



**COMBUSTION MONITOR
MODEL CM1000**

**INSTALLATION, OPERATING & MAINTENANCE
INSTRUCTIONS**

OM-CMIK/OI-001 REV C

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1 SYSTEM DESCRIPTION

1.1 GENERAL CM1000 FAMILIARIZATION

The Model CM1000 Combustion Monitor is a continuous operating flue gas analyzer which provides a digital display of measured oxygen, carbon monoxide and net stack temperature. Options include a variety of gas sensors such as nitric oxide or CO/combustibles and analog outputs.

The system consists of

SAMPLE PROBE,
SAMPLE CONDITIONING UNIT (SCU) and
MEASUREMENT and DISPLAY UNIT (MDU).

The sample probe is designed for insertion into the flue and directs stack gas to the sample conditioning unit (SCU). The SCU cleans the gas, disposes of condensate on a continuous basis and reduces the relative humidity of the sampled gas before it passes on to the measurement and display unit (MDU) which contains the sensors and circuitry to compute gas concentrations and display their values.

The abbreviations SCU (Sample Conditioning Unit) and MDU (Measurement and Display Unit) will be used throughout this manual.

A brief description of each component follows below. More detail and functional descriptions can be found in the section on Operating Instructions.

1.2 SAMPLE PROBE DESCRIPTION

The sample probe is installed in the stack. It provides a sampling path to the SCU from the flue or incinerator stack. Standard probes are constructed of type 316 stainless steel, permit insertion distances of approximately 10 inches and may house the thermocouple. Custom probes can be supplied for specific requirements. Contact the manufacturer for details.

1.3 SAMPLE CONDITIONING UNIT (SCU) DESCRIPTION

The SCU has three functions: it cleans the sampled flue gas, disposes of condensate on a continuous basis, and reduces the relative humidity of the gas.

PRESSURE SENSORS

Two pressure sensors in the SCU detect water pressure and air vacuum in the wash column. These sensors are connected to the MDU, which monitors their status.

SOLENOID VALVE

A solenoid valve controls the flow of room air into the sampling line for "zeroing". Its opening and closing is controlled by the MDU.

WATER FILTER

A filter containing a nominal 5-micron cartridge is located in the SCU. Its purpose is to prevent particles from getting through to the nozzle and causing the nozzle to block. Blockage of the filter would be indicated by an H2O ERR sampling fault since the pressure switch is downstream of the filter.

WATER BYPASS VALVE

A water bypass valve controls the flow in a path parallel to the nozzle and is used to increase the total amount of flow through the SCU to ensure a cold water supply.

HOUSING

The SCU is housed in a rugged aluminum cabinet suitable for wall or post mounting.

1.4 MEASUREMENT & DISPLAY UNIT (MDU) DESCRIPTION

The MDU microprocessor provides software management of all system functions, readout and controls of the CM1000 system. This includes the continuous display of measured gas concentration values and calibration functions associated with the SCU and sensors. The MDU is connected electrically to the SCU to monitor two pressure sensors, to transmit the thermocouple signal, and to activate a solenoid valve.

GAS READOUT

Oxygen and carbon monoxide are displayed in two front panel three-digit display windows. In standard form the instrument measures gas concentration by volume using electrochemical cells. The oxygen cell provides a resolution of 0.1% with a range of 0-20.9% and the electrochemical CO cell has 1 ppm resolution with a range of 0-2000 ppm. The oxygen measurement is calibrated automatically on room air. Both measurements are zeroed automatically and periodically to prevent drift. CO must be calibrated manually (potentiometer on the circuit board) using a suitable reference for comparison.

TEMPERATURE READOUT

When the system is instructed to display net stack temperature it does so in the left hand window in the place of the oxygen measurement. The instrument is compatible with a type K thermocouple which can be attached via a miniature connector located on the top of the SCU. Temperature must be calibrated manually (potentiometer on the circuit board) using a suitable reference for comparison.

SERIAL PORT

In addition to the digitally displayed values the instrument has a standard RS232C compatible output port which permits it to be connected to a serial device or printer. Baud rates and print frequency are selected on the control panel.

REMOTE CO ALARM

Provision has also been made in the monitor to provide a contact closure to be used for a remote CO alarm which triggers under standard conditions when the measured CO level exceeds 450 ppm. This threshold can be changed on special order only.

HOUSING

The MDU is housed in a rugged steel cabinet suitable for wall or post mounting.

1.5 OPTIONS AND ACCESSORIES

ANALOG CHANNEL OUTPUT (OPTION)

Up to three 1-5V analog output channels for chart recording can be provided as an option.

CO/COMBUSTIBLES CELL (OPTION)

Provision has been made in the instrument to accept a CO/combustibles sensor, which uses "catalytic bead sensors" and the heat of oxidation technique for measurement where the characteristics of this cell is more suitable for a given installation. This measurement has a resolution of .005% (50 ppm). For those monitors equipped with catalytic bead sensors, the CO/combustibles measurement appears in the right hand display and is expressed as a percentage ranging from .000 - 2.55%. Linearization and/or compensation adjustment must be made at the factory following the replacement of a CO/combustibles sensor.

NITRIC OXIDE CELL (OPTION)

Provision has been made in the instrument for the addition of other electrochemical cells such as nitric oxide for specific applications. Such modifications would be on special order.

2 INSTALLATION

This section outlines the electrical and mechanical requirements necessary for reliable operation of the CM1000 MONITOR.

2.1 SITE REQUIREMENTS

The following is a summary of the site requirements. The installation details in Sections 2.2 to 2.4 will provide a more complete description of the required services and equipment location constraints.

MDU ELECTRICAL: 115/120 VAC standard 3-wire 15-ampere duplex outlet

MDU EXHAUST: Sample gas/condensate exhaust lines

SCU WATER SUPPLY: Cold tap water or equivalent with shutoff valve

SCU DRAIN: Open drop through 1/2" tube to floor drain

2.2 PROBE INSTALLATION

Select the location for the probe bearing in mind that it will be easiest to install on a flat surface, that the probe tip should be close to the center of the flue and that it should not be located on an elbow. Also make-sure that the sampling line will have a continual downward slope to the top of the SCU so that condensate (which will trap dirt or produce steam) will not collect in the sampling line. A 3/8-inch NPT (M) brass tank fitting is provided with the standard probe and will allow mounting to plates sufficiently thick to allow threading. For other applications, please contact Dedesco for special order brackets.

THERMOCOUPLE

If the supplied probe is fitted with a type K thermocouple, the thermocouple wire may be wound around or loosely attached to the probe sample line leading to the SCU. The miniature plug must be inserted into the socket on the top right side of the SCU to make the temperature function available.

2.3 SCU INSTALLATION

THE SCU MUST BE LOCATED SO THAT THE SAMPLED FLUE GAS WILL HAVE A CONTINUOUS DOWNWARD PASSAGE FROM THE FLUE TO THE UNIT.

WATER SUPPLY

The water supply to the SCU should be as clean as possible to reduce maintenance requirements. Using 1/4-inch copper tubing connect a supply of clean tap water at 40 PSIG or greater to the water inlet of the SCU. This connection is located under the unit on the left hand side and identified as WATER INLET (See Figure 2-1). Install a shut-off valve in this line for servicing convenience later. Avoid passing the supply water line close to hot pipes where the water would be heated. This water must enter the sample conditioning unit at 10 Fahrenheit or more degrees colder than room temperature for proper operation. An even colder supply of water would be more effective for "drying" the flue gas.

WATER DRAIN

The short length of 5/16-inch copper tube leading from the SCU drain fitting (identified as WATER DRAIN) should be "open-dropped" into a 1/2-inch or larger drain line leading to a floor drain. The water discharge line should be permitted to discharge freely without back pressure from drain blockage or suction from an airtight connection.

SIGNAL WIRE CONNECTIONS

Signal wire exits the bottom of the SCU and this connection will have been made at the factory. Twenty feet of signal wire is included with the unit.

SAMPLE LINE FROM PROBE

Attach 3/8-inch ID clear vinyl or flexible Teflon tube to the probe and support it so as to achieve a continual downward slope to the top of the SCU. Push this sampling line through the large grommetted hole on the top of the SCU and onto the 3/8-inch elbow on the front of the central manifold located just below the spray chamber.

SAMPLE LINE TO MDU

Attach 3/16-inch ID clear vinyl sampling line to the sample outlet on the bottom of the SCU and run this line to the approximate location of the MDU. Avoid running this line along the floor or where it will get chilled more than 10F degrees below room temperature or condensate will form in the sampling line and may be passed into the MDU. The sample outlet is identified on the bottom of the SCU as "Sample Line To MDU". Twenty feet of 3/16-inch ID clear vinyl tubing is included for this purpose.

