Other products, such as air compressors, air filters and receivers, abrasives, scaffolding, hydraulic work platforms or booms, equipment for lighting, painting, ventilating, dehumidifying, parts handling, or specialized respirators or other equipment, even if offered by Clemco, may have been manufactured or supplied by others. The information Clemco provides is intended to support the products Clemco manufactures. Users must contact each manufacturer and supplier of products used in the blast job for warnings, information, training, and instruction relating to the proper and safe use of their equipment.

GENERAL INSTRUCTIONS

This material describes some, but not all, of the major requirements for safe and productive use of blast machines, remote controls, respirator systems, and related accessories. All equipment and accessories must be installed, tested, operated and maintained only by trained, knowledgeable, experienced users.

The blast operator and all workers in the vicinity must be properly protected from all job site hazards including those hazards generated by blasting.

Work environments involving abrasive blasting present numerous hazards. Hazards relate to the blast process from many sources that include, but are not limited to, dust generated by blasting or from material present on the surface being blasted. The hazards from toxic materials may include, but are not limited to, silica, cyanide, arsenic, or other toxins in the abrasives or in the coatings, such as lead or heavy metals. Other hazards from toxins include, but are not limited to, fumes from coating application, carbon monoxide from engine exhaust, contaminated water, chemicals or asbestos. In addition, physical hazards that may be present include, but are not limited to, uneven work surfaces, poor visibility, excessive noise, and electricity. Employers must identify all job site hazards and protect workers in accordance with OSHA regulations.

Never modify Clemco equipment or components or substitute parts from other manufacturers for any Clemco components or parts. Any unauthorized modification or substitution of supplied-air respirator parts violates OSHA regulations and voids the NIOSH approval.

IMPORTANT

Contact Clemco for free booklets:

Blast Off 2 – Guide to Safe, Productive, and Efficient Abrasive Blasting, and Abrasive Blasting Safety Practices – Guide to Safe Abrasive Blasting.

Clemco Industries Corp. One Cable Car Drive Washington MO 63090

Tel: 636 239-4300 — Fax: 800 726-7559

Email: info@clemcoindustries.com

Website: www.clemcoindustries.com

OPERATIONAL INSTRUCTIONS

OPERATOR SAFETY EQUIPMENT

WARNING

- OSHA regulation 1910.134 requires appropriate respiratory protection for blast operators and workers in the vicinity of blasting. These workers must wear properly-fitted, properly-maintained, NIOSH-approved, respiratory protection that is suitable for the job site hazards. Blast respirators are to be worn only in atmospheres not immediately dangerous to life or health from which wearers can escape without use of the respirator.
- The employer must develop and implement a written respiratory protection program with required worksite- specific procedures and elements for required respirator use. The employer must provide effective training to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually, and more often if necessary.
- NEVER use abrasives containing more than one percent crystalline silica. Fatal diseases, such as silicosis, asbestosis, lead or other poisoning, can result from inhalation of toxic dusts, which include, but are not limited to, crystalline silica, asbestos, and lead paint. Refer to NIOSH Alert 92-102; and OSHA CPL 03-00-007: "National Emphasis Program – Crystalline Silica", in which OSHA describes policies and procedures for implementing a national emphasis program to identify and reduce or eliminate health hazards from exposure to crystalline silica. Numerous topics associated with the hazards of crystalline silica in silica blasting sand can be found on [http:// osha.gov/](http://osha.gov/). Clemco urges users of silica blasting sand to visit this website, and read and heed the information it contains.
- Always make sure the breathing air supply (respirator hose) is not connected to plant lines that supply gases that include, but are not limited to, oxygen, nitrogen, acetylene, or other non-breathable gas. Never modify or change respirator air line connections without first testing the content of the line for safe breathing air. Failure to test the line may result in death to the respirator user.

- Breathing air quality must be at least Grade D, as defined by the Compressed Gas Association specification G-7.1, per OSHA Regulation 29 CFR 1910.134. When compressed air is the breathing air source, a Clemco CPF (suitable sorbent bed filter) should be used. Respirator hose connecting the respirator to the filter must be NIOSH approved. Non- approved hose can cause illness from chemicals employed to manufacture the hose.

- All workers must always wear NIOSH-approved respirators when any dust is present. Exposure to dust can occur when handling or loading abrasive, blasting, cleaning up abrasive, or working in the vicinity of blasting. Before removing the respirator, test the air with a monitoring device to ensure it is safe to breathe.

- Clemco respirators DO NOT remove or protect against carbon monoxide or any other toxic gas. Monitoring devices must be used in conjunction with the respirator to ensure safe breathing air. Always locate compressors and ambient air pumps where contaminated air will not enter the air intake.

- Always use Clemco lenses with Clemco respirators; installing non-approved lenses voids the NIOSH approval. Respirator lenses are designed to protect the wearer from rebounding abrasive; they do not protect against flying objects, heavy high-speed materials, glare, liquids, or radiation.

INDUSTRY ORGANIZATIONS

For additional information, consult:

Occupational Safety and Health Administration (OSHA) - www.osha.gov
Compressed Gas Association (CGA) - www.cganet.com
The Society for Protective Coatings (SSPC) - www.sspc.org
National Association of Corrosion Engineers (NACE) - www.nace.org
American Society for Testing and Materials (ASTM) - www.astm.org
National Institute of Occupational Safety and Health (NIOSH) - www.niosh.gov
American National Standards Institute (ANSI) - www.ansi.org

PREFACE

BLAST MACHINES AND REMOTE CONTROLS

WARNING

OSHA regulation 1910.169 describes the necessity of pressure relief valves on compressed air equipment. Do not operate blast machines with air compressors that are not equipped with properly functioning pressure relief valves.

OSHA regulation 1910.244(b) requires the use of remote controls on blast machines.

Serious injury or death can result from many sources, among them:

- Involuntary activation of the remote controls. Never modify or substitute remote control parts; parts are not compatible among different manufacturers. Welding hose is not suitable for remote control hose. Its ID and material composition make it unsafe for remote control use.
- Exceeding the maximum working pressure. Clemco blast machines are built to ASME-code and carry a 'U' or 'UM' stamp, and National Board/serial number. Every machine is marked with its maximum working pressure. Never exceed the maximum working pressure limits of the blast machine.
- Uncontrolled blast stream. High-velocity abrasive particles will inflict serious injury. Always point the blast nozzle in the direction of the blast surface only. Keep unprotected workers out of the blast area.
- Welding on the blast machine. Never weld on the blast machine; welding voids the National Board approval and may affect the dimensional integrity of the vessel.
- Moving the blast machine. Never manually move a blast machine containing abrasive, any machine containing abrasive must be moved with appropriate mechanical lifting equipment.

HOSES, COUPLINGS, AND NOZZLE HOLDERS

- The inside diameter (ID) of air hoses, fittings, and connections should be at least four times larger than the nozzle orifice size. Blast hose ID should be three to four times the size of the nozzle orifice. Example: a #6 nozzle (3/8" diameter orifice) calls for 1-1/2" ID blast hose and 1-1/2" ID or larger compressor hose. All hose runs should be kept as short as possible and run in as straight a line as possible to reduce pressure loss.
- To install, squarely cut the end of the hose so that it fits snugly against the coupling or hose end shoulder. Always use the screws recommended by the manufacturer ensuring that they do not penetrate the inner wall. Make sure the couplings tightly fit the hose. Install cotter pins at every connection or use couplings with built-in lock-springs to prevent disengagement. Install safety cables at all connections to prevent whipping if hoses disengage or blow out.

