

CMS-2 CARBON MONOXIDE MONITOR

O. M. 22925

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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.

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⚠ WARNING

- Read and follow ALL instructions before using this equipment.
- Failure to comply with ALL instructions can result in serious injury or death.
- In the event that the user, or any assistants of the user of this equipment cannot read or cannot completely understand the warnings and information contained in these instructions, the employer of the user and his assistants must thoroughly educate and train them on the proper operation and safety procedures of this equipment.

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

The products described in this material, and the information relating to those products, is intended for knowledgeable, experienced users of abrasive blasting equipment.

No representation is intended or made as to the suitability of the products described herein for any particular purpose or application. No representations are intended or made as to the efficiency, production rate, or the useful life of the products described herein. Any estimate regarding production rates or production finishes are the responsibility of the user and must be derived solely from the user's experience and expertise, and must not be based on information in this material.

The products described in this material may be combined by the user in a variety of ways for purposes determined solely by the user. No representations are intended or made as to the suitability or engineering balance of the combination of products determined by the user in his selection, nor as to the compliance with regulations or standard practice of such combinations of components or products.

Abrasive Blast Equipment is only a component of the range of equipment used in an abrasive blasting job. Other products may include an air compressor, abrasive, scaffolding, hydraulic work platforms or booms, paint spray equipment, dehumidification equipment, air filters and receivers, lights, ventilation equipment, parts handling equipment, specialized respirators, or equipment that while offered by Clemco may have been supplied by others. Each manufacturer and supplier of the other products used in the abrasive blasting job must be contacted for information, training, instruction and warnings with regard to the proper and safe use of their equipment in the particular application for which the equipment is being used. The information provided by Clemco is intended to provide instruction only on Clemco products. All operators must be trained in the proper, safe, use of this equipment. It is the responsibility of the users to familiarize themselves with, and comply with, all appropriate laws, regulations, and safe practices that apply to the use of these products. Consult with your employer about training programs and materials that are available.

Our company is proud to provide a variety of products to the abrasive blasting industry, and we have confidence that the professionals in our industry will utilize their knowledge and expertise in the safe efficient use of these products.

GENERAL INSTRUCTIONS

Described herein are some, **BUT NOT ALL**, of the major requirements for safe and productive use of blast machines, remote control systems, operator respirator assemblies, and related accessories. Completely read **ALL** instruction manuals prior to using equipment.

The user's work environment may include certain **HAZARDS** related to the abrasive blasting operation. Proper protection for the blaster, as well as anyone else that may be **EXPOSED** to the hazards generated by the blasting process, is the responsibility of the user and/or the employer. Operators **MUST** consult with their employer about what hazards may be present in the work environment including, but not limited to, exposure to dust that may contain **TOXIC MATERIALS** due to the presence of silica, cyanide, arsenic or other toxins in the abrasive, or materials present in the surface to be blasted such as lead or heavy metals in coatings. The environment may also include fumes that may be present from adjacent coatings application, contaminated water, engine exhaust, chemicals, and asbestos. The work area may include **PHYSICAL HAZARDS** such as an uneven work surface, poor visibility, excess noise, and electrical hazards. The operator **MUST** consult with his employer on the identification of potential hazards, and the appropriate measures that **MUST** be taken to protect the blaster and others that might be exposed to these hazards.

ALL machines, components and accessories **MUST** be installed, tested, operated and maintained only by trained, knowledgeable, experienced users.

DO NOT modify or substitute any Clemco parts with other types or brands of equipment. Unauthorized modification and parts substitution on supplied air respirators is a violation of OSHA regulations and voids the NIOSH approval.

OPERATIONAL INSTRUCTIONS

OPERATOR SAFETY EQUIPMENT

⚠ WARNING


- Blast operators and others working in the vicinity of abrasive blasting must always wear properly-maintained, NIOSH-approved, respiratory protection appropriate for the job site hazards.
- **DO NOT USE** abrasives containing more than one percent crystalline (free) silica. Ref. NIOSH Alert #92-102
- Inhalation of toxic dust (crystalline silica, asbestos, lead paint and other toxins) can lead to serious or fatal disease (silicosis, asbestosis, lead or other poisoning).

- **ALWAYS** wear NIOSH-approved supplied-air respirators as required by OSHA, in the presence of any dust including, but not limited to, handling or loading abrasive; blasting or working in the vicinity of blast jobs; and cleanup of expended abrasive. Prior to removing respirator, an air monitoring

instrument should be used to determine when surrounding atmosphere is clear of dust and safe to breathe.

- NIOSH-approved, supplied-air respirators are to be worn ONLY in atmospheres:
 - NOT IMMEDIATELY dangerous to life or health and,
 - from which a user can escape WITHOUT using the respirator.
- Clemco supplied-air respirators **DO NOT REMOVE OR PROTECT AGAINST CARBON MONOXIDE (CO) OR ANY OTHER TOXIC GAS.** Carbon monoxide and toxic gas removal and/or monitoring device must be used in conjunction with respirator to insure safe breathing air.
- Air supplied to respirator **MUST BE AT LEAST GRADE D QUALITY** as described in Compressed Gas Association Commodity Specification G-7.1, and as specified by OSHA Regulation 1910.139 (d).
- ALWAYS locate compressors to prevent contaminated air (such as CO from engine exhaust) from entering the air intake system. A suitable in-line air purifying sorbent bed and filter or CO Monitor should be installed to assure breathing air quality.
- ALWAYS use a NIOSH-approved breathing air hose to connect an appropriate air filter to the respirator. Use of a non-approved air hose can subject the operator to illness caused by the release of chemical agents used in the manufacture of non-approved breathing air hose.
- ALWAYS check to make sure air filter and respirator system hoses are NOT CONNECTED to in-plant lines that contain nitrogen, acetylene or any other non-breathable gas. NEVER use oxygen with air line respirators. NEVER modify air line connections to accommodate air filter/respirator breathing hose WITHOUT FIRST testing content of the air line. **FAILURE TO TEST THE AIR LINE MAY RESULT IN DEATH TO THE RESPIRATOR USER.**
- Respirator lenses are designed to protect against rebounding abrasive. They do not protect against flying objects, glare, liquids, radiation or high speed heavy materials. Substitute lenses from sources other than the original respirator manufacturer will void NIOSH-approval of this respirator.

BLAST MACHINES AND REMOTE CONTROLS

 WARNING
<ul style="list-style-type: none"> • ALWAYS equip abrasive blast machines with remote controls. • Abrasive blast machine operators must wear NIOSH-approved supplied-air respirators (ref: OSHA regulations 1910.94, 1910.132, 1910.139 and 1910.244).

- NEVER modify OR substitute remote control parts. Parts from different manufacturers are NOT compatible with Clemco

equipment. If controls are altered, involuntary activation, which may cause serious injury, can occur.

