ENMET Corporation
PO Box 979
Ann Arbor, MI 48106-0979

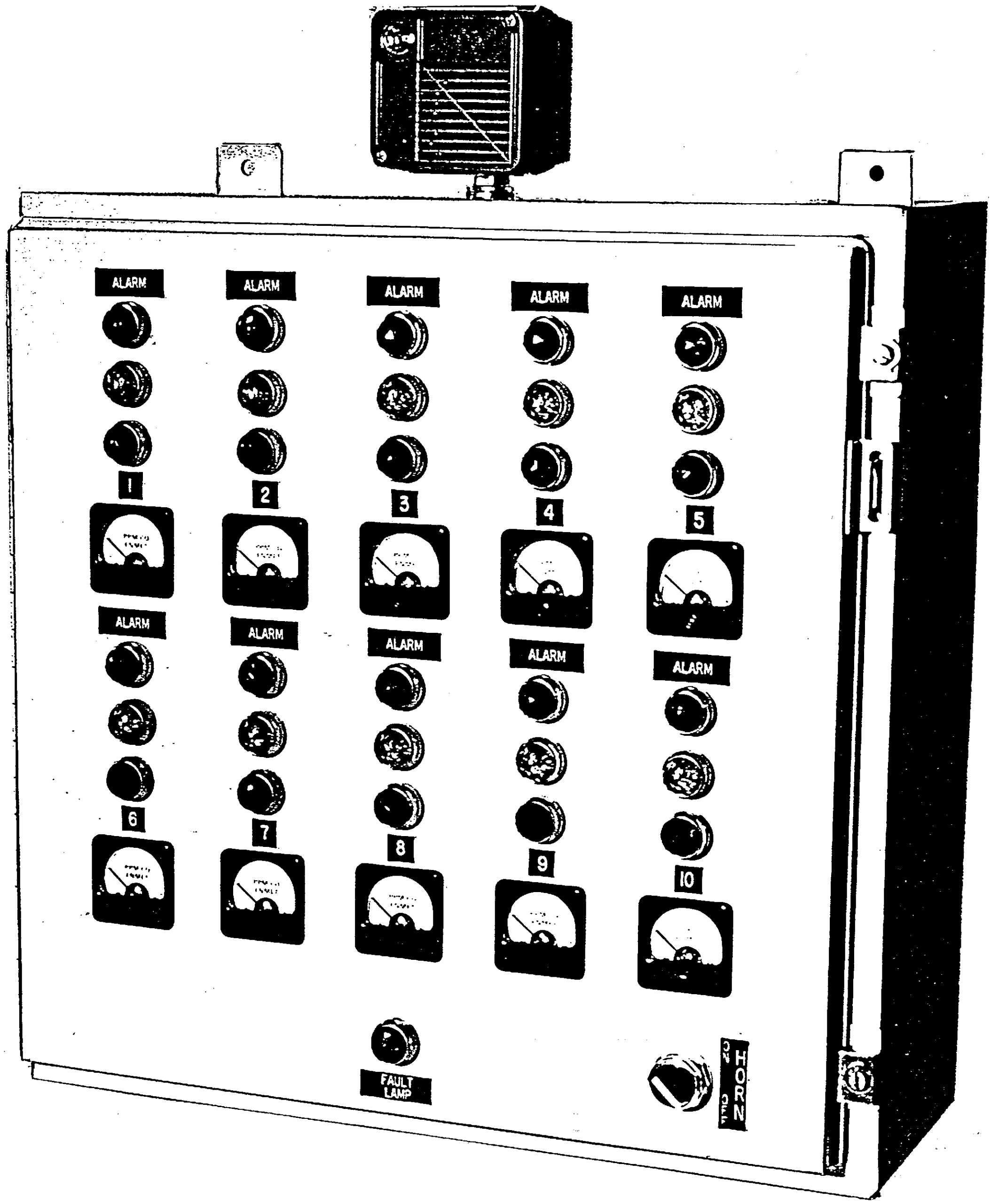
ISA – 44
Wall – Mounted
Gas Detection
System

80003-006
11-04-92
MCN 146, 5-22-95
MCN 196, 7-17-98
MCN 204, 10-20-98
MCN 206, 12-21-98

TABLE OF CONTENTS

FIGURES, ILLUSTRATIONS

FIGURE 1: ISA-44 CONTROL UNIT, EXTERNAL FEATURES



ISA-44 systems are supplied in NEMA-12 steel enclosures capable of holding either five channels or ten channels. A ten channel equipment is shown.

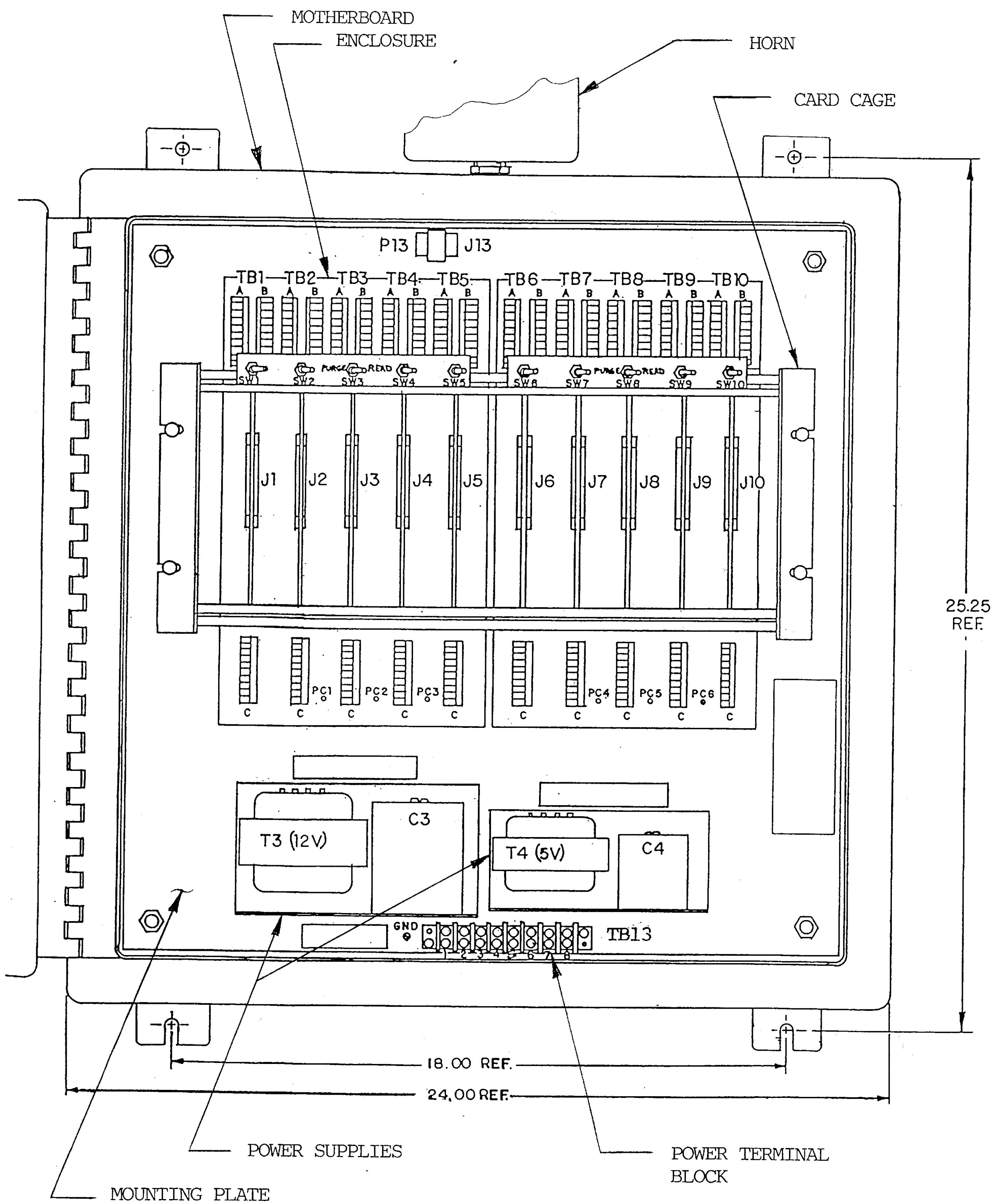


FIGURE 2a) CONTROL, SHOWING MAJOR INTERNAL COMPONENTS

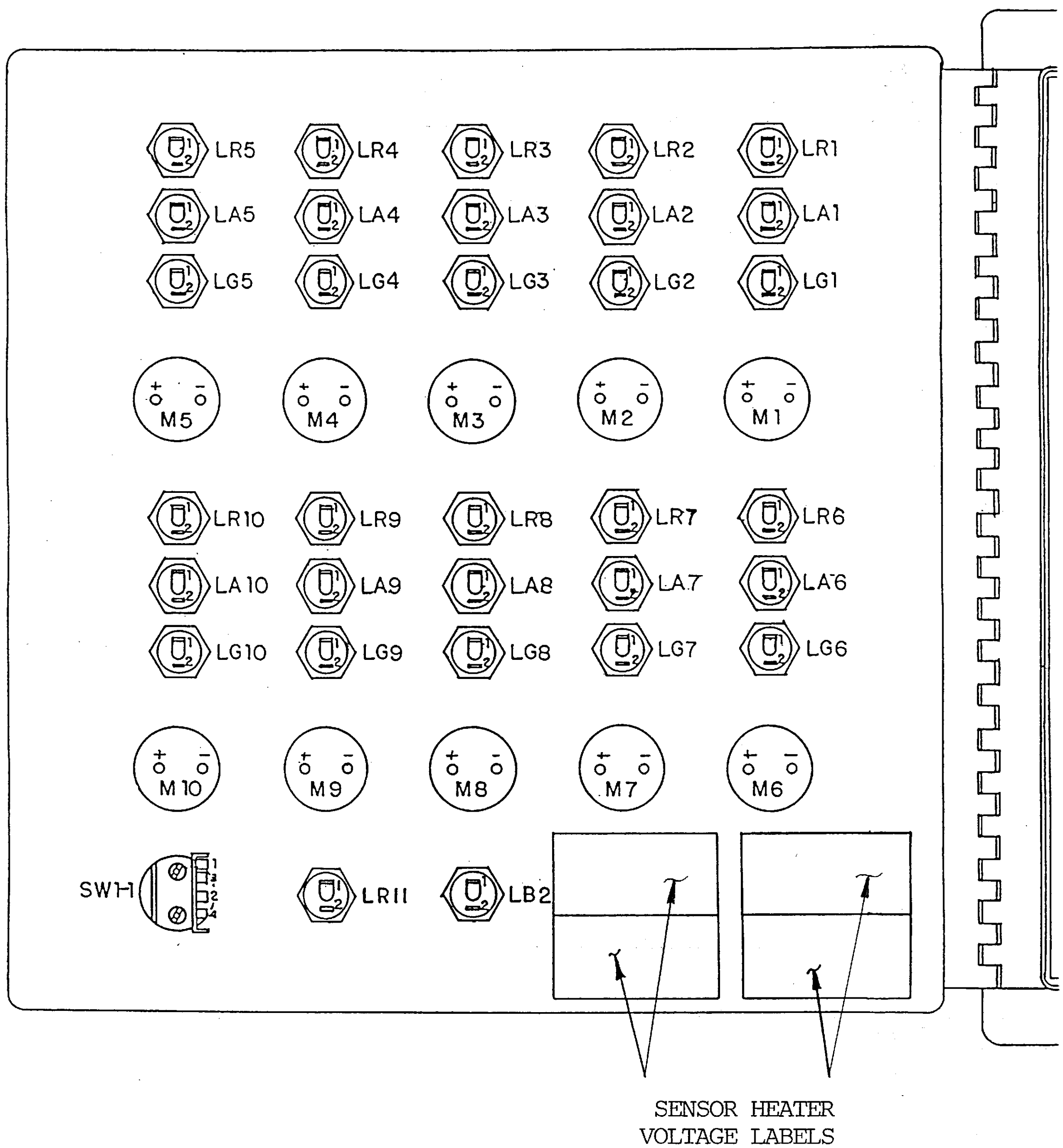
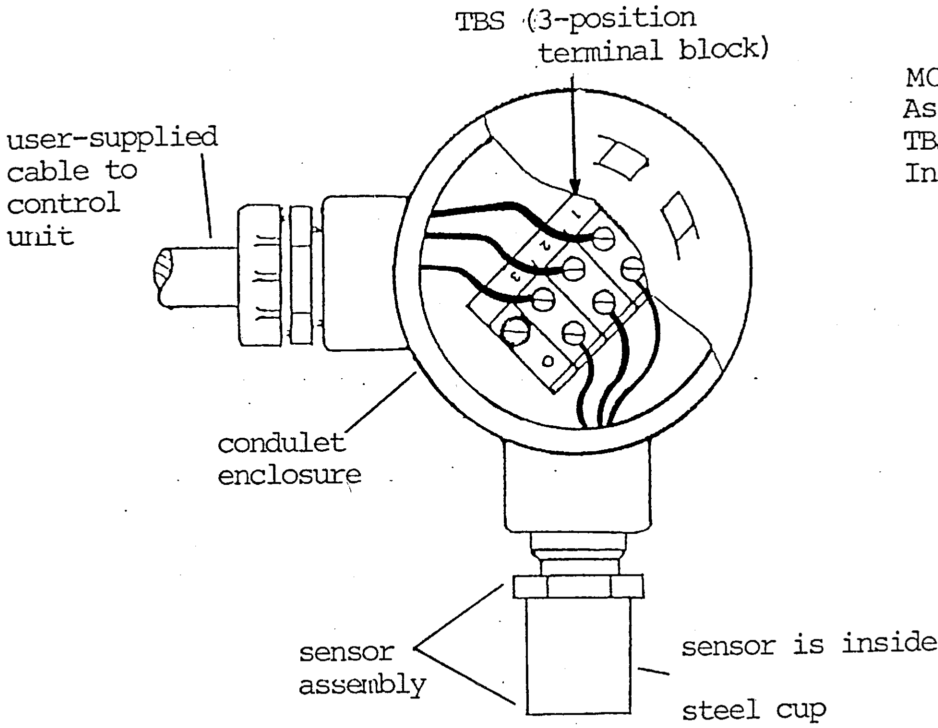
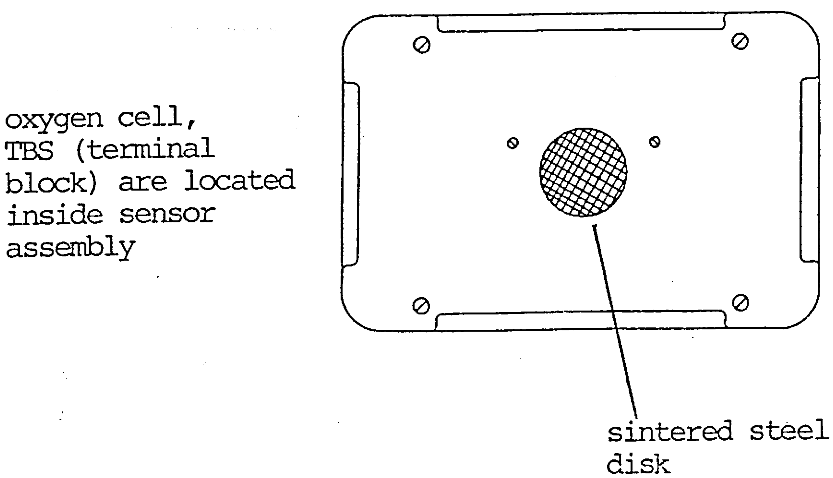


FIGURE 2b: CONTROL, BACK
OF FRONT COVER

FIGURE 3: MOS Sensor and Oxygen Sensor Assemblies Outlined



MOS Sensor Assembly Showing TBS (terminal block) Inside Condulet Enclosure



Oxygen Sensor Assembly

IMPORTANT: This assembly, as shipped from the factory, not approved for use in combustible atmospheres unless system is fitted with intrinsic safety barriers.