MAINTENANCE AND REPAIR

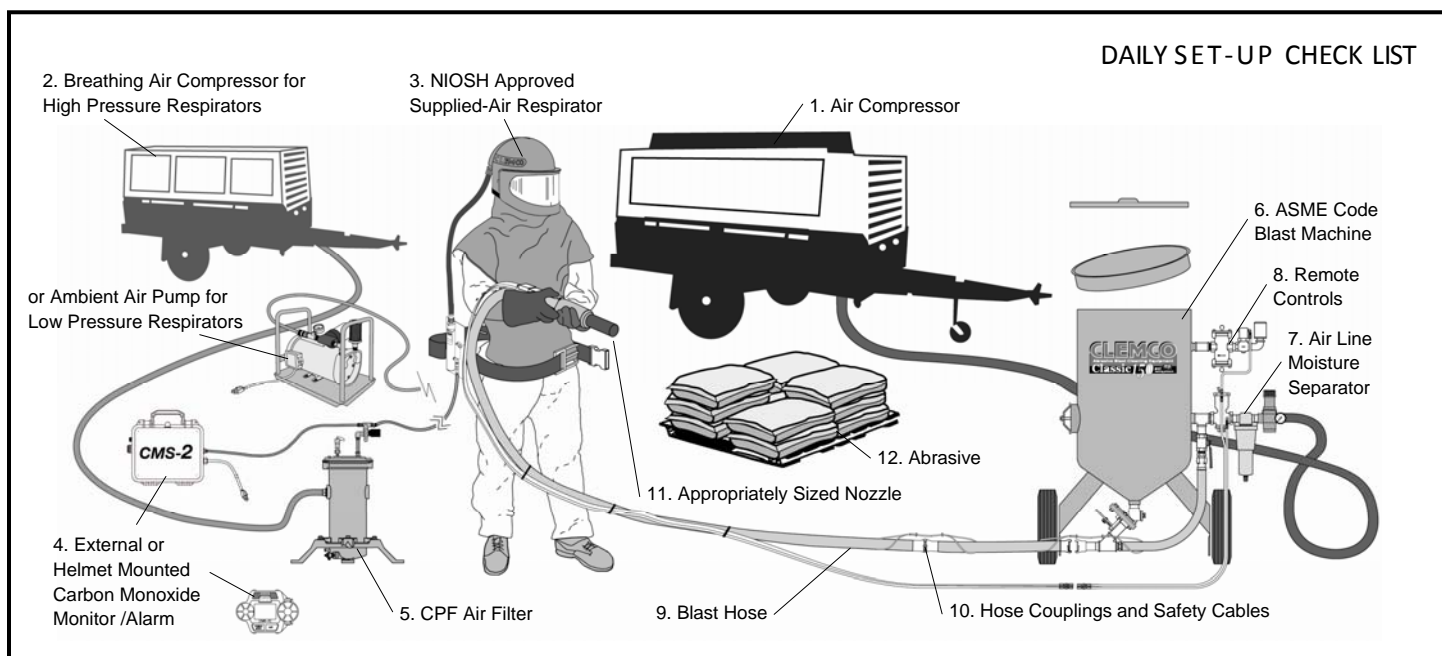
- Completely read and follow all service instructions and recommended maintenance intervals. Always shut off compressor and depressurize blast machine before performing any maintenance. At every service interval, clean all filters, screens, and alarm systems. If spring-loaded abrasive valves are used, always cage spring before disassembly.

WARRANTY

The following is in lieu of all warranties, express, implied or statutory, and in no event shall seller or its agents, successors, nominees or assignees, or either, be liable for special or consequential damage arising out of a breach of warranty. This warranty does not apply to any damage or defect resulting from negligent or improper assembly or use of any item by the buyer or its agent or from alteration or attempted repair by any person other than an authorized agent of seller. All used, repaired, modified, or altered items are purchased "as is" and with all faults. In no event shall seller be liable for consequential or incidental damages. The sole and exclusive remedy of buyer for breach of warranty by seller shall be repair or replacement of defective parts or, at seller's option, refund of purchase price, as set forth below

- :
1. Seller makes no warranty with respect to products used other than in accordance hereunder.
 2. On products seller manufactures, seller warrants that all products are to be free from defects in workmanship and materials for a period of one year from date of shipment to buyer, but no warranty is made that the products are fit for a particular purpose.
 3. On products which seller buys and resells pursuant to this order, seller warrants that the products shall carry the then standard warranties of the manufacturers thereof, a copy of which shall be made available to the customer upon request.
 4. The use of any sample or model in connection with this order is for illustrative purposes only and is not to be construed as a warranty that the product will conform to the sample or model.
 5. Seller makes no warranty that the products are delivered free of the rightful claim of any third party by way of patent infringement or the like.
 6. This warranty is conditioned upon seller's receipt within ten (10) days after buyer's discovery of a defect, of a written notice stating in what specific material respects the product failed to meet this warranty. If such notice is timely given, seller will, at its option, either modify the product or part to correct the defect, replace the product or part with complying products or parts, or refund the amount paid for the defective product, any one of which will constitute the sole liability of the seller and a full settlement of all claims. No allowance will be made for alterations or repairs made by other than those authorized by seller without prior written consent of seller. Buyer shall afford seller prompt and reasonable opportunity to inspect the products for which any claim is made as above stated.
- Except as expressly set forth above, all warranties, express, implied or statutory, including implied warranty of merchantability, are hereby disclaimed.

PREFACE



Make sure all blast operators are properly trained and suitably attired with a blast suit, safety boots, leather gloves, respiratory and hearing protection. Every day before start up, check all equipment components, including piping, fittings, and hoses, and valves, for leaks, tightness, and wear. Repair or replace as needed. Use the following checklist.

- ☐ **1. PROPERLY-MAINTAINED AIR COMPRESSOR** sized to provide sufficient volume (cfm) at given pressure for nozzle and other tools. ADD 50% volume (cfm) reserve to allow for nozzle wear. Use large compressor outlet and air hose (at least 4 times the nozzle orifice diameter). For oil-lubricated compressors, the employer shall use a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm. Follow the manufacturer's checklist and maintenance instructions.
- ☐ **2. BREATHING-AIR COMPRESSOR** (or oil-less ambient air pump) capable of providing Grade D quality air, located in a dust free area. Read # 1 above.
- ☐ **3. CLEAN, PROPERLY-MAINTAINED NIOSH-APPROVED SUPPLIED-AIR RESPIRATOR** worn by blast operators, and other workers exposed to blast dust. Make sure all respirator components are in place — all lenses, inner collar, and cape. Thoroughly inspect all components for wear. The NIOSH approval (approval number is listed in the owner's manual) is for a complete assembly from point of attachment on the CPF (sorbed bed) filter to the complete respirator. Substitution of any part voids the NIOSH approval.
- ☐ **4. CARBON MONOXIDE MONITOR/ALARM** installed at the CPF filter or inside the supplied-air respirator for monitoring for the presence of deadly CO gas and warning the operator(s) when the CO level reaches an unacceptable level. When an ambient air pump is used for breathing air, a CO monitor provides a measure of safety. Read # 1 above.
- ☐ **5. BREATHING-AIR FILTER (OSHA-REQUIRED sorbed bed filter)** for removal of moisture and particulate matter in the compressed air breathing-air supply. Monitor the condition of the cartridge and replace when odor is detected or at 3 month intervals, whichever comes sooner. The breathing air filter does NOT detect or remove carbon monoxide (CO). Always install a CO monitor/alarm.
- ☐ **6. BLAST MACHINE** (bearing U or UM stamp, National Board Number, and Maximum Working Pressure) sized to hold a 30-minute abrasive supply. Examine pop-up valve for alignment. Check piping, fittings, screens, valves for tightness, leaks, and wear. Always ground the machine to eliminate hazard of static shock. Install a blast machine screen to keep out foreign objects. Use a blast machine cover if left outdoors overnight. Never exceed the maximum working pressure of the vessel.
- ☐ **7. AIR LINE FILTER** (moisture separator) installed as close as possible to the blast machine inlet and sized to match the size of the inlet piping or larger air supply line. Clean filter and drain often. Damp abrasive causes operational problems.
- ☐ **8. REMOTE CONTROLS** are required by OSHA and must be in perfect operating condition. Test and check all components to ensure all parts are present and fully functional. Use genuine replacement parts. NEVER mix parts from different manufacturers. Never use welding hose for remote control hose.
- ☐ **9. BLAST HOSE** should have an inside diameter sized to suit the blast nozzle. The ID should be three to four times the size of the nozzle orifice diameter. Blast hose should be arranged in as straight a line as possible from the blast machine to the work area, avoiding sharp bends.
- ☐ **10. COUPLINGS AND NOZZLE HOLDERS** should fit snugly on the hose and be installed with manufacturer recommended screws. Coupling lugs must snap firmly into locking position. Gasket must always be used to form a positive seal, and cotter pins must be installed. Replace gasket when wear, softness or distortion is detected. Check nozzle holder for thread wear; replace at any sign of wear. Install safety cables at all connections.
- ☐ **11. NOZZLE** orifice size should be checked and nozzle replaced when worn 1/16" from original size. (No. 5 nozzle has 5/16" orifice diameter; replace when it measures 3/8"). Threads should be inspected daily for wear and nozzle should be replaced when wear is detected. Always use a nozzle washer.
- ☐ **12. ABRASIVE** must be a material specifically manufactured for blasting. It should be properly sized for the job. Check material safety data sheet for free-silica, cyanide, arsenic, lead and other toxins and avoid use when these toxic, harmful substances are present.
- ☐ **SURFACE TO BE BLASTED** should be examined for hazardous substances. Take appropriate protective measures as required by OSHA to ensure the blast operator, other workers in the vicinity, and any bystanders are properly protected.

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1.0 INTRODUCTION

1.1 Scope of manual

1.1.1 These instructions cover the set-up, operation, maintenance, troubleshooting, and replacement parts for the CMS-1 carbon monoxide (CO) monitor.

1.1.2 The CMS-1 monitor is manufactured by Invertech Inc., for Clemco Industries Corp. The monitor is a potential life saving instrument. To assure its performance, the monitor must be properly installed, tested, calibrated, and maintained. Before installing and using the monitor, all personnel involved with the operation and maintenance of the instrument must read this entire manual, including the orange cover.

1.2 Safety Alerts

1.2.1 Clemco uses safety alert signal words, based on ANSI Z535.4-1998, to alert the user of a potentially hazardous situation that may be encountered while operating this equipment. ANSI's definitions of the signal words are as follows:



This is the safety alert symbol. It is used to alert the user of this equipment of potential personal injury hazards.

