CMS-3

IN-HELMET CARBON MONOXIDE MONITOR

O. M. 24658

⚠ **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.

⚠ 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

- **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

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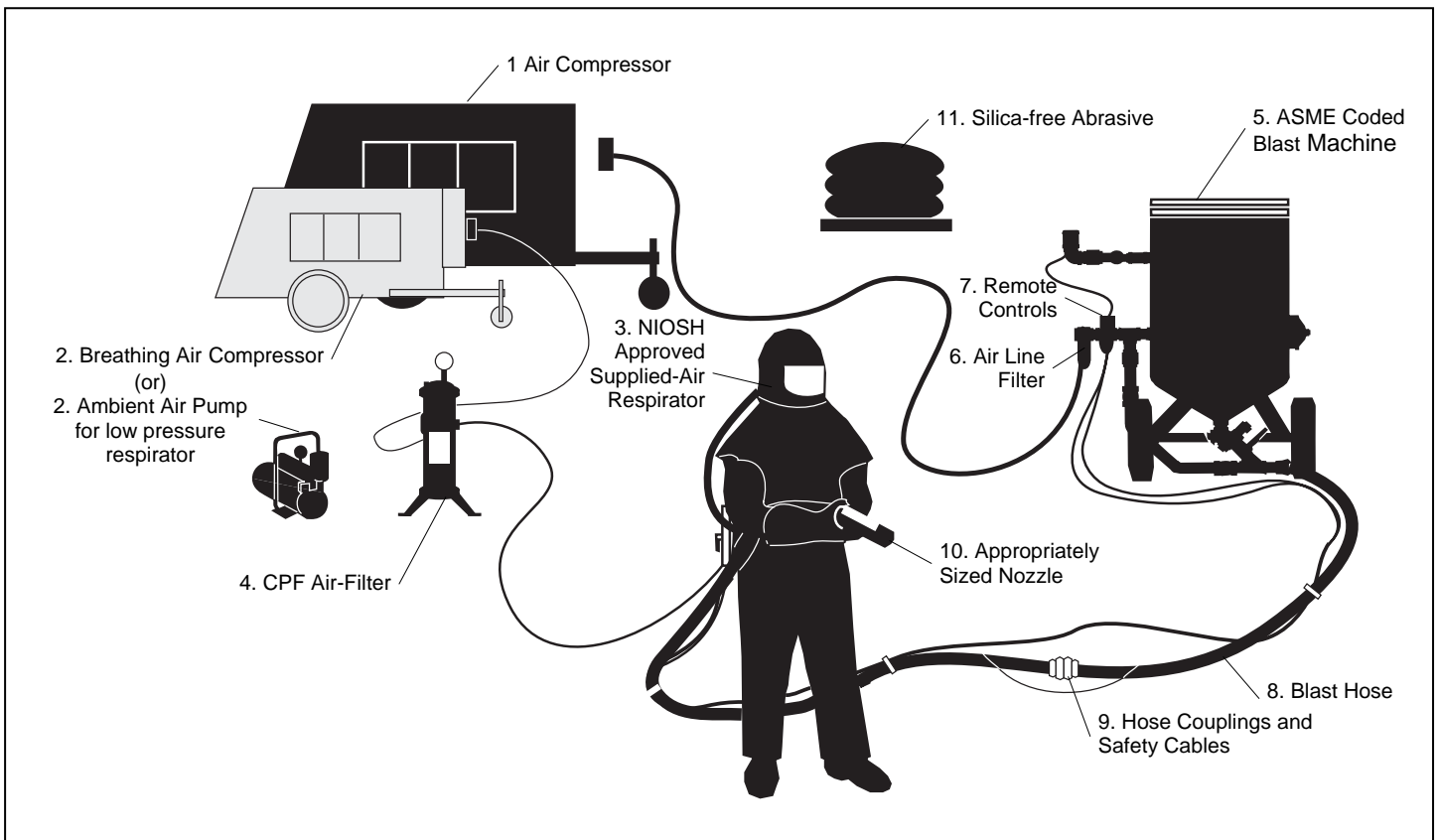
☐ **8. BLAST HOSE** with ID 3 to 4 times the nozzle orifice. Lines MUST be run AS STRAIGHT AS POSSIBLE from machine to work area with NO sharp bends. Check DAILY for internal wear and external damage.