- Inspect the air control orifice DAILY for cleanliness. NEVER use welding hose in place of twinline control hose. The internal diameter and rubber composition are UNSAFE for remote control use.
- UNLESS OTHERWISE SPECIFIED, maximum working pressure of blast machines and related components MUST NOT exceed National Board approved 125 psig (8.5 BAR).
- NEVER weld on blast machine. Welding may affect dimensional integrity of steel wall and WILL VOID National Board approval.
- Point nozzle ONLY at structure being blasted. High velocity abrasive particles WILL inflict serious injury. Keep unprotected workers OUT of blast area.
- NEVER attempt to manually move blast machine when it contains abrasive. EMPTY machines, up to 6 cu. ft.(270kg) capacity, are designed to be moved:
 - on flat, smooth surfaces by AT LEAST two people;
 - with the Clemco "Mule"; or
 - with other specially designed machine moving devices.
- Larger empty blast machines or ANY blast machine containing abrasive MUST be transported by mechanical lifting equipment.

AIR HOSE, BLAST HOSE, COUPLINGS, AND NOZZLE HOLDERS

- Air hose, air hose fittings and connectors at compressors and blast machines MUST be FOUR times the size of the nozzle orifice. Air hose lengths MUST be kept as short as possible AND in a straight line. Inspect DAILY and repair leakage IMMEDIATELY.
- Blast hose inside diameter MUST be THREE to FOUR times the size of the nozzle orifice. AVOID sharp bends that wear out hose rapidly. Use SHORTEST hose lengths possible to reduce pressure loss. Check blast hose DAILY for soft spots. Repair or replace IMMEDIATELY.
- ALWAYS cut loose hose ends square when installing hose couplings and nozzle holders to allow uniform fit of hose to coupling shoulder. NEVER install couplings or nozzle holders that DO NOT provide a TIGHT fit on hose. ALWAYS use manufacturers recommended coupling screws.
- Replace coupling gaskets FREQUENTLY to prevent leakage. Abrasive leakage can result in dangerous coupling failure. ALL gaskets MUST be checked SEVERAL times during a working day for wear, distortion and softness.
- Install safety pins at EVERY coupling connection to prevent accidental disengagement during hose movement.
- ALWAYS attach safety cables at ALL air hose AND blast hose coupling connections. Cables relieve tension on hose and control whipping action in the event of a coupling blow-out.

MAINTENANCE

- ALWAYS shut off compressor and depressurize blast machine BEFORE doing ANY maintenance.
- Always check and clean ALL filters, screens and alarm systems when doing any maintenance.
- ALWAYS cage springs BEFORE disassembling valves IF spring-loaded abrasive control valves are used.
- ALWAYS completely follow owner's manual instructions and maintain equipment at RECOMMENDED intervals.

ADDITIONAL ASSISTANCE

- Training and Educational Programs. Clemco Industries Corp. offers a booklet, Blast-Off 2, developed to educate personnel on abrasive blast equipment function and surface preparation techniques. Readers will learn safe and productive use of machines, components and various accessories, including selection of abrasive materials for specific surface profiles and degrees of cleanliness.
- The Society for Protective Coatings (SSPC) offers a video training series on protective coatings including one entitled "Surface Preparation." For loan or purchase information, contact SSPC at the address shown below.

TECHNICAL DATA AND RESEARCH COMMITTEES

- The following associations offer information, materials and videos relating to abrasive blasting and safe operating practices.

The Society for Protective Coatings (SSPC)
 40 24th Street, Pittsburgh PA 15222-4643
 Phone: (412) 281-2331 • FAX (412) 281-9992
 Email: research@sspc.org • Website: www.sspc.org

National Association of Corrosion Engineers (NACE)
 1440 South Creek Drive, Houston TX 77084
 Phone: (281) 228-6200 • FAX (281) 228-6300
 Email: msd@mail.nace.org • Website: www.nace.org

American Society for Testing and Materials (ASTM)
 100 Barr Harbor Dr., West Conshohocken, PA 19428
 Phone (610) 832-9500 • FAX (610) 832-9555
 Email: service@astm.org • Website: www.astm.org

NOTICE

This equipment is not intended to be used in an area that might be considered a hazardous location as described in the National Electric Code NFPA 70 1996, article 500.

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 the 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 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 a 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 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 the 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.

DAILY SET-UP CHECK LIST

 WARNING
<ul style="list-style-type: none"> • ALL piping, fittings and hoses MUST be checked DAILY for tightness and leakage. • ALL equipment and components MUST be thoroughly checked for wear. • ALL worn or suspicious parts MUST be replaced. • ALL blast operators MUST be properly trained to operate equipment. • ALL blast operators MUST be properly outfitted with abrasive resistant clothing, safety shoes, leather gloves and ear protection. • BEFORE blasting ALWAYS use the following check list.

1. PROPERLY MAINTAINED AIR COMPRESSOR sized to provide sufficient volume (cfm) for nozzle and other tools PLUS a 50% reserve to allow for nozzle wear. Use large compressor outlet and large air hose (4 times the nozzle orifice size). FOLLOW MANUFACTURERS MAINTENANCE INSTRUCTIONS.

2. BREATHING AIR COMPRESSOR (oil-less air pump) capable of providing Grade D Quality air located in a dust free, contaminant free area. If oil-lubricated air compressor is used to supply respirator, it should have high temperature monitor and CO monitor or both. If CO monitor is not used, air **MUST** be tested FREQUENTLY to ensure proper air quality.

3. Clean, properly maintained NIOSH-APPROVED SUPPLIED-AIR RESPIRATOR. ALL components should ALWAYS be present. NEVER operate without inner lens in place. Thoroughly inspect ALL components DAILY for cleanliness and wear. ANY substitution of parts voids NIOSH approval i.e. cape, lenses, breathing hose, breathing air supply hose, air control valve, cool air or climate control devices.

4. OSHA required BREATHING AIR FILTER for removal of moisture and particulate matter from breathing air supply. THIS DEVICE DOES NOT REMOVE OR DETECT CARBON MONOXIDE (CO). ALWAYS USE CO MONITOR ALARM.

5. ASME CODED BLAST MACHINE sized to hold 1/2 hour abrasive supply. ALWAYS ground machine to eliminate static electricity hazard. Examine pop up valve for alignment. Blast machine MUST be fitted with a screen to keep out foreign objects and a cover to prevent entry of moisture overnight.

6. AIR LINE FILTER installed AS CLOSE AS POSSIBLE to machine inlet. Sized to match inlet piping or larger air supply line. Clean filter DAILY. Drain OFTEN.

7. REMOTE CONTROLS MUST be in PERFECT operating condition. ONLY use APPROVED spare parts, including twin-line hose. DAILY: test system operation and check button bumper and spring action of lever and lever lock. DO NOT USE WELDING HOSE.