Obey all safety messages that follow this symbol to avoid possible injury or death.

CAUTION

Caution used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

CAUTION

Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNING

Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

DANGER

Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

1.3 Components

1.3.1 The primary components are shown in Figure 1. The instrumentation is enclosed in a non-metallic case. The monitor system includes the instrument case, filter/regulator, ten feet of 1/8" ID x 1/4" OD tubing with adaptor fittings, a cylinder of 10 PPM (parts per million) test gas, and the calibration connector, which includes the connector valve and tubing.

1.4 Operating Principles

1.4.1 The CMS monitor samples respiratory air from a breathing-air source. This enables one monitor to detect CO in the entire breathing-air system, not just for a single respirator. The air to the respirator does not actually pass through the monitor.

WARNING

When the CMS is correctly installed and maintained, it monitors the level of carbon monoxide in the air supply. The instrument is a monitoring device; it DOES NOT remove or convert carbon monoxide.

1.4.2 During operation, a small sample of air, referred to as "sample-air", passes through the instrument, and is continuously monitored by the chemical cell sensor. If the "sample-air" supply fails for any reason such as air blockage, loss of pressure, or excessively high pressure, an intermittent alarm horn will sound and the "Alarm Light" will illuminate yellow to alert the user.

1.4.3 In the event CO is detected in concentrations of 10 PPM or above, a continuous alarm horn sounds and the "AIR QUALITY" alarm light illuminates red. The alarms alert the user to immediately stop blasting, and remove the respirator as soon as it is safe to do so.

1.4.4 The alarm trip-point is preset at 10 parts per million (PPM), which is the maximum permissible exposure level (PEL) of CO for grade "D" breathing air.

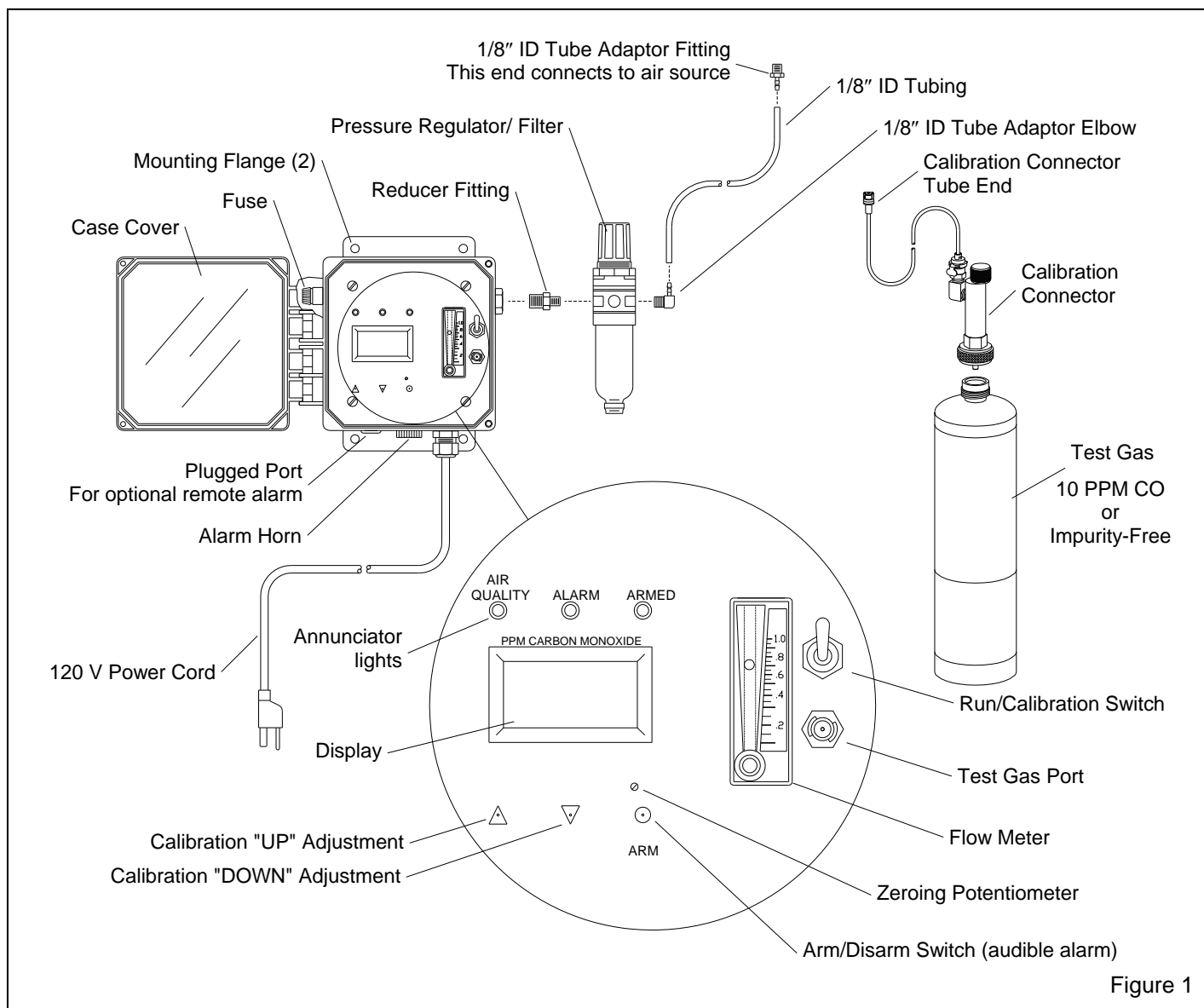


Figure 1

1.5 Annunciator Lights and Audible Alarm

1.5.1 A horn (audible alarm) is provided on the exterior of the instrument case, and annunciator lights (visual alarms) are mounted on the faceplate. The lights illuminate green when conditions are safe, or yellow or red when an alarm occurs. The alarm horn sounds in conjunction with the visual alarm.

⚠ WARNING

All alarm conditions require the immediate attention of the user. Stop blasting immediately, and remove the respirator as soon as it is safe to do so, and check the monitor to determine the cause for alarm.

1.5.2 The alarm lights and the nature of the alarm horn indicate the condition causing an alarm. Functions of the alarm annunciators are as follows:

Armed light: This indicates whether the alarm horn is armed. Green means the alarm horn is armed, no light means it is disarmed. **NOTE: The only time the horn should be disarmed is to temporarily silence it, by the technician during calibration.**

⚠ WARNING

Do not use compressed air monitored by this instrument for breathing without checking to make sure all three alarm lights are illuminated green. Failure to heed this warning could cause death from the inhalation of carbon monoxide.

Alarm light:**Green Light - No Audible Horn**

Indicates there is correct air flow and pressure to the sensor. Correct flow is observed on the flow meter; the flow ball is usually between .5 and .8 SCFH.

Yellow Light - Intermittent Alarm Horn

(Approximately every ten seconds)

Sample-Air Failure: This alarm is due to either low flow, or high flow in the test chamber. Low flow (flow ball is low in the flow meter) is usually due to loss of pressure or plug in the sample-air line, or the external pressure regulator is set too low. High flow (flow ball is high in the flow meter) is an indication that the external pressure regulator is set too high.

Yellow Light - No Audible Horn

Warm-Up Period: During the first minute or two of operation, the monitor goes through a warm-up period while the sensor stabilizes. During the warm-up period, this alarm occurs, and all other alarms are non-operational. After the warm-up is complete, the alarm light turns green if the air is free of CO, or turns red if the air is contaminated with CO.

Air Quality light:**Green Light - No Audible Horn**

Safe Condition: This means the sample-air gas is below the permissible exposure level. **Do not use the compressed air for breathing unless the "AIR QUALITY" light is illuminated green.**

Red Light - Continuous Audible Horn Alarm

Toxic Gas Detected: This alarm occurs when the sensor detects 10 PPM of CO. **NOTE: It is not unusual for the alarm light to be briefly RED as the sensor stabilizes after the warm-up.**

1.6 Digital Display

1.6.1 The digital display shows the level of carbon monoxide (CO) parts per million (PPM). The sensor also responds to a Hydrogen Sulfide and limited number of other toxic gases, and may display inflated CO readings when other toxic gases are detected. **NOTE: It is not unusual for the display to be slightly high for a brief period while the sensor stabilizes after the warm-up.**

1.7 Switches

1.7.1 Run/Calibration Switch: Position the toggle in the "RUN" position for all operations other than the actual calibration test and calibration process. If, for any reason, the toggle is not in the "RUN" position, the instrument will initiate a yellow light and intermittent

alarm, indicating that the sample-air is not reaching the sensor. Correctly positioning the toggle will terminate the intermittent alarm.

1.7.2 Arm/Disarm Switch: This switch arms and disarms the alarm horn. The switch is tripped by inserting a small probe (a straightened paper clip works well) through the small access opening in the faceplate, and pushing gently until the detent is felt. It may take a couple pushes to trip the switch. The horn is armed when the "ARM" light is green. The horn is disarmed when the light is unlit. **NOTE:** The only time the horn should be disarmed is to temporarily silence it, by the technician during calibration.