☐ **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 Air Compressor
11. Silica-free Abrasive
5. ASME Coded Blast Machine
2. Breathing Air Compressor (or)
2. Ambient Air Pump for low pressure respirator
3. NIOSH Approved Supplied-Air Respirator
7. Remote Controls
6. Air Line Filter
4. CPF Air-Filter
10. Appropriately Sized Nozzle
8. Blast Hose
9. Hose Couplings and Safety Cables

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 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

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

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 for carbon monoxide in Grade D compressed breathing air is 10 parts per million (ppm). 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.

⚠ WARNING

The CMS-3 detects carbon monoxide which can be dangerous or 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.

1.5.4 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. A 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 (H_2S) and certain hydrocarbons. If false or elevated CO readings are noticed, especially in the presence of H_2S, 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.

LED Alarm Lens

Audible Alarm Opening

LCD Display Window

Sensor Diffusion Port

Sensor Cap

Control Buttons

Mounting Plate and Clip
Clip not used with
respirator mounting

Sensor Cap

Sensor Cover

Charcoal Filter

Sensor Gasket

Sensor

Sensor Alignment Slots

Velcro® Loop Fastener Tape
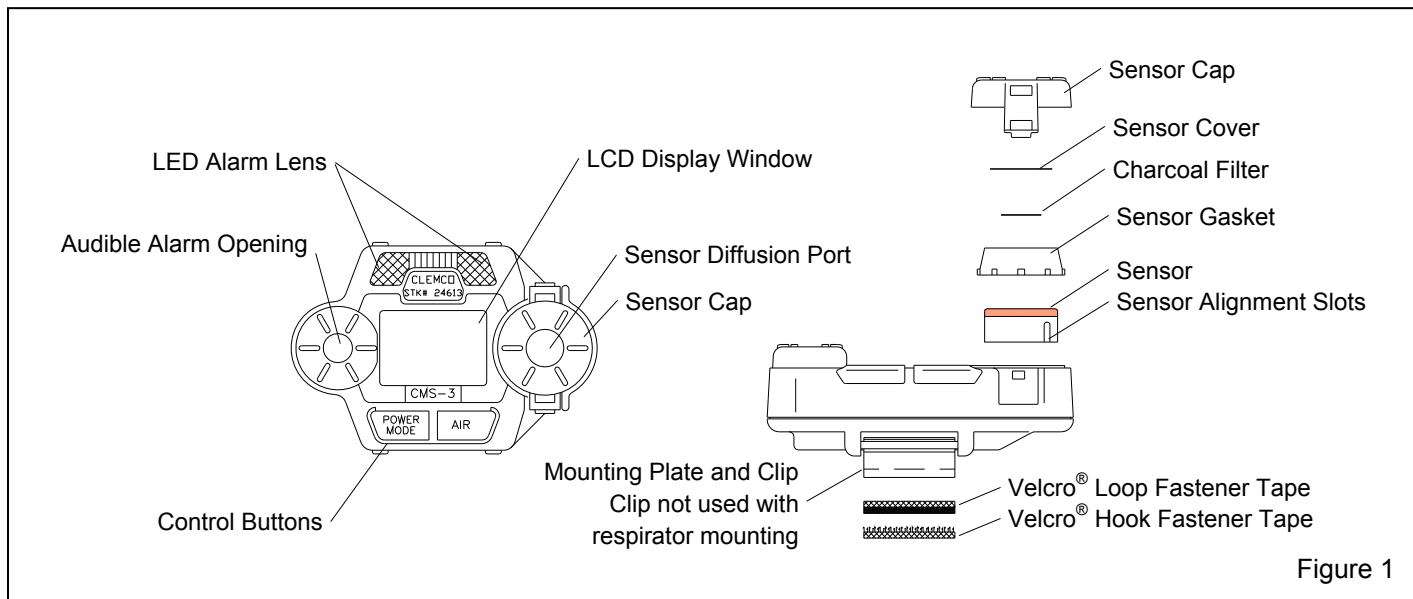
Velcro® Hook Fastener Tape