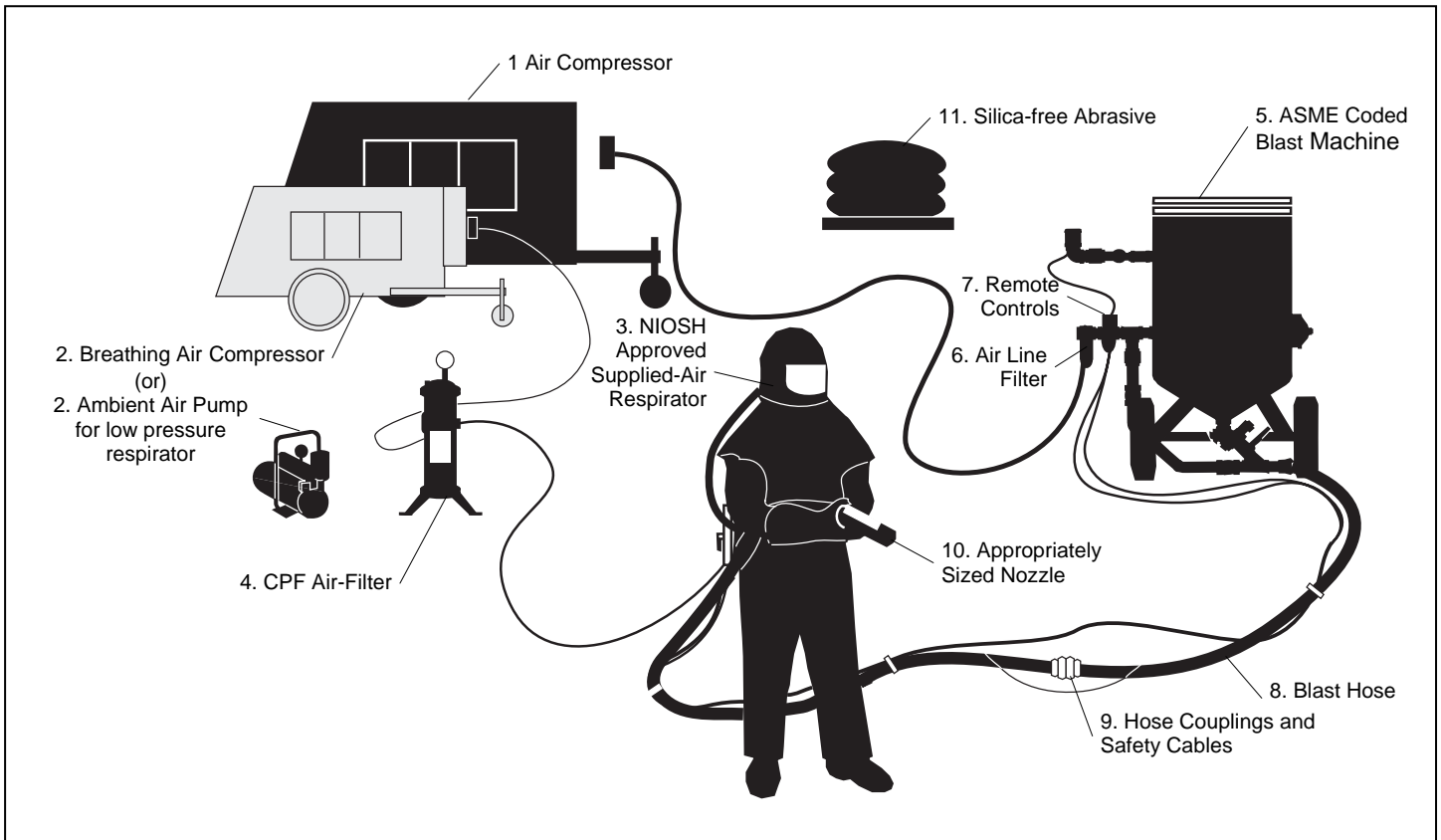
8. BLAST HOSE with ID 3 to 4 times the nozzle orifice. Lines MUST be run AS STRAIGHT AS POSSIBLE from machine to work area with NO sharp bends. Check DAILY for internal wear and external damage.

9. HOSE COUPLINGS, NOZZLE HOLDERS fitted SNUGLY to hose end and installed using PROPER coupling screws. Coupling lugs MUST be snapped FIRMLY into locking position. Gasket MUST form positive seal with safety pins inserted through pin holes. Check gaskets and replace if ANY sign of wear, softness or distortion. ALWAYS install safety cables at every connection to prevent disengagement. Check nozzle holder for worn threads. NEVER MIX DIFFERENT BRANDS OF COMPONENTS. Check each of these components DAILY.

10. Inspect NOZZLE and GASKET DAILY for wear. Replace nozzle when 1/16" larger than original size or if liner appears cracked. Check nozzle threads for wear.

11. Use abrasive that is properly sized and free of harmful substances; such as, free silica, cyanide, arsenic or lead. Check material data sheet for presence of toxic or harmful substances.

12. Test surface to be blasted for toxic substances. Take appropriate, and NIOSH required, protective measures for operator and bystanders which pertain to substances found on the surface to be blasted.



1.0 INTRODUCTION

1.1 Scope of manual

1.1.1 These instructions cover set-up, operation, maintenance, troubleshooting, and replacement parts for the CMS-2 contractor series carbon monoxide (CO) monitor.

1.1.2 The CMS-2 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 of the monitor are shown in Figure 1. The instrumentation is enclosed in a corrosion resistant polypropylene carrying case. The monitor system includes the instrument case, ten feet of 1/8" ID x 1/4" OD tubing with fittings, a cylinder of 10 PPM (parts per million) test gas, calibration connector which includes the connector valve, tubing and humidifier.

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 and other toxic gases in the entire breathing air system, not just for one 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 and other oxidizable toxic gases in the air supply. The instrument is a monitoring device; it DOES NOT remove or convert carbon monoxide or any other toxic gases.

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 broadband MOS (Metal Oxide Substrate) sensor. Although the sensor detects CO (carbon monoxide), it also detects other oxidizable toxic gases (hydrocarbons). If the "sample-air" supply fails for any reason such as air blockage, loss of pressure, or excessively high pressure, an intermittent audible alarm will sound and the exterior alarm light will illuminate "yellow" to alert the user.

1.4.3 In the event the sensor detects CO in the concentration of 10 PPM (parts per million) or above, a continuous audible alarm will sound and the exterior alarm light will illuminate "red" to alert the user.

