

CMS-3
IN-HELMET CARBON MONOXIDE MONITOR
O. M. 24658

DATE OF ISSUE: January 2011
REVISION: C, 10/13

! 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

- 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.

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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

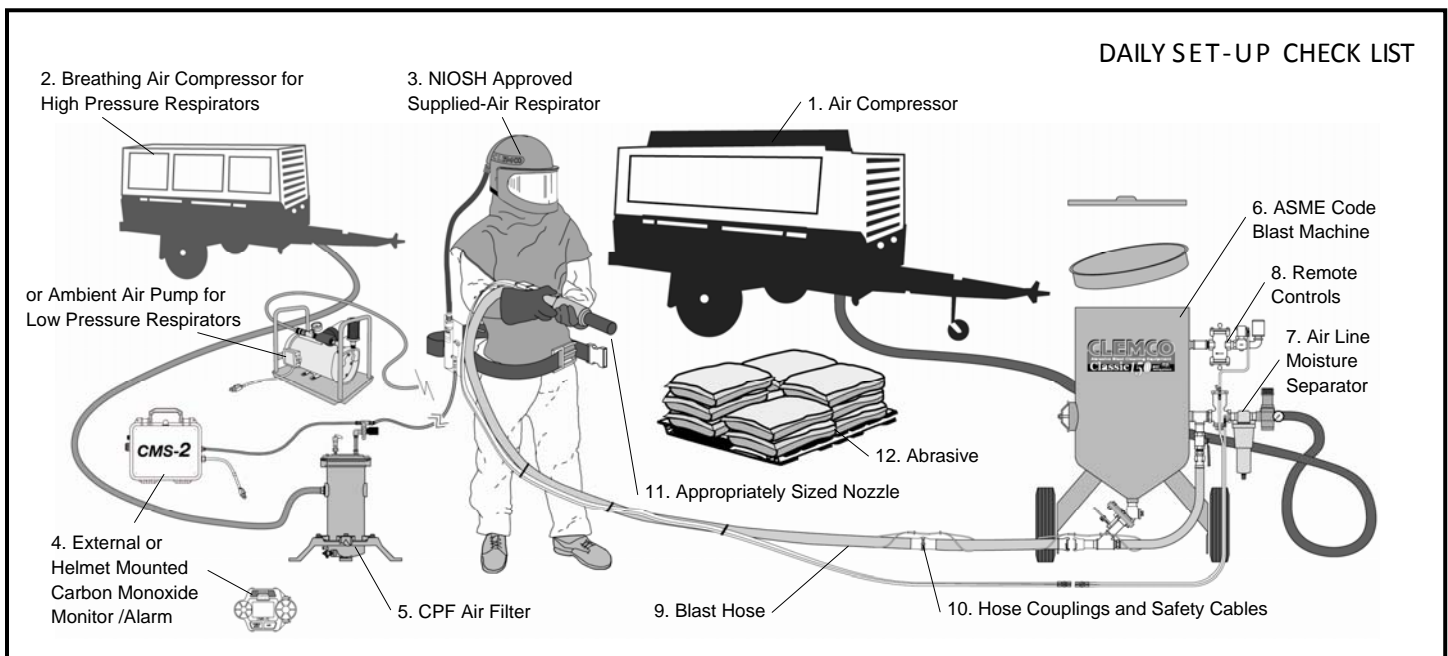
- Completely read and follow all service instructions and recommended maintenance intervals. Always shut off compressor and depressurize blast machine before performing any maintenance. At every service interval, clean all filters, screens, and alarm systems. If spring-loaded abrasive valves are used,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



DAILY SET-UP CHECK LIST

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 (sorbet 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 sorbet 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 operation, maintenance, troubleshooting and replacement parts for the CMS-3 Respirator-Mounted Carbon Monoxide (CO) Monitor.

1.1.2 The monitor is intended to detect the presence of CO inside Apollo supplied-air respirators, where the maximum CO exposure limit in the USA is 10 parts per million (ppm). This is the limit set to meet the requirement for Grade D quality breathing air. The monitor also has short-term exposure limit (STEL) and time-weighted average (TWA) features that enable its use as an ambient air monitor. Instructions on toggling through the STEL and TWA are explained in Section 3.3.

1.1.3 All respirator users and those responsible for maintenance and calibration of the monitor must read and understand this manual before using the respirator or operating with the monitor.

1.1.4 NIOSH (National Institute of Occupational Safety and Health) has approved the use of the CMS-3 with Clemco respirator models Apollo 20, 60, and 600.

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 Table of Contents

Topic	Page	Section
Specifications	2	1.4
Description of Operation	2	1.5
Ancillary Equipment Requirements	2	1.6
Components and Functions	2	1.7
Case	2	1.7.1
Sensor Cap and Sensor Cover	2	1.7.2
Charcoal Filter Disc	2	1.7.3
Sensor	2	1.7.4
LCD	3	1.7.5
Control Buttons	3	1.7.6
Alarm Lights	3	1.7.7
Audible Alarm	3	1.7.8
Vibrator Alarm	3	1.7.9
Lithium Battery (a spare is included) ...	4	1.7.10
Setup, Start Up and Operation		
Installation in Apollo 20	4	2.1.1
Installation in Apollo 60 and Apollo 600	4	2.1.2
Turning ON and Start-up Procedure	5	2.2
Performing a Fresh Air Adjustment	5	2.2.4
Process shown under calibration		
Turning Off the CMS-3	5	2.3
Operation		
Measuring Mode	5	3.1
Displaying Peak Gas Concentrations ..	5	3.2
Displaying STEL, & TWA	6	3.3
Alarms	6	3.4
Responding to Alarms	6	3.5
Displaying and Setting Alarm Points ...	8	3.6
Setting the Clock	9	3.7
Calibration		
Setting the Fresh Air Reading	9	4.1
Calibration	10	4.2
Maintenance		
Replacing the Lithium Battery	10	5.1
Replacing the Sensor	11	5.2
Replacing the Sensor Cover	12	5.3
Replacing the Charcoal Filter Disk	12	5.4
Troubleshooting	13	6.0
Accessories and Replacement Parts	14	7.0

1.4 Specifications

Target Gas	Carbon Monoxide (CO)
Detection Range	0 to 500 ppm
Display Increment	1 ppm
CO Sensor	Electro Chemical
Alarm Point, Low	10 ppm
Alarm Point, High	10 ppm

1.5 Description of Operation

WARNING

The CMS-3 detects carbon monoxide which can be life threatening. When using the CMS-3, follow the instructions and warnings in this manual to assure proper and safe operation of the unit and to minimize the risk of personal injury. Carbon monoxide poisoning could result in death or serious injury.

1.5.1 The CMS-3 respirator-mounted carbon monoxide monitor detects the presence of carbon monoxide (CO) inside a supplied-air respirator.