1.8 Optional Accessories

1.8.1 Remote Alarm: The 12-volt DC remote alarm is a high-intensity, red lens strobe light and high decibel horn. Unlike external alarms, this alarm does not require an external power source. It is recommended in high noise areas, or where the monitor cannot be placed in a conspicuous location. The alarm kit includes the alarm, stand, wiring connector, and 50 ft. cable. See Accessories in Section 9.1. With additional cable, the remote alarm may be placed up to 150 ft. from monitor. Consult Clemco Industries Corp. if longer length is required.

2.0 SET-UP**2.1 Assembly, Ref. Figure 2**

2.1.1 Using the screws and instructions provided in the mounting flange packet, attach the mounting flanges to the instrument case.

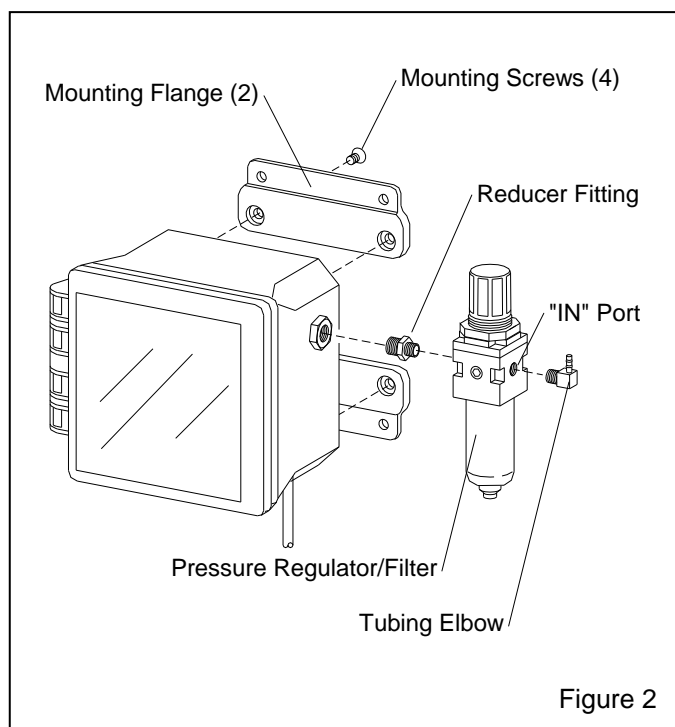
2.1.2 Apply Teflon thread sealing tape to the threads of the 1/4" x 1/8" reducer fitting and tubing elbow, and assemble as shown in Figure 2. Make sure the regulator is correctly installed so the air flow is toward the instrument. The tubing elbow may be rotated after the instrument is mounted, to enable the tubing to be connected with minimum bends.

2.2 Mounting

2.2.1 The simplest way to mount the CMS-1, is with the mounting flanges provided, ref. Figure 2. Mount the monitor in convenient location that is close to the compressed air source. Refer to Section 2.3.2. The monitor must be positioned upright and level, to ensure the flow meter responds correctly. Place the monitor on a wall or panel, and mark the mounting hole locations. Drill appropriately sized holes, and secure with fasteners.

⚠ WARNING

DO NOT mount this instrument inside a blast room. An operator inside a blast room wearing protective clothing will not hear the alarm and may not notice when the instrument is in an alarm condition. The alarm case is not designed to withstand the continual impact of abrasive that takes place inside a blast room. **DO NOT** mount this instrument inside a paint room, or in an explosive or flammable environment. This instrument is not rated for explosive atmospheres. Refer to instructions within the manual for installing auxiliary horns, lights, and safety shut-down devices.



2.3 Compressed Air Requirements

2.3.1 Air Pressure: If the compressed air source pressure is between 55 psi and 145 psi, no line pressure adjustment is required. If line pressure is above 145 psi, a regulator is required in the air line, (before the monitor's regulator) to reduce pressure to be within the 55 to 145 psi operating range.

2.3.2 Air Connection

CAUTION

NOTE: Do not use pipe joint compound to seal pipe fittings. Use Teflon tape for pipe thread sealer. Do not use any silicone-based lubricants up-stream of this instrument.

2.3.2.1 To ensure accurate and rapid air monitoring, the instrument must be placed as close to the compressed air source as practical. Ten feet of 1/8" ID tubing with one 1/8" NPT elbow adaptor and one 1/8" NPT straight adaptor are furnished, to be used between the compressed air source and monitor inlet. Larger diameter tubing or pipe, or longer tubing, increases the time it takes for the sample-air to reach the monitor.

2.3.2.2 Locate a suitable place to tap into the compressed air supply. Do not tap into a dead-end air line. The tap location must be where moving air is assured. The tap location should be within 10 feet of the monitor, and the monitor must be placed in a location that permits continual observance of the visual and audible alarms.

⚠ WARNING

The monitor or an auxiliary alarm must be in a conspicuous place to ensure that any alarm condition is observed. Using the auxiliary terminals and a relay, the monitor may be interlocked with other devices such as the compressor shut-down, to additionally safeguard against an unobserved alarm.

2.3.2.3 Place a tee in the air supply line, and use a bushing or other adaptor, to connect the 1/8" NPT tube adaptor supplied. Install an isolation valve at the source to enable depressurization for service and to remove the monitor. Typical set-ups are shown in Figure 3.

2.3.2.4 The air supply line tee should face upward to prevent water from accumulating in the sample-air line. If the tap cannot face upward, install a short 1/4" NPT drop pipe and drain to prevent water from entering the monitor.

2.3.2.5 Attach the urethane tubing between the air supply tube adaptor fitting and monitor inlet tube adaptor fitting. Cut-off excess tubing.

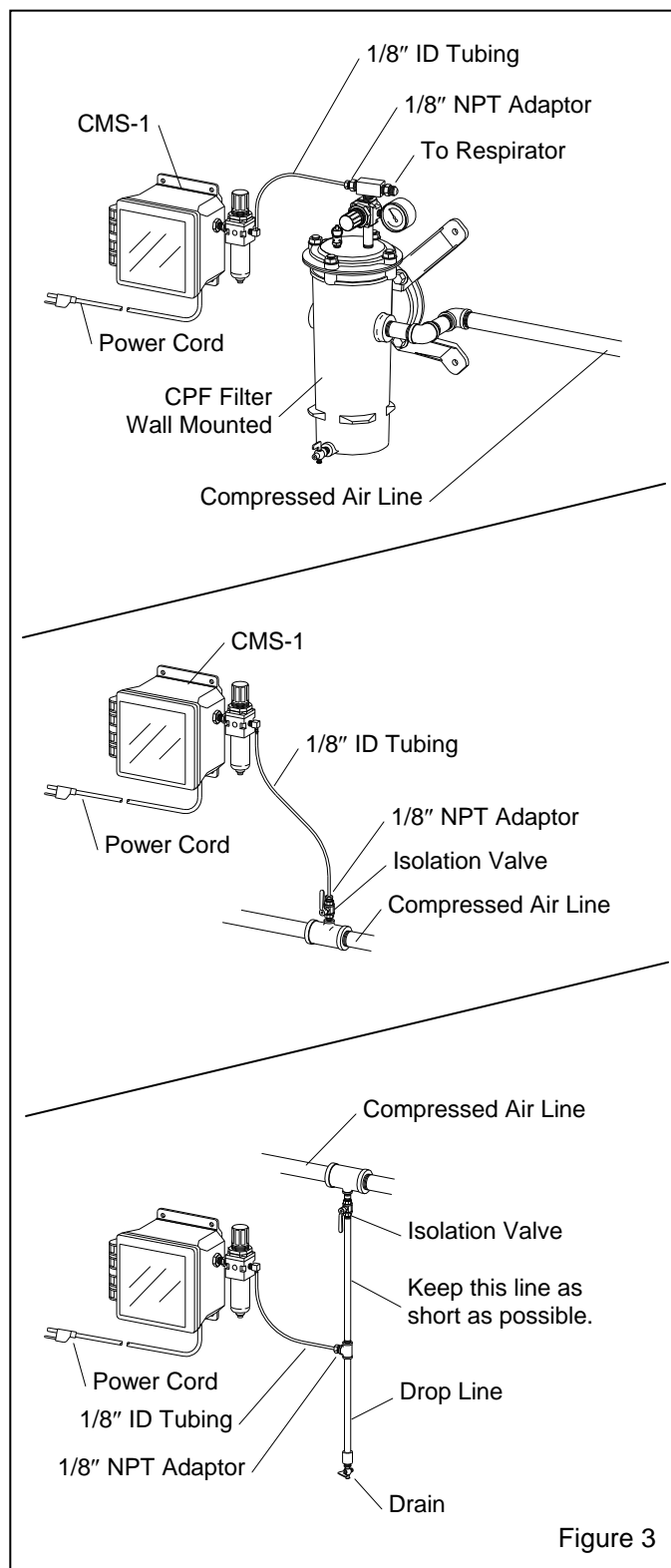


Figure 3

2.4 Electrical Requirements

2.4.1 120-Volt AC: CMS-1 Monitors are generally installed indoors and operate on AC power. A 120-volt AC power cord is supplied and can be plugged into a compatible AC grounded electrical service. Electrical

power may be rewired by a qualified electrician with conduit that conforms to applicable codes.