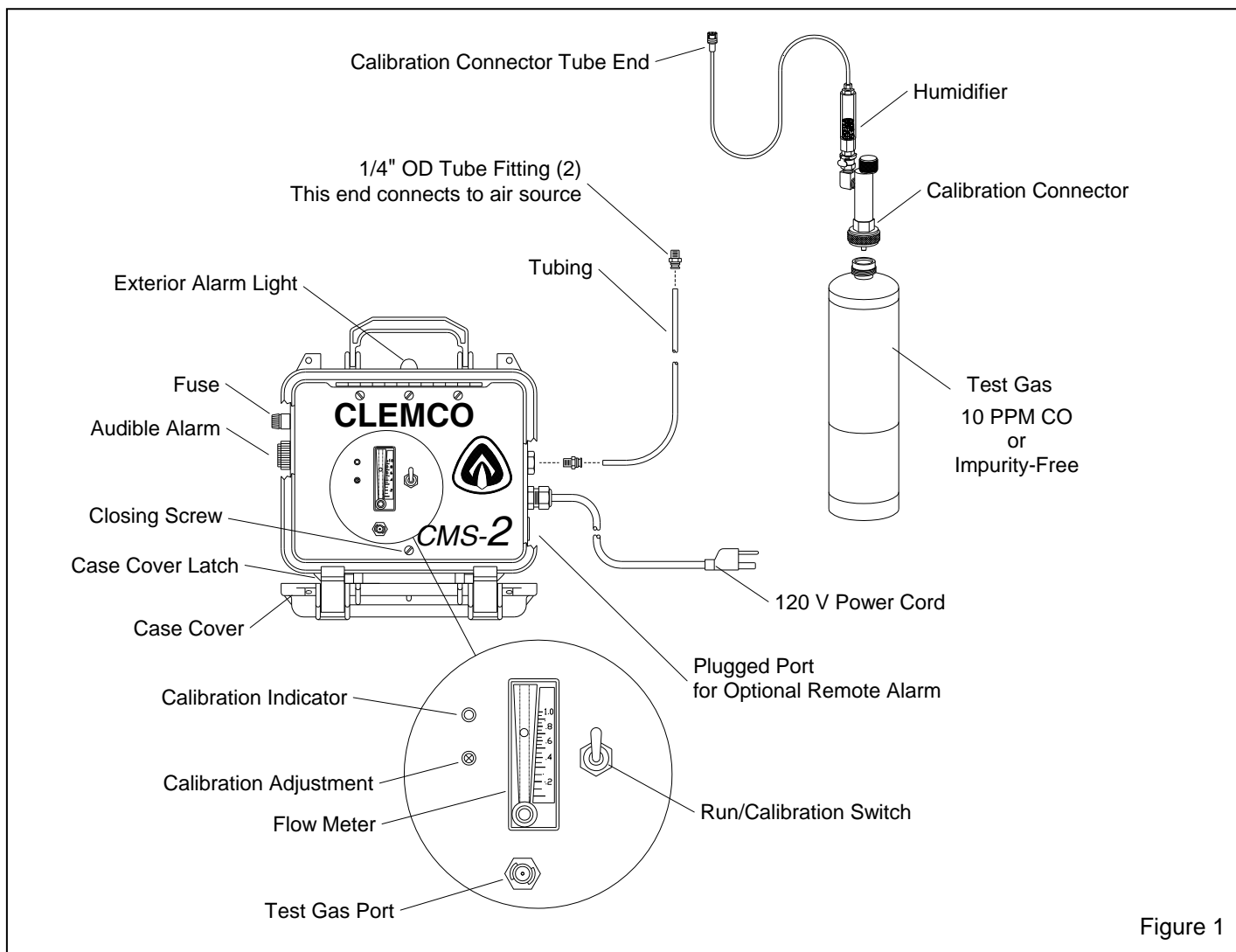


Figure 1

1.5 Annunciator Lights and Audible Alarms and Switches

1.5.1 Audible and visual alarms are provided on the exterior of the instrument case and on the interior faceplate. The exterior light illuminates "green" when conditions are safe, or "yellow" or "red", depending on the alarm condition. The audible alarm 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 color of the alarm light in conjunction with the nature of the audible alarm indicates the condition causing an alarm. Functions of the alarm annunciators are as follows:

1.5.3 Interior Calibration Light

Red Light - Intermittent Audible Alarm

- The interior alarm light (calibration indicator), on the faceplate of the instrument, responds to toxic gas conditions only. It is for use by the technician during calibration testing, and for calibration when the instrument case is open.

1.5.4 Exterior Alarm Annunciators

Green Light - No Audible Alarm

- No Alarm, Safe Condition: Do not use the compressed air for breathing unless the exterior light is illuminated "green".

Yellow Light - Intermittent Audible Alarm

Sample-Air Failure: This alerts the user that pressure in the test chamber is either too low or too high. Low pressure is usually due to loss of pressure in the sample-air air line. High pressure is an indication that the internal regulator is set too high. Correct flow is observed on the flow meter; the flow ball is usually between .5 and .8 SCFH.

- Calibration in process: During calibration testing and the calibration procedure, this alarm is activated. The alarm will terminate when the technician has correctly returned the monitor to service.

Yellow Light - No Audible Alarm

- Warm-Up Period: During the first several minutes of operation, the monitor goes through a warm-up period while the sensor stabilizes. During the warm-up period, the yellow light illuminates, and all other alarms are non operational. The alarm will terminate after the warm-up is complete.

Red Light - Continuous Audible Alarm

- Toxic Gas Detected: This alarm occurs when toxic gas or CO in excess of 10 PPM is detected in the breathing air line.

1.5.5 Run/Calibration Switch: The toggle should be 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.

1.6 Optional Accessories

1.6.1 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. This accessory 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 8.1. With additional cable, this alarm may be used up to 150 ft. from the monitor. Consult Clemco Industries Corp. if longer length is required.

1.6.2 Air Line Humidifier: This accessory is used to humidify sample-air when the instrument is used to monitor air lines where the air has been dried to 30% RH (relative humidity) or less.

2.0 SET-UP**2.1 Compressed Air Requirements**

2.1.1 Air Pressure: If the compressed air source is between 55 psi and 120 psi, no pressure adjustment is required. If line pressure is above 120 psi, a regulator is required to reduce pressure within the 55 to 120 psi operating range.

2.1.2 Air Connection**CAUTION**

Do not use pipe joint compound to seal pipe fittings. The monitor will respond to the gases given off by these compounds. Use teflon tape for pipe thread sealer.

Do not use any silicone based lubricants upstream of this instrument. Silicone exposure will prematurely damage the sensor.

2.1.2.1 If the instrument is used to monitor air lines where the air has been dried to 30% RH or less, mount an optional humidifier in an upright position between the air supply source and monitor inlet.

2.1.2.2 To ensure accurate and rapid air monitoring, the monitor must be placed as close to the compressed air source as practical. Ten feet of 1/8" ID tubing with two 1/4" NPT fittings are furnished, to be used between the compressed air source and monitor inlet. Larger diameter tubing or pipe, or longer lengths, increases the air supply volume, and the volume determines the length of time it takes for the sample-air to reach the monitor.

2.1.2.3 Determine a suitable place to tap into the compressed air supply. The tap location should be within 10 feet of the monitor, and the monitor 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, as an additional safeguard against an unobserved alarm.

2.1.2.4 Place a tee in the air supply line, and use a bushing or other adaptor, to connect one of the 1/4" NPT tube fittings supplied. Install an isolation valve at the source to enable depressurization to remove the monitor. Typical set-ups are shown in Figure 2.