1.5.2 The current maximum exposure limit in the USA for carbon monoxide in Grade D compressed breathing air is 10 parts per million (ppm). Users outside the USA should determine their local requirements and set the alarm threshold to their maximum PEL per Section 3.6. If CO concentrations reach the exposure limit, three alarms occur. The audible alarm beeps twice per second, the alarm lights flash twice per second, and the unit vibrates. If an alarm occurs, remove the respirator as soon as it is safe to do so.

1.5.3 The CMS-3 offers a full range of features, including:

- Digital liquid crystal display (LCD)
 - Visual, audible, and vibrating alarms
 - Low battery alarm
 - Sensor fail alarm
 - Current time display
 - Over 3,000 hours of operation from 1 battery
 - CSA classified for Class I, Division I, Groups A, B, C, and D hazardous atmospheres
 - * Peak, STEL, and TWA indication
 - * STEL, TWA, and over range alarms
- *Refer to notation in Paragraph 1.5.4, regarding usage of STEL and TWA. Refer to Section 3.2 for information on the Peak Display.

1.5.4 TWA and STEL: TWA is an acronym for time-weighted average, and it is the average reading of CO during the last eight hours. STEL is an acronym for short-term exposure limit, and it is the average reading of CO during the last 15 minutes. Although some may find TWA and STEL information useful, it is not pertinent

for supplied-air respirator use, because the maximum exposure limit for Grade D breathing air is 10 ppm.

1.6 Ancillary Equipment Requirements

1.6.1 In addition to the monitor, the following equipment is required to operate and maintain the CMS-3 Monitor.

- Calibration connector with tubing and calibration cup: Stock No. 25572.
- 25 PPM Test Gas: Stock No. 25573.

1.7 Components and Functions

The components include the case, sensor cap, sensor cover, charcoal filter disk, sensor, LCD, control buttons, printed circuit boards, alarm lights, audible alarm, vibrator, and lithium battery. Callouts shown in Figure 1 are items needed to perform routine functions.

1.7.1 Case: The digital LCD is visible through the top case. It displays gas concentrations, battery level, time, and other readings including TWA, STEL, and peak gas levels. Below the LCD are two black control buttons. The button on the left is labeled POWER/MODE. The button on the right is labeled AIR. To the left of the LCD is the audible alarm, which is located inside the case. To the right of the LCD is the sensor cap which retains the sensor. Above the LCD is a lens through which the alarm lights are visible. The battery cover is located on the back of the case and is held in place by two screws.

1.7.2 Sensor Cap and Sensor Cover: The sensor cap snaps onto the right side of the case and retains the sensor. It also retains the sensor cover which is a round hydrophobic disk membrane which protects the sensor from dirt and elements. A molded gasket installed on the sensor, seals the sensor, sensor cover, and sensor cap.

1.7.3 Charcoal Filter Disk: A charcoal filter disk is located in a recessed area of the sensor gasket beneath the sensor cover. The charcoal filter disk removes gases from the sampled air that will cause a response on the CO sensor, gases such as hydrogen sulfide (H₂S) and certain hydrocarbons. If false or elevated CO readings are noticed, especially in the presence of H₂S, change the charcoal filter disk. Refer to the maintenance Section 5.4.

1.7.4 Sensor: The sensor is protected by the white sensor cover which is held in place by the sensor cap and sensor gasket. The sensor cover allows air to diffuse past it to the sensor. A gas permeable membrane covers the sensor face and allows gas to diffuse into the sensor. The gas reacts in the sensor and produces a current proportional to the concentration of carbon monoxide. The current is amplified by the CMS-3's circuitry, converted to a measurement of gas concentration, and displayed on the LCD.

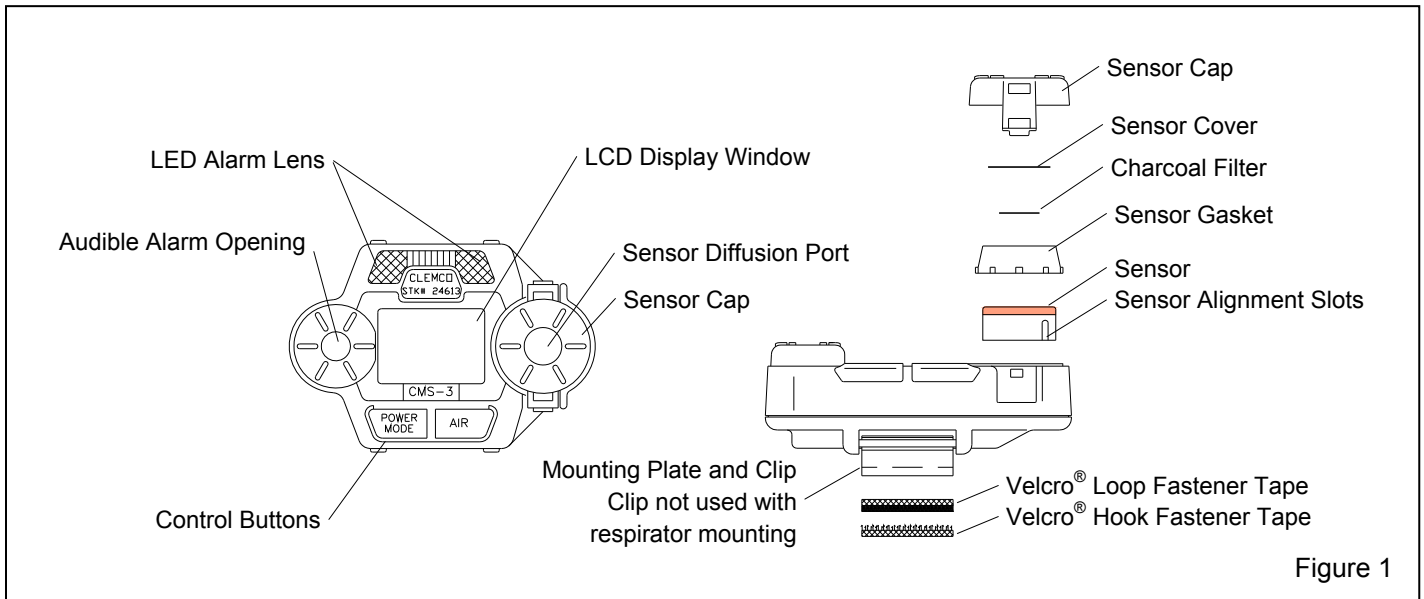


Figure 1

1.7.5 LCD: The LCD is visible through the top case. CO concentrations, the time, battery condition, and alarm indications are displayed on the LCD. Once the monitor is "ON", pressing the Power/Mode or Air control button, turns on the LCD backlight for 20 seconds.

1.7.6 Control Buttons: Below the LCD are the two control buttons. They are POWER/MODE and AIR. They turn on the power to the CMS-3 and turn it off. They control what is displayed on the LCD, including time, gas concentrations, peak, TWA, and STEL readings, as well as other messages. They also allow for a fresh air adjustment, change alarm points, change the time, and calibrate the instrument. The functions performed by the control buttons are summarized in the table in Figure 2.