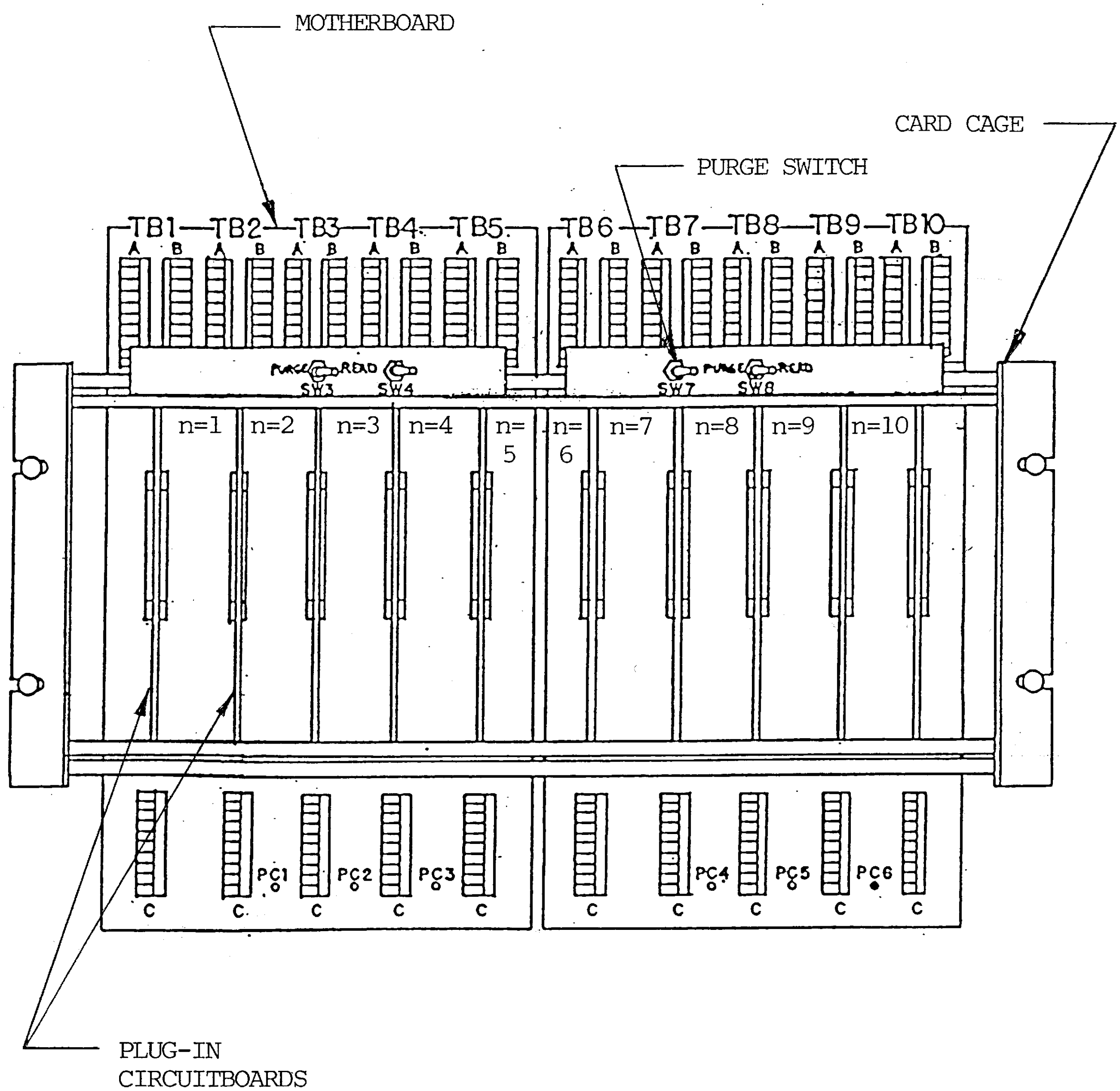


FIGURE 4: ISA-44 SYSTEM WIRING FEATURES

WIRING TABLE

Use in Conjunction with Figure 4

1.0 Power: Both single phase 110VAC, or single phase 220VAC, and + 12 VDC backup power are connected to TB13, the terminal strip at the bottom center of the unit, as follows:

Position	Power Connection
TB13-1	A.C. Ground
TB13-2	A.C. High
TB13-3	A.C. Neutral
TB13-4	+ 12 VDC
TB13-5	D.C. Ground

2.0 Three terminal strips, designated TB(n)-A, TB(n)-B, and TB(n)-C, are associated with each plug-in circuitboard position, as shown in Figure 4. Relay contact positions, NC, NO, and Common, are given below for the unpowered condition, which is identical to the alarm condition.

2.1 Gas Detection Channel: There is one channel of gas detection per plug-in circuitboard. The gas sensor and relay connection positions are given below, where "n" is the plug-in circuitboard position number:

```
                TB(n)   - C1
                   |      ||
Board -------------|      |L--------------- connection
position                  |                 identifier
identifier                |
                          L---------------- terminal strip
                                            identifier
```

Position	Connection
TB(n)-C1	Low alarm relay, NC
TB(n)-C2	Low alarm relay, NO
TB(n)-C3	Low alarm relay, Common
TB(n)-C4	High alarm relay, NC
TB(n)-C5	High alarm relay, NO
TB(n)-C6	High alarm relay, Common
TB(n)-C7	
TB(n)-C8	Sensor Signal
TB(n)-C9	Sensor Heater
TB(n)-C10	Sensor Ground

2.2 Oxygen Deficiency Detection Channels, without Intrinsic Safety Barriers: When single alarm oxygen deficiency channels are supplied without intrinsic safety barriers, connections are also to the TB(n)-terminal strips. In this case, there is room for two channels of oxygen deficiency detection on one plug-in circuit board, and there may be either one or two channels depending on the system configuration. Designating the two channels on a board in position "n" as channel "M" and channel "M + 1," the connections are:

for channel "M":

Position	Connection
TB(n)-A3	Oxygen cell -
TB(n)-A4	Oxygen cell +
TB(n)-C4	Relay, NC
TB(n)-C5	Relay, NO
TB(n)-C6	Relay, Common

for the second channel, "M + 1," if used:

Position	Connection
TB(n)-A8	Oxygen cell -
TB(n)-A9	Oxygen cell +
TB(n)-C1	Relay, NC
TB(n)-C2	Relay, NO
TB(n)-C3	Relay, Common

2.3 Oxygen Deficiency Detection Channels with Intrinsic Safety Barriers: The relay connection positions are the same as in 2.2, above, or 2.4, below. Connect the oxygen cell leads directly to the associated intrinsic safety barrier as shown in Figure 12.

2.4 Dual Alarm Oxygen Detection Channels: There is one plug-in circuitboard and three associated TB(n)- terminal strips per channel of dual alarm oxygen detection circuitry. If intrinsic safety barriers are not supplied, the oxygen sensor connections for each circuitboard position are:

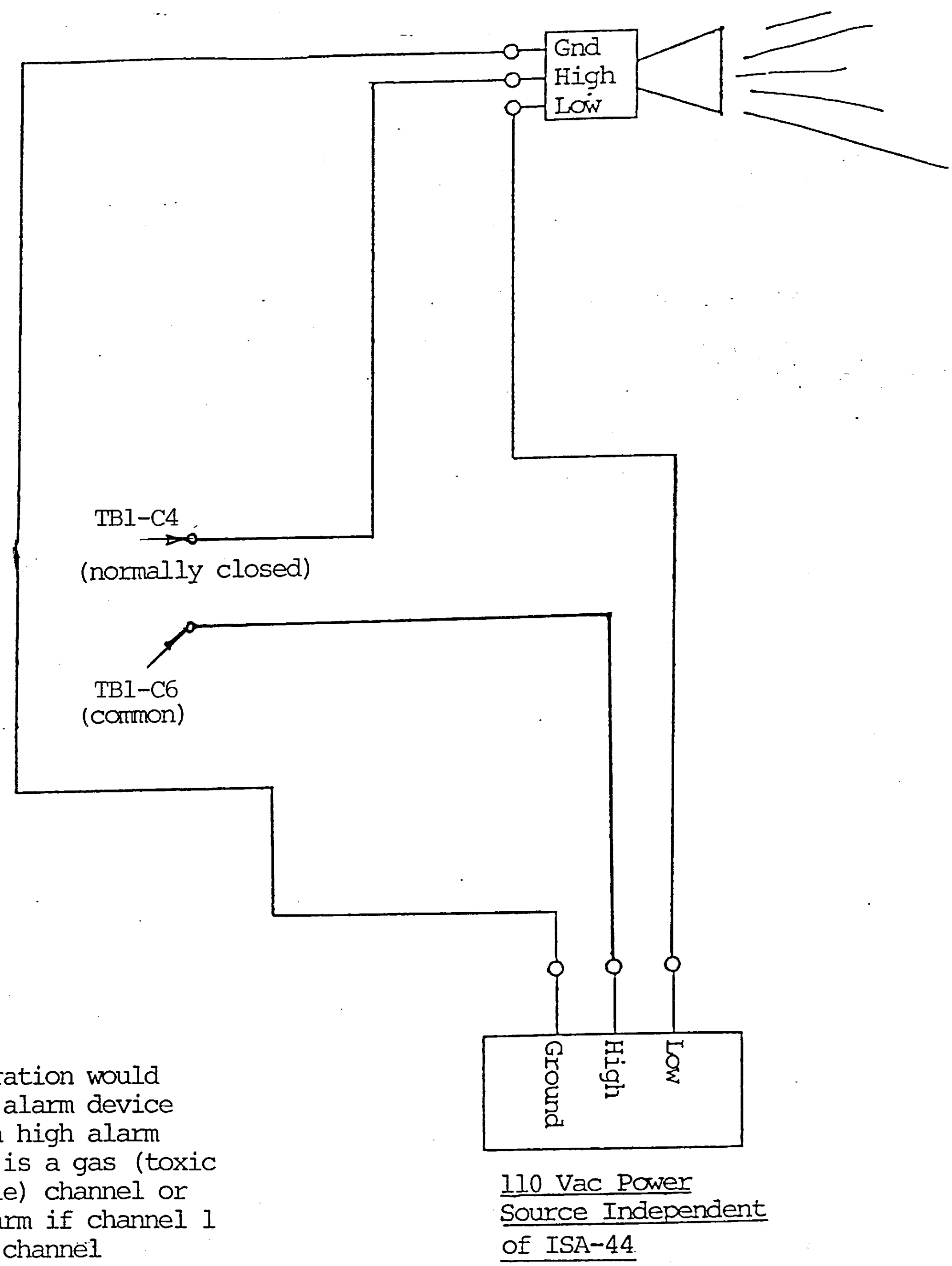
Position	Connection
TB(n)-A3	Oxygen cell -
TB(n)-A4	Oxygen cell +

Alarm configuration may be one of three options, dual low, high-low, or dual high. This nomenclature describes the setting of the alarms relative to the operating point of the monitor, 20.9% oxygen in fresh air for an area monitor, for example. A channel with dual low alarms might have alarm settings at 19.5% for the low alarm and 17.0% for the low-low alarm. Relay contact positions are as follows:

<u>Alarm Configuration</u>

dual low	high-low	dual high	Position	Contact
low-low	high	high-high	TB(n)-C1	NC
low-low	high	high-high	TB(n)-C2	NO
low-low	high	high-high	TB(n)-C3	Common
low	low	high	TB(n)-C4	NC
low	low	high	TB(n)-C5	NO
low	low	high	TB(n)-C6	Common

FIGURE 5: Possible Wiring Configuration for Activating Remote Auxiliary User-Supplied Alarm Using Relay Contacts At Control Unit for Channel 1*



* This configuration would activate the alarm device in event of a high alarm if channel 1 is a gas (toxic or combustible) channel or an oxygen alarm if channel 1 is an oxygen channel