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	• 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	• 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 3,000 hours 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. Source a new battery as soon as the low battery warning is activated. 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
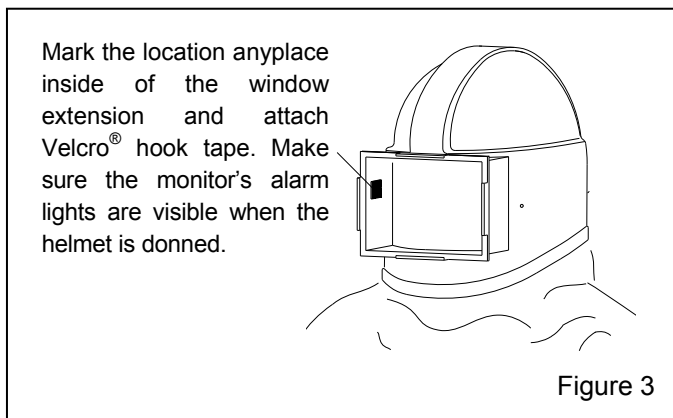This section explains the initial installation and of the CMS-3 inside the respirator.

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.
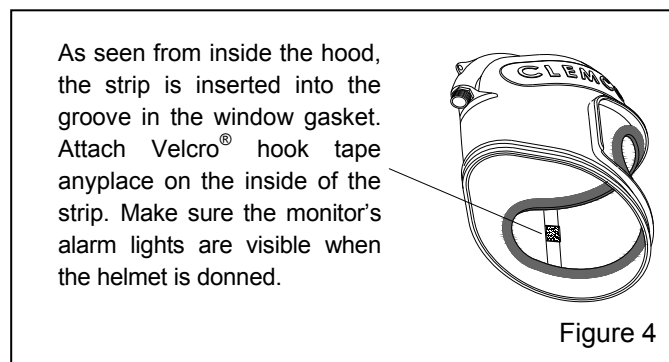
⚠ WARNING

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 if 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 display 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.
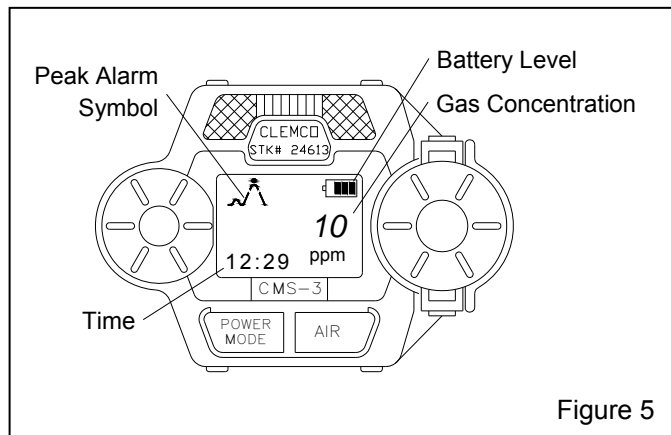

Figure 5

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 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 4.2.

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**
Low Alarm and High Alarm *Concentration of CO rises above the alarm point.* Note: Low and High Alarms are both set at the maximum exposure limit of 10 ppm.	• Gas reading flashes. • Back light turns on.	• Audible alarm beeps twice per second. • Unit vibrates twice per second. • Alarm lights flash twice per second.
TWA or STEL *Concentration of CO rises above the TWA or STEL alarm point.*	• 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.	• Audible alarm beeps once per second (Single Pulse). • Unit vibrates once per second. • Alarm lights flash once per second (Single Pulse).
Over Range *An over range condition may indicate an extreme CO concentration.*	• Gas reading replaced by blinking brackets (ΠΠΠΠ). • Back light turns on.	• Audible alarm beeps once per second (Single Pulse). • Unit vibrates once per second. • Alarm lights flash once per second (Single Pulse).
Low Battery Warning	• Last remaining bar on the right in battery icon flashes.	• None.
Dead Battery Alarm	• Gas reading replaced by **FAIL**. • Battery icon flashes.	• Audible alarm beeps twice per second (Double Pulse).
Sensor Failure	• Gas reading replaced by **FAIL.**	• Audible alarm beeps twice per second (Double Pulse).
System Failure	• Gas reading replaced by **FAIL**. • Time replaced by **SYS** below **FAIL**	• 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 4.2.