1.7.7 Alarm Lights: Two LED alarm lights are located above the LCD. The red alarm lights show through the reflective lenses. The red LED's alert the user to CO gas, low battery, and sensor failure.

1.7.8 Audible Alarm: An opening on the left side of the top case allows the alarm's sound (a beep) to resonate from the case. The alarm sounds for CO gas, unit malfunctions, low battery, and as an indicator during normal use of various display options.

1.7.9 Vibrator Alarm: A vibrating motor mounted inside the case vibrates momentarily during the power-up sequence and for CO gas alarms.

Button	Function
POWER/MODE	<ul style="list-style-type: none"> • Turns the unit on and off • Turns the LCD back light on. (when unit is on) • Displays STEL and TWA readings. • Displays peak (high) readings • Resets the alarm circuit (gas alarms). • Enters Calibration Mode when used with the AIR button. • Enters Alarm Adjustment Mode when used with the AIR button. • Enters Time Adjustment Mode when used with the AIR button.
AIR	<ul style="list-style-type: none"> • Turns the LCD back light on. (when unit is on) • Adjusts LCD readings when the fresh air adjustment is performed. • Enters Calibration Mode when used with POWER/MODE button. • Enters Alarm Adjustment Mode with the POWER/MODE button. • Enters Time Adjustment Mode with the POWER/MODE button. • Increases settings when the unit is in Alarm Adjustment Mode, Time Adjustment Mode, or Calibration Mode.

Figure 2

1.7.10 Lithium Battery: A 3.0 volt coin type lithium battery powers the CMS-3. The battery will run the monitor for approximately four months when no alarms have been activated during that time period. The battery icon on the LCD shows the charge remaining in the battery. When the CMS-3 detects low battery voltage, a low battery warning (the last remaining bar on the battery icon flashes) is activated. There may be conditions that cause rapid deterioration of a low battery. **A spare battery is provided with the monitor; keep a new battery on hand at all times.** When the battery is too low for normal operation, a dead battery alarm (battery icon flashes, audible alarm beeps twice per second) is activated. Refer to Section 5.1 for instructions on replacing the battery.

2.0 INSTALLATION, START-UP and SHUT-OFF

2.1 Installation

This section explains the initial installation of the CMS-3 inside the respirator.

2.1.1 Installation in Apollo 20 Respirator

Refer to Section 2.1.2 for installing the monitor in Apollo 60 and Apollo 600 respirators.

2.1.1.1 Open the lens frame and remove the lenses.

2.1.1.2 Don the helmet and temporarily place the monitor on one of the side walls of the window extension, as shown in Figure 3.

2.1.1.3 Mark the location and remove the monitor and helmet.

Mark the location anyplace inside of the window extension and attach Velcro[®] hook tape. Make sure the monitor's alarm lights are visible when the helmet is donned.

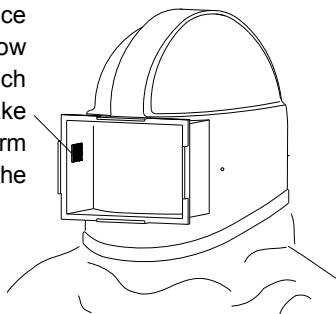


Figure 3

2.1.1.4 Remove backing from the Velcro[®] hook tape and adhere it at the marked location (the loop tape adheres to the monitor). Attach the monitor so the control buttons face toward lenses and alarm lights toward the inside of the respirator. Don the helmet to make sure the monitor's alarm lights are visible from inside the helmet.

2.1.1.5 Remove the monitor and prepare it for operation.

2.1.1.6 Replace the lenses and lens frame assembly.

2.1.1.7 After the initial setup is done, remove and reattach the monitor from inside the helmet. **Remove the monitor when taking off the respirator at the end of the shift and to do any service or calibration, including turning the monitor on and off.** Do this to make sure the monitor is fully functional before placing it inside the helmet.

WARNING

Remove the monitor at the end of the shift, turn it off and store it in a clean environment. At the beginning of each shift, turn on the monitor and make sure it is fully functional before installing in the helmet. Failure to do so could result in CO poisoning and death.

2.1.2 Installing in Apollo 60 and Apollo 600 Respirators

Refer to Section 2.1.1 for mounting the monitor in Apollo 20 respirators.

2.1.2.1 Place the transparent mounting strip on the inside of the inner lens, and into the same window gasket groove as the inner lens, as shown in Figure 4. Position it so it is within peripheral vision toward the side of the window opening.

As seen from inside the hood, the strip is inserted into the groove in the window gasket. Attach Velcro[®] hook tape anyplace on the inside of the strip. Make sure the monitor's alarm lights are visible when the helmet is donned.

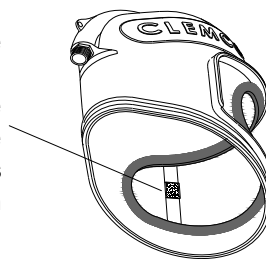


Figure 4

2.1.2.2 Remove backing from the Velcro[®] hook tape and adhere it anyplace on the mounting strip (the loop tape adheres to the monitor) making sure the alarm lights are visible from inside the helmet.

2.1.2.3 Attach the monitor to the strip, with the buttons facing toward the outer edge of the window opening and alarm lights toward the center of the window opening. Don the helmet to make sure the monitor alarm lights are visible from inside the helmet.

2.1.2.4 Remove the monitor and prepare it for operation.

2.1.2.5 After the initial setup is done, remove and reattach the monitor from inside the helmet. **Remove the monitor when taking off the respirator at the end of the shift and to do any service or calibration, including turning the monitor on and off.** Do this to make sure the monitor is fully functional before placing it inside the helmet.

WARNING

Remove the monitor at the end of the shift, turn it off and store it in a clean environment. At the beginning of each shift, turn on the monitor and make sure it is fully functional before installing in the helmet. Failure to do so could result in CO poisoning and death.

2.2 Turning On and Start-up Procedure

This section explains how to start up the CMS-3 and to prepare it for operation.

2.2.1 Press and hold the POWER/MODE button until the alarm beeps. The alarm sounds briefly, the vibrator vibrates briefly, all elements of display are activated, and the alarm lights and LCD backlight turn on for a few seconds.

2.2.2 The CMS-3 then displays CO (the target gas) and time before displaying the battery voltage.

WARNING

If the unit is in low battery warning, change the battery as soon as possible. Do not use the respirator if the dead battery warning is alarmed.

2.2.3 The alarm beeps again after the battery voltage is displayed. The CMS-3 is now in the Measuring Mode, which is the normal operating mode. The CO concentration (ppm) is displayed and the current time is shown at the bottom of the LCD. **NOTE:** When using the CMS-3 for the first time, check the current time and verify that it is correct for your time zone. If it is not, set the time as described in Section 3.7 "Setting the Time".

2.2.4 Performing a Fresh Air Adjustment

Before using the CMS-3, set the fresh air reading to ensure accurate gas readings in the monitoring environment. Refer to Section 4.1

2.2.4.1 Find a fresh air environment. This is an environment free of toxic or combustible gases and of normal oxygen content (20.9%).