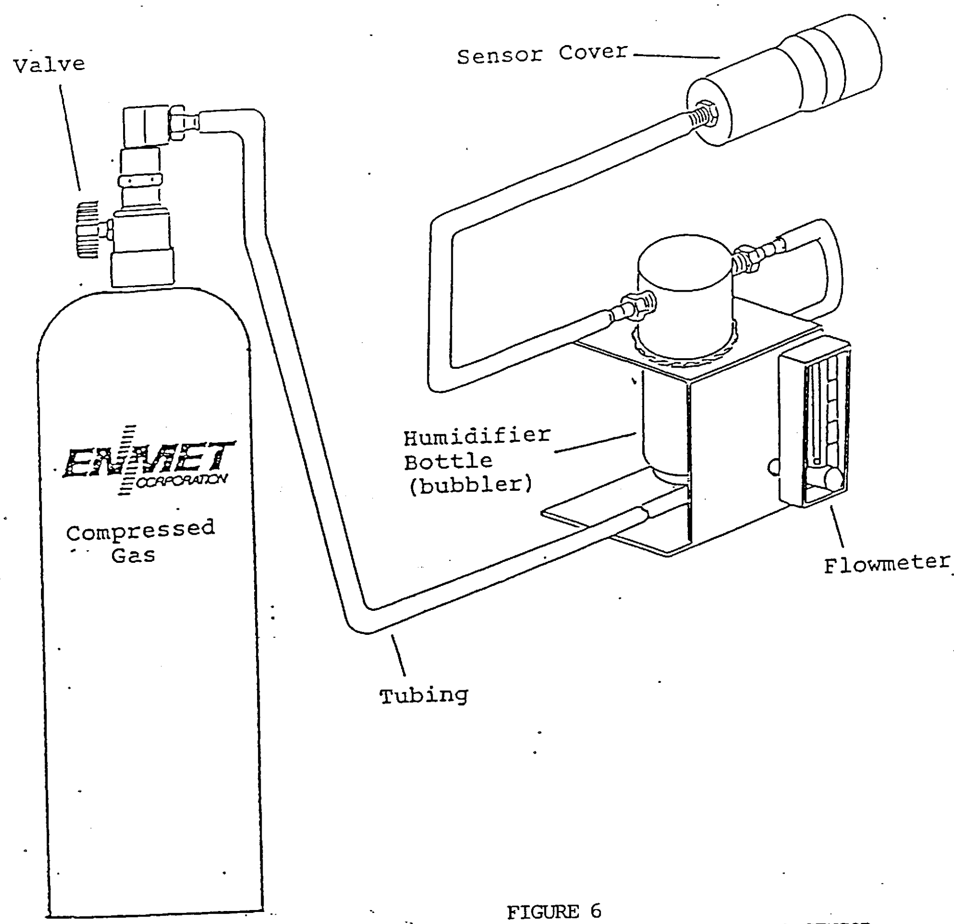
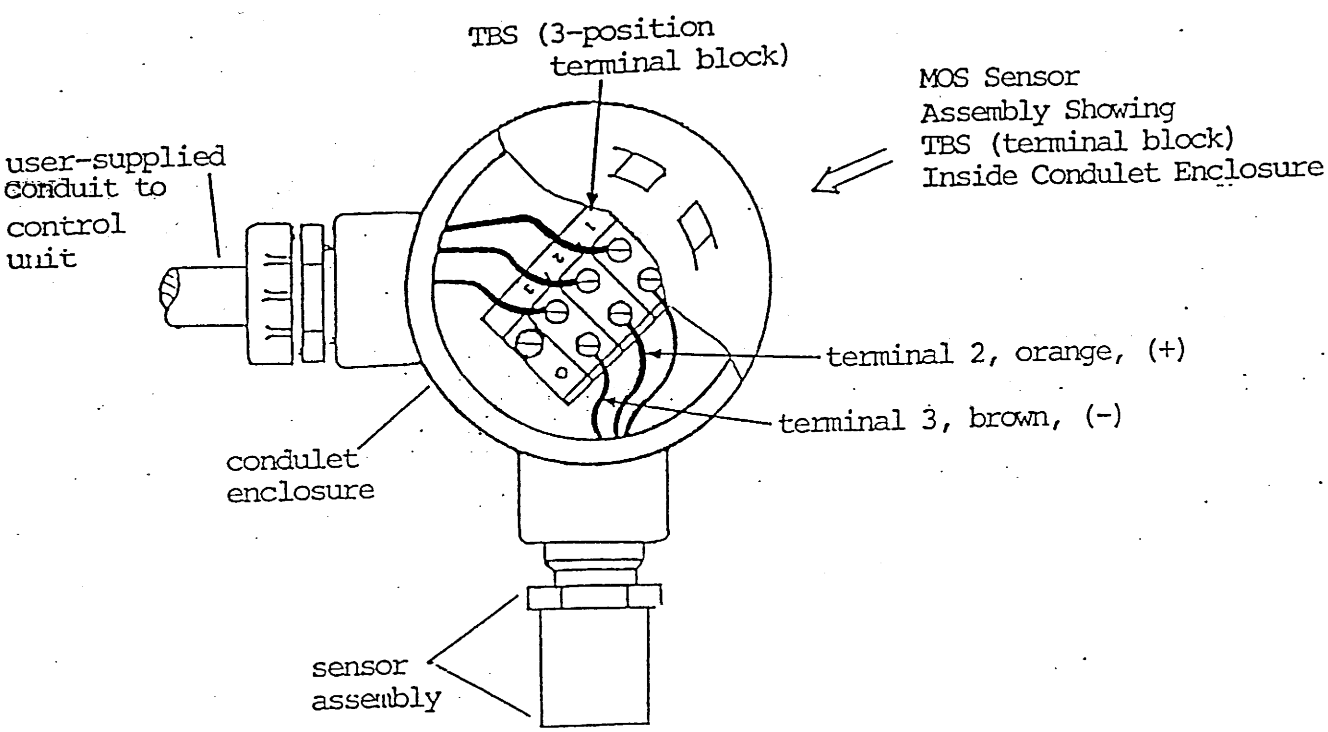


FIGURE 6
APPLYING TEST GAS TO MOS SENSOR

FIGURE 7: CHECKING, SETTING MOS SENSOR HEATER VOLTAGE



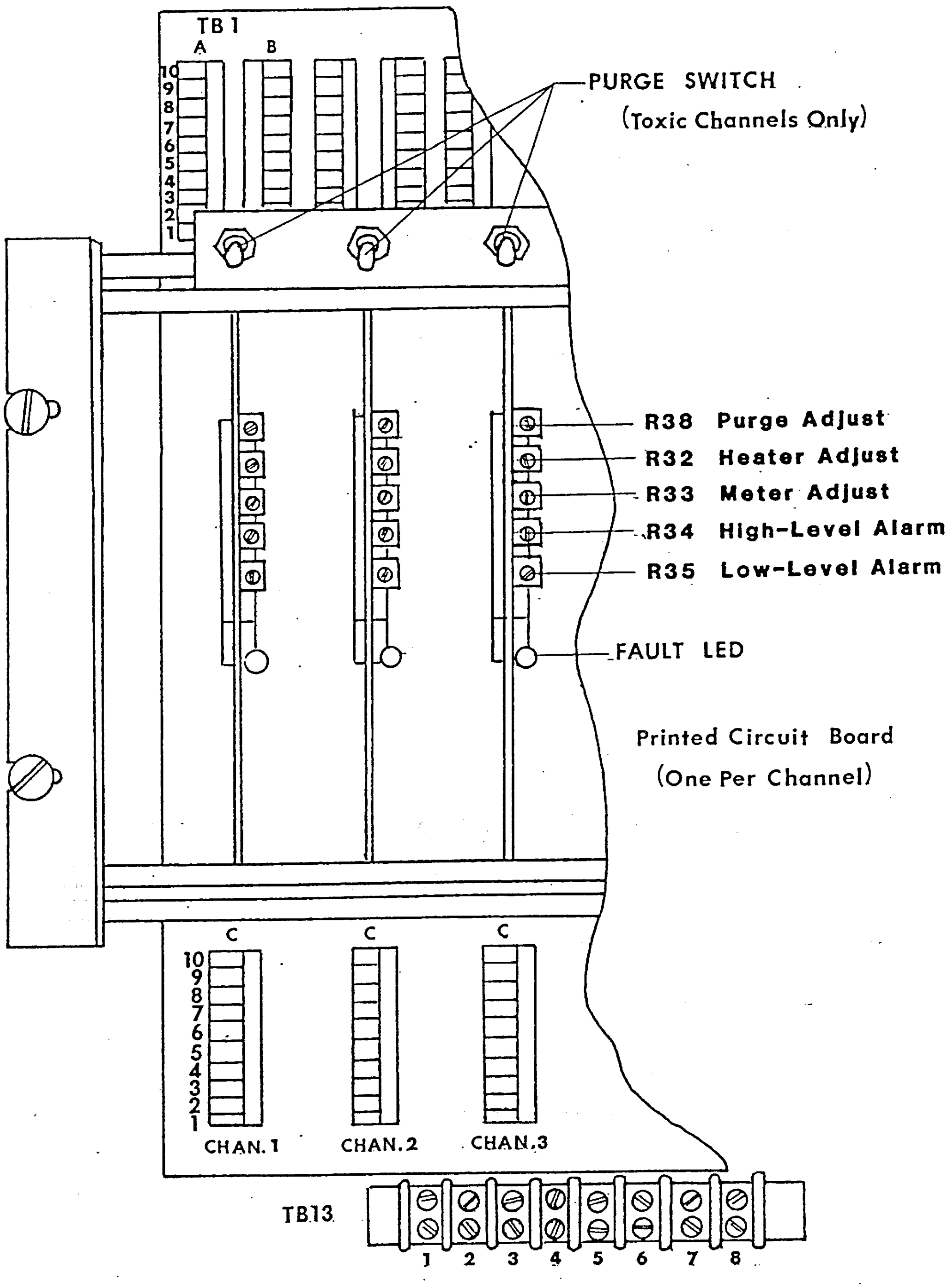
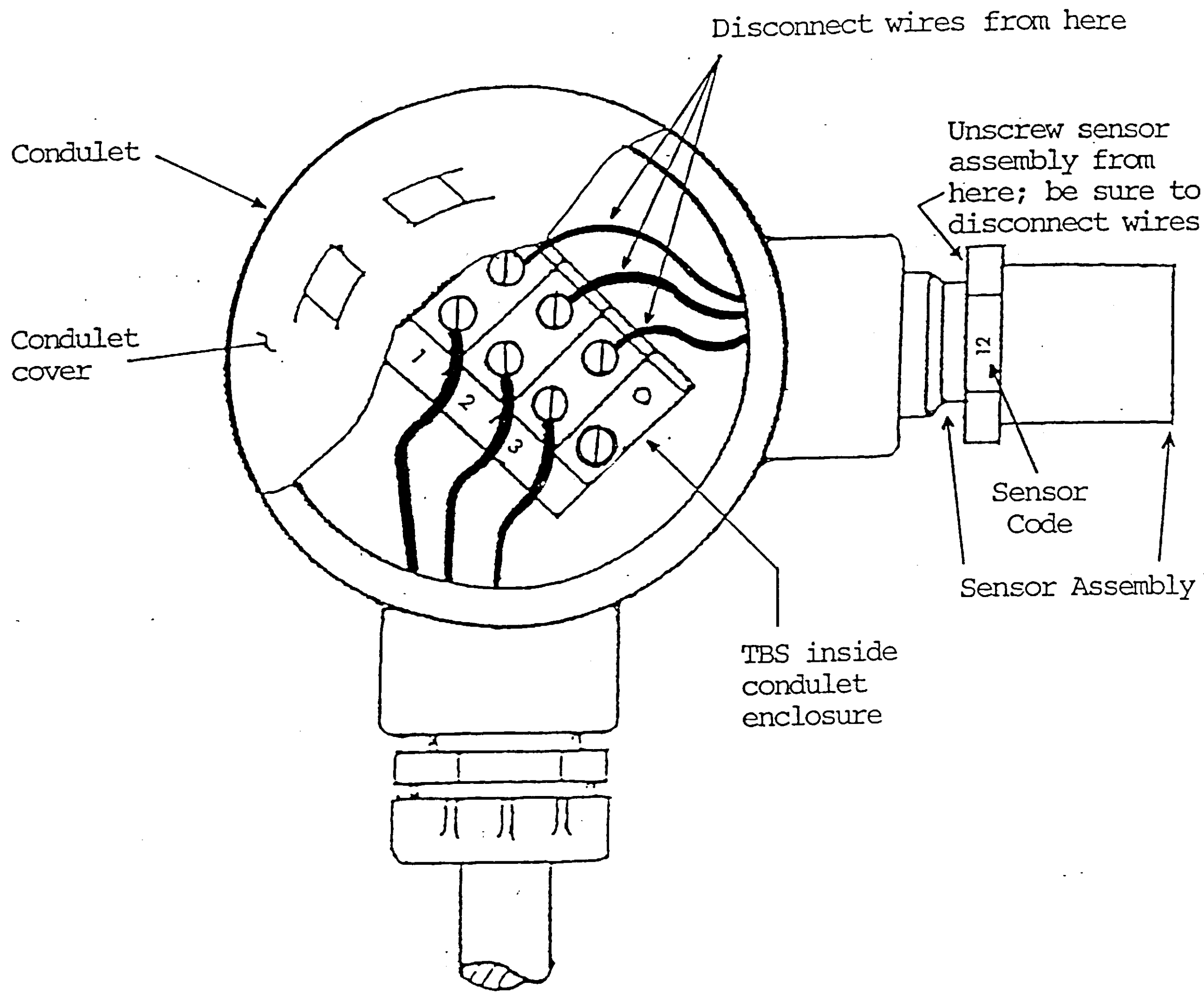


FIGURE 8

LOCATION OF INTERNAL CONTROLS
FOR TOXIC AND COMBUSTIBLE GAS CHANNELS

FIGURE 9: MOS Sensor Replacement

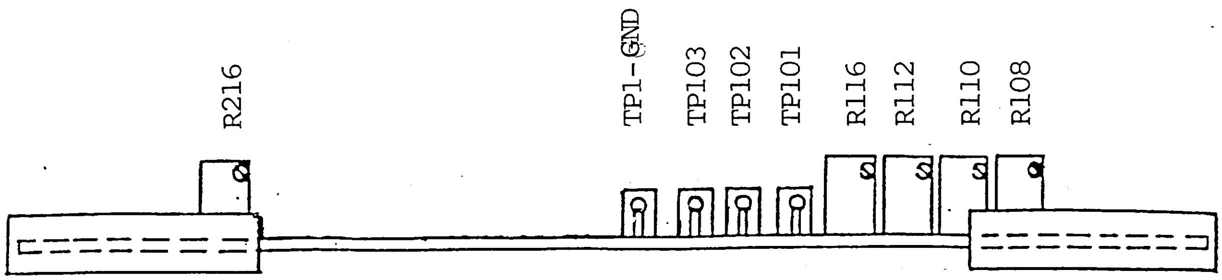


Sensor Code Number	Sensor
1	109
12	812
13	813
14	019

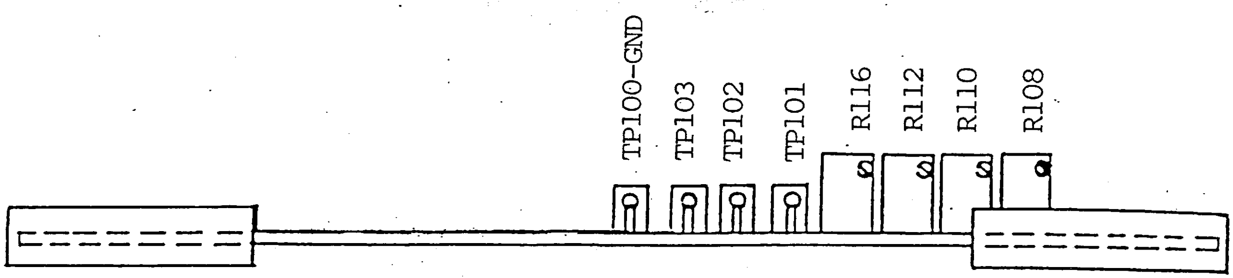
SENSOR WIRING

TBS Position	Signal	Sensor Wire
TBS-1	Sensor signal	Blue
TBS-2	Sensor heater	Orange
TBS-3	Sensor ground	Brown

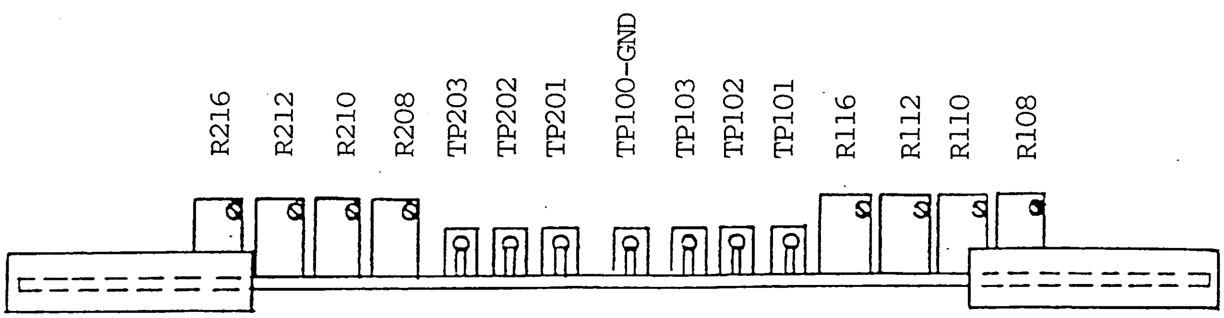
FIGURE 10: LOCATIONS OF INTERNAL CONTROLS
FOR OXYGEN CHANNELS