SCU "RUN-IN"

Turn on the water supply to the SCU at this point to check for leaks and that the water is discharging reliably to the drain. Allow the water to run while the remainder of the installation is made. Check the temperature of the discharge water periodically and if necessary increase the water flow slightly by using the bypass valve.

WATER BYPASS VALVE

The SCU water temperature may be controlled to a certain extent using bypass flow. It is adjusted by the bypass valve located in the SCU enclosure at the lower right. Turn the handle counterclockwise to open the valve and increase the bypass flow, which should decrease the water temperature. Use only as much bypass water as needed. With no bypass water the unit will discharge approximately 1 1/2 gallons of water per hour.

When sample gas is not being drawn through the unit, water will back up in the probe sample inlet line to a height slightly above the 3/8-inch plastic elbow. This is normal. This water level will disappear when the sample line is connected to the MDU and the sampling pump is operating.

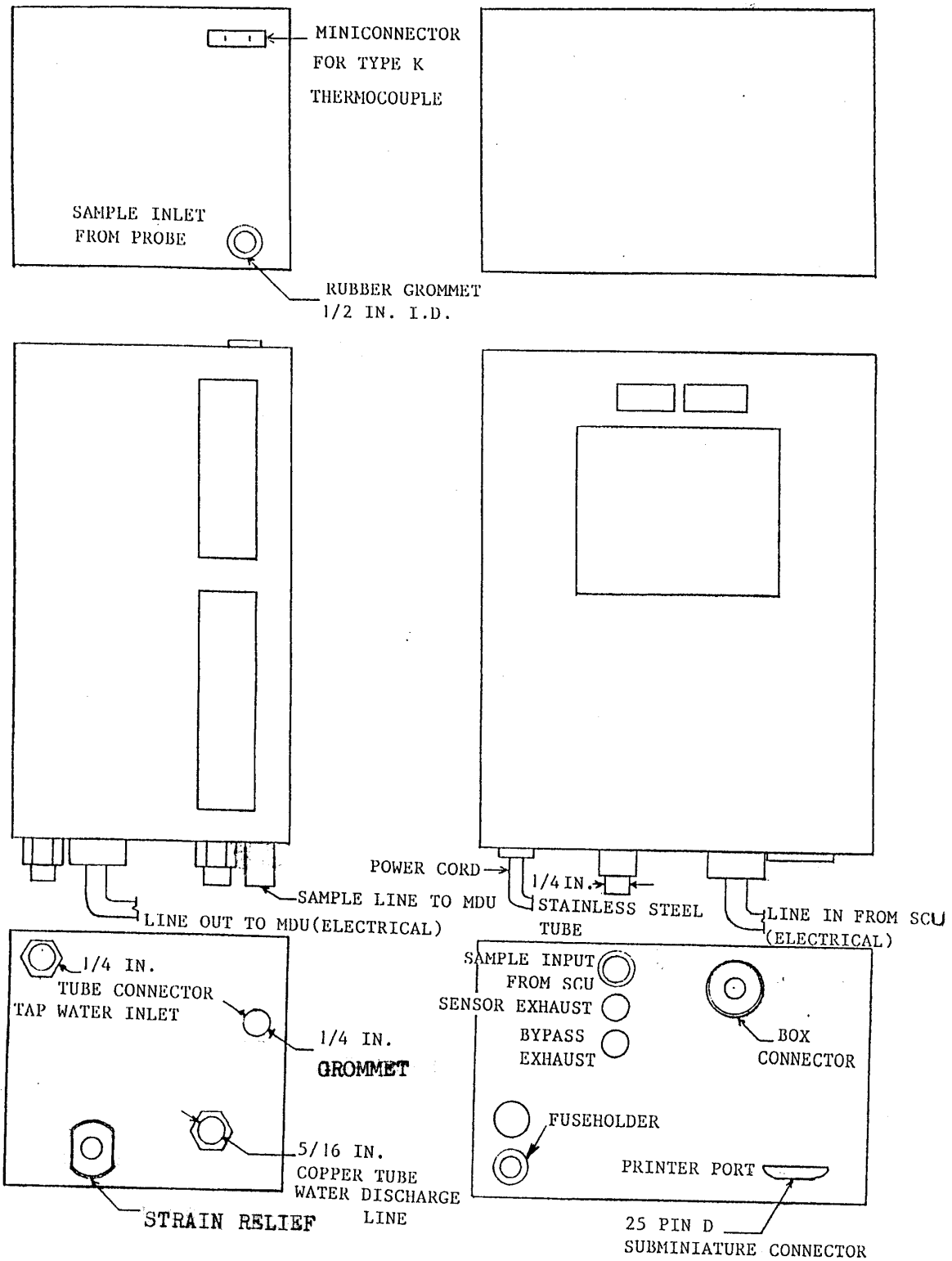


FIGURE 2 -1 EXTERNAL CONNECTIONS TO SAMPLE CONDITIONING UNIT (SCU) AND MEASUREMENT/DISPLAY UNIT (MDU)

CONNECTION SUMMARY

Table 2-1 summarizes the external mechanical and electrical connections to the SCU.

TABLE 2-1 SCU External Connections

Name	Function
Sample Inlet from Probe	Entry for gas sample from sample probe
Sample Line to MDU	Exit from SCU for gas sample to MDU
Cable out to MDU	Path for control signals (Electrical)
Water Supply Inlet	Provides cold water to clean the gas sample
Water Discharge Line	Provides outlet for water to drain

2.4 MDU INSTALLATION

LOCATION

Select a suitable location for the MDU. It needs a source of power (115 Volt - 1 Amp). It can be wall or post mounted so select a location that will offer maximum convenience for monitoring. Support the unit using the holes in the support plates at the rear top and bottom of the unit.

SIGNAL LINE CONNECTION

-----CAUTION-----

WHEN DISCONNECTING OR RECONNECTING THE ELECTRICAL CABLE BETWEEN THE SCU AND MDU, DISCONNECT THE POWER TO THE MDU FIRST TO PREVENT ANY DAMAGE TO THE MDU ELECTRONIC CIRCUITRY

With the power disconnected and the front door panel open, insert the signal wire up through the connector in the bottom of the MDU and make signal wiring connections on the 22-position connector E7 located in the bottom right hand side of the MDU. The CM1000 wiring hookup diagram (Figure 2 -2) provides wire color coding and connection positions.

SAMPLE LINE FROM SCU

Attach the 3/16-ID clear vinyl tubing, which originates at the SCU to the fitting on the bottom of the MDU identified as "Sample Line From SCU". Refer to Figure 2-1 for external connection locations.

EXHAUST LINES

Although the sample concentrations tend to be low, it is advised that the sensor and bypass gas exhaust from the MDU be ducted outside the working area using large diameter lines that will not produce back pressure on the sensors.

POWER CORD

This unit has a grounded (3 prong) plug for connecting to a standard 115V 15 Amp receptacle.