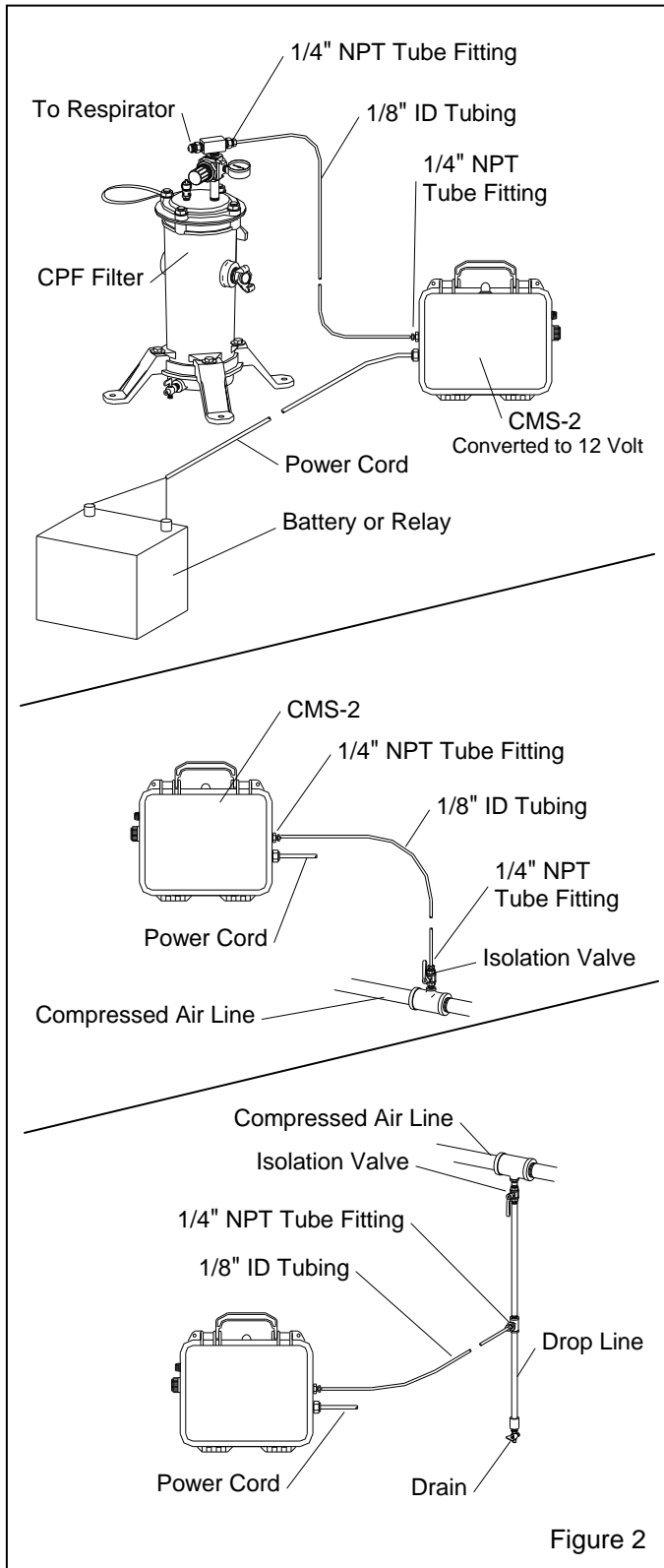


Figure 2

2.1.2.5 The air supply line tee should face upward to prevent water from accumulating in the sample-air line. If the tap cannot be up, install a drop pipe and drain to prevent water from entering the monitor.

2.1.2.6 Connect the other 1/4" NPT tube fitting to the monitor's inlet port.

2.1.2.7 Attach the urethane tubing between the air supply tube fitting and monitor inlet tube fitting. Remove excess tubing.

2.2 Electrical Requirements

2.2.1 **120-Volt AC:** Monitors are supplied with a 120-volt AC power cord, and can be plugged into a 120 volt grounded electrical source.

2.2.2 **12-Volt DC:** Although monitors are supplied with a 120-volt AC power cord, they are easily converted to operate on 12-volt DC. The following instructions explain the conversion. Use the supply cord provided with the monitor, or use another 2-wire cord if a longer one is required. Using the same process, but with 12-volt color codes, 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 the positive terminal. Refer to Figure 3.

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

2.2.2.2 Open the case to access the interior faceplate.

2.2.2.3 Loosen the closing screw located in the center of the lower edge of the faceplate. See Figure 1.

2.2.2.4 Swing the faceplate up to access the instrumentation.

2.2.2.5 Remove the connector from the outgoing side of the transformer (three wires) from the terminal board connector post as shown in Figure 3. If the monitor is to be permanently converted to 12-volts, remove the three wires from the transformer and remove the wire.

2.2.2.6 Loosen the transformer mounting screws and remove the plastic shield from the incoming side of the transformer. Remove the "white" and "black" wire terminal connectors from the incoming side of the transformer, Ref. Figure 3. Tighten the transformer mounting screws.

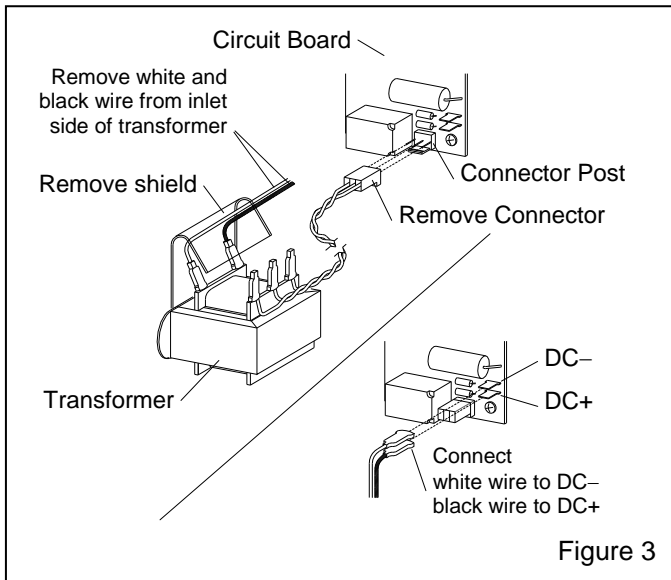


Figure 3

2.2.2.7 Plug the "black" wire connector to the "DC+" terminal on the lower left end of the circuit board, and the "white" wire connector to the "DC-" terminal.

2.2.2.8 Remove the u-ground plug from the other end of the cord.

2.2.2.9 When closing the faceplate, ensure that all internal air lines are free of interference, binding or kinks, and that all tube connections are secure. Tighten the closing screw.

2.2.2.10 Close and latch the instrument case cover.

2.2.2.11 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 terminal connectors that are compatible with the 12-volt DC system. However, take care to ensure that the connectors are clearly marked positive (+) and negative (-). Attach the positive connector to the wire leading to the "DC+" terminal, and the negative connector to the "DC-" terminal on the circuit board. The monitor will not operate if wires are reversed.

2.2.3 Connecting External Alarm and Shut-Down Device. Ref. Figure 4. Note: External alarms require an external power source. Do not confuse with the optional remote alarm that does not require external power.

2.2.3.1 A relay contact is mounted on the circuit board (Ref. Figure 4), 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.

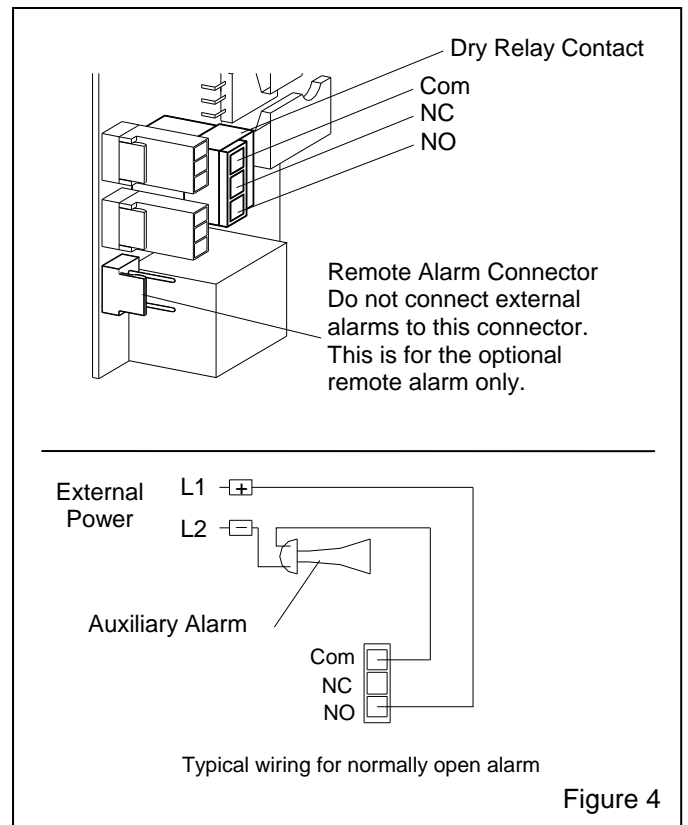


Figure 4

2.3 Mounting

2.3.1 The CMS-2 does not require any special mounting, and it will operate in any position. The carrying case handle may be used to hang the monitor in a convenient location that is close to the compressed air source. See Section 2.1.2.