220-Volt AC: These monitors are available from the factory on special order. The only difference between the 120-Volt and 220-Volt unit is the power cord.

2.5 AC to DC Field Conversion, Serial No. 4446 and greater.

To convert monitors with serial numbers lower than 4446, request Manual No. 23301, Revision D or earlier.

The AC power cord provided with the monitor may be used, using "black" as the positive. A user supplied DC, 2-wire cord may be used, using "red" as positive. If a new 12-volt cord is used, splice the positive through the fuse, and use the spade on the outlet of the fuse to connect to J5 DC positive post, as shown Figure 4.

2.5.1 Make sure that all electrical power to the monitor is disconnected.

2.5.2 Loosen the two case-cover screws and open the case cover.

2.5.3 Remove the four faceplate screws, and carefully remove the faceplate, being careful not to disconnect any wires or tubing. **NOTE: The screws on one side are shorter than the other side, replace accordingly.**

2.5.4 Remove the connector with red and black wires from the plug on the circuit board, as shown in Figure 4. If there is a chance the monitor will be converted back to AC power, tie the wires out of the way. If the monitor is to be permanently converted to 12-volts, pop off the clear terminal cover and remove the wires from the terminal.

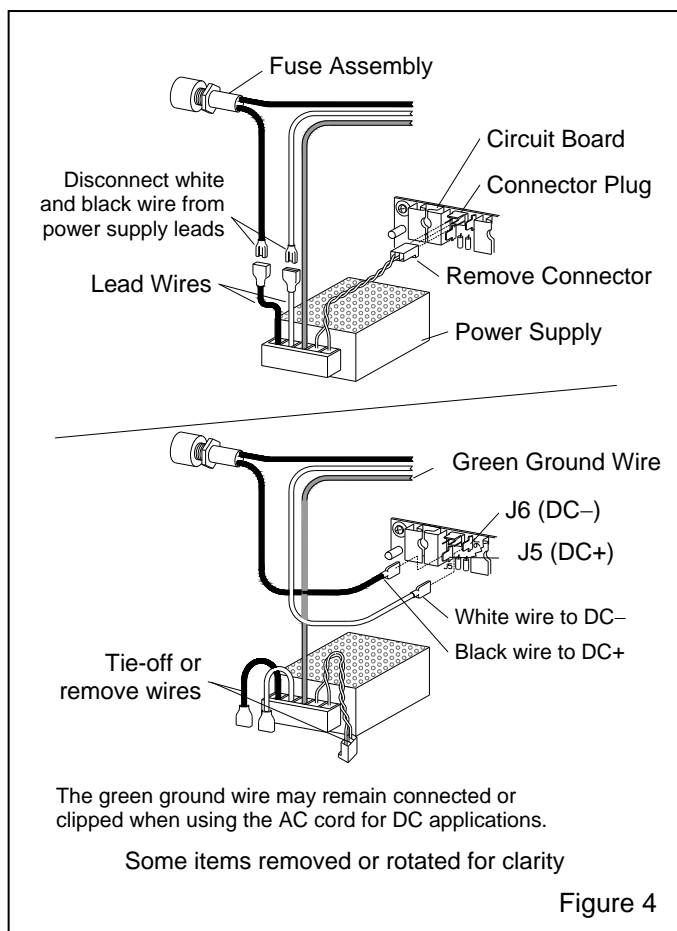
2.5.5 Disconnect the "white" and "black" wires from the power supply lead wires at the connectors, as shown in Figure 4.

2.5.6 Plug the "black" wire onto the "J5" (DC +) post at the upper edge of the circuit board, as shown in Figure 4. Plug the "white" wire onto the "J6" (DC-) post.

2.5.7 Reposition the faceplate, making sure that all internal air lines are free of interference, binding or kinks, and that all tube connections are secure. Tighten the faceplate screws finger-tight to ensure they are threading correctly, then tighten to barely snug with a screwdriver.

2.5.8 Close and secure the instrument case cover, tightening the screws to a maximum of 20-inch lbs.

2.5.9 Remove the plug from the other end of the cord.



2.5.10 Attach a positive (+) terminal connector to the end of the black wire and a negative (-) connector to the end of the white wire. Clip the green wire.

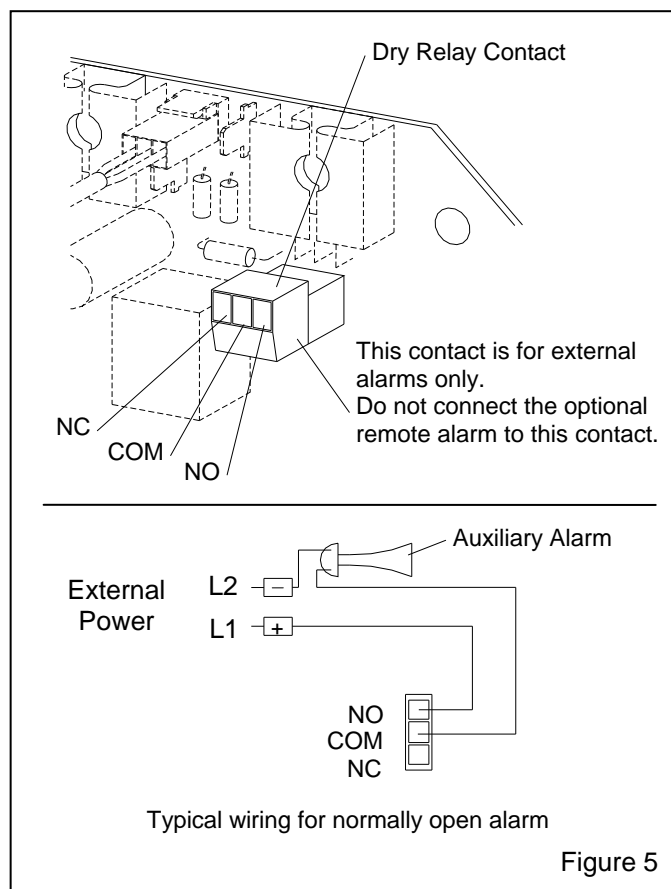
CAUTION

Use any connectors that are compatible with a 12-volt DC system. Make sure the connectors are clearly marked positive (+) and negative (-). Attach the positive connector to the wire leading to the "DC+" post on the circuit board, and the negative connector to the "DC-" post on the circuit board. The monitor will not operate if wires are reversed.

2.6 Connecting External Alarm and Shut-Down Device. Ref. Figure 5.

Note: External alarms require external power. Do not confuse an external alarm with the optional remote alarm, which does not require external power.

2.6.1 A dry relay contact is mounted on the circuit board (Ref. Figure 5), for use with external alarms and shut-down devices. These contacts are rated at 5 amperes. Use the contacts to operate relays for external devices.



3.0 OPERATION

⚠ WARNING

Do not breathe compressed air that this instrument monitors unless the instrument has been calibration tested, and if needed calibrated per Section 4.0. Using a monitor that has not been calibration tested could permit undetected CO to enter the respirator air lines. Breathing toxic gases could cause death.

3.1 Set-Up for Operation

3.1.1 Position the Run/Calibration toggle switch to the "RUN" position.

3.1.2 Open the sample-air isolation valve to supply air to the monitor.

3.1.3 Observe the flow meter ball, and adjust the pressure regulator until the ball remains between .5 and .8 SCFH.

3.1.4 Plug the instrument into a grounded 120-volt AC power supply. If the monitor is converted to operate on 12-volt, connect to a 12-volt DC power source, being certain the positive and negative leads go to the correct terminal. There is no on/off switch on the monitor, it will begin operation as soon as power is applied.

3.2 Warm-Up Period

3.2.1 With electrical power applied and sample-air flow set between .5 and .8 SCFH, the monitor goes through a warm-up period of approximately one minute.

3.2.2 During the warm-up period, the alarm horn is disabled and the "ALARM" light is yellow.

3.2.3 At the end of the warm-up period, the alarm horn is reactivated, and all the annunciator lights will be green indicating the following:

- "ARMED": The alarm horn is armed, to provide an audible alarm if CO reaches the permissible limit of 10 PPM.
- "ALARM": There is correct sample-air flow to the sensor.
- "AIR QUALITY": The sample-air at the sensor does not exceed the permissible contamination limit.

3.2.4 Ensure alarms function per Section 6.4. If the alarms function as described, proceed to place the instrument in operating mode, per Section 3.3.

3.2.5 If the instrument goes into any alarm mode (any annunciator light is any color other than green, or any audible alarm) after the warm-up, re-initiate the warm-up by terminating and restarting power. If the "ARMED" light is not lit, or the "ALARM" light is yellow with an intermittent horn proceed as follows:

"ARMED" light is not lit: The alarm may be disarmed. Arm the alarm by inserting a probe (straightened paper clip) through the small access opening in the faceplate, pushing gently until the detent is felt. It may take several pushes to trip the switch.