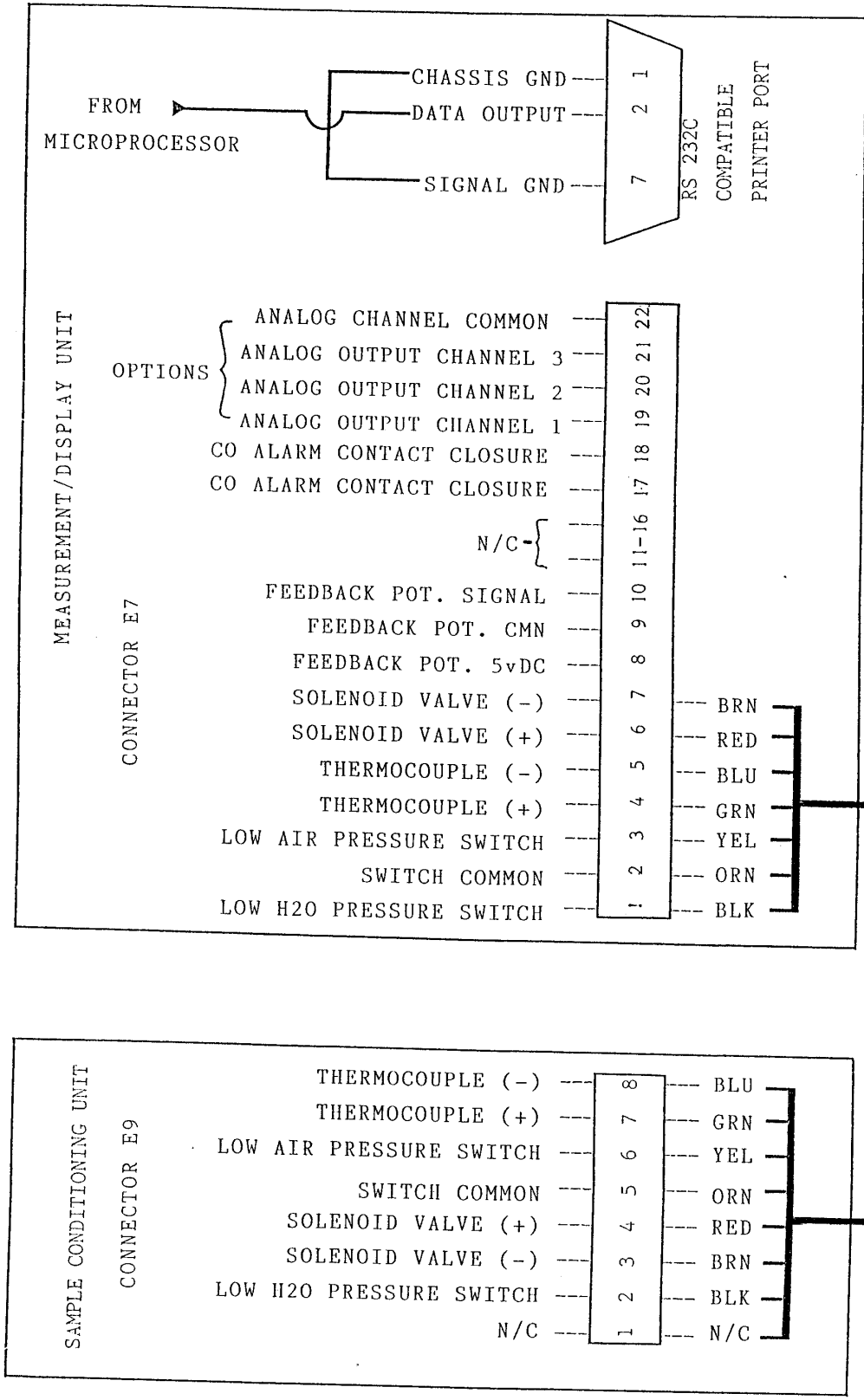


FIGURE 2 -2 CM1000 WIRING HOOKUP DIAGRAM

CONNECTION SUMMARY

Table 2-2 summarizes the external mechanical and electrical connections to the MDU.

TABLE 2-2 MDU External Connections

Name	Function
Sample Input from SCU	Gas sample from sample conditioning unit
Sensor Exhaust	Exhaust line from the sensors
Bypass Gas Exhaust	Drain for H ₂ O which may condense in sample line
	Also provides path for exhausting sample gas
Cable in from SCU	Path for control signals (electrical)
Power Cord	AC Power from Mains

2.5 PRINTER CONNECTION

An RS232C compatible serial port is provided for output to a printer, datalogger or computer. A 25pin D-subminiature female connector is located on the bottom right-hand side of the MDU for connecting a printer cable.

2.6 REMOTE CO ALARM CONNECTION

A PCB-mounted relay contact closure is provided for tripping a remote CO alarm. In standard form this relay closure will take place when the CO level exceeds 450 PPM. Use of the relay closure can be made by connecting an alarm circuit to connection points 17 and 18 of the MDU connector strip E7 (Figure 2-2). The relay is rated at 0.5 Ampere and 10 Volt-amperes.

2.7 ANALOG RECORDER CONNECTION

Output connections for 1-5VDC analog output channels for up to three measured values is an optional capability that can be provided. The signals are available on the MDU terminal strip E7 (Figure 2-2) at connections points 19 through 22. The normal locations of the analog channel connections are found in Table 2-3.

TABLE 2-3 Analog Channel Connections

Output	Channel	Connector	Position		Figure
			Signal	Ground	
02	1	E7	19	22	2-2
Net T	2	E7	20	22	2-2
CO	3	E7	21	22	2-2
NO (option)	**	E7	**	**	2-2

** NO adopts the 02 or NET T channel

Field adjustment of the analog channels is generally not required and is not recommended. Refer to the Maintenance section for the required procedures.

2.8 FIRING RATE POTENTIOMETER CONNECTION

Provision is made on the front panel to indicate 15 levels of burner firing rate (or load). To utilize this function a 5,000 ohm potentiometer must be attached to the burner so that it will rotate through approximately 90 degrees as the burner progresses from off to high fire. Electrical connections for the potentiometer are located on connector E7 in the MDU (Figure 2-2). The MDU is programmed in such a way that when the potentiometer is first installed it will automatically recognize its full travel in one direction as firing level 8 (high fire) and its full travel in the opposite direction as level 1 (low fire).

Should it be necessary to re-establish or re-initialize this condition, this can be done by first disconnecting the power to the MDU and then pressing an unmarked front panel switch located $\frac{3}{4}$ inch to the right of the printer, on/off switch while reconnecting power to the MDU. Keep light finger pressure on this switch until you hear 3 beeps after connecting the power. The MDU will then reestablish the upper and lower limits as soon as the burner goes through a full operating cycle.

2.9 POWERING UP

-----NOTE-----

To reduce the warm-up time of the electrochemical CO cell after shipping, the MDU is shipped with a BLUE SHORTING WIRE across the "S" AND "R" terminals of the CO cell (located to the left of the printed circuit board after opening the front door). THIS BLUE SHORTING WIRE MUST BE REMOVED BEFORE THE MDU IS POWERED UP.

After removing the blue shorting wire and double-checking all connections, plug in the MDU to start operation. On power up, the MDU will immediately enter an automatic calibration/zero routine as signified by the displays showing CAL. The Calibrating LED will be lit for a period of approximately 2 - 1/2 minutes following which the digital readout will display measured values.

Different sensors require different times to stabilize. On initial installation or after the unit has been powered down for maintenance, CO measurement by electrochemical cell and the CO/combustibles measurement may require up to 3 hours to fully stabilize after which analyzed gas calibrations can be performed. The net stack temperature and gas concentration measurements other than oxygen have been calibrated at the factory and should not require immediate calibration.

After the complete system has operated for 1 hour check that the top chamber in the SCU is clear and free of any water droplets (normal condition). If droplets are noted, refer to Troubleshooting section for remedies.

After the full 3 -hour warm-up period, the CM1000 is ready for normal operation.

3 OPERATING INSTRUCTIONS

3.1 MDU FRONT PANEL

It is recommended that the operator become fully familiar with the system features, status indicators and controls before proceeding. Operator involvement is minimal since the CM1000 serves primarily as a monitoring device. Figure 3-1 illustrates the MDU front panel.

3.1.1 SENSOR MEASUREMENT AND DISPLAY

Once the unit has been installed and powered up as described in the previous sections it is automatically in full operation. The main 6 digit LED display window will provide continuous indication of O₂ and CO concentrations. Temperature can be temporarily accessed at any time.

OXYGEN (O₂)

The oxygen measurement is displayed in the left hand window of the main display. The measurement of oxygen concentration by volume is shown to the nearest tenth of a percent, XX.X%.

CARBON MONOXIDE (CO)

In the standard unit, the right hand window will display the CO concentration in ppm ranging from 000 to 999 ppm. Values from 1000 to 1999 ppm will be shown by a flashing three digit display. A flashing display of 450 therefore indicates 1450 ppm.

TEMPERATURE (NET T)

Temperature, when selected by pushing the switch marked "DISPLAY" on the front panel, will be displayed in the oxygen window with the indication of degrees C or degrees F in the right hand window.

CARBON MONOXIDE/COMBUSTIBLES (CO/Comb) [Option]

For units equipped with the optional CO/Combustibles sensor, the right hand window will display CO/combustibles concentration by volume. Levels below .999% will be displayed to the nearest .005% (50 ppm). For higher levels, the decimal point will shift and combustibles will be displayed up to approximately 3%.

NITRIC OXIDE (NO) [Option]

For units equipped with the optional electrochemical NO sensor, the left hand window will display the NO concentration in ppm ranging from 000 to 999 ppm. Values from 1000 to 1999 ppm will be shown by a flashing three digit display. A flashing display of 450 therefore indicates 1450 ppm. The NO measured value is selected by pressing the NO_x push-button located below the RESET push-button on the front panel. The left hand window will display the measured value of NO in ppm. A second pressing of the NO_x push-button will restore the display to the normal O₂ reading.