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. Refer to instructions within the manual for installing auxiliary horns, lights, and safety shut-down devices.

3.0 OPERATION

WARNING

Do not use compressed air that this instrument monitors for respiratory use 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 test air to the monitor.

3.1.3 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 initiate operation as soon as power is applied.

3.2 Warm-Up Period

3.2.1 With electrical power applied and 55 to 120 psi sample-air supplied to the inlet, the monitor will go through a five minute warm-up period.

3.2.2 During the warm-up period, the audible alarms are disabled and the external visual alarm is "yellow". At the end of the warm-up period the "yellow" exterior light turns "green", indicating that the instrument is functioning and the sample-air does not exceed the contamination limit.

NOTE: If the instrument has been off for a prolonged period, it is normal for the alarms to activate for a short period of time after the warm up cycle.

3.2.3 Insure alarms function per Section 5.5. If the alarms function as described, proceed to place the instrument in operating mode, per Section 3.3.

3.2.4 If the instrument goes into an alarm (exterior light remains "red" with continuous audible alarm) after the warm-up, re-initiate warm-up by terminating and restarting power.

3.2.5 Continued alarm condition after several warm-up periods indicates that the sample-air exceeds the

permissible contamination level, or the instrument requires calibration. 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 correctly 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; The exterior alarm light must be "green", with no audible alarm.

WARNING

Do not use compressed air monitored by this instrument for breathing without first checking to make sure the instrument is in full operating mode, and the exterior alarm light is 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 not to be moved, and is protected from the weather, simply shut off the isolation valve, and unplug the power cord. If the unit is to be transported, or if it is not protected from the weather, proceed as follows:

3.4.2 Watch the flow meter; when air flow stops, remove the urethane tubing from the supply line and monitor inlet. The tubing is easily removed by pushing in the tube fitting ring while pulling the tubing.

3.4.3 Coil the tubing and place it inside the instrument case to keep the tubing clean.

3.4.4 Place tape or other cover over the inlet fitting to keep instrumentation clean.

3.4.5 Transport the instrument in the passenger compartment of the service vehicle, not in the trunk or truck bed. See "Care and Handling" in Section 5.1

4.0 CALIBRATION TEST and CALIBRATION

Note: Thoroughly review the calibration testing and the calibration process before testing or calibrating the instrument.

⚠ WARNING

This instrument must be tested and calibrated with 10 PPM Test Gas. Do not test or calibrate with any other test gas concentration. Doing so will place the monitor out of calibration, and may fail to alert the user of toxic gases. Breathing toxic gases could cause death.

4.1 Testing and Calibration

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

4.1.2 Calibration testing: Calibration testing means applying test gas of a known concentration to the instrument to ensure that it 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 Materials Required for Tests and Calibration

- 10 PPM Test GasStock No. 22865
- Impurity-Free Test GasStock No. 11132
(when required, see Section 4.9)
- Calibration ConnectorStock No. 22893
- Distilled water
- Small adjusting screwdriver
(when calibration is required)

4.3 Stabilization

4.3.1 The monitor must be in operation for at least 30 minutes before calibration testing. 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.

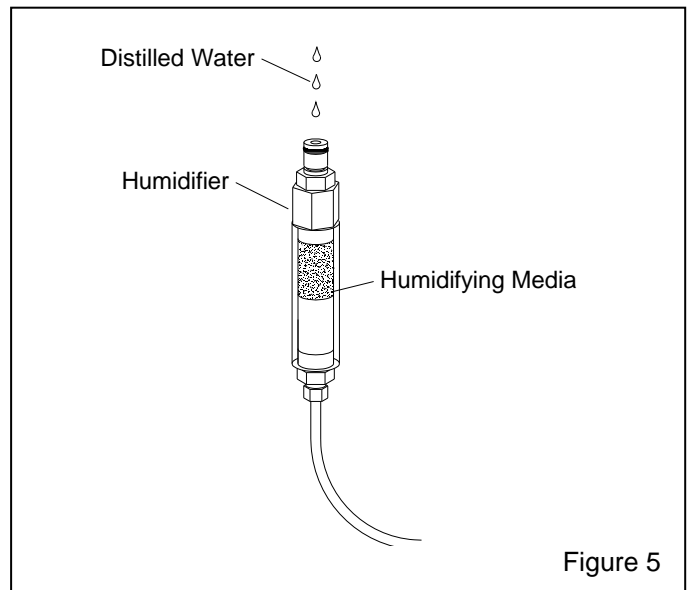
4.4 Prepare Calibration Connector

NOTE: Unlike ambient air, calibration test gas is bone-dry. Attempts to test or calibrate the monitor without humidifying the test gas will cause significant reading errors of compressed air with normal levels of humidity.

4.4.1 Before connecting the calibration connector to the test gas, dampen the humidifier media with distilled water as follows: Ref. Figure 5.

4.4.2 Press and hold the release button and the pull the humidifier assembly out of the release connector body.

4.4.3 Turn the humidifier upside down, and moisten the sponge by putting a few drops of distilled water into the connector, as shown in Figure 5.



4.4.4 Hold the tubing end of the connector and shake out excess water. **NOTE: The humidifier needs to be dampened only; excess water must be removed so that it does not enter the instrument plumbing.**

4.4.5 Reconnect the humidifier to the connector by pushing the humidifier into the release body. Gently pull the connector to make sure it is correctly seated in the body.

4.4.6 Make sure the flow-control knob is turned fully clockwise to the "OFF" position. Refer to Figure 6.

4.4.7 Attach the test gas connector to the cylinder of calibration gas (Use 10 PPM CO test gas to check the calibration or to calibrate the monitor. Use zero, impurity-free air to check if alarm is due to contaminated air or other condition).

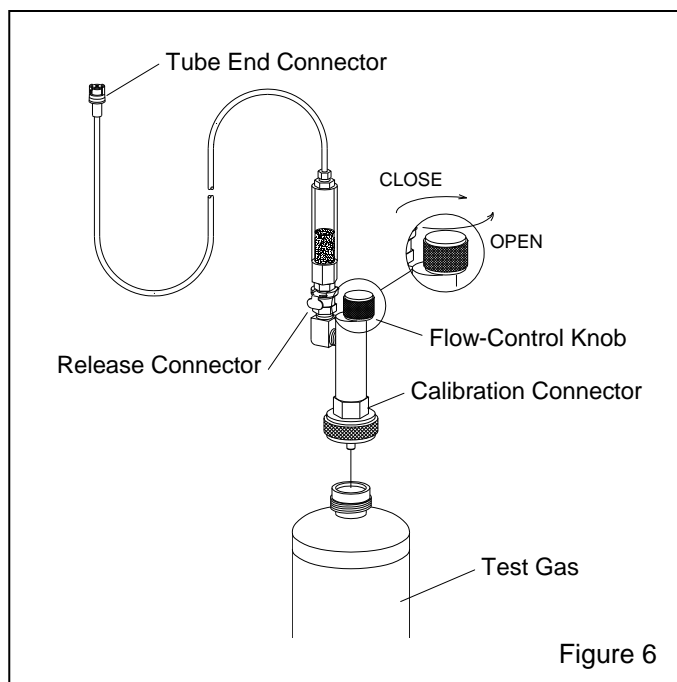


Figure 6

4.5 Prepare Instrument

4.5.1 Open the instrument case cover to access the interior faceplate. Take care not to introduce blast environment contaminants into the instrument when the case is open. See Figure 7 for faceplate-calibration testing and calibration callouts.

