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MODEL CD-3A

CARBON DIOXIDE ANALYZER

INSTRUCTION MANUAL

FOR THE

CD-3A CARBON DIOXIDE ANALYZER

SERIAL NUMBERS

READOUT/CONTROL ___
SENSOR (P-61B) ___

CONTENTS

CONTENTS CONT'D.

Warranty and Claims

We warrant that any equipment of our own manufacture or manufactured for us pursuant to our specifications which shall not be, at the time of shipment thereof by or for us, free from defects in material or workmanship under normal use and service will be repaired or replaced (at our option) by us free of charge, provided that written notice of such defect is received by us within eighteen (18) months from date of shipment. All equipment requiring repair or replacement under this warranty shall be returned to us at our factory, or at such other location as we may designate, transportation prepaid. We shall examine such returned equipment and if it is found to be defective as a result of defective materials or workmanship, it shall be repaired or replaced as aforesaid. Our obligation does not include the cost of furnishing any labor in connection with the installation of such repaired or replaced equipment or parts thereof, nor does it include the responsibility or cost of transportation. In addition, instead of repairing or replacing the equipment returned to us as aforesaid, we may, at our option, take back the defective equipment and refund in full settlement the purchase price thereof paid to Buyer. If you are returning equipment from outside the United States, a statement should appear on the documentation accompanying the equipment being returned declaring that the goods being returned for repair are American goods, the name of the firm who purchased the goods, and the shipment date.

This warranty shall not apply to any equipment (or part thereof) which has been tampered with or altered after leaving our control, or which has been repaired by anyone except us, or which has been subject to misuse, neglect, abuse, or improper use. Misuse or abuse of the equipment, or any part thereof, shall be construed to include, but shall not be limited to, damage by negligence, accident, fire, or force of the elements. Improper use or misapplication shall be construed to include improper or inadequate protection against shock, vibration, high or low temperature, overpressure, excess voltage and the like, or operating the equipment with or in a corrosive, explosive or combustible medium unless the equipment is specifically designed for such service, or exposure to any other service or environment of greater severity than that for which the equipment was designed.

This warranty does not apply to used or second-hand equipment, nor extend to anyone other than the origina1 purchaser from us.

THIS WARRANTY IS GIVEN AND ACCEPTED IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF FITNESS OR OF MERCHANTABILITY OTHER THAN AS EXPRESSLY SET FORTH HEREIN, AND OF ALL OTHER OBLIGATIONS OR LIABILIES ON OUR PART. IN NO EVENT SHALL WE BE LIABLE UNDER THIS WARRANTY OR ANY OTHER PROVISION OF THIS AGREEMENT FOR ANY ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES, CONSEQUENTIAL DAMAGES, TIME CHARGES, OR ANY OTHER LOSSES INCURRED BY THE ORIGINAL PURCHASER OR ANY THIRD PARTY IN CONNECTION WITH THE PURCHASE, INSTALLATION, REPAIR, OR OPERATION OF EQUIPMENT, OR ANY PART THEREOF, COVERED BY THIS WARRANTY OR OTHERWISE, WE MAKE NO WARRANTY, EXPRESS, OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF FITNESS OR OF MERCHANTABILITY, AS TO ANY OTHER MANUFACTURER'S EQUIPMENT, WHETHER SOLD SEPARATELY OR IN CONJUNCTION WITH THE EQUIPMENT OF OUR MANUFACTURE. WE DO NOT AUTHORIZE ANY REPRESENTATIVE OR OTHER PERSON TO ASSUME FOR US ANY OTHER LIABILITY IN CONNECTION WITH EQUIPMENT, OR ANY PART THEREOF, COVERED BY THIS WARRANTY.

CAUTION

DO NOT USE THIS INSTRUMENT IN THE PRESENCE OF FLAMMABLE ANESTHETICS OR FLUORINATED GASES.

NOT FOR USE WITH ANESTHETIC GAS MIXTURES.

THIS INSTRUMENT MUST BE ELECTRICALLY GROUNDED.
DO NOT USE AN UNGROUNDED CONNECTOR OF ANY KIND.

DO NOT OPEN SENSOR CABINET WITHOUT PRIOR FACTORY AUTHORIZATION.

FOR HIGHEST ACCURACY, TOP COVER MUST REMAIN ON INSTRUMENT.

I

GENERAL INFORMATION

1.1 INTRODUCTION

The CD-3A Carbon Dioxide Analyzer system provides continuous and accurate measurement of carbon dioxide concentrations from 0-15%. The CD-3A Analyzer consists of a readout/control unit with a connecting cable to the P-61B sensor.