EDGE-VIEW OF CIRCUITBOARD
WITH ONE CHANNEL OF OXYGEN DETECTION
HAVING TWO ALARM POINTS



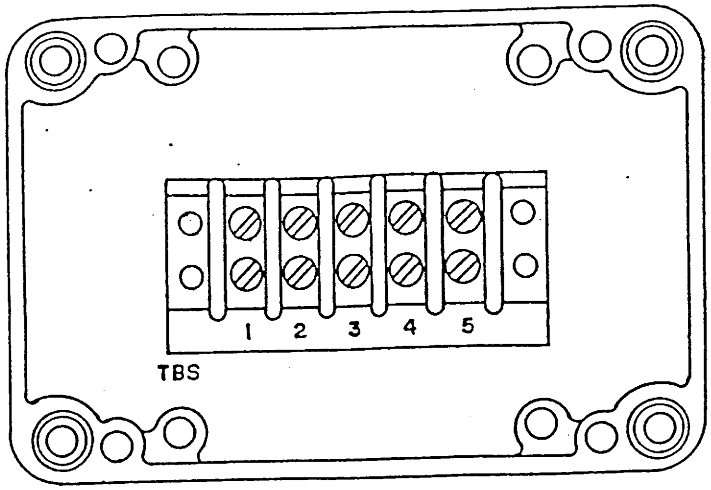
EDGE-VIEW OF CIRCUITBOARD
WITH ONE CHANNEL OF OXYGEN DETECTION
HAVING ONE ALARM POINT



EDGE-VIEW OF CIRCUITBOARD
WITH TWO CHANNELS OF OXYGEN DETECTION
EACH HAVING ONE ALARM POINT

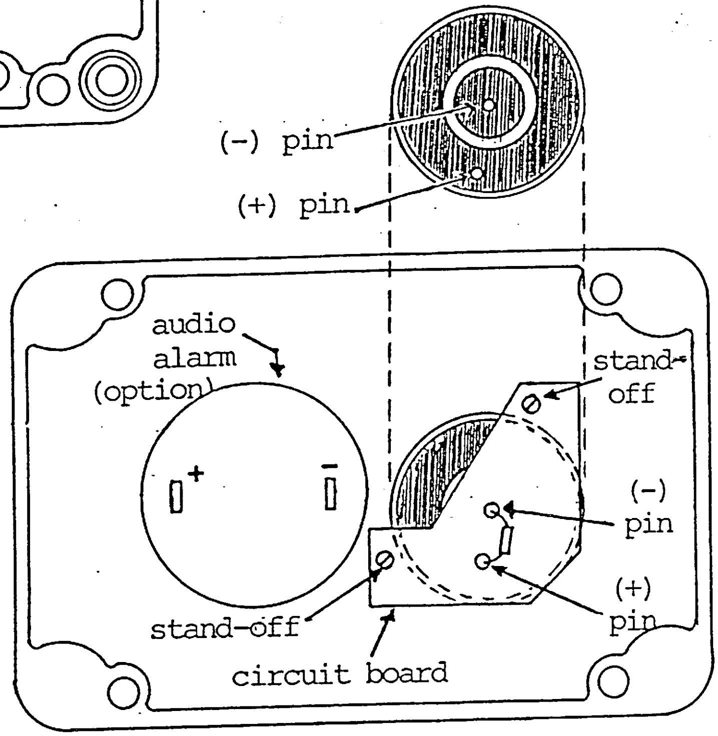
Potentiometers

R108, R208	null adjust
R110, R210	meter full scale adjust
R112, R212	low level set
R116, R216	alarm point adjust



TOP VIEW OF BOX

(cover removed)



BOTTOM VIEW OF COVER

FIGURE 11
INSTALLING OXYGEN CELL
INTO SENSOR ASSEMBLY

ASSEMBLY COVER,
SIDE VIEW

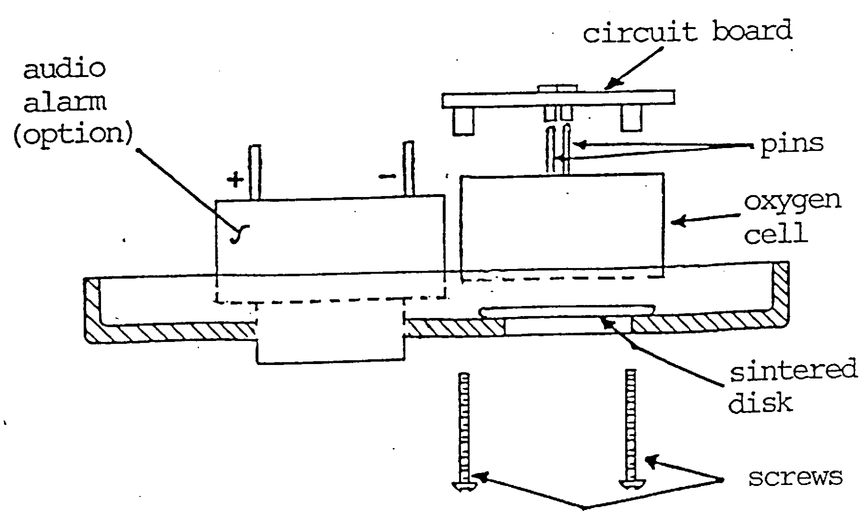
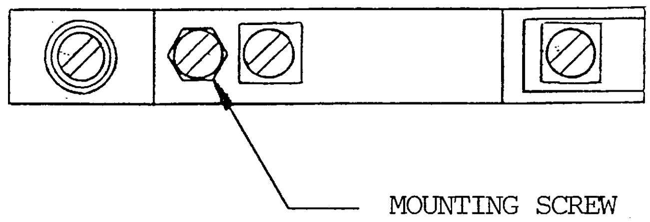
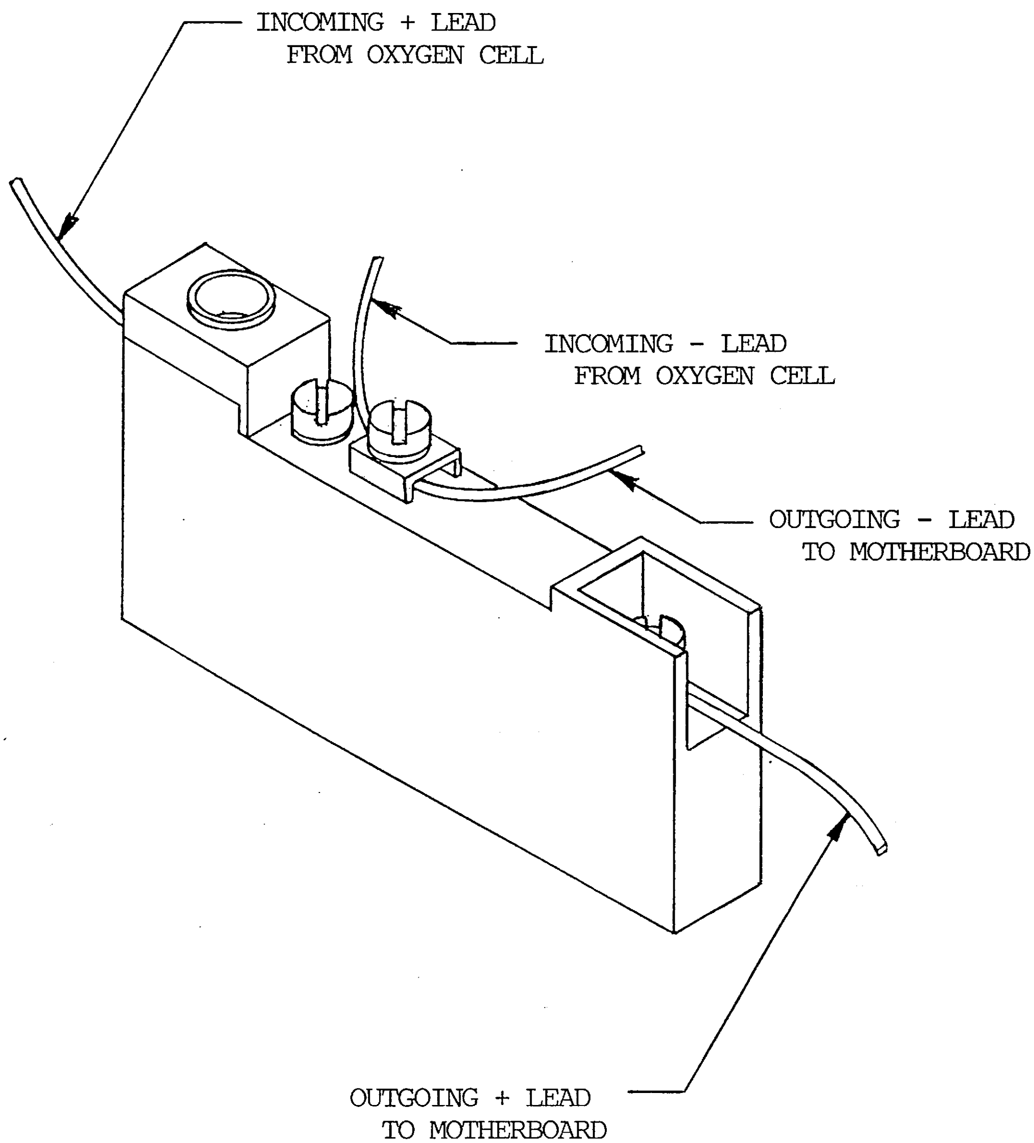


FIGURE 12: INTRINSIC SAFETY BARRIER MOUNTING AND WIRING





1.0 UNDERSTANDING THE ISA-44 MULTI-CHANNEL SYSTEM

1.1 Introduction

ENMET ISA-44 gas detection systems alert personnel to potentially hazardous toxic or combustible gas concentrations and oxygen levels. The ISA-44 system permits continuous monitoring of the atmospheres of remote locations from a control room environment. The control unit is wall mounted and interfaces with as many as 10 sensors located up to 1000 feet away. Meters on the control unit provide continuous readings of the atmospheric conditions at each sensor location. Audio and visual alarm signals on the control unit activate to indicate predetermined potentially hazardous conditions. Service relays inside the control unit can be utilized for activating additional remote alarms.

Each system consists of three or more channels of detection. A channel consists of a sensor, dedicated circuitry in the control unit, and a meter and indicator lights on the front panel of the control unit. The green light on a channel gives positive indication that the circuit is operational when not in alarm. Red or amber lights indicate alarm conditions.

Two basic channel types are available for the ISA-44 system. Toxic or combustible detection channels include a solid-state MOS (metallic oxide semiconductor) sensor and a non-linear gas concentration meter. These channels have usually have two alarm modes: low and high. Oxygen detection channels include a micro-fuel cell (oxygen cell) sensing element and a linear-scale oxygen concentration meter. The oxygen channels can have one or two alarm modes, responding to oxygen-deficient or oxygen-enriched atmospheres.

A model suffix number indicates the number of channels included in any particular system. For example, an eight channel ISA-44 system is an ISA-44-8, and a 10 channel system is an ISA-44-10.

1.2 Operating Principles

ISA-44 systems use two types of sensing elements: a gas sensitive metallic-oxide semiconducting element (MOS sensor) for toxic or combustible gas detection and an electrochemical fuel cell (oxygen cell) for oxygen detection.

Inside the MOS sensor an oxidation reaction occurs on the electronically heated surface of the sensor element upon contact with a suitable gas, changing the electrical resistance of the sensor. The resulting non-linear electrical signal is transmitted via wire to the control unit, where it is processed by

1.2 Operating Principles (continued)

instrument electronics and translated into an approximate gas concentration for display on the channel's meter. If this concentration exceeds the low alarm point for the channel, an amber alarm light activates. If the concentration exceeds the high alarm point for the channel, a red light and the system audio alarm activate.

Even though conditioned electronically for response to a particular gas, the MOS sensor responds to a variety of gases and vapors mainly hydrocarbons. However, MOS sensor response to gases other than those for which it is calibrated does not identify specified concentrations of such gases. For example, a sensor calibrated to activate alarm signals for 20% LEL methane may also alarm in the presence of gasoline. In such a case, although the alarm signals indicate the presence of a hydro-carbon, the alarm signals and instrument meter response does not identify a particular concentration of gasoline.

The electrochemical fuel cell (oxygen cell) is a linear device specific to oxygen gas. Ambient air diffuses through a thin, selective, permeable membrane on the surface of the cell screen, inducing a chemical reaction within the cell. This produces a small current which is linearly proportional to the partial pressure of oxygen in the ambient air. Circuitry in the instrument processes this current signal from the cell, translating it into an approximate oxygen concentration for display on the meter. If the concentration falls below the calibrated oxygen alarm point for the instrument, audio and visual alarm signals activate.

1.3 Calibrated Alarm Points Explained

The terminology and other specifics of some typcial calibrations for the ISA-44 system are discussed below. Note that the calibrated alarm points of any system are indicated on bright orange stickers located near the channel alarm lights on the instrument. Always check these stickers to verify the calibrated alarm levels of your instrument.

Used to identify combustible gas concentrations, "LEL" refers to the Lower Explosive Limit of a gas. Often expressed as "100% LEL", the Lower Explosive Limit is the lowest concentration of gas in air that will explode if exposed to a sufficient ignition source, like an open spark or flame. Concentrations above 100% LEL, such as 110% LEL, are potentially combustible. Concentrations below 100% LEL, such as 80% LEL, are not combustible, but indicate the presence of the gas and its proximity to the LEL. ENMET usually calibrates the combustible channel low alarm levels to identify 10-20% LEL of a designated combustible gas, non-combustible concentrations one-tenth to one-fifth (respectively) the amount required for combustion.

1.3 Calibrated Alarm Points Explained (continued)

Used to identify toxic gas concentrations, the term "ppm" refers to "parts per million". Expressing a gas concentration in parts per million identifies the relative quantity of the gas as a proportion of the total volume of a space. For example, the concentration 20 ppm carbon monoxide in an area indicates that if the atmosphere of the area were divided into one million cubes (volumetric units) of equal volume, and the carbon monoxide could be concentrated in one area, exactly 20 of the cubes would consist of carbon monoxide and the remaining 999,980 cubes would be comprised of clean air. In reality it is not possible to separate the carbon monoxide gas from the the rest of the atmosphere; this gas, when present, is dispersed throughout the atmosphere of the area.