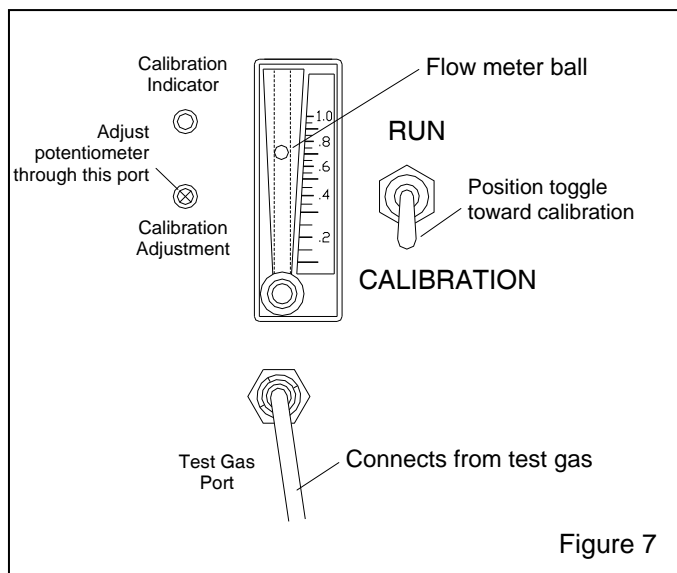


Figure 7

4.5.2 Connect the calibration connector to the "Test Gas Port", by aligning the tabs and inserting the tube end connector into the port and turning it slightly clockwise until it locks.

4.5.3 Place the Run/Calibration toggle toward "CALIBRATION". The external alarm light will

immediately turn "yellow", and within a few seconds the intermittent audible alarm will sound (the calibration indicator remains "green").

4.6 Calibration Testing

4.6.1 With the flow meter vertical, slowly open the flow-control knob 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.

4.6.2 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.

4.6.3 Allow test gas to flow through the instrument for about one minute, or until the interior calibration indicator light turns "red".

4.6.4 After the calibration light turns "red", the initial phase of the calibration test is complete. Return the instrument to operating mode per Section 4.8. If the indicator light does not turn "red" proceed with Paragraph 4.6.5.

4.6.5 If after one minute of operation with test gas the calibration indicator light has not turned "red", and the instrument has been in operation for 30 minutes, calibrate the instrument per Section 4.7. If the instrument has not been in operation for 30 minutes, return it to operating mode per Section 4.8, and operate with sample air flowing through for at least 30 more minutes. Re-test the calibration, and if the calibration light does not turn "red", calibrate the instrument per section 4.7.

4.7 Calibration

4.7.1 Do not calibrate the instrument unless it has gone through two stabilizing periods and calibration tests, per Sections 4.3 and 4.6, and only if the calibration indicator light has not turned "red".

4.7.2 Prepare the calibration connector per Section 4.4 and attach it to a cylinder of 10 PPM CO test gas.

4.7.3 Connect the calibration connector to the "Test Gas Port4" on the faceplate.

4.7.4 Place the Run/Calibration toggle toward "CALIBRATION". Slowly open the flow-control knob and adjust the flow so the flow ball remains between .5 and .8 SCFH.

4.7.5 Allow test gas to flow through the instrument for about one minute. Insert a small screwdriver into the calibration adjustment port, and turn the potentiometer as follows:

- If the potentiometer is **BLUE**, turn **clockwise** until the calibration indicator light turns "red".
- If the potentiometer is **"WHITE"**, turn **counterclockwise** until the calibration indicator light turns "red".

4.7.6 Once the indicator is "red", turn the potentiometer in the opposite direction until the light turns "green". Then, slowly turn the potentiometer from "green" to "red" several times to find the trip point. The monitor is calibrated at the spot where the light turns "red". Return the instrument to operating mode per Section 4.8.

4.8 Return to Operating Mode

4.8.1 Push the connector's slide valve to the "CLOSE" position.

4.8.2 To remove the calibration connector from the monitor, grip the tube end connector, turning it slightly counterclockwise to unlock, and pull straight out.

4.8.3 Place the calibration toggle switch to the RUN position. The flow meter ball should rise to .5 to .8 SCFH. After several seconds the external alarm light should change from "yellow" to "green", and the interior light should change to "green". If the lights respond as described, proceed with 4.8.4 to return the instrument to operation. If after about one minute of operation, the lights do not change to "green", do both of the following:

- Calibrate the instrument per Section 4.7.
- Test instrument function by applying impurity-free air, per Section 4.9.

4.8.4 Close and latch the instrument case cover.

4.8.5 Remove the calibration connector from the test gas cylinder. 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.

4.8.6 Store all material in a clean, dry area.

4.9 Impurity-Free Air (zero contamination) Test

4.9.1 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 monitor malfunction.

4.9.2 Follow the steps in Section 4.6 "Calibration Testing", except use impurity-free test gas in place of the 10 PPM gas. The alarm light will either remain "red" or turn "green". Proceed as follows:

4.9.3 Alarm light turns "green"

4.9.3.1 If the monitor is correctly calibrated and in working order, the alarm light will turn "green" during this test. This means the monitor was reading contaminated air. **DO NOT USE THE COMPRESSED AIR FOR BREATHING.**

WARNING

Do not use compressed air that this instrument has identified as toxic for breathing until the source of contamination is identified and corrected. Breathing toxic gases could cause death.

4.9.3.2 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.

4.9.4 Alarm light remains "red"

4.9.4.1 If the monitor is out of calibration or not in good working order, the alarm light will remain "red".

4.9.4.2 Calibrate the monitor per Section 4.7 and apply impurity-free gas per Section 4.9. If the alarm light remains "red", the monitor requires service. Refer Section 6.0.

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 GENERAL MAINTENANCE

5.1 Care and handling

5.1.1 This monitor is designed for portable, field use and is not adversely affected by normal handling that is required of any test and measurement instrument.

5.1.2 Transport the instrument in the passenger compartment of the service vehicle, not in the trunk or truck bed.

CAUTION

Do not subject this instrument to extreme hot or cold environments. Placing the instrument case on the dashboard or trunk of the service vehicle in direct sunlight or similar condition will elevate the temperature inside the case to a level that will damage the instrument's electronic components.

5.2 Cleaning

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

5.2.2 Clean the exterior of the case with a solution of water and mild detergent. Do not use solvent cleaners.

5.3 Calibration Testing Schedule

5.3.1 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. Refer to Section 4.0 for test procedure.