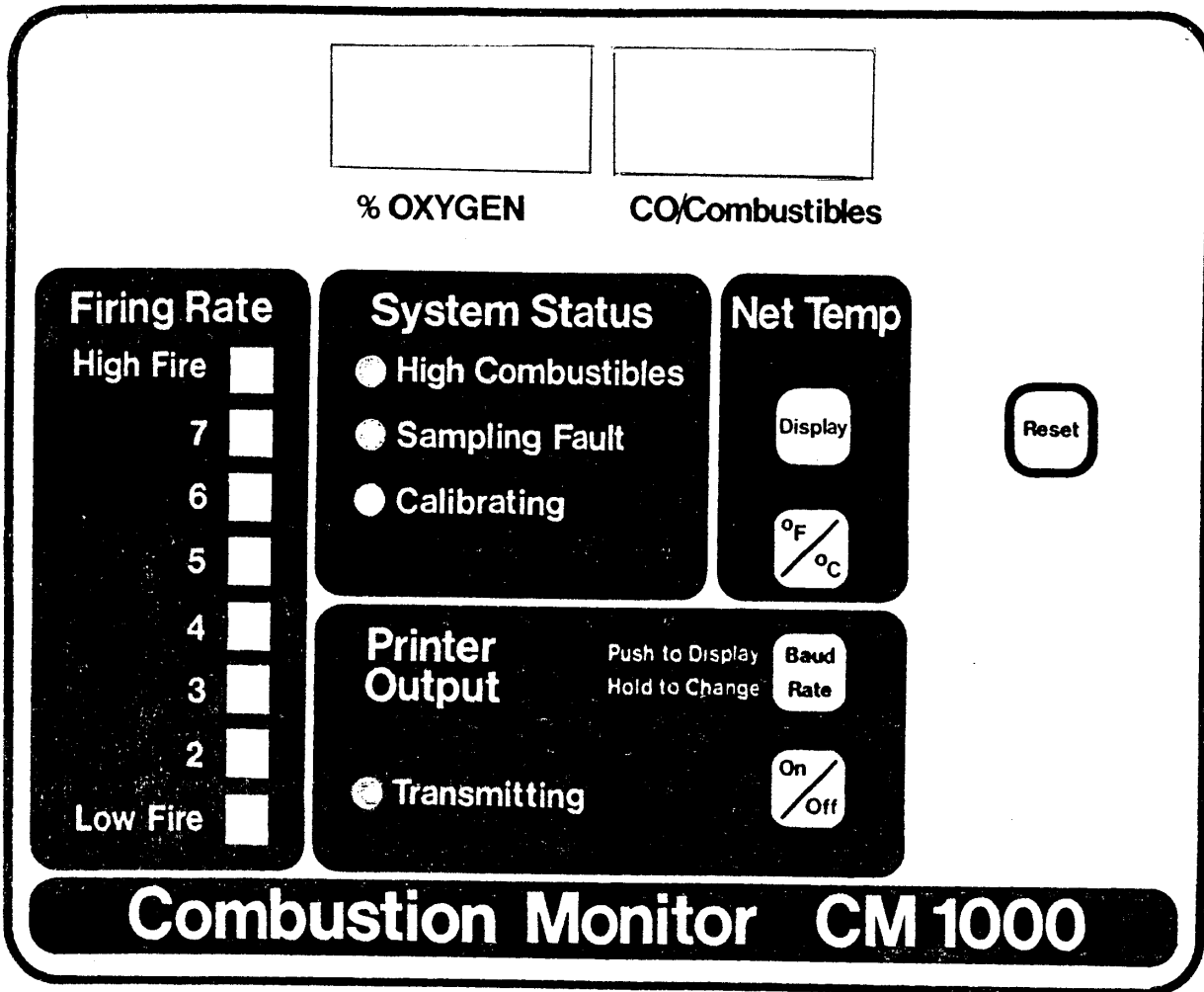


FIGURE 3 - 1 MDU FRONT PANEL

3.1.2 SYSTEM STATUS INDICATORS

The CM1000 Combustion Monitor is equipped with means to detect and indicate certain status and fault conditions in the system to inform the operator and protect the sensors and instrument.

HIGH COMBUSTIBLES (RED LED)

This warning LED functions only with the CO/combustibles catalytic bead sensors. It is not intended to function with electrochemical CO sensors. The high Combustibles LED will turn on and stay on for combustibles concentrations of .515% or greater. This value is well above normal levels expected in the flue and is intended to serve as a warning in the event such levels are detected. It could indicate the early stages of a leaking gas valve and when this warning light is on the cause should be determined. It can be turned off by disconnecting power to the unit and then reconnecting the power.

SAMPLING FAULT (RED LED)

When the Sampling LED is lit, one of the following system errors has occurred:

- H2O Err Water pressure problem
- AIR Err Gas sampling problem
- O2 Err O2 cell malfunction
- CO Err CO cell malfunction
- NO Err NO cell [optional] malfunction

The type of error which has occurred will be displayed in the 6 digits of the main LED display. Any of the above faults may produce false readings from the unit. The operator should refer to the Troubleshooting section for a full description of and remedy for the indicated problem.

CALIBRATING (YELLOW LED)

When the Calibrating LED is lit, it indicates to the operator that the MDU has entered an automatic re-zeroing cycle. At this time, the MDU is taking a sample of room air and re-establishing the span and zero levels. During this 2 1/2 minute cycle the 6 digit display will indicate CAL CAL. This autozeroing cycle occurs every 2 hours and 16 minutes.

TRANSMITTING (GREEN LED)

When lit, the, Transmitting LED indicates that the MDU is sending data out via the serial output port.

FIRING RATE (YELLOW LEDs)

The firing rate LEDs provide visual indication of the load or firing rate of the burner. They divide the range into fifteen distinct regions labeled as LOW FIRE, 2 - 7, HIGH FIRE. Loads between these eight settings are indicated by two adjacent LEDs being lit.

FLASHING DISPLAY

If the unit is equipped with an electrochemical cell to measure a gas in ppm, the display will flash if that gas concentration exceeds 999 ppm. Therefore, if a 3 digit display is flashing and reads "045" the actual measurement is 1045 ppm (or in rare cases 2045 ppm).

LEFT HAND DISPLAY FLASHING "LO"

If the unit is equipped with an electrochemical cell to measure O₂, and the output of that cell has been reduced to a level that no longer guarantees accurate oxygen measurements, a "LO" warning message is displayed in the left hand window alternating with the measured O₂ value. The O₂ cell should be replaced at this time.

3.1.3 SYSTEM CONTROLS

Several controls are available to the operator. They are activated by pressing the push-button membrane switches located on the front panel.

RESET Push-button

Press the RESET push-button to initiate an automatic calibration cycle.

NET TEMP - DISPLAY Push-button

Press the NET TEMP - DISPLAY Push-button to display net stack temperature. Net stack temperature is the difference between the stack temperature and the room temperature in the location of the SCU (thermocouple cold junction location). A flashing net temperature display indicates temperatures over 10000.

NET TEMP - °F/°C Push-button

Press the degrees °F/°C push-button to change the displayed value from degrees Fahrenheit to degrees Celsius or vice versa.

PRINTER OUTPUT - BAUD RATE Push-button

Press the BAUD RATE push-button once to briefly display the current baud rate. The system is shipped with a default baud rate of 1 bd (600 bd). To change the baud rate for data transmission, press and hold the same push-button. The display will cycle through the codes 0 - 3 bd and back to 0. These codes correspond to baud rates as follows:

DISPLAY	BAUD RATE
0 bd	300
1 bd	600
2 bd	1200
3 bd	2400

Release the push-button at the desired baud setting. Setting the baud rate is required only once since the MDU will store the information in nonvolatile memory.

PRINTER ON/OFF

Push the ON/OFF push-button to turn the output to the serial port on or off. When first turned on, the Transmitting LED will turn on to indicate that the CM1000 is sending data out through its serial port. After a few seconds delay, the main display will indicate the current delay time between data package transmission as "xxx SEC". The print interval may be selected from 8 values ranging from 2 to 256 seconds (approximate real-time seconds only since it depends on the MDU microprocessor cycle times). To change the transmission interval time, press and hold the ON/OFF

push-button and release at the desired time indicated in the display. The data package will vary with the sensors selected but will normally provide a header indicating company name and date, followed by a measured value header (02 CO NET_T LD SEC), followed by measured values. The LD column indicates the firing rate.

3.1.4 KEYLOCK

The panel contains a keylock which may be used to restrict access to the cabinet. Two keys are provided for the door of the MDU to provide access to authorized personnel.

3.2 ANALOG OUTPUT CHANNELS (OPTION)

The output signals are continuous on the output connector and require no action by the operator. Up to three 1 - 5V analog output channels are optionally available to supply continuous analog recording. Each analog output signal results from an 8-bit digital-to-analog conversion process performed on the selected digital signal. The standard zero/span limits are factory set to 1 and 5V. These limits may be adjusted prior to shipment to 0 - 5 V upon request. To connect the analog output channels to a recording device, refer to the installation Section.

4 MAINTENANCE

The CM 1000 MONITOR has a low maintenance requirement. Maintenance intervals will be dictated by the cleanliness of the water supplied to the sample conditioning unit and by the cleanliness of the flue gas. To ensure reliable continuous operation, a maintenance timetable, general systems checks and maintenance procedures are included in this section.