Unlike "%LEL", gas accumulations expressed in ppm do not in themselves express safe or potentially hazardous concentrations. Therefore, some safety standard is needed. The TLV-TWA (Threshold Limit Value-Time Weighted Average) is such a standard for toxic gas and vapor concentrations. As defined in the American Conference of Governmental Industrial Hygienists' (ACGIH) Handbook, a TLV-TWA is

> ...the time-weighted average concentration for a normal 8-hour workday and 40 hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Note that the TLV-TWA is not a strict boundary between "safe" and "dangerous" concentrations; it is an average exposure limit. A worker can be exposed to concentrations slightly above the TLV-TWA for a short time as long as this is balanced by exposure to atmospheres sufficiently below the TLV for at least the same amount of time. However, a worker should never be exposed to concentrations equal to 5 times the TLV or above. ENMET usually calibrates toxic channel low alarm levels to identify TLV concentrations of a toxic gas. For a more complete explanation of the TLV as well as additional safety guidelines and actual TLV values, consult an ACGIH handbook.

The term "% oxygen by volume" expresses oxygen concentrations as a proportion of the total volume of a space. The concentration 20.9% oxygen by volume is the normal concentration of oxygen in clean, fresh air, indicating that just over one-fifth (20.9%) of the volume of clean, fresh air consists of oxygen; the balance is nitrogen and traces of other inert gases. The term "% by volume" expresses a gas concentration as the proportion of the total volume of a space, and therefore does not give any indication as to the safety of any particular concentration. A safety standard is needed.

1.3 Calibrated Alarm Points Explained (continued)

An alarm point of 19.5% oxygen by volume is the typical alarm point for ISA-44 oxygen channels. This concentration has been established by the federal Occupational Safety and Health Association (OSHA) as the minimum oxygen requirement for entry to a confined work space. This OSHA limit provides a good safety margin between the limit (19.5%) and the point at which humans are first significantly affected by lack of oxygen, about 16.0% by volume. If the oxygen level falls below 16.0% by volume, the senses and perceptivity of exposed workers are affected. At 14% oxygen by volume, degradation of the senses is serious. At 10% oxygen by volume the worker quickly becomes unconscious, and his life is in serious danger. Atmospheres containing 5% or less oxygen by volume are instantly fatal.

Oxygen enrichment also presents a hazard to workers. When the oxygen content of an area rises above approximately 23-25% oxygen by volume, the risk of combustion or explosion increases with many substances. Although most oxygen channels on the ISA-44 do not activate alarm signals to indicate oxygen-enriched areas, the scale on the typical oxygen meter indicates oxygen concentrations exceeding 23% by volume, to a maximum of 26% by volume. On special order, ISA-44 oxygen channels can be calibrated to identify oxygen-enriched atmospheres. Dual-alarm level ISA-44 oxygen channels can be calibrated to respond to both oxygen-deficient and oxygen-enriched atmospheres.

2.0 DESCRIPTION OF SYSTEM COMPONENTS AND ALARM MODES

2.1 System Description

2.1.1 Control Unit External Components (see Fig. 1)

CHANNEL INDICATOR LIGHTS

Toxic or Combustible Channels

power light (green)	One per channel. When lit, this light gives positive indication of non-alarm channel operation. This light is off during alarms and automatically activates when the gas content at the sensor falls below the low alarm point.
low alarm (amber)	One per channel. When lit, this light indicates that the gas concentration at the sensor location exceeds the low alarm point for the channel. It automatically deactivates when the gas content at the sensor falls below the low alarm point for the channel.

2.1.1 <u>Control Unit External Components</u> (continued)

high alarm (red)	One per channel. When lit, this light indicates that the gas concentration at the sensor location exceeds the high alarm point for the channel. It automatically deactivates when the gas content at the sensor falls below the high alarm point for the channel.
Oxygen Channels	
power light (green)	One per channel. When lit, this light gives positive indication of non-alarm channel operation. This light is off during alarms but automatically activates when the oxygen content at the sensor rises above the alarm point.
alarm light (red)	One per single alarm level oxygen channel, two per dual alarm level oxygen channel. When lit, the light indicates that the oxygen content at the sensor location has fallen below or exceeded the corresponding oxygen alarm point for the channel. This light automatically deactivates when the oxygen hazard at the sensor dissipates beyond the alarm point for the channel.
METERS	
Toxic or Combustible Channels	One per channel. This meter continuously indicates the gas concentration at the sensor location on a non-linear scale. The term "non-linear" means that only the marked points on the meter are calibrated to correspond to gas concentrations. Therefore, do not infer accurate readings from non-marked areas of the meter scale.
Oxygen Channels	One per channel. This meter indicates the % by volume oxygen concentration at the corresponding sensor location on a linear scale. The term "linear" means that the entire scale of the meter, usually from 16 - 26% oxygen by volume, is calibrated to correspond to oxygen concentrations.
HORN	Activates when a gas channel goes into high alarm, or when an oxygen channel goes into alarm. The horn deactivates automatically when none of the channels are in these designated alarm modes.

HORN DEFEAT SWITCH	This switch is used to defeat the horn during testing or maintenance. This switch does not defeat auxiliary alarms connected to system relays or optional audio alarms contained in oxygen sensor assemblies.
HORN DEFEAT LIGHT	This light warns that horn has been defeated by the horn defeat switch.
FAULT LIGHT	Activates when there is a problem with an MOS sensor, also when a purge switch is on. See section 2.2 (alarm modes) for a description of fault condition.

2.1.2 Control Unit Internal Components (see Fig. 2)

MOTHERBOARD	The motherboard interconnects channel circuit boards with terminal blocks and various control unit components.
CIRCUIT BOARDS	A circuit board includes the basic circuitry required for one channel of ISA-44 gas or one or two channels of oxygen detection. Potentiometers, located on the upper edge of the circuit board, are used to change circuit voltages to adjust the response of a channel to gas concentrations. Do not adjust these potentiometers except as specified in procedures in this manual.
PURGE SWITCH (selected gas channels only)	One per selected toxic gas channel. Located on the circuit board rack inside the control unit, the purge switch increases sensor heater voltage to clear the sensor element of contaminants. IMPORTANT: When switch is in "Purge" position, the sensor does not respond to gas or vapor concentrations, and the fault light is on.
GAIN POTENTIOMETER (oxygen channels only)	One per oxygen detection channel. Located on the front of the control unit, this potentiometer is periodically adjusted to compensate channel circuitry for oxygen cell depletion. The adjustment is made by resetting the "clean air" reference of the circuit to 20.9% oxygen when the oxygen cell is in fresh air. See section 5.2.2 for a description of this adjustment.

description of this adjustment.

INTRINSIC SAFETY BARRIERS (selected oxygen channels only)
The intrinsic safety barriers are optional components used to safeguard the oxygen cell against becoming an ignition source in potentially combustible environments. The barrier acts as a fuse, which opens to block any current surge which could overload the oxygen cell. Once opened ("blown"), the intrinsic safety barrier must be replaced. See section 5.2.7 for replacement. An oxygen sensor assembly deployed in potentially combustible atmospheres MUST be connected to an intrinsic safety barrier establishing the junction between the oxygen cell and control unit circuitry.

NON-LATCHING SERVICE RELAYS
One set per channel alarm point. Non-latching service relay connections are available on terminal strips inside the control enclosure. These relays change state when the corresponding channel is in alarm, and automatically reset when the potentially hazardous gas or oxygen concentration at the channel's sensor diminishes beyond the alarm point for the channel. Relay current is rated 2 amps continuous, 5 amps non-inductive surge (dry contacts), at 110 VAC.

TERMINAL STRIPS
These screw type terminal strips are used to connect power supply, sensor and relay contact wiring to control unit terminals.

2.1.3 Sensor Assemblies (see Fig. 3)

MOS SENSOR ASSEMBLIES AND ENCLOSURES (toxic or combustible gas channels)
These explosionproof assemblies consist of MOS sensor assemblies connected to heavy condulet enclosures (with internal terminal blocks for wiring connections). The entire sensor assembly is approved for use in Class I, Groups A, B, C and D and Class II, Groups E, F and G combustible atmospheres. The sintered steel cup protecting the sensing element is not waterproof but does resist rapid permeation of water.

OXYGEN SENSOR ASSEMBLIES
These assemblies consist of a heavy-duty plastic enclosure, internal terminal block (for wiring connections), a small circuit board and the oxygen cell. Note that the

2.1.3 Sensor Assemblies (continued)

sintered steel disk in the enclosure is not water-proof but does resist rapid permeation of water. The oxygen sensor assemblies are NOT designed for deployment in potentially combustible atmospheres unless sensor circuit is equipped with an intrinsic safety barrier.

2.2 Operating, Alarm Modes for a Channel

Condition	Signals	Indication
Non-alarm operation	Green light for channel is on.	Channel is operating, not in alarm. Toxic/combust. channels: Gas concentration at sensor is below alarm point for channel. Oxygen channels: Oxygen concentration at sensor is above oxygen deficiency alarm point or below oxygen enrichment alarm point.

This is the normal operating condition for the channel. The green light gives positive indication that the channel is operational while not in alarm. NOTE: Meters on oxygen channels calibrated exclusively for response to oxygen-deficient or oxygen-enriched air may indicate the opposite oxygen hazard while channel is in non-alarm condition.

Condition	Signals	Indication
Power Interrupt	All channel lights are off.	Power to the channel has been interrupted.

When all the lights on a channel are off, the power to the channel has been interrupted, indicating that the channel is no longer monitoring the sensor location. Take appropriate action. The relay contacts are in alarm state, but do not activate auxiliary equipment unless such equipment is connected to a separate power source which is still operating. NOTE: Sometimes, if all the lights on only one or two channels are off, it may be that the green lights are simply burned out. Power interruptions usually affect the entire system.

2.2 Operating, Alarm Modes for a Channel (continued)

Condition	Signals	Indication
Toxic or Combustible Gas Channel Low Alarm	Gas channel green light is off, amber light is on, meter indicates low alarm concentration or higher. Gas channel low alarm relay contacts in alarm state.	Presence of at least the low alarm concentration of toxic or combustible gas at the sensor.

The amber light for the combustible gas channel alerts personnel to at least a low alarm concentration of the designated toxic or combustible gas at the gas sensor location. If the gas content of the air at the sensor subsequently falls below the low alarm point, the amber light turns off, the green light turns on, and the low alarm gas channel relay contacts reset to non-alarm state.

Condition	Signals	Indication
Toxic or Combustible Gas Channel High Alarm	Gas channel green light off, amber light on, red light on, meter indicates high alarm concentration or above. Gas channel low, high alarm relay contacts in alarm state. Horn is on	Presence of at least the high alarm concentration of toxic or combustible gas at the sensor.

The red light for the toxic or combustible gas channel alerts personnel to at least a high alarm point concentration of the designated toxic or combustible gas at the sensor location. The meter indicates a gas concentration exceeding the high alarm point. If the gas concentration at the sensor location falls below the high alarm point, the red light deactivates, and the high alarm relay contacts automatically reset. The low alarm light (amber) and low alarm relay contacts remain in alarm position until the gas concentration falls below the low alarm point. IMPORTANT: If the meter has reached full scale (its highest reading), it is possible that the designated gas content at the sensor location has reached imminently hazardous concentrations (combustible or severely toxic concentrations). Take appropriate action.

2.2 Operating, Alarm Modes for a Channel (continued)

Condition	Signals	Indication
Oxygen Alarm	Oxygen channel green light is off, red light is on. Oxygen channel relay contacts in alarm state. Horn on.	Oxygen content at sensor location is either above or below corresponding alarm point.

The red light for an oxygen channel alerts personnel to an oxygen content below an oxygen deficiency alarm point or above an oxygen enrichment alarm point. Meter indicates oxygen content. If the oxygen hazard dissipates beyond the corresponding alarm point, the red light deactivates, the green light turns on, and the channel's relay automatically resets. IMPORTANT: If the oxygen indication is at the bottom of the meter scale, it is possible that the oxygen concentration at the sensor is low enough to cause serious injury or even quick death. Take appropriate action. NOTE: For channels with an oxygen deficiency alarm point, sometimes an oxygen alarm indicates a bad sensor wiring connection, a need for oxygen gain adjustment, a depleted oxygen cell, or an opened intrinsic safety barrier, if channel is equipped with a barrier. Check all connections, or see section 5.2.2 for oxygen gain adjustment, section 5.2.5 for verification of depleted cell or section 5.2.7 for intrinsic safety barrier check and replacement.

Condition	Signals	Indication
Sensor Fault (toxic or combustible gas channels only)	Fault light is on Channel red and green lights and horn are on. Channel high alarm relay in alarm state.	Problems with toxic or combustible channel MOS sensor or circuitry.

Sensor fault alarm indicates a problem with an MOS sensor or circuitry (toxic or combustible channels only). The channel in fault is indicated by a lighted red LED on the channel's circuit board inside the control unit. The sensor heater voltage of the MOS sensor must be checked (see section 5.1.4). If the channel's fault light is on, the channel's sensor is no longer monitoring ambient air for the presence of gas. Take appropriate action.

3.0 INSTALLATION OF THE ISA-44

Installation consists of choosing appropriate locations for mounting the sensor assemblies, completing wiring connections between sensor assemblies, power supply and control unit, setting

MOS sensor heater voltages, installing the oxygen cells in the oxygen sensor assemblies, performing oxygen gain adjustments, and supplying power to the control unit.

Both 110 Vac and 12 Vdc may be applied to appropriate terminal strips in the control unit, which in turn operates the sensors. If both 110 Vac and 12 Vdc are applied at the same time, the ac current flows; the dc current will flow during ac power interruption. If equipment connected to control unit relays is to operate during power interruptions to the control unit, connect the equipment to a power source independent of that for the control unit. Relays are rated 2 amps continuous, 5 amps non-inductive surge (dry contacts), at 110VAC.

When choosing locations for the sensors, carefully consider the nature of the application. Identify the relative density of the gas to be monitored; lighter-than-air gases accumulate near the ceiling of an area, while heavier-than-air gases accumulate near the floor. As an example, if an oxygen sensor is to safeguard against oxygen displacement by a heavier-than-air gas, locate the sensor assembly approximately 3-5 feet from the floor. Ventilation air currents and location of personnel work stations should also be considered. IMPORTANT: If the oxygen sensors are to operate in a potentially combustible environment, the oxygen cell circuit must be equipped with intrinsic safety barriers establishing the junction between control unit circuitry and the oxygen cell. The MOS sensor assemblies (toxic or combustible channels) are approved for use in Class I, Groups A,B,C and D and Class II, Groups E,F and G hazardous atmospheres.

As shipped from the factory, the oxygen cells are not installed in the oxygen sensor assemblies. When installing oxygen cells, note that the cell must be allowed to adjust to the operating environment for 4 hours after the cell is removed from its package before the cell will respond accurately to the new environment; see section 5.2.6.

MATERIALS

-- mounting hardware and tools for punching the control unit enclosure, mounting the sensor assemblies, and installing the control units into appropriate cabinets.

-- suitable sealed fittings for power, sensor, and relay wiring entrances into the control enclosure, to maintain the NEMA-12 rating of the enclosure.

-- oxygen sensor wiring: 2-conductor, 18 gauge or larger for oxygen cell, 2 additional conductors for optional audio alarm in sensor assembly. Shielded cable or wire in conduit recommended for environments with radio frequency or electromagnetic interference.