5.4 Calibration Schedule

5.4.1 Avoid the urge to calibrate the instrument. Calibrate only when the calibration test shows it is required. See Section 4.0.

5.5 Alarm Tests

5.5.1 Although uncommon, alarm lights and horns do fail. Check their function before each use by placing the Run/Calibration toggle toward "CALIBRATION". The external alarm light will immediately turn "yellow", and within a few seconds the intermittent audible alarm 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; the exterior alarm light must be "green", with no audible alarm.

6.0 SERVICE MAINTENANCE

NOTE: Do not attempt to repair or replace any item that is not listed in this section, or that requires parts not listed in Section 8.2. Contact an authorized distributor of Clemco products for authorization to return the instrument for evaluation or service.

6.1 Sensor Replacement

6.1.1 Sensor life depends upon several factors, but in most cases the sensor should last approximately two years.

6.1.2 The following materials are required before replacing the sensor:

- 10 PPM Test Gas Stock No. 22865
- Calibration Connector Stock No. 22893
- Sensor Stock No. 22919
- Standard screwdriver

6.1.3 Open the instrument case to access the interior faceplate. Take care not to introduce contaminants into the instrument when the case is open.

6.1.4 Loosen the closing screw located in the center of the lower edge of the faceplate.

6.1.5 Using the top hinge as the pivot, swing the faceplate up to expose the instrumentation.

6.1.6 Locate the clear-plastic sensor housing, shown in Figure 8, and while supporting the circuit board, loosen the two mounting screws.

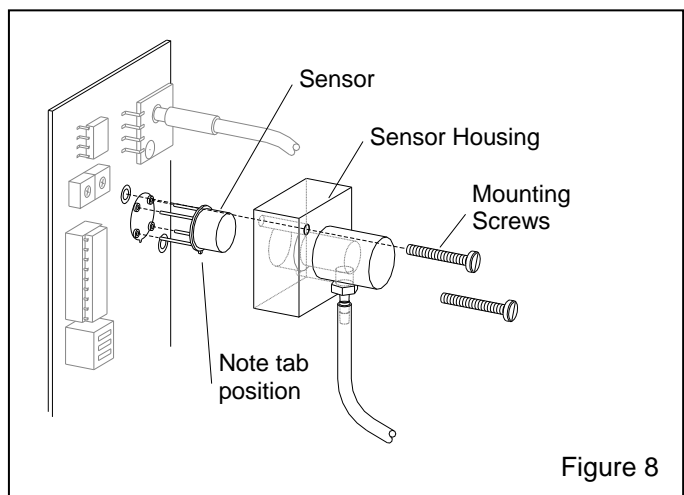


Figure 8

6.1.7 Carefully pull straight up to lift the sensor housing off the circuit board. The sensor may come off with the housing or stay plugged into the board.

6.1.8 If the sensor remains on the circuit board, note the location of the small tab, as the new sensor must be installed in the same orientation. While supporting the circuit board, carefully pull straight up to remove the sensor.

6.1.9 If the sensor comes off with the housing, note the tab location, and remove the sensor by pulling on a couple of the sensor pins.

6.1.10 Discard the old sensor to avoid attempts to reuse.

6.1.11 Handle the new sensor with care not to distort the pins. Rotate the sensor so the tab is in the same position as was the old one (as shown in Figure 8) and plug the pins into the socket, some pin alignment may be required, and is normal. Push firmly but carefully to seat the sensor. The sensor will stand off the circuit board by approximately 1/4" when seated.

6.1.12 Place the sensor housing over the sensor, align the mounting screw holes, and while supporting the circuit board, tighten the screws snugly. **Do not over-tighten the screws.**

6.1.13 When closing the faceplate, ensure that all internal air lines are free of interference, binding or kinks, and that all tube connections are secure. Tighten the closing screw.

6.1.14 Close the instrument case and apply sample air and power per section 3.0, and allow the monitor to run in operating mode for at least one hour.

6.1.15 Calibrate the monitor per Section 4.0.

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

6.1.17 Follow the calibration testing schedule per Section 5.3.

6.2 Fuse Replacement

6.2.1 The fuse cap is located on the side of the instrument case. To access the fuse, push the cap in and rotate counterclockwise.

7.0 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.

7.1 Instrument Will Not Calibrate: If the alarm sounds when test gas is applied but does not stop when gas is removed, or if response is very slow.

7.1.1 Calibration humidifier not moistened during calibration. Ensure that the humidifying media is dampened with distilled water before calibrating.

7.1.2 Faulty sensor, replace with new sensor.

7.2 Intermittent Alarm: A pressure switch mounted on the circuit board monitors pressure of the 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 psi, the monitor will initiate an intermittent alarm.

7.2.1 Before doing pressure tests make sure the Run/Calibration toggle switch is toward "RUN" position. If for any reason 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.

7.2.2 Make sure the pressure of the sample-air is between 55 psi and 120 psi. If the sample-air is higher than 55 psi, the restriction is internal. Proceed as follows.

7.2.3 Check flow through the flow meter. If the flow ball is below .5 SCFH or above .9 SCFH adjust the internal pressure regulator accordingly, until the ball remains between .5 and .8 SCFH. The regulator was factory set slightly higher than the pressure switch and should rarely require adjustment. If the regulator pressure was outside the limits, the alarm will disengage as soon as the pressure is corrected. After the pressure is correctly set, close the faceplate.

7.2.4 Check internal instrumentation lines for breaks, kinks, or disconnection. If a line has come loose, reconnecting it will re-establish function and the monitor could be correctly used. NOTE: This type of failure

could be the result of improper service, as the instrument is tested with pressure much higher than operating pressure. The monitor should be returned to the maintenance service technician for review as soon as practical.

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

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

7.3.2 Check the fuse located inside the case; make sure it is not blown.

7.3.3 Check to make sure that the power supply is on.

7.3.4 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.

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

7.4 Either alarm light or audible alarm fails.

7.4.1 Check for loose plug connections on circuit board.

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

7.4.3 To test the circuit board, remove the plug connection from the faulty alarm. Use a volt meter to check voltage across circuit board pins. Note: When testing an audible alarm, 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.

8.0 ACCESSORIES AND REPLACEMENT PARTS

8.1 Accessories

Item	Description	Stock No.
(-)	CMS-2 CO monitor package, includes: monitor, calibration connector, and 10 PPM test gas	22894
(-)	CMS-2 CO monitor (instrument only)	22892
(-)	Calibration connector assembly	22893
(-)	Test gas, 10 PPM	22865
(-)	Test gas, impurity-free	11132
(-)	Remote alarm kit, Includes: alarm, stand, wiring connector and 50 ft. cord	22909
(-)	Cable, remote alarm extension 50 feet	22910
(-)	Air line humidifier	03600

8.2 Replacement Parts

Item	Description	Stock No.
(-)	Sensor	22919
(-)	Regulator /Filter	22920
(-)	Filter element.....	22921
(-)	Flow meter.....	21376
(-)	Horn w/ wire, (audible alarm) 12-volt DC ...	22922
(-)	Alarm light, exterior w/ wire & connector....	22923
(-)	Fitting, 1/4" OD quick fit	22924
(-)	Tubing, urethane, ten feet required	12475
(-)	Orifice, .004 purple restrictor	24423
(-)	Orifice, .006 red restrictor	24424