4.1 MAINTENANCE TIMETABLE

4.1.1 WEEKLY

The operator should briefly inspect the MDU front panel display for normal function.

The operator should inspect the SCU to observe that:

- (i) the spray pattern of nozzle is uniform and conical.
- (ii) the water levels 1,2,3 in the SCU are appropriate (Figure 5-1)
- (iii) the water temperature at inlet fitting is cold to the touch and at least 10 degrees below ambient temperature.
- (iv) the top chamber of the SCU is free of condensate

4.1.2 SIX MONTHS

It is recommended that if the unit is equipped with electrochemical cells to measure gases other than O₂ that a reference gas calibration be performed on 6 months basis (see Maintenance procedures). If the burner is producing consistently high levels of these gases, more frequent calibration may be required. Replace SCU water filter cartridge.

4.1.3 YEARLY

It is recommended that the SCU nozzle be changed each year (more frequently if conditions warrant). Replace the SCU water filter cartridge. Replace the oxygen cell on a yearly basis. Replace CO and NO (option) cells on a 2 year basis.

4.1.4 GENERAL SYSTEM CHECKS

SCU NOZZLE SPRAY PATTERN CHECK

Check periodically that the water spray pattern below the nozzle has remained unchanged and that the water is spreading to contact the clear lexan tube at the bottom of the chamber.

SCU WATER LEVEL CHECKS

Check that the lower passageways are clear and that the spray water is discharging properly from the unit. The water level in the lower chamber will normally be 1 1/2 - 5 inches above the 1/2 -inch diameter discharge tube.

VISUAL SAMPLE LINE CHECKS

Check that the probe and sampling line are clear so as not to cause excessive negative pressure on the sampling line. Check periodically to ensure there are no leaks in the sampling lines or in the diaphragm of the pump.

SYSTEM LEAK CHECKS

To check for the absence of system leaks connect the sampling line to a gas cylinder simulating flue gas and containing 15.5% CO₂, 1% Argon, balance Nitrogen and monitor the oxygen reading. It should read essentially 00.0% O₂. Do not force the analyzed gas into the monitor. Allow it to be drawn in by the gas sampling pump through a Tee fitting in the supply line from the cylinder.

SCU SOLENOID VALVE CHECK

Check that the air passageway through the brass solenoid valve located behind the filter (at nozzle height) is clear. This can be done by watching the height of the water column in the gas sampling line where it enters the spray chamber during calibration. If the valve is opening fully and providing a clear air passage the water will rise in the sampling line to be visible above the elbow. If it does not, excessive flow resistance in the valve is indicated and it should be removed and cleaned.

4.2 SCU MAINTENANCE PROCEDURES

4.2.1 SCU FILTER CARTRIDGE REPLACEMENT

It is recommended that the water filter cartridge be replaced at least twice a year. Replacement cartridges are available from Dedesco or may be available from local suppliers. The cartridge is a P5 (Nominal 5 micron) 5" long Polypropylene Replacement Cartridge.

Replacement Procedure

- a. Obtain replacement filter cartridge from manufacturer
- b. Remove power to MDU
- c. Turn off water supply to SCU
- d. Remove SCU cover to allow access to filter
- e. Wait for the pressure to reduce. If the nozzle is blocked, open one of the filter connections to reduce the internal pressure
- f. Unscrew filter bowl, remove and wash bowl and O-ring
- g. Install new filter cartridge and re-attach filter bowl
- h. Turn on water supply to SCU and check for leaks around filter housing
- i. Replace SCU chassis cover and restore power to the MDU

Note: DO NOT USE SILICONE SEALANT ANYWHERE IN THE GAS SAMPLING SYSTEM. SILICONE VAPOURS WILL DAMAGE THE CATALYST ON THE CO/COMBUSTIBLES SENSORS TO THE POINT WHERE THEY WILL HAVE NEGLIGIBLE RESPONSE TO CARBON MONOXIDE.

4.2.2 SCU SPRAY NOZZLE REPLACEMENT

Nozzle replacement is recommended every two years but more frequent replacement may be necessary depending upon the condition and cleanliness of the water supply.

Procedure

- a. Obtain replacement nozzle from manufacturer
[IE5, 1.50 GAL, 30 degree solid spray]
- b. Remove power supply to MDU
- c. Turn off water supply to SCU
- d. Remove SCU cover
- e. Disconnect vacuum switch tubing at column tee
- f. Disconnect tube fitting on nozzle manifold leading to filter
- g. Disconnect hex bolts on bottom of SCU
- h. Tip column forward and disconnect tube fitting on rear of nozzle manifold
- i. Carefully separate upper part of column including nozzle manifold from spray chamber
- j. Remove nozzle and discard but keep O-ring
- k. Place O-ring on new nozzle and install
- l. Clean plastic tubes as required for visual checks
- m. Reassemble unit by reversing procedures
- n. Turn on water supply and check for proper operation
- o. Replace SCU cover and restore power to MDU

4.3 MDU MAINTENANCE PROCEDURES

4.3.1 ELECTROCHEMICAL CELL CALIBRATION

4.3.1.1 O₂ CELL CALIBRATION

The CM1000 automatically performs a zero and span correction of the oxygen measurement on room air every 2 hours and 16 minutes. If the SCU is sitting in an oxygen poor environment (ie. the room air contains less than 20.9% oxygen), there will be a loss of accuracy in the measurement of the oxygen content of the flue gas. To avoid this problem, ensure that the SCU has access to a 20.9% O₂ room air sample during its zero/span checks.

4.3.1.2 CO AND NO CELL CALIBRATION

Equipment Required

- a. Calibration gas cylinder with two stage gas regulator
(100-400 ppm CO nominal, balance Nitrogen)
(75-125 ppm NO nominal, balance Nitrogen)
- b. Flow regulating valve
- c. Flowmeter
- d. Tee connector
- e. Vinyl tubing of sufficient length to direct exhaust gas out of work area
- f. Small standard screwdriver (blade width 3/16" - 1/4")
- g. Key to monitor cabinet
- h. Figure 4-1 "Attachment of Sample Gas Cylinder to CM1000 System"
- i. Figure 4-2 "Electrochemical Cell and Calibration Circuitry"

---- WARNING ----

CARBON MONOXIDE IS A COLOURLESS, ODOURLESS, FLAMMABLE TOXIC GAS WITH A TLV OF 25 PPM (ACGIH 2002). IT SHOULD BE PROPERLY EXHAUSTED AWAY FROM THE WORK AREA

---- WARNING ----

NITRIC OXIDE IS A COLOURLESS, HIGHLY TOXIC GAS WHOSE ODOUR IS INSUFFICIENT TO PROVIDE ADEQUATE WARNING OF DANGEROUS CONDITIONS.

NO has a threshold limit (TLV) of 25 ppm (ACGIH 2002). For safe handling, the Material Safety Data Sheet should be carefully read and adhered to before proceeding with a gas calibration. All fittings and lines should be stainless steel due to the oxidizing nature of the gas.