2.2.4.2 With the unit on and in Measuring Mode, press and hold the AIR button for about three seconds to allow the CMS-3 to set the fresh air reading. While pressing the AIR button, the LCD displays "hold," a prompt to keep pressing the AIR button.

2.2.4.3 When the fresh air readings have been set, the LCD displays "Adj" for 2 seconds which prompts you to release the AIR button. The unit will set the reading to 0 ppm.

2.2.4.4 The unit then returns to normal operation and the display indicates the current gas concentration.

2.3 Turning Off the CMS-3

2.3.1 Remove the monitor when taking off the respirator at the end of the shift.

2.3.2 Press and hold the POWER/MODE button for about five seconds to turn off the unit. The alarm will beep while the POWER/MODE button is being pressed before the unit turns off.

2.3.3 Release the button when the LCD is blank. The unit is off.

2.3.4 Store the monitor in a clean dry area.

3.0 OPERATION

This section describes the normal operation of the CMS-3, and includes alarm indications. Ref. Figure 5

3.1 Measuring Mode

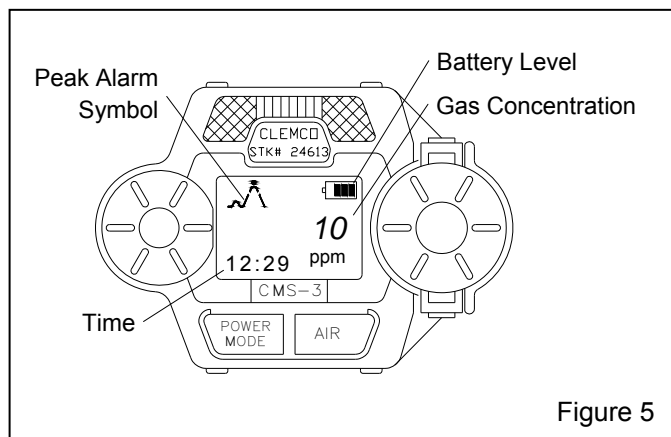
After having powered up the CMS-3 and performed a fresh air adjustment following the instructions of the previous section, "Turning ON and Start Up," the CMS-3 is in Measuring Mode. In Measuring Mode the monitor is in the normal operating mode, the battery level, time, and CO concentration are displayed on the LCD. The battery icon has four bars visible when the battery is full. As the battery charge decreases, the bars disappear. CO is displayed in parts per million (ppm). The time is shown in military format with the hour going from 0 to 24.

3.2 Displaying the Peak CO Concentration

3.2.1 The Peak Display shows the highest concentration of CO the monitor has detected from the time it was last turned on.

3.2.2 Make sure the CMS-3 is in Measuring Mode. The current gas concentration should be displayed on the LCD.

3.2.3 When the CMS-3 is in Measuring Mode (normal operating mode), Press and release the POWER/MODE button to enter Peak Display Mode. This activates the LCD backlight and displays the Peak reading. A small Peak symbol is displayed in the upper left corner of the LCD. The time the spike occurred is shown in the time location.



3.2.4 A Peak alarm display cannot be cleared until the monitor is turned off.

3.3 Displaying STEL, and TWA

Although some may find TWA and STEL information useful, it is not pertinent for supplied-air respirator use, because the maximum exposure limit for Grade D breathing air is 10 ppm.

3.3.1 STEL is an acronym for short-term exposure limit, and it is the average reading of CO during the last 15 minutes. TWA is an acronym for time-weighted average, and it is the average reading for CO during the last eight hours. If eight (8) hours has not elapsed since the unit was turned on, the TWA is still calculated over eight hours, with the missing time assigned a zero (0) value for the readings. Similarly, if the unit has not been on for 15 minutes, the missing time is assigned a 0 value and the STEL is calculated over 15 minutes. The Peak, STEL, and TWA readings are cleared when the unit is turned off.

3.3.2 When the CMS-3 is in Measuring Mode (normal operating mode), Press and release the POWER/MODE button to enter Peak Display Mode. Press and release the POWER/MODE button again to enter STEL Display Mode. This will display the STEL reading. The word "STEL" is displayed in the middle of the LCD above the reading.

3.3.3 Press and release the POWER/MODE button again to enter TWA Display Mode. This will display the TWA reading. The word "TWA" is displayed in the middle of the LCD above the reading.

3.3.4 Press and release the POWER/MODE button once again to return to Measuring Mode.

NOTE: If you do not press a button for 20 seconds while displaying the Peak, STEL, or TWA readings, the unit will return to Measuring Mode automatically and the backlight will turn off.

3.4 Alarms

This section covers alarm indications. It also explains how to reset the CMS-3 after an alarm has occurred and how to respond to an alarm condition.

3.4.1 Alarm Indications

The audible alarm beeps, the unit vibrates, and the alarm lights flash when CO concentrations rises above the low alarm point. The CMS-3 also alarms when the high alarm point, the STEL alarm point, or the TWA alarm point is reached. It has a low battery warning, dead battery alarm, an over range alarm, sensor failure alarm, and a system failure alarm. The table in Figure 6 summarizes the types of alarms produced by the CMS-3.

3.4.2 Resetting CO Alarms

3.4.2.1 To reset a CO carbon monoxide gas alarm, after the CO reading falls below the low alarm point (10 ppm) press and release the POWER/MODE button once.

NOTE: Even though the gas concentration may have fallen below the alarm point, the alarm indications will continue until the alarm is reset using the MODE/POWER button as noted. A Peak alarm display cannot be cleared until the monitor is turned off. If a TWA or STEL alarm has been activated, it cannot be reset unless the monitor is turned off.

3.5 Responding to Alarms

This section describes response to gas, over range, battery, sensor failure, and system failure alarms.

3.5.1 Responding to CO Alarms

3.5.1.1 Follow an established procedure for responding to CO gas alarms. It should include but not be limited to removing the respirator as soon as it is safe to do so.

3.5.1.2 Reset the alarm by pressing and releasing the POWER/MODE button once, after the CO reading falls below the low alarm point.

3.5.2 Responding to an Over Range Alarm

An over range alarm could indicate CO gas are above the detection limit of 500 ppm. The CO concentration reading is replaced by blinking brackets (ΠΠΠΠ).

⚠ WARNING

An over range condition may indicate an extreme CO concentration. Remove the respirator as quickly as possible when it is safe to do so.

3.5.2.1 Follow an established procedure for responding to CO gas alarms. It should include but not be limited to removing the respirator as soon as it is safe to do so.

3.5.2.2 Reset the alarm using the MODE/POWER button once the alarm condition has cleared.

3.5.2.3 Calibrate the CMS-3 as described in Section 4.3.

3.5.2.4 Confirm the gas concentration with a different CMS-3 or with another gas detecting device.

3.5.2.5 If the over range condition continues, the sensor may need to be replaced.

3.5.2.6 If the over range condition continues after replacing the sensor, contact Clemco Customer Service at 636 239-4300 for further instructions.