-- MOS sensor (gas) wiring: up to 250 ft., use 16 AWG wire; from 250 to 1000 ft., use 14 AWG wire. Shielded cable or wire in conduit recommended for environments with radio frequency or electromagnetic interference.

-- appropriate gauge wiring for power supply line, relay wiring (if desired), and all connections between control units and any relay-activated equipment.

-- small screwdriver (for adjusting potentiometers inside the control unit)

-- crimp on fork or ring terminals for power wires.

PROCEDURE

1. Set horn defeat switch on front panel of control unit to "off".

2. Mount the sensor assemblies in appropriate locations for detecting the designated gases. IMPORTANT: Do not drill holes in gas (MOS) sensor housings to mount them; use external mounting brackets.

3. Mount the control unit on a wall or other vertical surface.

4. Complete appropriate wiring connections. Refer to Wiring Table and Figs. 4, 5, 7, and 11 for illustration. Be sure to read applicable notes in Wiring Table.

5. Supply power to the control unit.
6. Install oxygen cells in the oxygen sensor assemblies. See section 5.2.6 of this manual for procedure. Then perform gain adjustment for each oxygen channel (section 5.2.2). NOTE: Remember that oxygen cells require a 4-hour adjustment period following removal from their shipping package prior to operation.

7. Set and check sensor heater voltages for combustible and toxic gas channels. See section 5.1.4 of this manual.

8. Turn the horn defect switch to "On." Unit is ready for operation. Proceed to section 4.0 Operation.

4.0 OPERATION OF THE ISA-44

4.1 Toxic or Combustible Channels

Following installation or prolonged periods of inoperation, the MOS sensors for these channels require an initial warm-up period prior to operation. This warm-up is described below. In addition, if a channel includes a purge switch, the channel must be purged upon installation, after prolonged periods of inoperation, and periodically during operation in particularly "dirty" environments. See section 5.1.2 for a description of this procedure.

1. Turn the Horn off.

2. For 5-30 minutes, after first applying power, the alarm lights for gas channels remain on as the channels' sensors heat and clear off contaminating molecules that have accumulated on the sensor surfaces during inoperation.

3. When the channel alarm lights are off, and the green power lights are on, the initial warm-up for the channel is complete.

4. Turn horn on. Monitor the ISA-44 control unit for alarm signals; see section 2.2 for description of alarm modes.

IMPORTANT: All purge switches must be in READ position during operation (see Fig. 8 for location of any purge switches in system).

4.2 Oxygen Channels

The oxygen cells inside the sensor assemblies for these channels require a 4-hour adjustment period, and the oxygen channels require a subsequent gain adjustment prior to operation. Following this, the channels are ready for operation. Monitor the control units for alarm signals; see section 2.2 for description of alarm modes. Perform oxygen gain adjustment (section 5.2.2) monthly or as required.

4.2.1 Oxygen Channels and Atmospheric Pressure Variations

The oxygen cell current output is directly proportional to the partial pressure of the oxygen in the atmosphere surrounding the cell. The partial pressure of oxygen is a function of the percent by volume of oxygen in the air and the air pressure. Air pressure varies as natural weather systems move through the area, causing changes in barometric pressure as well as oxygen content.

4.2.1 Oxygen Channels and Atmospheric Pressure (cont.)

The barometric pressure changes cause a relatively small change in the oxygen content indication on the system meters. For example, if the gain is set to give an oxygen meter indication of 20.9% oxygen when the barometric pressure is 29.9 inches of mercury, normal variations of barometric pressure cause variations in meter readings of + or - 0.25%, from 20.65% oxygen by volume to 21.15% oxygen by volume. If the gain is set during a normal high pressure weather cycle, the variation is 0.50% by volume downscale. Conversely, if the gain is set during a normal low, the variation is upscale. This response to atmospheric pressure is not distressing when understood. The variation of the alarm point by + or - 0.25% is not significant when the liberal safety factor between the alarm point, usually 19.5%, and the point at which oxygen deficiency first emphatically affects human performance, approximately 16.0%, is taken into consideration.

4.2.2 Oxygen Channels and Temperature Variations

The cell output is temperature dependent; consequently, the cell is temperature compensated by means of a thermistor-resistor network on the circuit board in the sensor assembly. Significant changes in temperature cause erratic initial readings, as the cell and thermistor do not track due to the difference in their locations and thermal masses.

4.3 Precautions

Do not expose the oxygen cell to temperatures below 32 degrees F (0 C) or above 130 degrees F (55 C). The cell freezes when subjected to sustained use or storage at or below 25.7 degrees F. If the cell is frozen, its current output drops,and the channel goes into alarm.

Do not adjust or even touch circuit potentiometers except as specified in section 5.1.4 (Sensor Heater Voltage Adjust- ment), section 5.1.5 (Toxic/Combustible Channel calibra- tion), section 5.2.2 (Oxygen Gain Adjustment) and section 5.2.4 (Oxygen Channel Circuit Realignment). Even accidental adjustment of these components could miscalibrate the instrument, a dangerous situation for personnel exposed to potential hazards.

Do not blow cigarette smoke on a sensor.

Do not squirt pure gases or liquid hydrocarbons, such as butane, propane, gasoline, etc. directly on the sensor.

Do not use a strong cleaning agent, wax or lacquer near a sensor.

Only perform an oxygen gain adjustment (section 5.2.2) when there is clean, fresh air (or bottled 20.9% oxygen in nitrogen) at the

4.3 Precautions (continued)

Avoid exposure of the oxygen cell to corrosive toxic gas environments. Prolonged exposure to corrosive toxic gas can degrade the oxygen cell.

5.0 MAINTENANCE OF THE ISA-44

5.1 Toxic or Combustible Channels

5.1.1 Toxic or Combustible Channel Maintenance Schedule

Section	Purpose of Maintenance	Frequency of Maintenance 6 wks	Frequency of Maintenance as req'd
5.1.2 Purging	Clears the sensor of contaminating molecules which accumulate on the sensor surface over time or during inoperation. Required prior to calibration.		X
5.1.3 Alarm Test	To quickly verify the alarm capability of the channel and to determine whether or not the channel is grossly out of calibration.	X AND (and upon install.)	X
5.1.4 Sensor Heater Voltage	To condition the MOS sensor electronically to respond to the designated gas. Failure of channel to respond to Alarm Test mandates setting the sensor heater voltage prior to calibration. Also required when system is installed or when MOS is replaced.		X (and upon install.)
5.1.5 Calibration	To readjust channel response to alarm concentrations of gas. Required when channel fails Alarm Test, when sensor heater voltage is adjusted or when sensor is replaced.		X

5.1.2 Purging

Purge switches are located inside the control unit on the circuit card cage. Only selected toxic or combustible channels in any

5.1.2 Purging (continued)

ISA-44 are equipped with purge switches. See Figures 2 and 8. During inoperation or as a result of operation in "dirty" environments, contaminating molecules accumulate on the surface of these channel's sensors, affecting sensor accuracy. The result is a slowly increasing meter reading, which may eventually put the channel into alarm. To clear off these contaminants, the sensor heater voltage is temporarily increased to a "purge" voltage (via a purge switch).

Purging of these channels is required upon installation or following prolonged periods of system inoperation (due to power failures, prolonged maintenance procedures, etc.). Purging is also required periodically when the channel's sensor operates in particularly dirty environments.

PROCEDURE:

1. Set horn defeat switch to "off", and open the control enclosure door.

2. Purge switches are located on the circuit board card cage. Depending upon how long the system has been inoperative or how dirty the sensor is, set switch to PURGE and leave in PURGE position for the following periods:

   periodic purging for dirty environments: 1/2 hour
   1-3 hours inoperation: 10 minutes
   1 day of inoperation: 1 to 1.5 hours
   2 or more days of inoperation: overnight or 24 hours

   Initially, the channel usually goes into alarm. After the purge period, if the channel's meter has stabilized at a low reading, purging is complete.

   IMPORTANT: WHEN PURGE SWITCHES ARE IN "PURGE" POSITION, SENSORS DO NOT MONITOR THE ATMOSPHERE FOR THE DESIGNATED GAS, AND THE BLUE FAULT LIGHT IS ON.

3. Set switch to READ position. NOTE: Sometimes, after returning switch to READ position, the channel's meter will move upscale and the channel may go into alarm. Allow sensor to stabilize for 10-30 minutes; usually the channel comes out of alarm and the meter stabilizes at a low reading. If meter subsequently climbs upscale and into alarm, purge again for 1/2 hour. If the meter again climbs upscale and the channel goes into alarm, and the problem does not involve gas concentrations at the sensor, recalibrate the channel (see section 5.1.5).

4. Set the horn defeat switch to "on."

5.1.3 Toxic or Combustible Channel Alarm Test

The Alarm Test applies a calibration or correlation gas to a toxic or combustible channel sensor to quickly verify the alarm capability of the channel and determine whether or not the channel is out of calibration. We recommend this test be performed at least every six weeks.

Correlation gases are often used to test and calibrate the alarm points of ISA-44 instruments. For purposes of transport and ease of use, these gases are often substituted for the actual gas used to calibrate the channel. A correlation gas causes the same channel response as does the gas for which the channel is calibrated. For example, for channels calibrated to alarm at 10 ppm hydrogen sulfide, 50 ppm carbon monoxide causes the same alarm response as 10 ppm hydrogen sulfide.

It is important to apply appropriate humidified gases to the sensor at the designated flow rate for proper test response. Appropriate calibration or correlation gases are set in a background of hydrocarbon-free air; gases set in a background of pure inert gas (such as argon or nitrogen) will cause erratic sensor response. Appropriate calibration gases are available from ENMET. Humidity and flow rate requirements are met using the designated ENMET calibration assembly.

If the sensors are located far from the control unit, it is expedient to have two people for this procedure; one to apply gas at the sensor, and the other to observe channel signal response at the control unit.

MATERIALS:

- -- cylinder (propane torch size) of high alarm point calibration or correlation gas concentration (see section 5.4 for alarm point; contact ENMET for correct correlation gas concentrations, if applicable).
- -- calibration assembly (with humidifier/regulator, plastic tubing, sensor cover and flowmeter. ENMET part #03700-001)
- -- clean water

PROCEDURE (refer to Fig. 6):

1. Prior to test, system must operate continuously for 24 hrs.
2. After 24 hours, turn the HORN off.
3. Fill the humidifier bottle half-way with clean water.

5.1.3 <u>Toxic or Combustible Channel Alarm Test</u> (continued)

4. Attach the calibration assembly to the cylinder containing high alarm point gas concentration or correlation gas. Set the flow-meter/humidifier assembly upright on a level surface.

5. Open the calibration assembly valve to allow a steady stream of gas to bubble through the water at a flow rate of 0.9 - 1.1 scfh (standard cubic feet/hour) as shown on flowmeter.

6. Place the sensor cover of the calibration assembly over the gas sensor. Let the gas flow over the sensor for 1-2 minutes for combustible gas, 3-5 minutes for toxic gas. If channel meter needle (at control unit) is off more than 2-3 meter needle widths from the high alarm point, or if appropriate alarm signals do not activate at within designated time period for gas flow, channel requires recalibration. Proceed to sections 5.1.4 and 5.1.5.

7. If the meter and alarm response for each channel are verified, turn the gas off and remove the calibration assembly from the gas cylinder.

8. Turn the Horn back on. Test for channel is complete.

5.1.4 <u>Toxic or Combustible Sensor Heater Voltage</u>

The heater voltage determines the temperature to which the sensor element is heated, which in turn determines the response of the equipment to the designated gas. Small screws in designated potentiometers (components on gas channel circuit boards) are manually adjusted, using a screwdriver, to adjust the sensor heater voltage.

A chart, located inside the control unit, specifies the sensor heater voltage (and purge voltage, if applicable) for each MOS sensor. Refer to Fig. 8 for chart and potentiometer locations. NOTE: DO NOT EXCEED THE SENSOR VOLTAGES GIVEN ON THE CHART. EXCESSIVE VOLTAGE CAN DAMAGE THE SENSOR HEATER WINDING, REQUIRING SENSOR REPLACEMENT.

If the sensors are located far from the control unit, it is expedient to have two people for this procedure; one to check the voltage at the sensor, and the other to make potentiometer adjustments at the control unit.

> IMPORTANT: IF THE SENSOR HEATER VOLTAGE REQUIRES SIGNIFICANT READJUSTMENT, CHANNEL SHOULD BE CALIBRATED (SECTION 5.1.5). IF SENSOR HEATER VOLTAGE CANNOT BE SET TO THE REQUIRED VOLTAGE, THE SENSOR MUST BE REPLACED (SEE SECTION 5.1.6)

5.1.4 Toxic or Combustible Sensor Heater Voltage (continued)

MATERIALS:

-- a digital voltmeter with a + or - 0.05% accuracy

-- a small screwdriver for adjusting potentiometers on gas channel circuit boards.

PROCEDURE: CHANNELS WITH PURGE SWITCH

1. Set the channel's purge switch to PURGE; see Fig. 8.

2. Unscrew the condulet enclosure lid at the sensor assembly (CAUTION: Enclosure is no longer explosionproof once the lid is removed).

3. Check the purge voltage across the brown (-) and orange (+) wires inside the condulet enclosure of the sensor assembly (see Fig. 7). It should be within + or - 0.02 vdc of the purge voltage given on the chart inside the control unit. If necessary, adjust the small screw in potentiometer R38 (counterclockwise to increase, clockwise to decrease voltage) on the channel's circuit board until the correct voltage is obtained.

4. Now set the channel's purge switch to READ. Check the voltage (sensor heater voltage) across the brown (-) and orange (+) wires inside the condulet enclosure of the sensor assembly. It should be within + or - 0.02 vdc of the value given for sensor heater voltage on the sensor voltage chart inside the instrument. If necessary, adjust the small screw in potentiometer R32 (clockwise to increase, counterclockwise to decrease voltage) on the channel's circuit board until the correct voltage is obtained.

PROCEDURE: CHANNELS WITHOUT A PURGE SWITCH

1. Unscrew the sensor enclosure lid at the sensor assembly. CAUTION: Once the sensor enclosure lid is removed, the enclosure is no longer explosionproof.

2. Check the sensor heater voltage across the brown (-) and orange (+) wires inside the condulet enclosure of the sensor assembly. Voltage should be within + or - 0.02 vdc of the sensor heater voltage given on the chart inside the control unit. If necessary, adjust potentiometer the small screw in potentiometer R32 (clockwise to increase, counterclockwise to decrease voltage) on the channel's circuit board until the required voltage is obtained. NOTE: Sometimes, if a sensor is located a great distance from the control unit, the heater adjust potentiometer (R32) may not, by itself, be

5.1.4 Toxic or Combustible Sensor Heater Voltage (continued)

sufficient to raise the voltage to the required reading. If this is the case, adjust potentiometer R32 clockwise to set the voltage as high as it will go. Then adjust the small screw in potentiometer R38 on the channel's circuit board counterclockwise to raise the voltage to the required level.