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.
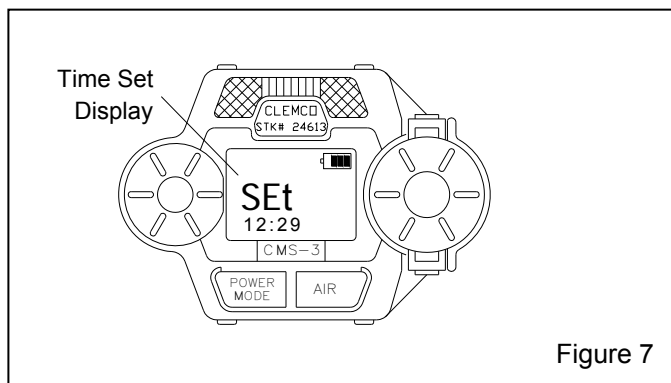

Figure 7

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   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 4.1.2.

4.1.1   Setting the fresh air reading with ambient air

4.1.1.1 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.

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

4.1.1.3 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.

4.1.2   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.

4.1.2.1 Make sure the monitor is off.

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

4.1.2.3 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.

4.1.2.4 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.

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

4.1.2.6 Press and hold the AIR button. While pressing the AIR button, the LCD displays "Hold," a prompt to keep pressing the AIR button.
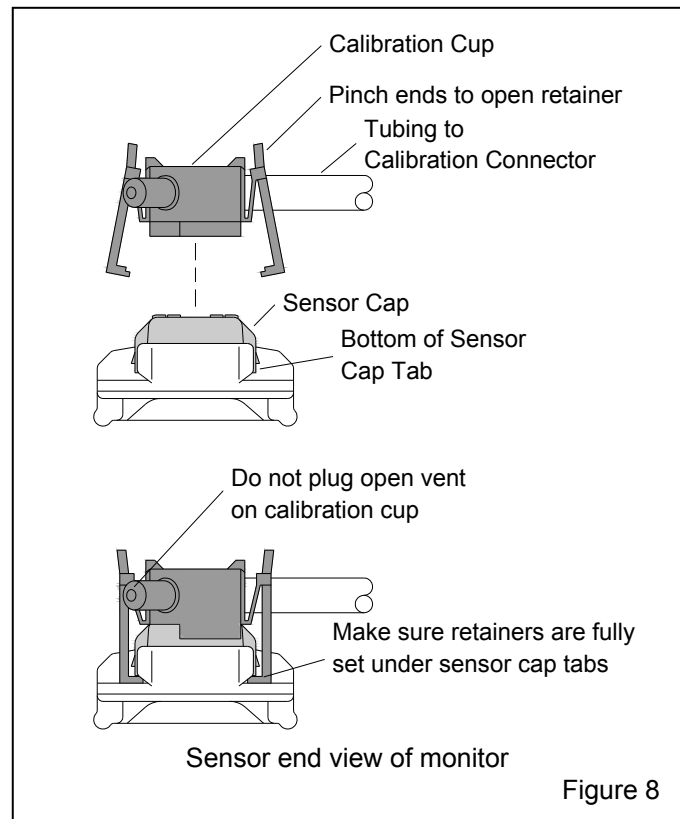
4.1.2.7 When the fresh air reading has been set, the LCD displays "Adj," a prompt to release the AIR button. It will set the reading to 0 ppm.

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

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

4.1.2.10 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.

4.2   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.

4.2.1   Make sure the fresh air reading was set per Section 4.1.

4.2.2   Make sure the monitor is off.

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

4.2.4   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.

4.2.5   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.