Alarm Types and Indications		
Alarm Type	LCD Indications	Other Alarm Indications
<p>Low Alarm and High Alarm</p> <p><i>Concentration of CO rises above the alarm point.</i></p> <p>Note: Low and High Alarms are both set at the maximum exposure limit of 10 ppm.</p>	<ul style="list-style-type: none"> Gas reading flashes. Back light turns on. 	<ul style="list-style-type: none"> Audible alarm beeps twice per second. Unit vibrates twice per second. Alarm lights flash twice per second.
<p>TWA or STEL</p> <p><i>Concentration of CO rises above the TWA or STEL alarm point.</i></p>	<ul style="list-style-type: none"> Back light turns on. TWA or STEL blinks to the left of the battery icon. If the unit is in both TWA alarm and STEL alarm, both TWA and STEL will be displayed. 	<ul style="list-style-type: none"> Audible alarm beeps once per second (Single Pulse). Unit vibrates once per second. Alarm lights flash once per second (Single Pulse).
<p>Over Range</p> <p><i>An over range condition may indicate an extreme CO concentration.</i></p>	<ul style="list-style-type: none"> Gas reading replaced by blinking brackets (ΠΠΠΠ). Back light turns on. 	<ul style="list-style-type: none"> Audible alarm beeps once per second (Single Pulse). Unit vibrates once per second. Alarm lights flash once per second (Single Pulse).
<p>Low Battery Warning</p>	<ul style="list-style-type: none"> Last remaining bar on the right in battery icon flashes. 	<ul style="list-style-type: none"> None.
<p>Dead Battery Alarm</p>	<ul style="list-style-type: none"> Gas reading replaced by FAIL. Battery icon flashes. 	<ul style="list-style-type: none"> Audible alarm beeps twice per second (Double Pulse).
<p>Sensor Failure</p>	<ul style="list-style-type: none"> Gas reading replaced by FAIL. 	<ul style="list-style-type: none"> Audible alarm beeps twice per second (Double Pulse).
<p>System Failure</p>	<ul style="list-style-type: none"> Gas reading replaced by FAIL. Time replaced by SYS below FAIL 	<ul style="list-style-type: none"> Audible alarm beeps twice per second (Double Pulse).

Figure 6

3.5.3 Responding to Battery Alarms

WARNING

The CMS-3 is not operational during a dead battery alarm. Do not use the respirator until the battery is replaced.

3.5.3.1 The CMS-3 is fully functional in a low battery warning condition. However, only a couple of days of operation may remain depending on certain conditions such as alarm occurrences. Change the battery as soon as possible when a low battery warning occurs. Refer to Section 5.1 “Replacing the Lithium Battery.”

NOTE: Alarms and the back light feature consume battery power and reduce the amount of operating time remaining.

3.5.4 Responding to a Sensor Failure Alarm

3.5.4.1 Perform a calibration as described in Section 4.3.

3.5.4.2 If the sensor failure alarm continues, replace the sensor as described in Section 5.2.

3.5.4.3 If the sensor failure alarm continues after replacing the sensor, contact Clemco Customer Service at 636 239-4300 for further instructions.

3.5.5 Responding to a System Failure Alarm

3.5.5.1 If a system failure occurs, turn off the unit and turn it on again.

3.5.5.2 If the unit is still in system failure, contact Clemco Customer Service at 636 239-4300 for further instructions.

3.6 Setting the Alarm Points

3.6.1 There is a low-alarm point, a high-alarm point, and STEL and TWA alarm points. The alarm points and their factory settings are summarized below:

- **Low Alarm (displayed (LO)):** is triggered when CO concentrations reach 10 ppm, which is the maximum exposure limit for Grade D compressed air. Remove the respirator as soon as it is safe to do so.
- **High Alarm (displayed (HI)):** Because the maximum exposure limit for grade D breathing air is 10 ppm of CO, the high alarm is also set to alarm when CO concentration reaches 10 ppm. This alarm is a rapid, twice per second beep and stresses the urgency to remove the respirator as soon as it is safe to do so.

- ***TWA Alarm:** TWA is an acronym for time-weighted average; it is the average reading of CO during the last eight hours.
- ***STEL Alarm:** STEL is an acronym for short-term exposure limit; it is the average reading of CO during the last 15 minutes.

* Although some may find TWA and STEL information useful, it is not pertinent for supplied-air respirator use, because the maximum exposure limit for Grade D breathing air is 10 ppm.

3.6.2 To begin, make sure the CMS-3 is turned off. The LCD should be blank.

3.6.3 Press and hold the AIR button, then press and hold the POWER/MODE button.

3.6.4 As soon as segments appear on the display (approximately one second), release the AIR button. When the unit “beeps,” release the POWER/MODE button to put the CMS-3 into Alarm Point Adjustment Mode.

3.6.5 The LCD should display the Low (LO) Alarm setting (10 ppm), the battery level, and peak alarm symbol as Shown in Figure 5. *NOTE: If the LCD shows “CAL” in the lower left corner, the CMS-3 is in Calibration Mode. Press and hold the POWER/MODE button to turn off the unit. Repeat the process beginning with Paragraph 3.6.2.*

NOTE: You can only cycle through the alarm points in the sequence noted in paragraph 3.6.1 once before the monitor goes into its startup sequence followed by Measuring Mode (operating mode). To cycle through the alarm points again, press and hold the POWER/MODE button to turn off the unit. Then repeat the process beginning with Paragraph 3.6.2 to put the unit back into Alarm Point Adjustment Mode.

3.6.6 To change the alarm point, press and release the POWER/MODE button to cycle through the alarms. *NOTE: If you press and hold the POWER/MODE button the monitor may turn off.*

3.6.7 When an alarm point is displayed, use the AIR button to increase the alarm point. If you pass the desired setting, continue increasing the alarm point until it reaches the maximum setting (50 for low alarm, and 500 for high alarm) and it will “wrap around” to the minimum setting (0 for low alarm and 10 for high alarm).

3.6.8 If the alarm setting has been changed, press the POWER/MODE button to save the new setting. The next alarm point will be displayed.

3.6.9 When finished viewing or adjusting the alarm point settings, press and release the POWER button

repeatedly until the ROM number for the unit appears on the LCD. (The ROM is the component that contains the software that runs the CMS-3.) The CMS-3 will then go into its startup sequence followed by Measuring Mode.

3.7 Setting the Clock

3.7.1 Make sure the CMS-3 is on and in Measuring Mode.

3.7.2 Press and hold the Air button, then press and hold the POWER/MODE button to put the monitor into Time Adjustment Mode. Release the buttons when the word “SEt” appears on the LCD as noted in Figure 7. Below “SEt”, the time will be displayed and the hour in the time will be flashing.

3.7.3 Use the AIR button to increase the hour to the desired setting. If you pass the desired setting, continue to increase the hour until it reaches 23 and then wraps around to 0, then set to the desired setting.