"ALARM" light is yellow with an intermittent horn: This usually means low or high flow through the sensor. Generally, with the correct flow, the ball will be between .4 and .9, in some cases slightly higher or lower flow is required. Increase or decrease pressure at the pressure regulator in half turn increments until the horn silences. Approximately one minute later, the "ALARM" light should change from yellow to green.

3.2.6 A continuous alarm with red "AIR QUALITY" light indicates that the sample-air exceeds the permissible contamination level (the digital display

confirms the contamination level), or the instrument requires a calibration test. Refer to Section 4.0.

WARNING

DO NOT use the respirator during the warm-up period. The alarms are disabled and will not warn against toxic gases.

3.3 Operating Mode

3.3.1 Following the warm-up period, with the toggle positioned to "RUN", and the sample-air flowing through the unit, the monitor is in full operating mode.

3.3.2 Before donning the respirator, verify that the monitor is in the operating mode; all three alarm lights must be lit green, with no audible alarm.

WARNING

Do not use compressed air monitored by this instrument for breathing without checking to make sure the instrument is in full operating mode, and all the annunciator lights are illuminated green. Failure to heed this warning could cause death from the inhalation of carbon monoxide.

3.4 Shut-down

3.4.1 If the instrument is in a facility that has 24-hour compressed air and electrical power, there is no need to shut off the monitor. If the compressed air system is shut-down, the electrical power must also be turned off, by unplugging the power cord, or disengaging power if the monitor is permanently wired.

CAUTION

If the compressed air source is shut-down without shutting off electrical power, the monitor will go into low flow alarm, sounding an intermittent alarm and displaying a yellow "ALARM" light.

4.0 CALIBRATION TEST and CALIBRATION

Note: Thoroughly review and understand the calibration test and calibration process before testing or calibrating the instrument. Refer to Section 4.1.

WARNING

The following calibration instructions are written for 10 PPM Test Gas. To avoid confusion, do not test or calibrate the instrument with any other test gas concentration. Using other concentrations, while following the calibrating instructions, will place the monitor out of calibration, and may fail to alert the user of toxic gases. Breathing toxic gases could cause death.

The following materials are required for tests and calibration:

- 10 PPM test gas Stock No. 22865
- Impurity-free test gas Stock No. 11132 (when required, see Section 4.8)
- Calibration connector..... Stock No. 23011
- Small probe such as a straightened paper clip (only when calibration is required)

4.1 Testing and Calibration

4.1.1 It is important to understand the difference between calibration testing and the calibration process.

4.1.2 Calibration testing: Calibration testing means applying test gas of a known concentration to ensure the instrument responds with an alarm when CO concentrations exceed the permissible level, and that it responds with a safe signal when impurity-free air is applied. Calibration testing does not include any adjustment of the instrument. Calibration (adjustments) should be done only when calibration testing shows it is necessary.

4.1.3 Calibration: Calibration means adjusting the instrument. Calibration should be done only when the instrument does not respond during calibration testing, or remains in alarm at start-up.

4.2 Stabilization

4.2.1 The monitor must be in operation for at least 30 minutes before calibration tests. DO NOT test the instrument until it has gone through the warm-up period and has been in operation with sample air flowing through it (See Section 3.0) for at least 30 minutes.

4.3 Prepare Calibration Connector

4.3.1 Make sure the flow-control knob is fully clockwise to the "OFF" position.

4.3.2 Thread the calibration connector onto the cylinder of calibration gas.

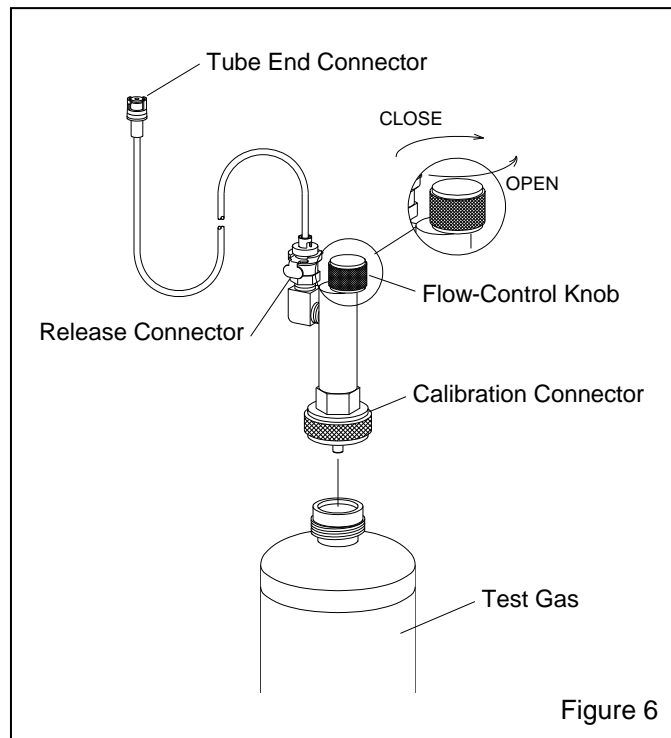


Figure 6

4.4 Prepare Instrument

4.4.1 Open the instrument case cover to access the faceplate. Refer to Figure 7 for faceplate-calibration and testing callouts.

4.4.2 Connect the tube end connector to the "Test Gas Port" by aligning the tabs and inserting the tube end connector into the port, and turn it clockwise to lock.

4.4.3 Place the Run/Calibration toggle toward "CAL" (calibration). The "ALARM" light will immediately turn yellow, and within a few seconds the intermittent alarm horn will sound. Disarming the alarm per Section 1.7.2 will silence the horn during calibration tests.

4.5 Calibration Testing

4.5.1 Gently pull the tubing side of the release connector to make sure it is correctly seated in the body. Slowly open the calibration connector valve to introduce test gas. Test gas is entering the unit when the flow meter ball rises. If the ball does not rise when the calibration valve is opened, the test gas cylinder is probably empty.

4.5.2 Adjust the flow-control knob until the flow meter ball remains between .5 and .8 SCFH. The valve is extremely sensitive. Minor adjustments may be required to correctly position the ball.

4.5.3 Allow test gas to flow through the instrument until the digital readout stabilizes (about one minute).

4.5.4 If the display stabilizes between 9 PPM and 11 PPM (10 PPM plus or minus one), the calibration test is complete. Return to operating mode per Section 4.7.

4.5.5 If the display stabilizes at any value other than between 9 PPM to 11 PPM, and if the instrument has been in operation for at least 30 minutes, calibrate the instrument per Section 4.6. If the instrument has not been in operation for 30 minutes, return it to operating mode per Section 4.7, and operate with sample air for at least 30 additional minutes. Re-test the calibration. If the display stabilizes at a value other than 10 PPM plus or minus one, calibrate the instrument per Section 4.6

4.5.6 When test/calibration is completed, return the instrument to operating mode per Section 4.7.

4.6 Calibration

4.6.1 Do not calibrate the instrument unless it has gone through two stabilizing periods and calibration tests, per Sections 4.2 and 4.5, and only if the digital display is other than 09, 10, or 11 (10 PPM plus or minus one).

4.6.2 If the number in the display is lower than 10 PPM, calibrate through the upright triangle. If the number is higher than 10 PPM, calibrate through the inverted triangle. Calibrate by inserting a straightened paper clip through the small access opening in the appropriate triangle, pushing gently until the detent is felt. It takes several gentle pushes to change the display. Repeatedly and slowly press the switch until the display registers 10 PPM.

4.6.3 When the display shows 10 PPM, the monitor is calibrated. Return the instrument to operating mode per Section 4.7.

4.7 Return to Operating Mode

4.7.1 Close the connector's flow-control valve.

4.7.2 Remove the calibration connector from the monitor by gripping the tube end connector, push in lightly and turn it counterclockwise to unlock, and then pull straight out.

4.7.3 Place the Run/Calibration toggle switch to the "RUN" position. The flow meter ball should rise to .5 to .8 SCFH. After the warm-up, the "ALARM" light should change from yellow to green. If the light does not change to green, increase or decrease flow by adjusting the pressure regulator as required.

4.7.4 Make sure the "ARM" light is lit. See Sec. 1.7.2.

4.7.5 Close the instrument case cover and tighten the screws to a maximum of 20-inch-lbs.

4.7.6 Remove the calibration connector from the cylinder of test gas. The test gas cylinder has a positive seal, whereas the calibration connector valve does not. If the connector is not removed from the test gas cylinder, over a period of time the cylinder will empty.

4.7.7 If for any reason the tubing needs to be removed from the calibration connector, press and hold the release button and gently pull the tubing side of the connector out of the body.

4.7.8 Store all material in a clean, dry area.

4.8 Impurity-Free Air (zero contamination) Test

4.8.1 This test should be done whenever the instrument stays in an alarm condition after it is returned to the operating mode. This test shows whether the alarm condition is due to contaminated air, or a malfunctioning monitor.