Calibration Cup
Pinch ends to open retainer
Tubing to
Calibration Connector

Sensor Cap
Bottom of Sensor
Cap Tab

Do not plug open vent
on calibration cup

Make sure retainers are fully
set under sensor cap tabs

Sensor end view of monitor

Figure 8

4.2.6   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.

4.2.7   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.

4.2.8   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.

4.2.9   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.

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

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

4.2.12 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.

4.2.13 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

Replace the lithium battery 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.

Battery Cover

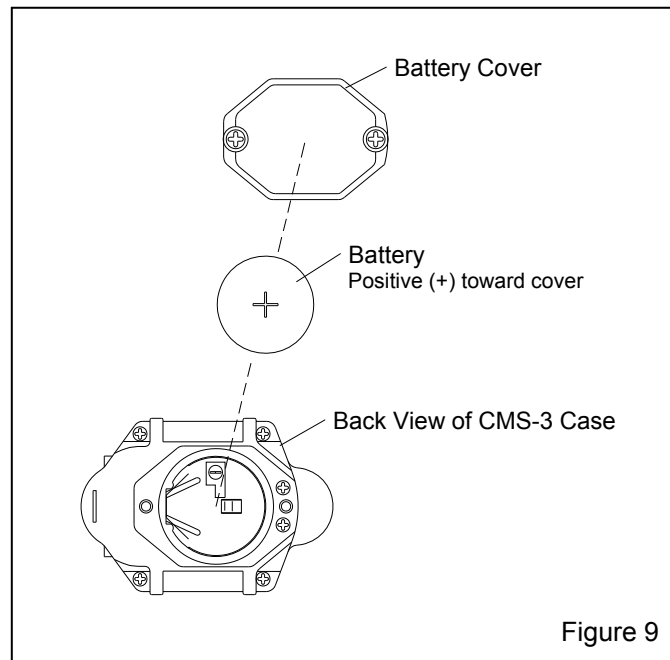Battery
Positive (+) toward cover

Back View of CMS-3 Case

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.

Sensor Cap

Sensor Cap Tabs

Sensor Cover

Charcoal Filter

Sensor Gasket

Sensor

Sensor Alignment Key Slots

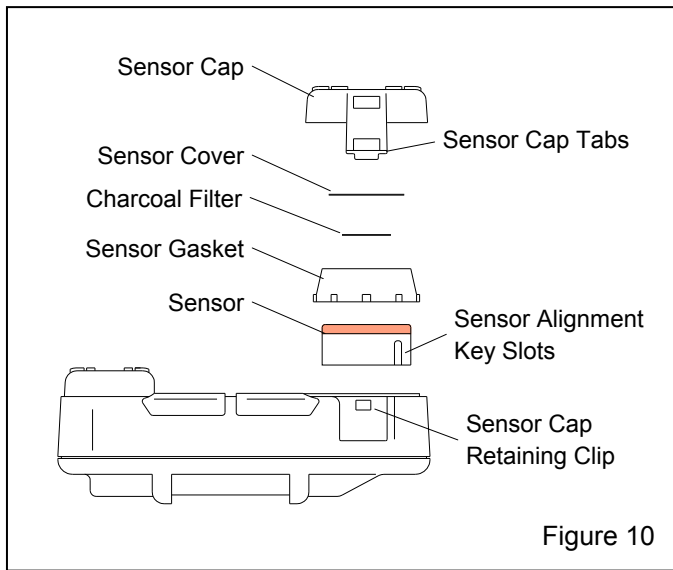Sensor Cap Retaining Clip

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.