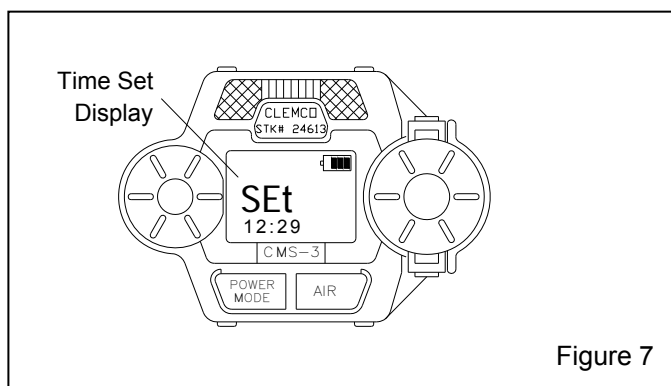


Figure 7

3.7.4 Press the POWER/MODE button to accept the hour setting. The minute starts flashing.

3.7.5 Use the Air button to increase the minute setting to the desired setting.

3.7.6 Press the POWER/MODE button to accept the minute setting and return to Measuring Mode.

4.0 CALIBRATION

This section covers the calibration of the CMS-3. Setting the fresh air reading is described first followed by setting the calibration value.

⚠ WARNING

Use a 0.5 LPM (liters per minute) fixed flow calibration connector (Clemco Stock No. 25572) when calibrating. Use of a different flow rate may adversely affect the accuracy of the calibration.

4.1 Calibration schedule

- Calibrate daily for the first week of operation.
- Calibrate weekly for the first month of operation.
- Calibrate at least monthly thereafter.
- Calibrate before use if the monitor was out of service for more than one week.

4.2 Setting the Fresh Air Reading

Fresh-air settings must be done in a fresh air environment, free of toxic or combustible gases and of normal oxygen content (20.9%). The usual method is to set it in fresh ambient air. If fresh, ambient air cannot be assured, set the fresh air reading with impurity free test gas, as described in Section 4.2.2.

4.2.1 Setting the fresh air reading with ambient air

4.2.1.1 Turn on the CMS-3 by pressing and holding the POWER/MODE button for one second. Allow the unit to finish its warm-up sequence.

4.2.1.2 Press and hold the AIR button. While pressing the AIR button, the LCD displays “Hold,” a prompt to keep pressing the AIR button.

4.2.1.3 When the fresh air reading has been set, the LCD displays “Adj,” a prompt to release the AIR button. It will set the reading to 0 ppm.

4.2.2 Setting the fresh air reading with impurity free test gas

The following is required to set the fresh air setting with impurity free test gas.

- Impurity free test gas, Stock No. 11132
- Calibration connector with tubing and calibration cup.

4.2.2.1 Make sure the monitor is off.

4.2.2.2 Make sure the calibration connector valve is closed, and then attach the connector to the test gas cylinder.

4.2.2.3 Attach the calibration cup to the sensor cap, as shown in Figure 8. The cup opens up like a clothes pin to fit over the sensor cap and locks onto the cap.

4.2.2.4 Turn on the CMS-3 by pressing and holding the POWER/MODE button for one second. Allow the unit to finish its warm-up sequence.

4.2.2.5 Open the connector by sliding the regulator valve to the "OPEN" position.

4.2.2.6 Press and hold the AIR button. While pressing the AIR button, the LCD displays "Hold," a prompt to keep pressing the AIR button.

4.2.2.7 When the fresh air reading has been set, the LCD displays "Adj," a prompt to release the AIR button. It will set the reading to 0 ppm.

4.2.2.8 Close the connector by sliding the regulator valve to the "CLOSE" position.

4.2.2.9 Carefully remove the calibration cup from the unit, being careful not to misplace the gasket on the bottom of the cup.

4.2.2.10 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.

4.3 Calibration (setting the span adjustment)

Calibrate the CMS-3 in a non-hazardous environment, as used to set the fresh air reading.

The following is required to calibrate the CMS-3

- Test gas with 25 ppm concentration of CO, Stock No. 25573.
- Calibration connector with tubing and calibration cup.

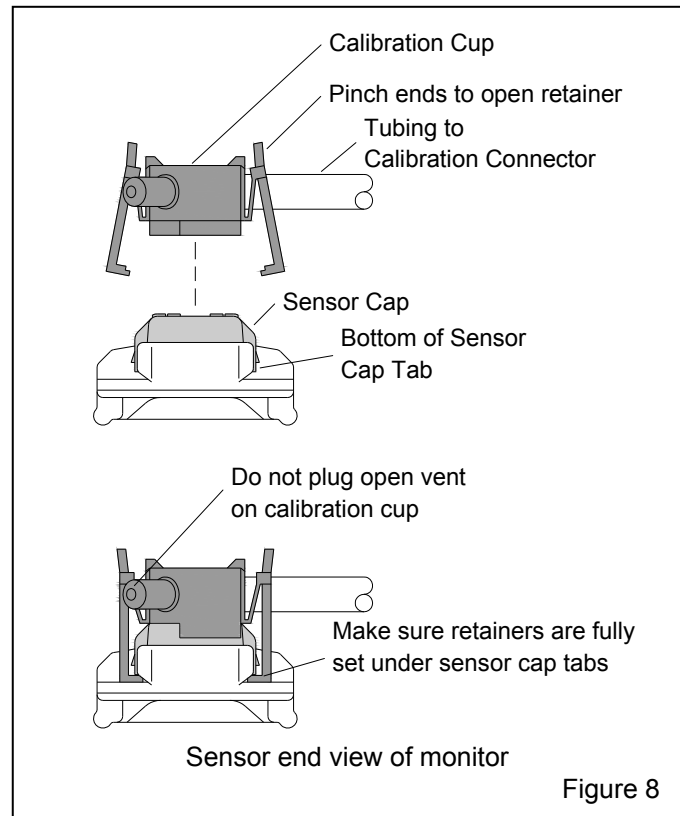
4.3.1 Make sure the fresh air reading was set per Section 4.2.

4.3.2 Make sure the monitor is off.

4.3.3 Make sure the calibration connector valve is closed, and then attach the connector to the test gas cylinder.

4.3.4 Attach the calibration cup to the sensor cap, as shown in Figure 8. The cup opens up like a clothes pin to fit over the sensor cap and locks onto the cap.

4.3.5 Press and hold the AIR button, then press and hold the POWER/MODE button. Release both buttons when you hear a "beep." The unit is in calibration mode and the LCD displays "CAL" in the lower left and the battery level in the upper right. It also displays the gas concentration that is to be used to calibrate the unit.



4.3.6 If necessary, use the AIR button to adjust the calibration value (the value shown on the display) to match the gas concentration in the calibration cylinder.

4.3.7 Press the POWER/MODE button to accept the calibration value and proceed to the calibration screen. The current gas reading is displayed and the "CAL" display blinks.