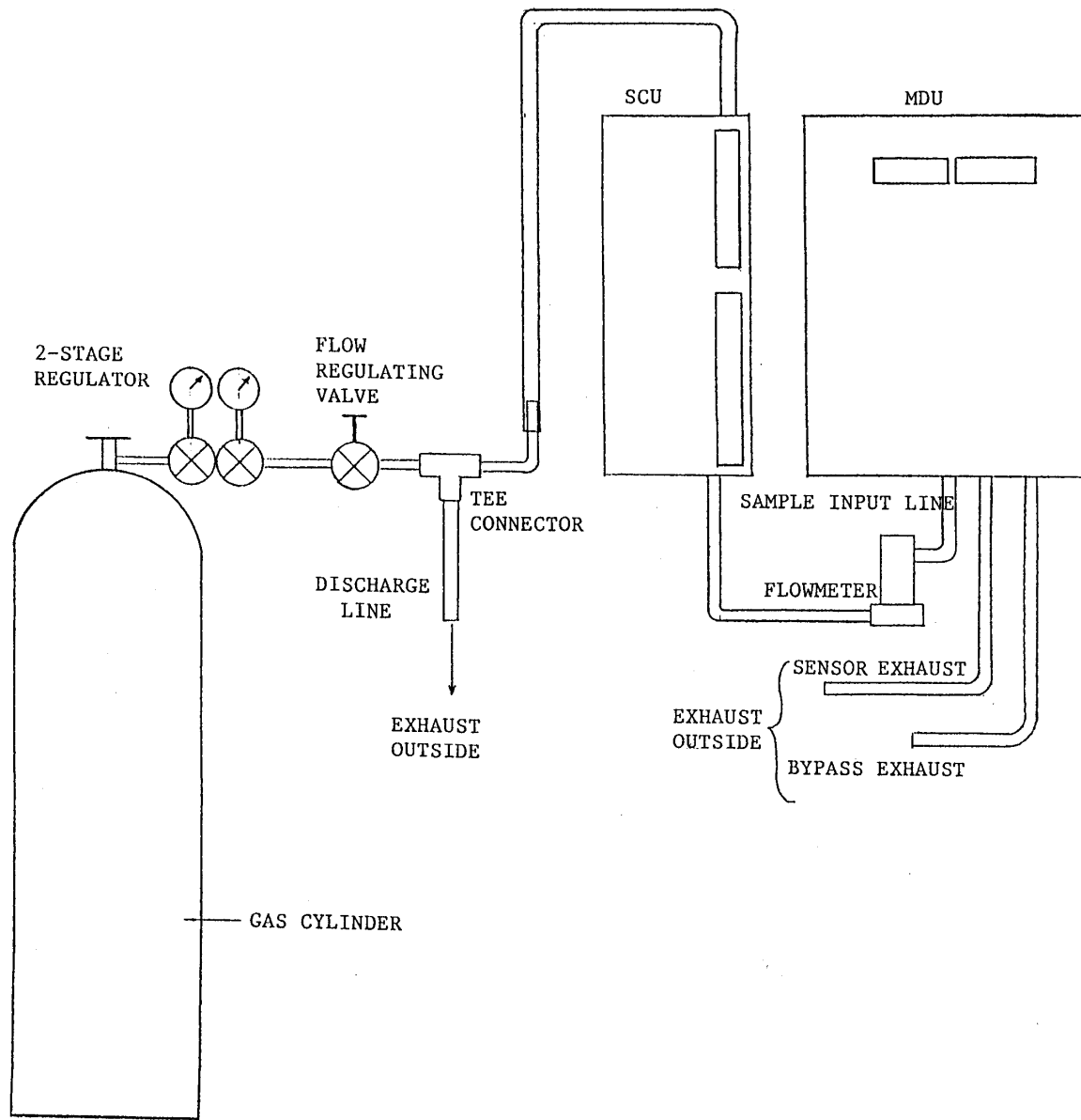


FIGURE 4-1 ATTACHMENT OF SAMPLE GAS CYLINDER TO CM1000 SYSTEM

Calibration Procedure

- a. Set up the gas sample equipment as shown in Figure 4-1 but do not connect the sample conditioning incoming line to the TEE fitting.
- b. Check the pump flowrate using the flowmeter in the sample line between the SCU and MDU. It should indicate a flowrate in the range of 2.5 - 4 Lpm. A low reading indicates possible blockage in the system ahead of the pump or a malfunction in the pump. Check and remedy this problem if necessary before continuing.
- c. Remove the flowmeter from the test circuit and connect the SCU sample line directly to the MDU.
- d. Connect the flowmeter to the discharge line of the TEE connector to read outward flow at this point.
- e. Press the RESET button on the MDU to establish the zero and prevent the monitor from entering the autozero process during the gas calibration. This takes 2 minutes to complete.
- f. After the zero cycle close the, flow regulating valve and adjust the gas cylinder regulator to between 2 and 5 psig.
- g. Connect the free side of the TEE connector to the SCU input line and slowly open the flow regulating valve until a very low outward flow is indicated by the flowmeter. This means that the monitor's pump will be just drawing its normal flowrate and there will be no air intake at the TEE connection.
- h. Open the door of the MDU and locate the correct gain adjust (calibration) potentiometer from the label located inside the front door (or from Figure 4-2).
- i. Continue to run the analyzed sample gas until a steady reading is obtained on the CM1000 display. Proceed with the calibration when the displayed value has remained steady for about 2 minutes.
- j. Adjust the correct gain (calibration) pot to obtain a displayed value which agrees with the content of the bottled calibration gas:

To INCREASE the gain of the circuit (which will INCREASE the displayed gas value) turn the pot adjustment screw CLOCKWISE.

Turning the screw 1/4 turn will change the displayed value by approximately 8 ppm.

NOTE: This potentiometer will also provide the range of adjustment required when a new cell must be installed in the unit. DO NOT ADJUST ANY OTHER POTENTIOMETERS.

- k. Remove the calibration equipment and reconnect the sample line from the SCU to the flue.
- l. Close and lock the MDU.

4.3.2 ANALOG OUTPUT CHANNEL ADJUSTMENT (Option)

Up to three analog output channels are available. Connections to access the analog output channels are located on the lower right hand connector E7 (Figure 2-2) inside the MDU on position 22 (common) and another selected position for the gas or variable selected.

The standard output voltage span is 1-5V DC corresponding to normal sensor ranges. Factory adjustments can be made upon request to set a 0-5V DC span for normal spans or portions thereof.

TABLE 4-1 Analog Channel Designations

ANALOG CHANNELS										
SENSOR		Reference Figure 4-2								Reference Figure 2-2
Channel	Normal Signal Span	Output Voltage Span	V-Min Adjust Pot	Direction to Increase Limit	V-Max Adjust Pot	Direction to Increase Limit	V-Min Adjust Pot	Direction to Increase Limit	Connector Output E7	
O2	1 0-20.9%	1-5 VDC	P11	CW	P12	CCW			19 Signal 22 Common	
CO	3 0-2000 PPM	1-5 VDC	P15	CW	P16	CCW			21 Signal 22 Common	
NO	1 or 2 0-1000 PPM	1-5 VDC	P11 P13	CW	P12 P14	CCW			19 Signal 20 Signal 22 Common 22 Common	
Option	1 or 2 0-1000 PPM	1-5 VDC	P11 P13	CW	P12 P14	CCW			19 Signal 20 Signal 22 Common 22 Common	
T	2 0-1275 F	1-5 VDC	P13	CW	P14	CCW			20 Signal 22 Common	

ANALOG V-min-ADJUST POTENTIOMETERS

These pots are used to establish the lower output voltage limit of the range and must be adjusted when the monitor is displaying the value that is to be the lower desired limit. Since this adjustment will offset the entire range, the V-max adjustment must be corrected after any V-min adjustment.

CLOCKWISE (CW) adjustment INCREASES the lower voltage limit.

ANALOG V-max - ADJUST POTENTIOMETER

These pots are used to establish the upper voltage limit of the range and must be adjusted when the monitor is displaying the value that is to be the upper limit. For this reason the limit is factory set to the user's requirements and is not considered to be field adjustable. Adjusting the V-max limit does not affect the V-min setting.

COUNTERCLOCKWISE (CCW) adjustment INCREASES the upper voltage limit.

Table 4-1 summarizes the standard sensor signal and analog output voltage spans. The V-min and V-max adjust potentiometer designations are listed along with output connector positions for each sensed value.