Alignment arrows show location of key slots

Top View of Sensor

Sensor Alignment Key Slots

Bottom View of Sensor

CLEMCO STK# 24613

CMS-3

POWER MODE   AIR

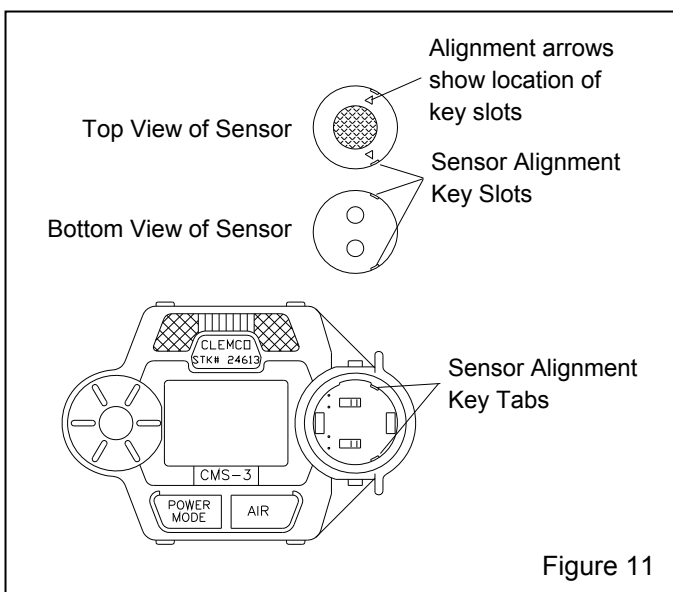Sensor Alignment Key Tabs

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 4.2.

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 4.2.
	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 only	24613
2.	* Calibration connector assembly	24614
3.	Test gas,	
	* 25 ppm CO	25573
	Impurity free	11132
4.	Calibration connector valve	25572
5.	Calibration cup	24615
6.	Tubing, 3/16 ID, 2-feet required	13074
7.	* Mounting strip assembly, used with Apollo 60 and 600 only Included with kit 25577 shown in Figure 14.	

Figure 13

7.2   Replacement Parts, Figure 14

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

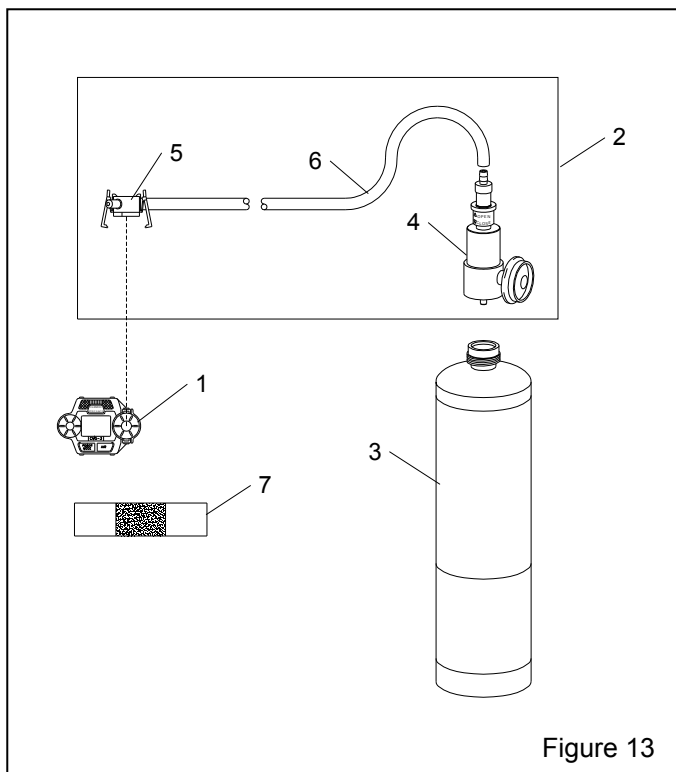| Item	Description	Stock No.
(-).	CMS-3 CO Monitor only	24613
1.	Sensor	24616
2.	Service kit, includes Items 3, 4 and 5	24617
3.	Kit, screws and seal and mounting strip	25577
	3a Cap, sensor	
	3b Gasket, sensor	
	3c Screw set, (8) case and (4) battery cover	
	3d O-ring, battery cover	
	3e Velcro® tape, loop side,1" x 1-1/4"	
	3f Velcro® tape, hook side, 1" x 2" (qty of 2)	
	3g Mounting strip (qty of 2)	
4.	Discs, sensor cover, pack of 10	25563
5.	Filter, charcoal, pack of 5	25564
6.	Mounting plate	25575
7.	Battery, Lithium, purchase locally Model CR2450	

Figure 14