4.8.2 Follow the steps in Section 4.5 "Calibration Testing", except use impurity-free test gas in place of the 10 PPM gas.

4.8.3. If the monitor is correctly calibrated and in working order, the display will show 00 PPM. This means the monitor was accurately reading contaminated air. **DO NOT USE THE COMPRESSED AIR FOR BREATHING.**

WARNING

Do not breathe air that this instrument identifies as toxic, until the source of contamination is identified and corrected. Breathing toxic gases could cause death.

4.8.4 Identify the source of contamination. Do not overlook the possibility that contaminated air entered the compressor intake. The contamination could be from engine or other exhaust entering the intake. If the source of contamination is temporary, the monitor will return to a non-alarm (safe) condition after the contamination is cleared from the compressed air system.

4.8.5 If the monitor is out of adjustment or not in good working order, the display will show other than 00 PPM. Zero the instrument per Section 5.0.

4.8.5.1 Re-calibrate the monitor per Section 4.6 and reapply impurity-free gas. If the display is other than 00 PPM, the monitor requires service.

⚠ WARNING

Do not use compressed air monitored by this instrument for breathing unless the instrument is in good working condition. Using a monitor that is not in calibration or not working correctly could permit undetected CO to enter the breathing-air lines. Breathing toxic gases could cause death.

5.0 ZEROING DIGITAL DISPLAY

The following materials are required before zeroing the display:

- Impurity-Free Gas Stock No. 11132
- Calibration Connector Stock No. 23011
- Medium size screwdriver
- Miniature screwdriver

5.1 The monitor must be in operation for at least 30 minutes before zeroing. NOTE: If the zeroing follows sensor replacement, repeat the process after two days of operation.

5.2 Open the instrument case cover to access the faceplate. See Figure 7 for callouts.

5.3 Attach the calibration connector to the impurity-free gas, per Section 4.3.

5.4 Connect the calibration connector to the "Test Gas Port" on the faceplate, by aligning the tabs and inserting the tube end connector into the port and turning it slightly clockwise to lock.

5.5 Place the Run/Calibration toggle toward "CAL" (calibration). The "ALARM" light will immediately turn yellow, and within a few seconds the intermittent alarm horn will sound. Disarming the alarm per Section 1.7.2 will silence the horn during the adjustment.

5.6 Gently pull the tubing side of the release connector to make sure it is correctly seated in the body. Slowly open the calibration connector valve to introduce test gas. Test gas is entering the unit when the flow meter ball rises. If the ball does not rise when the calibration valve is opened, the test gas cylinder is probably empty.

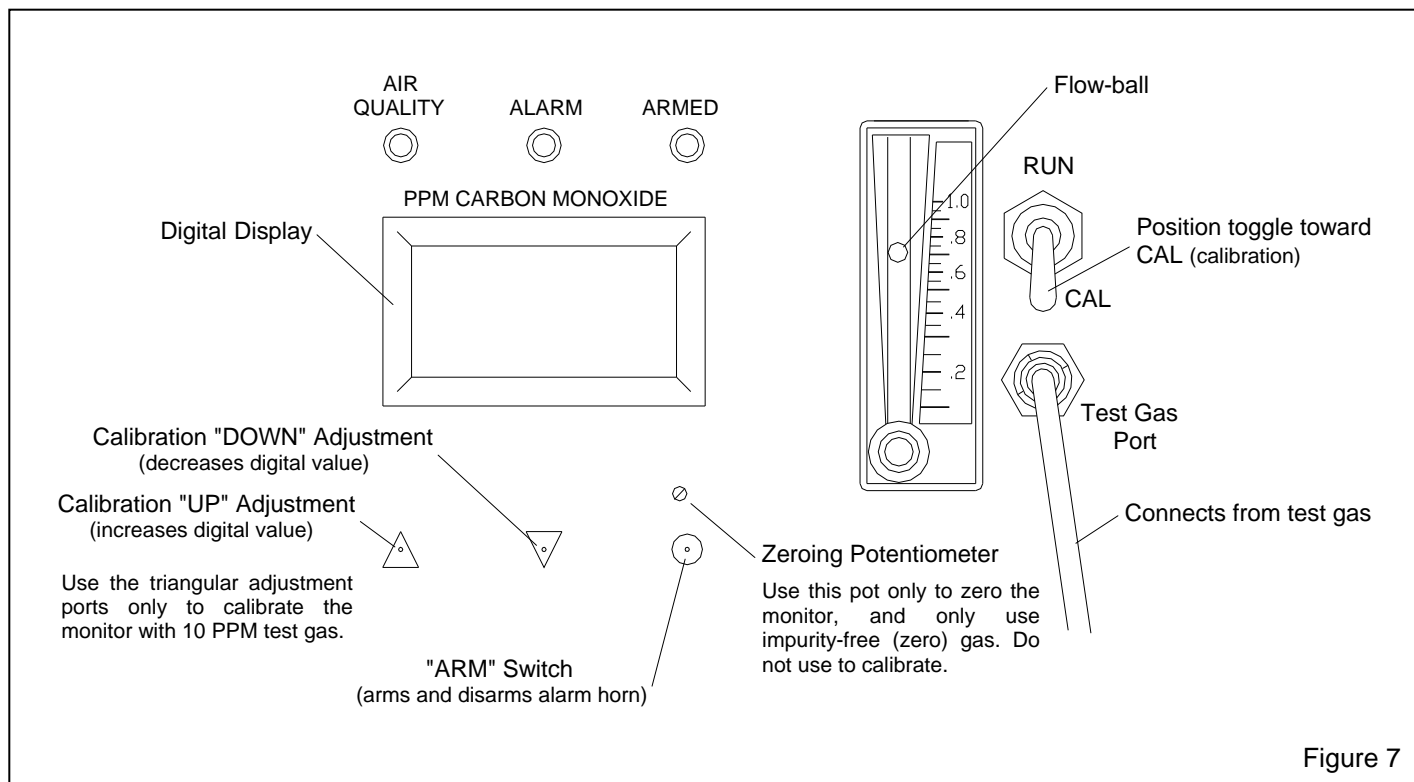


Figure 7

5.7 Adjust the flow-control knob until the flow meter ball remains between .5 and .8 SCFH. The valve is extremely sensitive. Minor adjustments may be required to correctly position the ball.

5.8 Allow test gas to flow through the instrument until the digital readout stabilizes (about one minute).

5.9 Using a miniature screwdriver inserted through the zeroing potentiometer opening, adjust the potentiometer until the display reads ".00" (decimal, zero, zero) **NOTE: The readout responds slowly to the potentiometer adjustment. Turn it slowly when making adjustments.**

5.10 After the display shows ".00", slowly turn the potentiometer clockwise until the decimal disappears.

5.11 Return to the instrument to operating mode per Section 4.7.

6.0 GENERAL MAINTENANCE

6.1 Cleaning

6.1.1 The need to open the case periodically to calibrate the instrument subjects it to external contamination. Take care not to introduce contaminants into the instrument when the case is open.

6.1.2 Clean the exterior of the case with a cloth soaked in a solution of water and mild detergent. Do not clean with solvent cleaners.

6.2 Calibration Test Schedule

6.2.1 Test the calibration when it is initially set-up, and again the day after. Check it once a week for the first month. Check it at least once a month thereafter. See Section 4.0 for test procedure.

6.3 Calibration Schedule

6.3.1 Avoid the urge to calibrate the instrument. Calibrate only when the calibration tests show it is required. See Section 4.0.

6.4 Alarm Tests

6.4.1 Although uncommon, alarm lights and horns do fail. Check their function before each use by placing the Run/Calibration toggle toward "CALIBRATION". The "ALARM" light will immediately turn yellow, and within a few seconds the intermittent alarm horn will sound. Placing the toggle in "RUN" position returns the alarms

to their normal operation. **Never use the respirator without first verifying that the monitor is in the operating mode; all three annunciator lights must be green, with no audible alarm.**

7.0 SERVICE MAINTENANCE

NOTE: Do not attempt to repair the instrument or replace any item that is not listed in this section, or that requires parts not shown in Section 9.0. Contact a Clemco distributor for authorization to return the instrument for evaluation or service.

7.1 Sensor Replacement

7.1.1 Sensor life depends on several factors, but in most cases the sensor should last two to three years.

7.1.2 The following materials are required before replacing the sensor:

- 10 PPM test gasStock No. 22865
- Impurity-free gasStock No. 11132
- Calibration connectorStock No. 23011
- SensorStock No. 23015
- Medium size screwdriver
- Small screwdriver

7.1.3 Open the instrument case and remove the four faceplate screws. **NOTE:** The screws on the left are shorter than those on the right, replace accordingly.

7.1.4 Carefully lift the faceplate, to expose the instrumentation, using care not to disconnect any wires or tubing.

7.1.5 Locate the clear-plastic sensor housing, shown in Figure 8, and remove the mounting screws. The screws are easily removed, do not press hard against the screw-heads; excessive pressure could damage the board.