4.3.8 Open the connector by sliding the regulator valve to the "OPEN" position.

NOTE: To cancel the span adjustment process, press and hold the AIR button for about 3 seconds. The unit will cancel the adjustment and begin its startup sequence.

4.3.9 Let the gas flow for one minute and then press the POWER/MODE button. The unit will adjust the span based on the calibration value that was saved as described in Paragraphs 4.2.5 through 4.2.7.

4.3.10 Close the connector by sliding the regulator valve to the "CLOSE" position.

4.3.11 Immediately and carefully remove the calibration cup from the unit, being careful not to misplace the gasket on the bottom of the cup. The monitor goes into the start up and measuring mode as soon as the calibrations is complete. If the cup is not immediately removed, residual gas may cause the monitor to alarm. Refer to Paragraph 4.3.13.

4.3.12 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.

4.3.13 As soon as the unit makes the calibration adjustment, it will begin its startup sequence and then enter the Measuring Mode. **NOTE:** If the gas reading is high enough when the unit enters Measuring Mode, an alarm condition will occur. Reset the alarm using the POWER/MODE button when the gas reading falls below the alarm point.

5.0 MAINTENANCE

WARNING

Service, calibration, and repair of the instruments should be performed by personnel properly trained for this work. Improper service could result in malfunction and loss of life.

NOTE: The printed circuit boards contain no user serviceable parts.

5.1 Replacing the Lithium Battery, Refer to Figure 9

Always keep a spare lithium battery on hand, and replace it when the battery icon indicates that the unit is in low battery warning. When in low battery warning, only one battery level indication bar remains and it is flashing. Use a CR 2450 battery manufactured by Sony, Eveready, Maxell, Hitachi, or Toshiba.

5.1.1 Make sure the monitor is off.

5.1.2 From the back of the unit, unscrew the two screws that retain the battery cover far enough to pull the cover away from the bottom case. The screws are

held captive in the battery cover if they are not unscrewed too far.

5.1.3 Carefully remove the old battery.

5.1.4 Carefully install the new battery, noting the polarity indications on the underside of the battery cover and in the battery compartment. The negative (-) side of the battery goes in first.

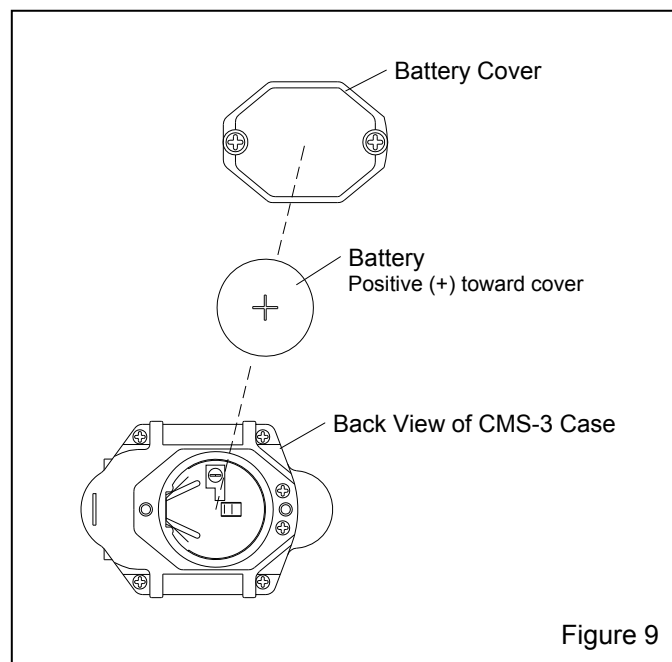


Figure 9

5.1.5 Reinstall the battery cover.

NOTE: All power to the unit is lost when the old battery is removed. The clock is reset to 0:00 when the new battery is installed. The clock must be set to the correct time after the battery is changed. Refer to Section 3.7 to reset the clock.

5.2 Replacing the Sensor, Ref Figures 10 and 11 *Replace the sensor in a clean, non-hazardous environment.*

5.2.1 Make sure the monitor is off.

5.2.2 The sensor cap snaps onto the case with two tabs. With a small flat blade screw driver, gently expand the two tabs to pry off the sensor cap.

5.2.3 Remove the sensor gasket, cover, and charcoal filter from the sensor.

5.2.4 Carefully remove the old sensor from the sensor socket. **NOTE:** The sensor is keyed and can only be

inserted in the socket one way. Note the orientation of the old sensor, as shown in Figure 11 before removing it.

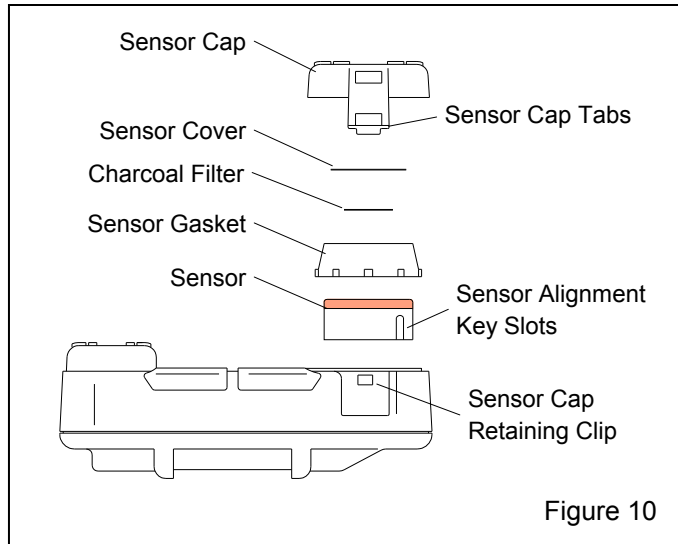


Figure 10

5.2.5 Carefully insert the replacement sensor in the socket. Make sure the sensor face with the colored ring is facing up, and that the sensor key slots are properly aligned with the key tabs in the socket as shown in Figure 11, before inserting.

CAUTION

Do not force the sensor into the socket; when correctly aligned, the sensor easily fits into the socket. Forcing it could damage the sensor or the socket.

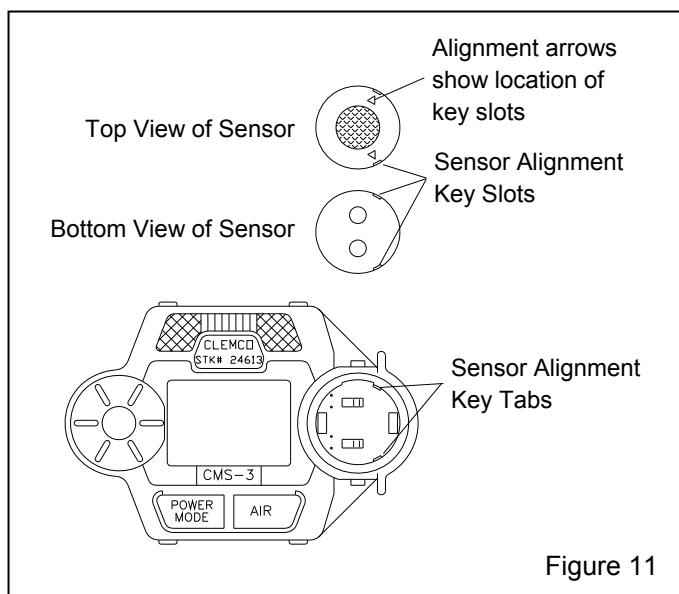


Figure 11

5.2.6 Reinstall the sensor gasket; install a new charcoal filter, and sensor cover into the recess in the sensor gasket.

5.2.7 Reinstall the sensor cap, making sure both tabs snap into place.

5.2.8 Calibrate the new sensor as described in Section 4.3.

5.3 Replacing the Sensor Cover

Replace the sensor cover in a non-hazardous environment.