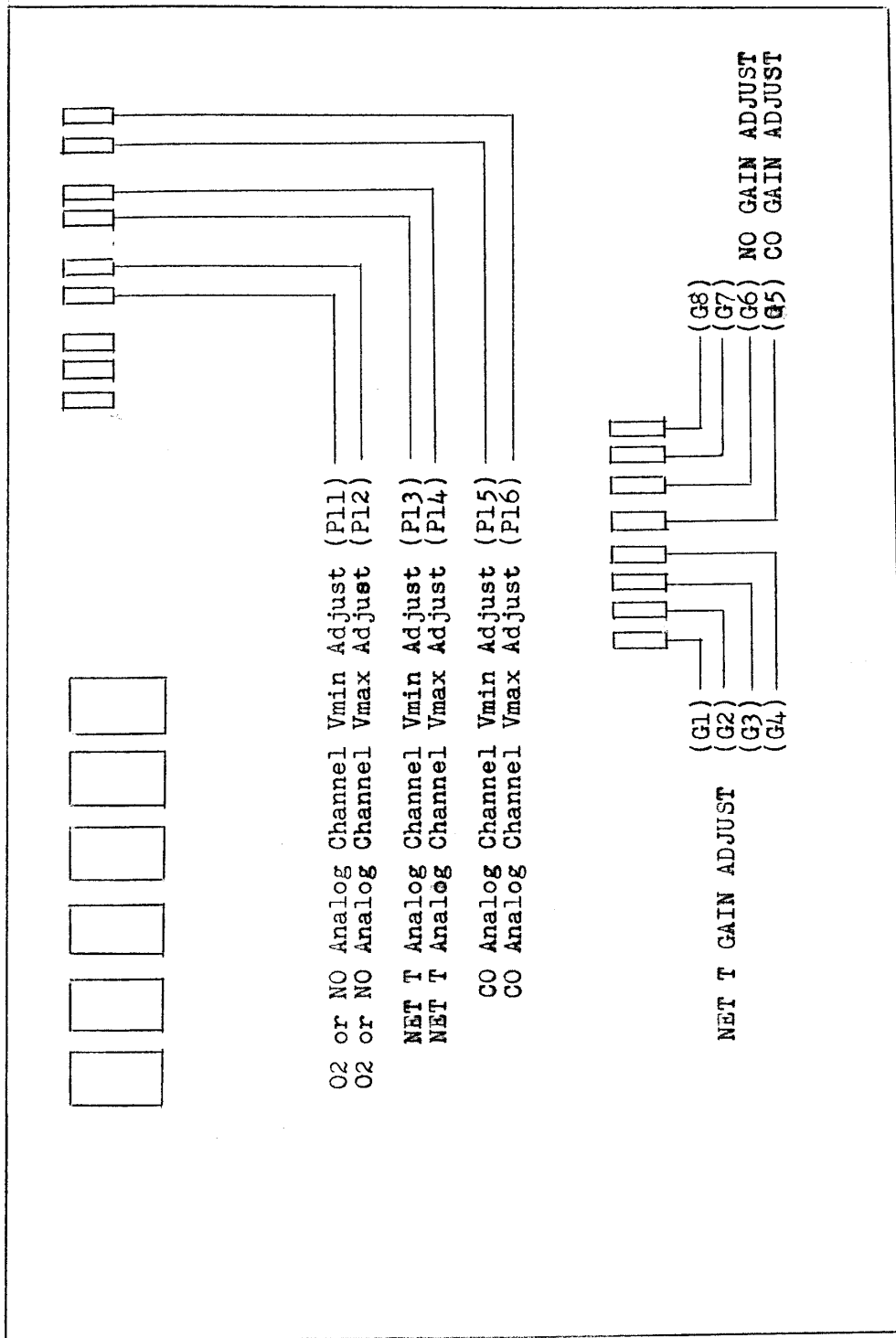


FIGURE 4 - 2 ELECTROCHEMICAL CELL & CALIBRATION CIRCUITRY

4.3.3 ELECTROCHEMICAL CELL REPLACEMENT

4.3.3.1 O2 CELL REPLACEMENT

Equipment Required

- a. New O2 cell
- b. Small Phillips screwdriver
- c. Figure 4-2: Electrochemical Cell & Calibration Circuitry

Replacement Procedure

- a. Locate the O2 cell using Figure 4-2.
- b. Remove the 4 #6 Phillips screws which secure the cap of the gas chamber containing the O2 cell
- c. Remove the cap and the black- foam seal which sits on top of the O2 cell
- d. Remove the 2 #4 Phillips screws which secure the cell to the gas chamber and take the old cell out
- e. Place the new cell carefully into the gas chamber. Make sure that the two tabs are seated properly.
- f. Replace the two cell mounting screws and snug them up evenly being careful not to overtighten them as this can strip the threads in the cell mount or damage the sensor.

Note: Do not twist the tabs on the cell as this may cause internal breakage in the cell.

- g. Install new black foam seal with cutout over the red tab on the O2 cell
- h. Replace the gas chamber cap and the four screws which secure it. Do not overtighten the screws.

---- CAUTION ----

The sensor contains a small amount of mineral acid. If there is any leakage, flush the contaminated parts with water and handle the old cell with care, ensuring that the contents do not get on hands or material that would be damaged.

4.3.3.2 CO AND NO CELL REPLACEMENT

Calibration must be carried out following the replacement of a CO or NO electrochemical cell.

Equipment Required

- a. New electrochemical cell
- b. Small standard screwdriver (blade width 3/16" - 1/4")
- c. Figure 4-2: Electrochemical Cell & Calibration Circuitry
- d. Soldering iron
- e. Wire strippers

Replacement Procedure

- a. Locate the correct electrochemical cell using Figure 4-2
- b. Unsolder the three signal wires from the cell's solder tabs
- c. Remove the 3 screws which secure the cell to its gas chamber
- d. Remove the cell being careful not to lose the small O-ring and filter which fit between the sensor and the gas chamber
- e. Place the filter, with its Teflon side up, back on top of the gas chamber. Place the O-ring on the filter making sure they are both centered
- f. Place the new cell on top with the same orientation
- g. Replace the mounting screws and snug them evenly being careful not to over-tighten them as this can strip the threads in the cell mount or damage the cell
- h. Resolder the three signal wires to the appropriate cell tabs on the cell.

Note: Do not twist the tabs on the cell as this may cause internal breakage in the cell.

---- CAUTION ----

The sensor contains a small amount of mineral acid. If there is any leakage, flush the contaminated parts with water and handle the old cell with care, ensuring that the contents do not get on hands or material that would be damaged.

5 TROUBLESHOOTING

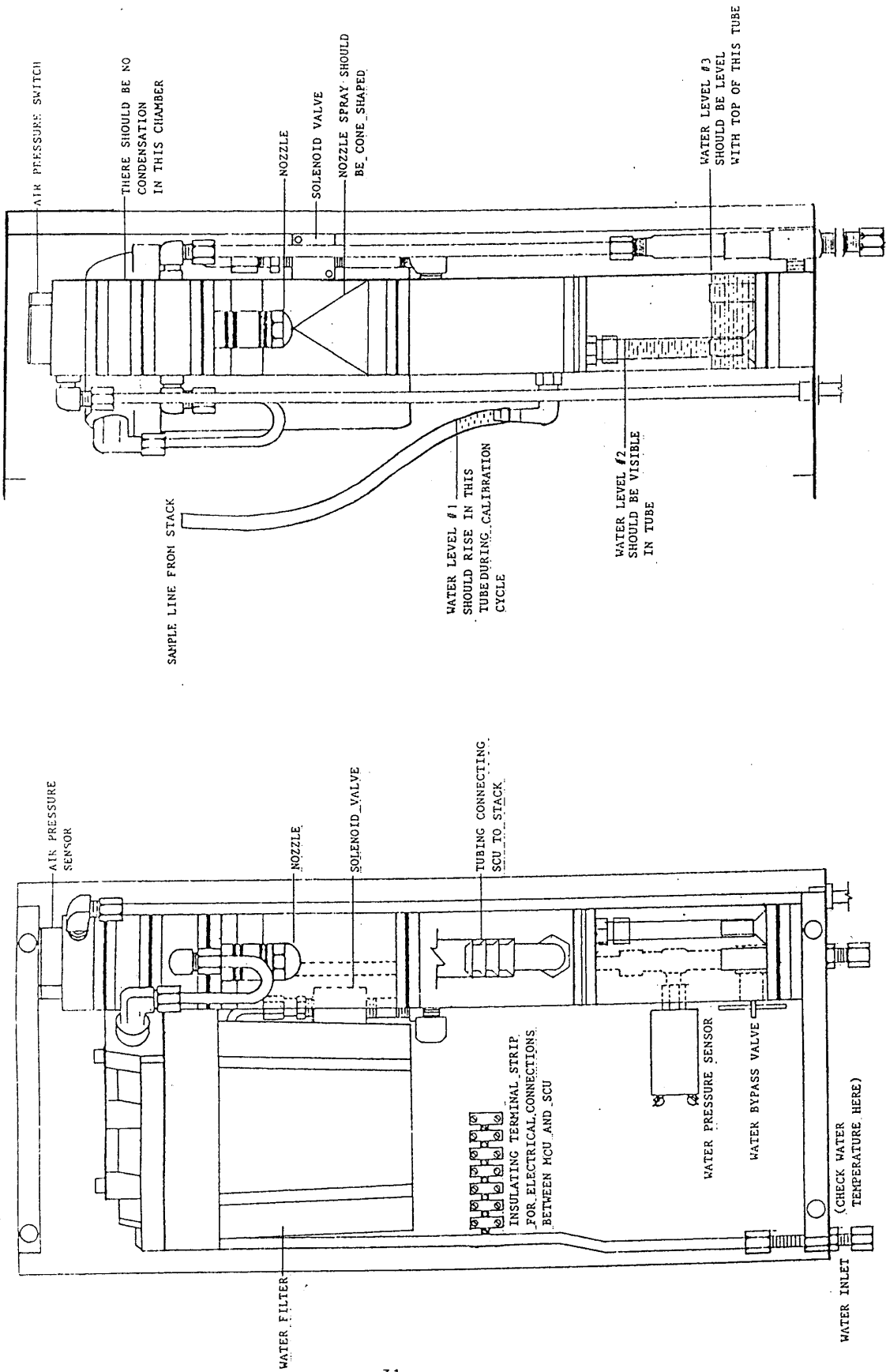
5.1 SCU TROUBLESHOOTING

Table 5-1 summarizes problems which may be observed in the SCU, and lists the possible causes and remedies. See Figure 5-1 for water levels and location of components.