7.1.6 Carefully lift the sensor housing out of the way.

7.1.7 Pull straight up to remove the sensor.

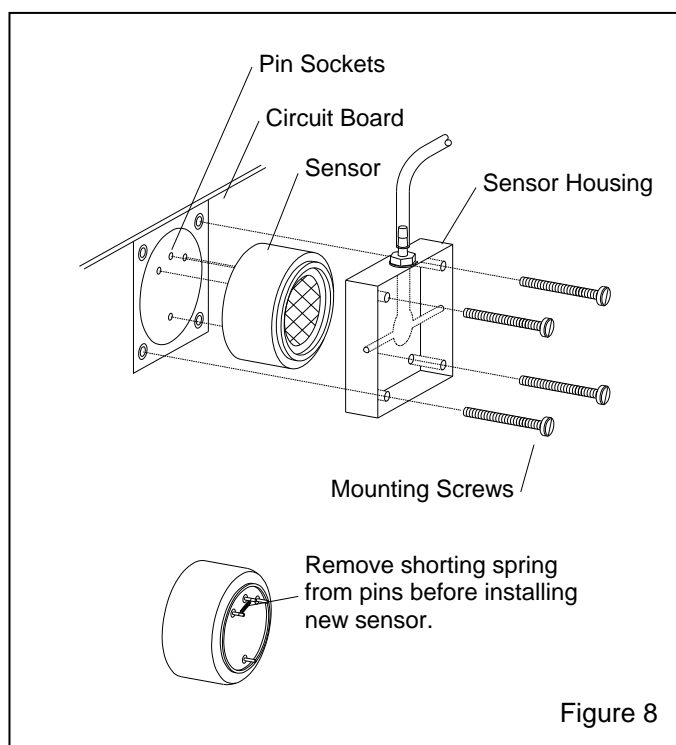
7.1.8 Discard the old sensor to avoid attempts to reuse.

7.1.9 Handle the new sensor with care. Remove the shorting spring from the pins, as shown in Figure 8, and then plug the sensor into the sockets.

7.1.10 Place the sensor housing over the sensor. Align the mounting screw holes, and alternately tighten the screws until snug. **Do not push hard on the screw heads when tightening. Do not over-tighten.**

7.1.11 Replace the faceplate, making sure that all internal air lines are free of interference, binding or kinks, and that all tube connections and wire connections are secure. Tighten the faceplate screws finger-tight to ensure they are threading correctly, then tighten them barely snug with a screwdriver.

7.1.12 Apply sample air and power per Section 3.0. Run the monitor in operating mode for at least four hours before calibrating.



7.1.13 Check the display to verify it reads zero (00). If not, adjust per Section 5.0.

7.1.14 Calibrate per Section 4.0.

7.1.15 Close and secure the instrument case cover, tightening the screws to a maximum of 20-in-lbs.

7.1.16 Return the monitor to service and record sensor replacement date.

7.1.17 Follow calibration test schedule per Section 6.2.

7.2 Fuse Replacement

7.2.1 The fuse cap is located on the side of the instrument case. Remove the cap to access the fuse. Purchase a 1-amp fuse locally.

8.0 TROUBLESHOOTING

WARNING

Shorting electrical components could result in serious electrical shocks, or could damage equipment. All electrical troubleshooting must be performed by a qualified electrician.

8.1 Instrument will not calibrate: If the display does not stabilize, or respond to calibration adjustments.

8.1.1 Make sure the Run/Calibration toggle switch is set toward "CALIBRATE".

8.1.2 Check flow meter. If the flow ball does not rise, the connector's slide valve may be off, or calibration cylinder may be empty.

8.1.3 Replace sensor.

8.2 Intermittent alarm: A pressure switch monitors pressure of sample-air delivered to the sensor. If pressure at the switch (which is monitored by flow through the flow meter) drops below minimum requirement, or rises above maximum, the monitor initiates an intermittent alarm.

8.2.1 Before doing pressure tests, make sure the Run/Calibration toggle switch is toward "RUN". If the toggle is not in the "RUN" position, the instrument will initiate an intermittent alarm, indicating that the sample-air is not reaching the sensor. Correctly positioning the toggle will terminate the intermittent alarm.

8.2.2 Make sure the sample-air is between 55 psi and 145 psi. If the sample-air is higher than 55 psi, the restriction is internal. Proceed as follows:

8.2.3 Check flow through the flow meter. If flow ball is below .4 SCFH or above .9 SCFH adjust the pressure regulator accordingly, until the flow ball remains between .5 and .8 SCFH. In some cases, slightly higher or lower flow is required. Slowly increase and decrease pressure at the pressure regulator. If the regulator pressure was outside the limits, the alarm will disengage as soon as the pressure is corrected.

8.2.4 Check internal instrumentation tubing for breaks, kinks, or disconnection. If tubing has come loose, reconnecting it will re-establish function and the monitor should operate correctly.

⚠ CAUTION

Tubing coming loose could be the result of supplying the instrument with pressure much higher than operating pressure. Refer to Section 2.3. If this type of failure occurs, the maintenance service technician should inspect the instrument as soon as practical.

8.3 No annunciator lights or alarms. This condition indicates a loss of electrical power, as it is unlikely that audible and visual alarms will fail at the same time.

8.3.1 Make sure the electrical power cord is connected to the appropriate power source.

8.3.2 Make sure the fuse, located in the case, is not blown.

8.3.3 Make sure that the power supply is ON.

8.3.4 For 12-volt system, make sure the battery is fully charged and that the charging system is operational. Make sure the positive and negative terminals are connected correctly.

8.3.5 Check for faulty transformer, or loose plug connection on circuit board.

8.4 Either alarm lights or alarm horn fails.

8.4.1 Check for loose plug connections on circuit board.

8.4.2 To test the alarm, remove the plug connection on the circuit board from the suspect alarm, and apply external 12-volt power to the alarm plug. If the alarm fails to activate, replace it.

8.4.3 To test the circuit board, remove the plug connection from the faulty alarm. Use a voltmeter to check voltage across circuit board pins. When testing an alarm horn, switch the Run/Calibration Switch to the "Calibration" position. This will cause an intermittent alarm, and should register on the voltmeter each time the alarm activates. Monitors with faulty circuit board should be returned for service.

9.0 ACCESSORIES AND REPLACEMENT PARTS

9.1 Accessories

Description	Stock No.
(-) Remote alarm kit, includes: alarm, stand, wiring connector and 50-ft. cable	22909
(-) Cable, 50 feet remote alarm extension	22910

9.2 Replacement Parts, Figure 9

Item	Description	Stock No.
(-)	CMS-1, 120-volt monitor package, includes: CO monitor, calibration connector and 10 PPM test gas	23017
(-)	CMS-1, 220-volt CO monitor package Special Order	Contact Clemco Distributor
1.	CMS-1, 120-volt monitor, includes: CO monitor and items 4 to 10	23012
2.	Calibration connector assembly	23011
3.	Test gas 10 PPM	22865
	Impurity-free	11132
4.	Regulator/filter	23013
5.	Flow meter	21376
6.	Horn w/ wire, 12-volt DC	22922
7.	Adaptor, straight, 1/8" NPT x 1/8" barb	11732
8.	Adaptor, elbow, 1/8" NPT x 1/8" barb	11733
9.	Tubing, 1/8" urethane, per foot	12475
10.	Reducer, 1/4" x 1/8"	02026
(-)	Sensor (not shown)	23015
(-)	Orifice, .004 purple restrictor	24423
(-)	Orifice, .006 red restrictor	24424
(-)	Filter element (not shown)	23014

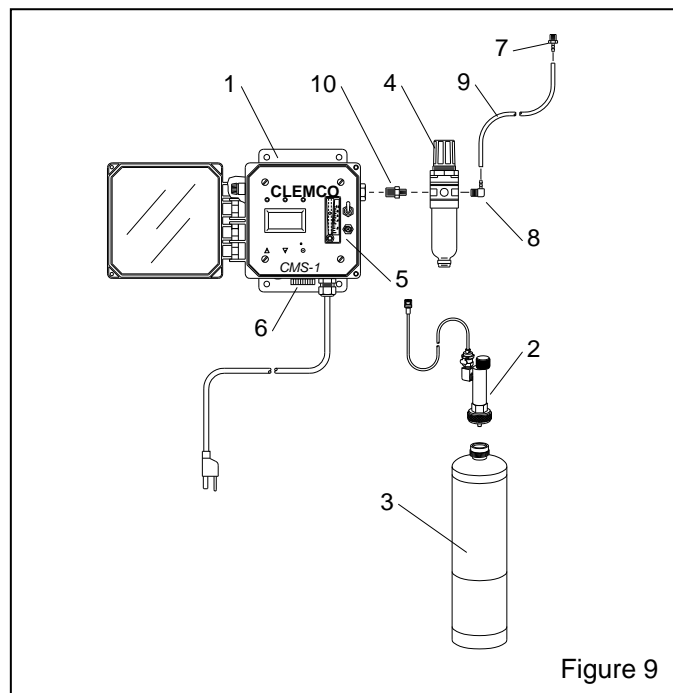


Figure 9