5.3.1 Make sure the CMS-3 is off.

5.3.2 The sensor cap snaps onto the case with two tabs. With a small flat blade screw driver, gently expand the two tabs to pry off the sensor cap.

5.3.3 Remove the old sensor cover from its recess in the sensor gasket.

5.3.4 Install the new sensor cover into the recess in the sensor gasket.

5.3.5 Reinstall the sensor cap, making sure both tabs snap into place.

5.4 Replacing the Charcoal Filter Disk

Replace the charcoal filter disk in a non-hazardous environment.

5.4.1 Make sure the CMS-3 is off.

5.4.2 The sensor cap snaps onto the case with two tabs. With a small flat blade screw driver, gently expand the two tabs to pry off the sensor cap.

5.4.3 Remove the old sensor cover from its recess in the sensor gasket.

5.4.4 Remove the old charcoal filter from its recess in the sensor gasket.

5.4.5 Install the new charcoal filter into its recess in the sensor gasket.

5.4.6 Install a new sensor cover into its recess in the sensor gasket.

5.4.7 Reinstall the sensor cap, making sure both tabs snap into place.

6.0 TROUBLESHOOTING

The troubleshooting table describes error messages, symptoms, probable causes, and recommended action for problems encountered with the CMS-3.

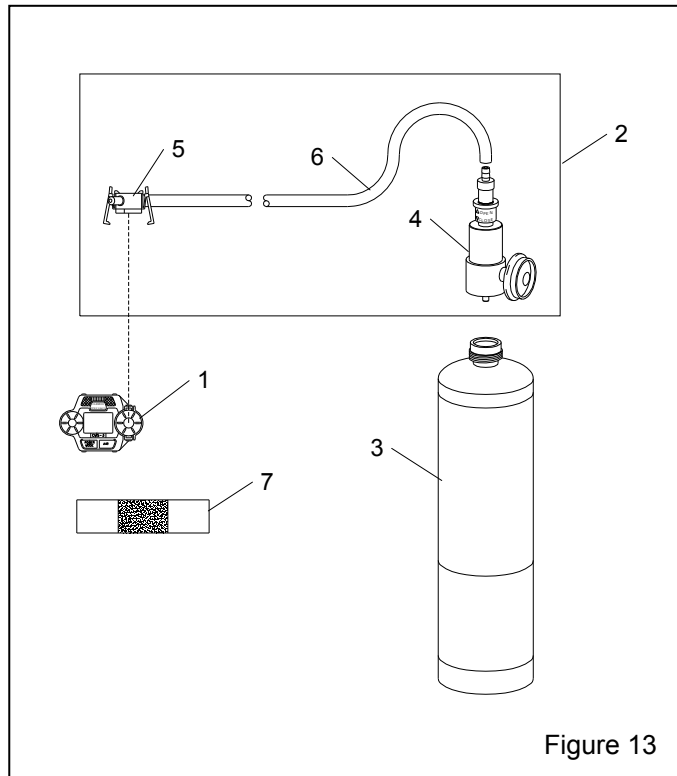
SYMPTOMS	PROBABLE CAUSES	RECOMMENDED ACTION
The LCD is blank.	The unit may be turned off.	1. To turn on the unit, press and hold the MODE/POWER button.
	The battery may need to be replaced.	1. If the unit does not turn on, replace the battery. 2. If the difficulties continue, contact an authorized Clemco distributor for further instructions.
The LCD shows abnormally high or low readings but other gas detection instruments do not.	The unit may need to be recalibrated.	1. Recalibrate the unit. Review Section 4.0.
	The sensor may need replacement.	1. Replace the sensor and calibrate the unit. 2. If the difficulties continue, contact an authorized Clemco distributor for further instructions.
“FAIL” displays during span or zero adjustment.	The calibration value may not match the cylinder gas concentration.	Make sure the calibration value matches the cylinder gas. Refer to Section 4.0.
	CMS-3 not correctly set up for calibration.	Make sure the CMS-3 has been properly set up for calibration per Section 4.0.
	The sample gas is not reaching the sensor because of a bad connection.	1. Check all calibration tubing for leaks or for any bad connections. 2. Make sure the calibration cup is correctly clipped to the sensor cap. Review Section 4.3.
	The calibration cylinder may be out of gas or is outdated.	Make sure the calibration cylinder contains an adequate supply of fresh test sample.
	The sensor may need replacement.	1. If the fail condition continues, replace the sensor. 2. If the difficulties continue, contact an authorized Clemco distributor for further instructions.
“FAIL SYS” is indicated on the LCD.	A microprocessor failure has occurred.	1. Turn off the unit and turn it on again. 2. If the difficulties continue, contact an authorized Clemco distributor for further instructions.

Figure 12

7.0 ACCESSORIES and REPLACEMENT PARTS

7.1 System and Accessories, Figure 13

Item	Description	Stock No.
(-)	CMS-3 CO Monitor Package Includes items shown with asterisk (*)24612	
1.	* CMS-3 CO monitor, instrument only24613	
2.	* Calibration connector assembly24614	
3.	Test gas, * 25 ppm CO25573 Impurity free11132	
4.	Calibration connector valve25572	
5.	Calibration cup24615	
6.	Tubing, 3/16 ID, 2-feet required13074	
7.	* Mounting strip assembly, used with Apollo 60 and 600 only Included with kit 25577 shown in Figure 14.	



7.2 Replacement Parts, Figure 14

NOTE: The printed circuit boards contain no user serviceable parts.

Item	Description	Stock No.
(-)	CMS-3 CO Monitor only24613	
1.	Sensor24616	
2.	Service kit, includes Items 3, 4 and 524617	
3.	Kit, screws and seal and mounting strip25577 3a Cap, sensor 3b Gasket, sensor 3c Screw set, (8) case and (4) battery cover 3d O-ring, battery cover 3e Velcro® tape, loop side, 1" x 1-1/4" 3f Velcro® tape, hook side, 1" x 2" (qty. of 2) 3g Mounting strip (qty. of 2) 3h Spring pin (qty. of 2)	
4.	Discs, sensor cover, pack of 1025563	
5.	Filter, charcoal, pack of 525564	
6.	Mounting plate25575	
7.	Battery, Lithium,24619 or purchase locallyModel CR2450	