TABLE 5-1 SCU Troubleshooting Summary

Observation	Cause	Remedy
Nozzle spray not conical	Nozzle Blockage	Replace Nozzle
Condensation in upper chamber of SCU column	Water temperature too high	Open bypass valve to increase flowrate And to reduce water temperature
Water level #2 too high	Increased probe resistance due to blockage	Remove sample line at elbow in SCU; if water level drops to normal, blockage is between stack and SCU; clear blockage
Water level #2 not rising in tube	Blockage between SCU and MDU Pump not operating properly	Clear blockage or replace sample line between SCU and MDU Check that flowrate through pump is < 3 Lpm
Water level #3 too high	Water bypass flow too high Drain line blocked	Reduce the bypass flow by partially closing the bypass valve (clockwise) Clear drain line
Water level #1 not rising during CAL cycle	Solenoid valve plugged	Clean solenoid valve

FIGURE 5.1 SAMPLE CONDITIONING UNIT, COVER REMOVED



5.2 MDU TROUBLESHOOTING

5.2.1 SAMPLING ERRORS

The sampling error LED will light for any of the following system errors: H2O Err, AIR Err, O2 Err, CO Err and NO Err. The specific fault is indicated by the 6-digit display. They are related to sampling. The possible causes and corresponding corrective actions which may be taken by the operator are summarized in Table 5-2 and described in more detail below.

H2O Err

Since correct water spray in the unit is essential to the proper operation of the SCU the water pressure is monitored by the system. In the event that the water pressure drops below 40 psi the control unit will turn off the pump, light the LED on the front panel signifying Sampling Error and display H2O Err on the display. Once the water pressure again exceeds 40 psi the fault indications will clear and the unit will automatically, resume normal operation.

AIR Err

Excessive flow resistance or blockage in the probe sampling line would cause the water trap to back up and air and water would be drawn into the system. Hence the negative pressure in the chamber is monitored with a vacuum switch located on the top of the SCU wash unit. Should the probe sampling line block sufficiently to restrict flow, the water trap will reverse and water will flow upwards into the spray chamber. A plastic poppet valve in the bottom of the 1/2 inch acrylic drain will provide resistance to this reversed flow. The excessive negative pressure in the top chamber will be detected by the vacuum switch and the sample pump in the MDU will shut down. The Sampling Fault LED will light and the display will show AIR Err. When the blockage has been cleared, power to the MDU must be disconnected and reconnected for this fault indication to clear and for the unit to resume normal operation.

O2, CO, NO Err

In the event that a sensor fails open-circuit (due to a broken or burned sensor wire for example) the condition will automatically be recognized by the circuitry. The error will be indicated in the main display as O2 Err or CO Err or NO Err as appropriate. The display will alternate showing the fault followed by a measurement display.

TABLE 5-2 Sampling Errors - Causes and Remedies

ERROR	Cause	Remedy
H2O Err	Main water supply turned off Bypass flow rate too high Main water pressure below 40 psi Filter blocked Leak or break in water supply line	Turn main water supply on Close down bypass valve on SCU Correct supply pressure Replace filter cartridge Repair line
AIR Err	Probe blockage Sample line blockage between probe and SCU	Disconnect sample line, remove probe, clean and reinstall Disconnect and clean or replace
O2/CO/NO Err	Broken wire Sensor failure O2/CO/NO circuit malfunction	Replace or resolder wire Contact manufacturer for replacement Contact manufacturer

5.2.2 ABNORMAL DISPLAY

BLANK DISPLAY

The possible causes of a blank MDU display are listed below.

TABLE 5-3 Blank MDU Display - Causes and Remedies

Cause	Remedy
Power supply to unit	Ensure unit is plugged in
Main power failure	Check power at mains
Fuse blown	Replace fuse
Board electronics	Contact manufacturer

IRREGULAR DISPLAY

If the display appears "frozen" or is displaying irregular values, first try resetting the system by briefly disconnecting power from the unit and then reconnecting it. If this does not restore normal operation, contact the manufacturer.

SENSOR MALFUNCTION

The display may be responding to erroneous sensor information due to a problem with the sensor itself or leakage in the sample line. A calibration should be performed using analyzed gas to confirm possible incorrect sensor response. Table 5-4 lists possible causes of abnormal response and suggested remedies. If a calibration is not readily performed, then Table 5-4 may be used directly to troubleshoot the problem.

TABLE 5-4 Sensor/Display Response Troubleshooting

Cause	Remedy
Break in sample line between stack and MDU	Repair sample line
Pump failure	Check flow rate through pump. Contact manufacturer for replacement
Broken sensor connection	Check solder connection
Sensor requires replacement	Contact manufacturer for replacement cell
Board electronics	Contact manufacturer

5.2.3 MDU FUSE REPLACEMENT

Procedure

- a. Obtain replacement fuse (3AGC – 1 amp - 250V)
- b. Disconnect power to unit
- c. Locate fuseholder on bottom of MDU chassis (see Figure 2-1)
- d. Remove fuseholder knob and fuse and replace fuse
- e. Reconnect power to unit

6 APPENDICES

APPENDIX A

CM1000 SPECIFICATIONS

Measurement Range	Oxygen	0-20.9%
	CO (electrochemical cell)	0-1999 ppm
	CO/combustibles .000 -.100% (Combustibles readings to 3%) (optional)	(1000 ppm)
	Net Stack Temperature	0-999 deg. F or C
Resolution	Oxygen	.1%
	Net Stack Temperature	1 degree F or C
	CO/combustibles(option)	.005% (50 ppm)
	CO (electrochemical cell)	1 ppm
Calibration	Oxygen measurement calibrated automatically on room air	
	CO, NO, CO/combustibles calibrated on analyzed gas	
	All parameters automatically zeroed	
Ambient Operating Temperature	32 - 120 deg. F	0 - 50 deg. C
Power	115/120 volts	1 Amp
Fuse Rating	1 Amp 250V	

**APPENDIX A
(continued)**

Size	Measurement Unit	
	13.5" W x 18.5" H x 5.75" D 343mm W x 470mm H x 146mm D	
	Sample Conditioning Unit	
	8.0" W x 21.5" H x 6.0" D 203mm W x 546mm H x 153mm D	
Weight	Measurement Unit	22 lbs. (10 Kg.)
	Sample Conditioning Unit	10 lbs. (4.5 Kg.)
Outputs	RS232C Compatible Serial Port	
	High CO Alarm contact closure	
	Three 1-5V analog output channels (Optional)	
	Oxygen Carbon Monoxide Temperature Nitric Oxide CO/Combustibles	

CERTIFICATIONS

As of January 1990, the Combustion Monitor Model CM1000 has CSA approval as indicated on the nameplate located on the bottom face of the MDU enclosure.

APPENDIX B

ELECTROCHEMICAL CELL SPECIFICATIONS

02 Measurement	Measurement range	0 - 20.9%
	Sensitivity	.1%
	Calibration	room air (20.90/o)
	Lifetime	6 mos - 1 year
	Storage life in CTL container under dry conditions at 0-20 Celsius (off load)	6 months
CO Measurement	Measurement range	0 - 2000 ppm
	Sensitivity	1 ppm
	Calibration	analyzed gas
	Lifetime	1 1/2 - 2 years
	Storage life in CTL container under dry conditions at 0-20 Celsius (off load)	6 months
NO Measurement	Measurement range	0 - 1000 ppm
	Sensitivity	1 ppm
	Calibration	analyzed gas
	Lifetime	1 1/2 - 2 years
	Storage life in CTL container under dry conditions at 0-20 Celsius (off load)	6 months

APPENDIX C

WARRANTY

This instrument is warranted against defects in material and workmanship for a period of six months after date of purchase by original purchaser. R A B Dedesco Ltd. agrees to repair or replace any assembly or component found to be defective, under normal use, during this period. R A B Dedesco's obligation under this warranty is limited solely to repairing any such instrument which in R A B Dedesco's sole opinion proves to be defective within the scope of the warranty when returned to the factory.

Transportation to the factory is to be prepaid by the purchaser. Shipment should not be made without prior authorization by R A B Dedesco Ltd.

This warranty does not apply to any products repaired or altered by persons not authorized by R A B Dedesco Ltd., or not in accordance: with instructions furnished by R A B Dedesco Ltd. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at standard rates. R A B Dedesco's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for R A B Dedesco Ltd. any liability in connection with the sales of our products other than set forth herein.

When returning an instrument ship prepaid to:

QEL / Dedesco Ltd.
5935 OTTAWA STREET, P.O. BOX 749, RICHMOND, ONTARIO KOA 2Z0
PHONE: (613) 838-4005, FAX: (613) 838-4018
www.QELsafety.com

APPENDIX D

OPERATOR MAINTENANCE RECORD

MODEL: CM1000

SERIAL NUMBER:

INSTALLATION DATE:

DATE	UNIT / ASSEMBLY	MAINTENANCE PERFORMED	PERFORMED BY