The Model R-1 or R-2 Flow Control is frequently used in conjunction with the CD-3A Oxygen Analyzer, although separate equipment can certainly be used for gas handling if desired. The Model R-1 Flow Control contains the flow meter, pump, and needle valve in a single cabinet. The Model R-2 Flow Control contains 2 flow meters, pump, and 2 needle valves in a single cabinet.

1.2 FLOW DIAGRAM

The preferred flow arrangement is to draw the gas sample through the Sensor with the pump and then vent it to the room or into a hood. A presence of carbon dioxide partial pressure in the sensor generates a voltage signal which is fed to the CD-3A Readout/Control unit where it is processed. The carbon dioxide concentration of the sample is then displayed on the Display contained in the CD-3A and can be recorded simultaneously via the Analog Output.

1.3 MODEL CD-3A READOUT/CONTROL

The readout/control unit performs the following major functions:

- Provides convenient digital readout of the unknown carbon dioxide concentration in percentage.
- Provides rapid zero and span calibration.
- Provides power to the sensor.
- Provides Analog Output for %CO2.

The front panel controls/indicators are:

END TIDAL SWITCH: Button Starts/Stops End Tidal mode of operation.
END TIDAL INDICATOR: LED lamp indicates End Tidal mode of operation.
CALIBRATE/SAMPLE SWITCH: Switches instrument between the CALIBRATE position and SAMPLE position.
ZERO POTENTIOMETER: Sets instrument for “low end” calibration gas chosen.
SPAN POTENTIOMETER: Sets instrument for “high end” calibration gas chosen.
DISPLAY: Displays readings in %CO2.

The rear panel controls/indicators are:

ON/OFF SWITCH: All power to unit switched on and off.
MAIN FUSE, Fl: 2.5 Amp slo-blo for entire unit. (1.5 Amp for 230 Volt units).
FAST/SLOW SWITCH: Speed of the Analog Output response time. Fast = 25 msec. Slow = 800 msec.
CONNECTOR: 17-pin connector for sensor cable.
ANALOG OUTPUT: %CO2 0-7.5V.

1.4 SENSOR

The insulated sensor cabinet contains the Sample and Reference cells, motorized chopper wheel, and control and sensing circuitry.

1.5 INSPECTION AND INSTALLATION

1.5.1 Inspection

The CD-3A Carbon Dioxide Analyzer has been thoroughly inspected and carefully packed prior to shipment. When the instrument is received, it should be examined both before and after unpacking for any physical damage that may have occurred in transit. Install and operate the instrument as soon as possible to check for any internal damage. Save all packing materials until this inspection is complete. If damage is found, a claim should be filed promptly with the carrier and AEI Technologies should be notified so that we can arrange for any repair or replacement necessary.

1.5.2 Installation

Connect the Sensor Cable to the Sensor and the Control Unit. As shipped, the sensor inputs are protected by flexible tubing that should be removed. Also see Start-Up Section 2.4 and Calibration Section 2.5.

II

OPERATING INSTRUCTIONS

2.1 INTRODUCTION

The following sections provide much of the information necessary to Start-up, Calibrate, Operate, and use the CD-3A.

2.2 GAS CONNECTIONS

2.2.1 General

The sample gas must flow through the sensor. The tubing on the Model P-61B Sensor is 1/8 inch O.D. For normal use, connect the sample gas to the IN port of the sensor. As shipped, the sensor inputs are protected by flexible tubing that should be removed. The gas supply system must be free of leaks, water, and sources of contamination. For typical respirometry applications 1/8 inch I.D. flexible PVC tubing should be used. 1/16 inch I.D. may be adapted for use in applications requiring the fastest response times or minimal dead space.

When certain that the sample tubing corrections are correctly connected, secure them onto the sensor IN - OUT port tubes using the cable ties provided. Use 3 cable ties rotated 120 degrees from each other on each sensor port tube.

The effect of a contaminant will depend on its chemical composition. Any contaminant will dilute the gas stream, decreasing the carbon dioxide concentration accordingly. Any adsorbed carbon dioxide present may desorb and result in a higher reading.

Some further precautions should be observed to prevent damage to the sensor. Care must be taken not to introduce gas into the sensor at high pressures (or at very high flow rates). (If necessary, the sensor can be protected from strong pressure surges by installation of a rupture disk.) A slug of liquid or particulate that is accidentally swept through the sensor may interfere with the optical signal path. If the possibility of drawing liquid through the sensor exists, either because the sample contains liquid or as a result of condensation in the gas line, a filter or trap should be installed in the line before the sensor. A filter should also be used if any particulate matter is present which could clog the sensor. For fast response applications, where a filter may not be advisable, see Section 2.2.4.