FOR EASE OF MAINTENANCE: Once the sensor heater voltage has been set, measure the voltage across the heater and ground MOS sensor wiring positions on the appropriate terminal strip on the ISA-44 control unit (see wiring table for MOS sensor wiring positions on ISA-44 terminal strips). Record this as the sensor's "reference voltage" on the chart inside the control unit next to the sensor heater voltage chart. The next time sensor heater voltage must be verified, simply check the reference voltage across the terminal strip positions. If the reference voltage at the motherboard has not changed, the sensor heater voltage at the sensor remains the same. However, if the reference voltage has changed, the sensor heater voltage must again be set at the sensor, and the reference voltage again checked and recorded. As the name implies, "reference" voltage is only for checking, not setting, the sensor heater voltage.

5.1.5 Toxic or Combustible Channel Calibration

Calibration is required when Alarm Test (section 5.1.3) indicates inadequate channel alarm response. Prior to calibration, verify correct sensor heater voltage (section 5.1.4).

Calibration readjusts the channel's alarm response to designated concentrations of gas. To calibrate, a high alarm point calibration (or correlation) gas is applied to the sensor. Subsequently, potentiometers are adjusted to calibrate the meter and alarm signal reponse. In a like manner, the low alarm point gas is applied and the appropriate alarm potentiometer adjusted.

MATERIALS:

-- high and low alarm point calibration or correlation gas (see section 5.4 for part numbers; contact ENMET for correlation gas concentrations, if applicable).

-- calibration assembly (with humidifier/regulator, plastic tubing, sensor cover and flowmeter. ENMET part #03700-001)

-- small flat-headed screwdriver for adjusting screws in potentiometers

-- clean water

5.1.5 Toxic or Combustible Channel Calibration (continued)

PROCEDURE (refer to Fig. 8 for potentiometer identification)

1. The unit must operate continuously for at least 24 hours before this test. If channel includes a purge switch, set switch to PURGE for 1/2 hour, then set back to READ.

2. Set the horn defeat switch to "off".

3. Fill the humidifier bottle of the calibration assembly half-way with clean water.

4. Attach the calibration assembly to the cylinder containing the high alarm point calibration or correlation gas. Set the flowmeter/humidifier assembly upright on a level surface.

5. Open the calibration assembly valve to allow a steady stream of gas to bubble through the water at a flow rate of 0.9 - 1.1 scfh (standard cubic feet/hour) as shown on flowmeter.

6. Place the sensor cover of the calibration assembly over the gas sensor. Let the gas flow over the sensor for 1-2 minutes for combustible gas, 3-5 minutes for toxic gas (refer to Fig. 6 for illustration).

7. When meter has stabilized, while gas is still flowing, adjust the small screw in potentiometer R33 (counterclockwise to increase, clockwise to decrease) to set the channel's gas meter to high alarm point or correlation gas concentration. If high alarm light does not activate when meter is set to high alarm point, adjust the small screw in potentiometer R34 counterclockwise until the high alarm light just activates.

8. Turn off the gas. Remove sensor cover of calibration assembly from the sensor. Allow the sensor to recover for 10 minutes.

9. Attach the calibration regulator assembly to the cylinder of low alarm point calibration or correlation gas.

10. Repeat step 6.

11. The channel's meter should stabilize at some point within 3-4 meter needle widths of the low alarm point. If the low alarm light is not on when meter is within this range, adjust pot. R35 counterclockwise until the low alarm light just activates. NOTE: If meter is not within the designated range, recalibrate the HIGH alarm point (step 7 above). If meter is again more than 3-4 needle widths from

5.1.5 Toxic or Combustible Channel Calibration (continued)

the low alarm point when low alarm point gas is applied, contact ENMET for repair instructions.

12. Repeat step 8.

13. Attempt Alarm Test for high alarm point (section 5.1.3). If both low and high alarm lights activate within the specified time period, calibration is complete. Turn the horn on.

IMPORTANT:

> There must be ten percent (10%) relative humidity content, or greater, in the test gas for accurate testing and calibration. The humidifier bottle in the ENMET calibration assembly provides this humidity when used correctly.

> Make sure proper flow rate of calibration gas is maintained (0.9 to 1.1 scfh).

> Do not use a calibration gas with 100% nitrogen as a background gas. ENMET calibration gases have an appropriate background of hydrocarbon-free air for accurate sensor response.

5.1.6 Toxic or Combustible Channel MOS Sensor Replacement

An MOS sensor must be replaced if the sensor heater voltage cannot be set to the correct value, the sensor cannot be calibrated in accordance with the procedures in section 5.1.5, or the sensor is subjected to gross contamination.

Gross contamination usually occurs during close exposure to an open gas flame, contact with a a liquid hydrocarbon (such as lacquer), or continuous exposure to heavy concentrations of industrial vapors. A grossly contaminated sensor causes a continuous alarm which cannot be deactivated by purging (5.1.2) or recalibration (section 5.1.5)

MATERIALS:

-- adjustable wrench, flat-headed screwdriver

-- new sensor (match sensor code number with ENMET part no.; see Fig. 13 for code and section 5.4 for part no.'s)

PROCEDURE (refer to Fig. 9):

1. Unscrew the lid of the condulet enclosure (enclosure is not explosionproof when cover is removed). Disconnect the

5.1.6 Toxic or Combustible Channel MOS Sensor Replacement (continued)

orange, brown and blue sensor wires inside the condulet enclosure of sensor assembly.

2. Unscrew the old sensor assembly from the condulet enclosure; install the new sensor and connect the wires as in Fig. 13.

3. Set the sensor heater voltage (Section 5.1.4), and recalibrate the channel (Section 5.1.5).

5.1.7 Toxic or Combustible Channel Trouble-Shooting

Symptom	Problem/Correction
When power is first applied, unit alarms for up to 10-20 minutes.	If the system has been inoperative, this is normal. The MOS sensor is cold and/or contaminated. Keep unit ON or operate overnight with the sensor in fresh air channels with purge switches may be purged overnight.
Alarm light stays on continuously, even after allowed to operate (or PURGED) overnight.	Either hazardous gas conditions exist, or there is a contaminated sensor, or a bad circuit. Attempt calibration (section 5.1.5).
One or more of the lights do not work.	Rotate lamps to be sure problem is not burned-out lamp.
Channel fails to alarm when Alarm Test gas is applied.	Attempt calibration of channel. See section 5.1.5. If calibration fails, contact ENMET for further instruction.
Channel gradually creeps into alarm or seems too sensitive.	Either hazardous gas conditions exist, or recalibration is necessary; problem may be corrected by purging the chan- if equipped with purge switch
Fault light on	Sensor circuit open or sensor defective, or purge switch is on. Determine which. Replace sensor if necessary.

5.2 Oxygen Channel

5.2.1 Oxygen Channel Maintenance Schedule

Procedure	Purpose	Frequency of Maintenance Monthly		As Req'd
Oxygen Gain Adjustment (Sec. 5.2.2)	To compensate the circuit for oxygen cell depletion by raising the meter reading to 20.9% while sensor assembly is exposed to clean, fresh air (oxygen content 20.9% by volume oxygen).	X	AND	X
Rough Test (Sec. 5.2.3)	To verify that channel alarm signals activate at correct point when sensor assembly is exposed to oxygen-deficient or oxygen-enriched air.	X	AND	X
Oxygen Channel Realignment (Sec. 5.2.4)	To realign channel circuitry so alarm signals activate at the correct oxygen concentration (required when a channel fails the Rough Test).			X
Oxygen Cell Check (Sec. 5.2.5)	To determine whether oxygen cell requires replacement. Necessary when oxygen gain adjustment for a channel is unsuccessful.			X
Oxygen Cell Replacement (Sec. 5.2.6)	To replace depleted oxygen cell. Cell replacement requires gain adjustment and Rough Test, which determines whether realignment is required.			X

5.2.2 Oxygen Gain Adjustment

Over time, the oxygen cell becomes slowly depleted as the chemical fuel supply in the cell is used up. This causes the cell current output to drop, resulting in a slowly decreasing oxygen channel meter reading at the control unit even though the cell is in fresh air. To compensate the circuit for this current drop, the circuit gain must be adjusted once a month (or as required) to keep the "fresh air" reference on the meter scale (20.9% oxygen by volume) accurate. The rate of cell depletion accelerates near the end of the cell's life (average life of oxygen cells is approximately 14 months; warranty is six months from date of shipment from ENMET).

5.2.2 Oxygen Gain Adjustment (continued)

IMPORTANT: During the gain adjustment, it is imperative that the cell is exposed to clean, fresh air (oxygen content of 20.9% by volume). If the cell is exposed to oxygen-deficient air during this adjustment, the oxygen circuit could become seriously inaccurate and present a situation of great danger to exposed personnel.

Perform the following upon installation of the oxygen cell and once a month thereafter (or as required) for each oxygen channel.

MATERIALS

-- clean, fresh air supplied to the sensor (if clean, fresh air is not available, use bottled 20.9% oxygen in nitrogen)

-- small screwdriver

PROCEDURE

1. Supply clean, fresh air to the sintered steel disk of the channel's sensor assembly for 5 minutes. Remember to use bottled 20.9% oxygen if there is a possibility that the ambient air at the sensor assembly is oxygen-deficient.

2. After 5 minutes, adjust the gain potentiometer for the channel located on the exterior control surface next to the meter for that channel. Adjust clockwise to increase, counterclockwise to decrease meter reading, so that the oxygen meter for the channel reads at the fresh air reference, 20.9% oxygen by volume.

5.2.3 Oxygen Channel Rough Test

The Rough Test provides quick verification that the oxygen circuit alarm signals respond to oxygen-deficient or oxygen-enriched air. Perform the Rough Test whenever you wish to verify channel alarm response to the corresponding oxygen concentrations.

If the sensor assemblies are located far from the control unit, this test requires one person at the sensor assembly to apply the test and one at the control unit to verify channel alarm signal and meter response.

MATERIALS:

-- cylinder containing compressed air mixture with oxygen content approximately 10% below (oxygen deficiency) or 10% above (oxygen enrichment) corresponding alarm point. NOTE: For channels with 19.5% by volume oxygen deficiency alarm point, human breath can be used to test the alarm point.

5.2.3 Oxygen Channel Rough Test (continued)

-- calibration assembly (use ENMET assembly part no. 03700-001, the same used for Alarm Test in section 5.1.3).

PROCEDURE:

1. While the sensor is in clean, fresh air (or while 20.9% oxygen is being supplied to the sensor), verify that the meter reading for the channel is at the clean air reference, 20.9% oxygen by volume. If it is not, perform an oxygen gain adjustment for the channel (see section 5.2.2).

2. A) TEST FOR 19.5% OXYGEN DEFICIENCY ALARM POINT: At the sensor, hold your breath for 15 seconds, then slowly exhale all your breath over the sintered steel disk in the oxygen sensor assembly. Cover the disk with your hand (be sure to hold your breath for the specified period).

   B) TEST FOR ALL OTHER ALARM POINTS: Supply appropriate bottled oxygen concentration to the sensor at a low flow rate (approx. 1.0 scfm [standard cubic feet/minute]) for 30 seconds.

3. Alarm signals must activate within 30 seconds, when channel's oxygen meter at the control unit reaches the alarm point.

4. If the channel does not respond as described above, try the test again; be sure to apply the gas directly to the sintered disk in the sensor assembly at a sufficient flow rate. If the channel fails the test repeatedly, realign the circuitry for that channel (see section 5.2.4). If channel responds appropriately, channel is ready for operation.

5.2.4 Oxygen Channel Circuit Realignment

Channel circuitry alignment may be required when the Rough Test (section 5.2.3) indicates that the channel does not activate alarm signals at the designated alarm point.

If the channel is in constant alarm, the problem may rectified by adjusting the oxygen gain; see section 5.2.2. If the gain adjustment is not sufficient to reset the channel meter to 20.9% oxygen when the sensor is in fresh air, see section 5.2.5 to determine whether the oxygen cell requires replacement. If the cell is replaced, perform the gain adjustment and Rough Test once again. If the channel again fails the Rough Test, perform channel circuitry realignment.

5.2.4 Oxygen Channel Circuit Realignment (continued)

IMPORTANT: Any deviation from the procedure described below voids the instrument warranty. If you have questions about the procedure, contact ENMET personnel. MAKE CERTAIN THE TEST POINTS AND POTENTIOMETERS WHICH ARE ADJUSTED CORRESPOND TO THE CHANNEL BEING ALIGNED; REFER TO FIG. 10.

MATERIALS

-- digital voltmeter (set to measure 0.00 - 5.00 vdc range).

-- small screwdriver (to adjust potentiometers on channel circuit boards inside the control unit).

PROCEDURE: Refer to Fig. 10 for test point and potentiometer locations, which are given for the three types of circuit boards available. This procedure is given relative to an S-2 cell, P/N 67013-008 as supplied as a replacement part. Note that the gain potentiometer for a channel is located on the exterior control surface next to the meter for that channel.

1. Turn the horn defeat switch to "off".

2. Null adjust:

   a) Disconnect the oxygen cell from the circuit by disconnecting the cell leads at TB(n)-A4 or TB(n) -A9 (where "n" is the channel number) on the control unit motherboard terminals (refer to Fig. 4 for terminal block TB(n) locations). NOTE: If channel has an oxygen deficiency alarm point, the channel goes into alarm once oxygen cell is disconnected.

   b) Check the null voltage for the channel. Connect the voltmeter leads to the appropriate testpoints, indicated below, on the channel's circuit board.

      null voltage test points: TP101 (-) and TP102 (+)
      TP201 (-) and TP202 (+)

   c) Adjust the appropriate null adjust potentiometer (indicated below) on the channel's circuit board so that the voltage between the points is 0.00 vdc:

      null adjust potentiometer: R108
      R208

3. Low Level Set Adjust:

   a) Reconnect the oxygen cell to the circuit by reconnecting the leads removed in step 2 a).

5.2.4 Oxygen Channel Circuit Realignment (continued)

b) Make sure the oxygen cell is properly connected by measuring the voltage between the cell leads at control unit terminals TB(n)-A3 (-) and TB(n)-A4 (+) or TB(n)-A8 (-) and TB(n) -A9 (+) where n is the channel number (see Fig. 4). This voltage must be between 0.043 and 0.09 Vdc.

c) Measure the Low Level Set voltage for the channel by connecting the voltmeter leads to the testpoints (indicated below) on the channel's circuit board:

low level set test points: TP101 (-) and TP103 (+)
TP201 (-) and TP203 (+)

d) Adjust the low level set potentiometer (indicated below) on the channel's circuit board to give 0.766 vdc between the testpoints identified in step 3 c:

low level set potentiometer: R112
R212

4. Full Scale Adjustment:

a) Place voltmeter leads at the testpoints identified below on the channel's circuit board to check the full scale voltage:

full scale voltage test points: TP101 (-) and TP102 (+)

b) Adjust the oxygen gain potentiometer for the channel, so the voltage between the testpoints identified in step 4 a) is 1.24 Vdc.

c) Adjust the meter full scale potentiometer (counterclockwise to increase, clockwise to decrease), identified below, on the channel's circuit board so the oxygen meter on the front panel reads full scale (26.0% oxygen for most meters).

full scale voltage potentiometer: R110
R210

d) Remove the voltmeter leads from the test points.

5. Alarm Set Adjust

a) Adjust the oxygen gain potentiometer for the channel so the channel's meter reads at the alarm point to be adjusted.

5.2.4 Oxygen Channel Circuit Realignment (continued)

b) Adjust the appropriate alarm point adjust potentiometer, identified below, on the channel's circuit board counterclockwise until the channel just goes into alarm. The oxygen alarm light should just activate. NOTE: If the alarm light is on before you begin the potentiometer adjustment, adjust this pot. clockwise until the light turns off, then readjust counterclockwise until the light just activates.

Channels with Single Alarm Point

alarm point adjust potentiometer: R116

Channels with Two Alarm Points

lower alarm point adjust potentiometer: R116
higher alarm point adjust potentiometer: R216

c) Adjust the oxygen gain potentiometer for the channel upscale (clockwise) and downscale (counterclockwise) so that the channel goes in and out of alarm at the designated alarm point(s).

d) Expose the channel's oxygen cell to clean, fresh air for 5 minutes. Adjust gain potentiometer for the channel (clockwise to increase, counterclockwise to decrease meter reading) so meter reads at 20.9%. IMPORTANT: The oxygen cell for the channel must be exposed to fresh, clean air for this adjustment. If oxygen-deficient air is suspected near the oxygen cell, supply bottled 20.9% oxygen in nitrogen to the cell for a few minutes and then make the potentiometer adjustment.

e) Perform a Rough Test (section 5.2.3). The oxygen alarm signals should activate when the meter reaches the corresponding alarm point(s).

f) If the oxygen alarm signals do not activate at the specified alarm point(s), repeat the entire realignment procedure, making sure to check terminal connections, test points, and voltage settings very carefully. If this still does not solve the problem, contact your authorized ENMET service center.

6. Circuit alignment for the channel is complete. Proceed to next channel requiring alignment. When all channels requiring alignment have been serviced, turn the system horn back on. Proceed to section 4.0, Operation.

5.2.5 Oxygen Cell Check

If the channel does not respond to the oxygen gain adjustment (section 5.2.2), perform the following to verify that the oxygen cell is depleted.

MATERIALS

-- digital voltmeter and screwdriver (to remove screws from sensor assembly lid)

PROCEDURE

1. Unscrew and remove the lid from the sensor assembly enclosure. Remove gently; the cell circuit board is bolted to the sensor assembly lid and wired to the base of the sensor assembly.

2. While the cell is still plugged into the cell circuit board, check the voltage across the cell leads (the center pin on the cell is negative, the outside pin on the cell is positive). Voltage is .043 to .09 vdc. If voltage is not within this range, the cell must be replaced. If cell voltage is within this range, then the lack of channel response to gain adjustment is due to another cause. Attempt channel circuit realignment (section 5.2.4).

5.2.6 Oxygen Cell Installation/Replacement

Oxygen cell replacement is usually required when the oxygen gain adjustment (section 5.2.2) can no longer compensate the circuit (reset a channel's meter to a 20.9% oxygen while the sensor is in fresh air) for oxygen cell depletion. If the gain adjustment does not compensate the circuit, check the cell voltage as described in section 5.2.5 to verify that the cell requires replacement.

As shipped from ENMET, the cell is packaged in an airtight plastic film bag filled with nitrogen to prevent cell depletion during shipment. Keep the cell in the bag until 4 hours before installation. Once the cell is removed from the bag, it must adjust to its operating environment for 4 hours prior to operation.

If the Oxygen Cell Check procedure (section 5.2.5) determines that a cell must be replaced, perform the following procedure.

MATERIALS

-- screwdriver (to open sensor assembly and to unscrew cell circuit board stand-offs inside sensor assembly)

5.2.6 Oxygen Cell Installation/Replacement (continued)

-- new oxygen cell (ENMET part no. 67013-008)

PROCEDURE

1. Remove the cell from the protective plastic bag.

2. Carefully remove the metal shorting clip from the cell.

3. Unscrew the lid of the sensor assembly (Remove gently. The cell circuit board is attached to the lid and wired to the base of the assembly). Unscrew the stand-offs holding the cell circuit board to the lid of the assembly.

4. Unplug the old cell from the circuit board. Install the new cell into the component side of the sensor assembly circuit board (see Fig. 11). The cell active face of the cell, which resembles the end of a salt shaker, faces the sintered steel disk in the assembly lid once installed.

5. Set the cell and circuit board in place on the sensor assembly lid with the cell face on the sintered steel disk and replace stand-off screws. CAUTION: Replace stand-off screws gently; over-tightening the screws may damage the circuit board components beneath the oxygen cell.

6. Replace sensor assembly lid onto sensor assembly.

7. Allow the cell to adjust to its new environment for four hours. Then proceed to sections 5.2.2 and 5.2.3 to perform both an oxygen gain adjustment and a Rough Test for the channel.

5.2.7 Intrinsic Safety Barrier Replacement

If a sufficient power surge occurs within an oxygen cell circuit containing an intrinsic safety barrier, the barrier opens to break the circuit (channel goes into alarm if channel has oxygen deficiency alarm point; alarm cannot be defeated by an oxygen gain adjustment or oxygen cell replacement). Once the barrier has opened, it must be replaced. See section 5.4 for part number.

To check if the intrinsic safety barrier has opened, disconnect power to the control unit. Using a voltmeter, check for electrical continuity across terminals 1 and 3 of the barrier (see Fig. 12). If no continuity, barrier has opened and must be replaced. To replace barrier, disconnect control unit power, unscrew terminal leads and mounting screw to remove barrier. Install new barrier and reconnect leads as shown in Fig. 12.

5.3 System Lamp Replacement

The lamps/lenses simply screw in (clockwise) and out (ccw) of the front panel of the control panel. See section 5.4 for part numbers of these components.

5.4 System Replacement Parts and Accessories

Description	Part Number
Channel circuit board, gas, 109 sensor	04514-000
Channel circuit board, gas	04514-002
Single channel circuit board, oxygen	04537-000
Dual channel circuit board, oxygen	04537-001
Single channel circuit board, oxygen	
With low-low alarms	04537-002
With high-low alarms	04537-003
With high-high alarms	04537-004
Gas cylinder regulator with flowmeter	03700-001
Gas cylinders (24 liter, 300 psi)	
carbon monoxide, 10 ppm	03219-010
" 20 ppm	03219-020
" 35 ppm	03219-035
" 50 ppm	03219-050
" 75 ppm	03219-075
" 100 ppm	03219-100
" 150 ppm	03219-150
" 200 ppm	03219-200
" 300 ppm	03219-300
" 400 ppm	03219-400
" 500 ppm	03219-500
methane, 2% LEL	03220-002
" 5% LEL	03220-005
" 10% LEL	03220-010
" 15% LEL	03220-015
" 20% LEL	03220-020
" 25% LEL	03220-025
" 30% LEL	03220-030
" 40% LEL	03220-040
" 50% LEL	03220-050
" 60% LEL	03220-060
propane, 5% LEL	03221-005
" 10% LEL	03221-010
" 20% LEL	03221-020
" 40% LEL	03221-040
" 50% LEL	03221-050
methyl chloride, 25 ppm	03281-025
" 50 ppm	03281-050
" 60 ppm	03281-060
" 75 ppm	03281-075
" 100 ppm	03281-100

5.4 System Replacement Parts and Accessories (continued)

methyl chloride,	150 ppm	03281-150
"	200 ppm	03281-200
"	250 ppm	03281-250
"	300 ppm	03281-300
"	400 ppm	03281-400
"	500 ppm	03281-500
butane,	5% LEL	03282-005
"	10 LEL	03282-010
"	20 LEL	03282-020
oxygen ,	17% by volume	03296-170
"	18.0% by volume	03296-180
"	19.5% by volume	03296-195
"	20.9% by volume	03296-209

For ISA 44-3 through 10 with S/N 2249 and below

Lamp	63004-000
Lens, amber	62012-003
Lens, green	62012-002
Lens, red	62012-001

For ISA 44-3 through 10 with S/N 2250 and above

Lamp	63001-002
Lens, amber	62012-013
Lens, green	62012-012
Lens, red	62012-011

MOS Sensor Assemblies	
109 sensor	03033-109
812 sensor	03033-812
813 sensor	03033-813
814 sensor	03033-019
Oxygen cell	67013-008
Oxygen cell housing	03041-002
Intrinsic safety barrier	64011-000

6.0 SPECIFICATIONS

POWER	110 Vac single phase, 12 Vdc around 9 amps max. draw (10 channel unit) Contact ENMET for use of 220 Vac
ALARMS	Audio: high pitched steady tone, 2700 Hz, 95 Db at 2 feet Visual: red and amber lights
ELECTRONICS	Low power, all solid state, utilizing integrated circuits
GAS SENSOR LIFE	3 year or more in relatively clean air applications
RESPONSE TIME (MOS sensors)	Proportional to concentration of hazardous gas at the sensor location and calibration level of that particular channel. Channels calibrated to detect low concentrations of gas respond very quickly when exposed to very high concentrations. Range of 2–30 seconds for unit to show 90% of final reading. Very

6.0 SPECIFICATIONS (continued)

	low levels of gas take a maximum of 5 minutes for reading to level off.
CONTROL UNIT	Painted steel enclosure, NEMA-12
GAS SENSOR ENCLOSURE	Suitable for use in Class 1, Division 1, Groups A,B,C, and D hazardous atmospheres. Also in Class II, Groups E, F, and G atmospheres containing metallic carbon, or grain dust as defined by the National Electrical Code. NOTE: If oxygen sensor is to be used in combustible environments, it must be used in conjunction with an intrinsic safety barrier; contact ENMET for details.
WIRING	Terminal strips are provided inside the control unit. Sensors can be located up to 1000 feet from the control unit. Greater distances require other provisions. Contact your distributor or ENMET's Service Department for assistance.

7.0 WARRANTY AND REPAIR POLICY

ENMET warrants new instruments to be free from defects in workmanship and material under normal use for a period of one year from date of shipment from ENMET. The warranty covers both parts and labor; however, oxygen cells are limited to a warranty period of six (6) months from date of shipment from ENMET. Fuses and intrinsic safety barriers are not warranted. Equipment believed to be defective should be returned to ENMET within the warranty period (transportation prepaid) for inspection. If the evaluation by ENMET confirms that the product is defective, it will be repaired or replaced at no charge, within the stated limitations, and returned prepaid to any location in the United States. ENMET shall not be liable for any loss or damage caused by the improper use of the product. The purchaser indemnifies and saves harmless the company with respect to any loss or damages that may arise through the use by the purchaser or others of this equipment.

This warranty is expressly given in lieu of all other warranties, either expressed or implied, including that of merchantability, and all other obligations or liabilities of ENMET which may arise in connection with this equipment. ENMET neither assumes nor authorizes any representative or other person to assume for it any obligation or liability other than that which is set forth herein.

7.1 Repair of Certain Units

The warranty does not apply to equipment returned in either of the conditions defined below. These are not the result of defective workmanship or material.

A) GROSS RECALIBRATION involves significant maladjustment of one or more potentiometers. ENMET calibrates all ISA-44 channels according to customer order before shipping. Customer adjustment of the potentiometer settings voids the warranty, except when following the maintenance procedures described in this manual. If a system requiring gross recalibration is received at the ENMET repair departnment, and no defects exist, the unit is recalibrated according to the original order.

B) GROSS SENSOR CONTAMINATION involves a badly contaminated sensor which does not respond to either or all of the following: purging, sensor heater voltage adjustment or recalibration. Although the MOS sensor is durable, gross contamination occurs upon close exposure to an open gas flame, contact with chemicals such as lacquer, or continuous exposure to heavy concentrations of industrial vapors. A grossly contaminated sensor must be replaced. When such a system is received at the ENMET repair department, the sensor is replaced and the channel is recalibrated.

WHEN YOU RETURN A UNIT TO THE FACTORY FOR SERVICE (warranty or otherwise):

-- Be sure to include paperwork.

-- A purchase order, return address, and telephone number will assist in the expedient repair and return of your unit.

-- Include any specific instructions: For warranty service, include date of purchase; if you require an estimate, please tell us.

ENMET CORPORATION
PO Box 979
680 Fairfield Court
Ann Arbor, Michigan 48106-0979
734.761.1270 Fax 734.761.3220

Returning an Instrument for Repair

ENMET instruments may be returned to the factory or any one of our Field Service Centers for regular repair service or calibration. The ***ENMET*** Repair Department and Field Service Centers also perform warranty service work.

When returning an instrument to the factory or service center for service, paperwork must be included which contains the following information:

- A purchase order number or reference number.
- A contact name with return address, telephone and fax numbers
- Specific instructions regarding desired service or description of the problems being encountered.
- Date of original purchase and copy of packing slip or invoice for warranty consideration.
- If a price estimate is required, please note it accordingly *and be sure to include a **fax number**.*

Providing the above information assists in the expedient repair and return of your unit.

Failure to provide this information can result in processing delays.

ENMET charges a one hour minimum billing for all approved repairs with additional time billed to the closest tenth of an hour. All instruments sent to ***ENMET*** are subject to a minimum $30 evaluation fee, even if returned unrepaired. Unclaimed instruments that ***ENMET*** has received without appropriate paperwork or attempts to advise repair costs that have been unanswered, after a period of 60 days, may be disposed of or returned unrepaired COD with the evaluation fee.

Service centers may have different rates or terms. Be sure to contact them for this information.

Repaired instruments are returned by UPS/RPS surface and are <u>not insured</u> unless otherwise specified. If expedited shipping methods or insurance is required, it must be stated in your paperwork.

Note: Warranty of customer installed components.

If a component is purchased and installed in the field, and fails within the warranty term, it can be returned to ***ENMET*** and will be replaced, free of charge, per ***ENMET***'s returned goods procedure.

If the entire instrument is returned to ***ENMET*** Corporation with the defective item installed, the item will be replaced at no cost, but the instrument will be subject to labor charges at half of the standard rate.

Repair Return Form

Mailing Address:
ENMET Corporation
PO Box 979
Ann Arbor, Michigan 48106

Phone Number: 734.761.1270
FAX Number: 734.761.3220

Shipping Address:
ENMET Corporation
Attn: Repair Department
680 Fairfield Court
Ann Arbor, Michigan 48108

Your Mailing Address:

____
____
____
____

Your Shipping Address:

____
____
____
____

Contact Name: ____________________ **Your Phone:** ____________________

Your PO/Reference Number: _______________ **Your FAX:** ____________________

Payment Terms: (check one)
- ❑ ***COD***
- ❑ ***VISA / MasterCard*** ____________________ Card number ________ Expiration

Return Shipping Method:

- ❑ UPS/RPS Surface: ❑ 3 day ❑ 2nd Day Air ❑ Next Day Air
- ❑ Federal Express: ❑ Next Day Morning ❑ Next Day Afternoon ❑ Standard
- ❑ FedEx Account number: ____________________

Would you like *ENMET* to insure the return shipment?

❑ No ❑ Yes **Insurance Amount: $**________________