A flow rate of 50-500 ml/mm. may be used. 100 - 250 ml/mm. is recommended for most applications. 300-500 ml/mm. should be used for breath-by-breath analysis. The Model R-l Flow Control provides a convenient means of maintaining suitable constant flow rates and the flow arrangements discussed below. Other flow control equipment can be used if preferred. **IMPORTANT: The Sample (unknown) and Calibration gases should be flowed at the same rate so that the total gas pressure in the sensor remains the same.** Some variation in flow rate is permissible if the total gas pressure is not altered within the accuracy required. If separate lines are

used for the calibration and unknown gases, the lengths and diameters of the tubing should be the same to insure equal pressure drops. The same mode of flow (i.e., forcing or drawing the gas through the sensor) must be used for both calibration and unknown gases.

2.2.2 Preferred Gas Flow Arrangement

SAMPLE / CALIBRATION GAS → PARTICULATE FILTER → DRYER → MASS FLOWMETER [if needed] → CD-3A INPUT → R-1(2) FLOW CONTROL INPUT

The arrangement shown above is recommended for most applications. It permits maximum sensitivity to changes in sample carbon dioxide concentration and avoids any possible contamination from the neoprene pump. The sample gas is drawn through the sensor by the pump and the rate of flow is controlled by the flow meter needle valve on the Flow Control. A flow rate of 100 - 250 ml/min is suitable for most applications. In some instances, for example respiratory measurements with very small animals, the sample available for analysis may be limited and smaller flow rates should be chosen.

To adjust the sample flow rate partially close the flow meter needle valve by turning it clockwise but do not over tighten. Connect the calibration gas to the same Dryer input using approximately the same length and diameter tubing to be used for the unknown sample. Adjust the flow rate to the same value for both calibration and sampling using the needle valve.

The AEI Technologies Dryer Kit is ideal for drying of the sample gas.

2.2.3 Special Flow Arrangements

If the source of the gas is at high pressure (e.g., calibration gas in a tank), the pressure should first be reduced to atmospheric pressure. The gas may be collected in a sample bag and the sample bag can then be connected to the system. Alternately, the gas may be vented through a large syringe barrel to the atmosphere and sampled by placing a piece of small diameter tubing halfway down the barrel. The gas will be near room pressure at the point of sampling. Be sure to flow both the calibration and unknown gases through tubing of the same length and diameter and at the same flow rate so that the pressure drop will be the same.

2.2.4 Other Applications

The instrument responds extremely rapidly to changes in carbon dioxide content in the sensor itself. There is a delay in response due to the time necessary to transport the sample from its source to the sensor. This transport time can be minimized by use of a high flow rate (300—500 ml/min) and as short a length of small diameter tubing, 1/16” ID, as is practical.

To insure accurate response, mixing of the sample must be avoided. For optimum response, when the sample gas is clean and dry, no filter should be placed in the line as this may cause mixing and increase the transport time. For online pulmonary monitoring where large flow rates (500 ml/min) are used, special filter traps may be used to remove mucous and dust particles without significantly increasing the response time. If possible, the same plumbing should be used for calibration and

measurement to maintain the same total pressure in the sensor.

If the sample size is limited, smaller diameter tubing may be used. For example, 15mm ID catheter tubing can be used for infant respiratory measurements. Alternately, a restrictive orifice may be placed in the line immediately following the sample, i.e., for respiratory measurements, at the mouthpiece. The pressure in the line and sensor will be decreased below 1 atmosphere, allowing a high flow rate to be maintained while decreasing mass flow. Be sure that the calibration gas is also passed through the orifice. It may be necessary to clean the line more frequently to prevent clogging or to use a special filter trap.

In breath-by-breath analysis, the exhaled breath is saturated with water vapor. The effect of the water vapor is to dilute the carbon dioxide content of the sample; it does not interfere with the accuracy or response of the instrument. Condensation of moisture can occur when the sample is cooled from body temperature to that of the room. Accumulation of water in the line is undesirable and can be avoided by use of a Dryer.

The AEI Technologies Dryer Kit is ideal for drying of the sample gas.

2.2.5 Flow Dependence

The readings obtained may vary somewhat with flow rate. For this reason, the rate of sample gas flow through the sensor should be carefully controlled using the R-l or R-2, or other suitable flow control equipment.

At flow rates of less than 10 ml/min, or under no flow conditions, the reading will drift initially until a steady state is reached. This may take from a few minutes to several hours. Once equilibrium is established, further measurements may be made with a high degree of accuracy provided that a continuous gas flow at a constant flow rate is maintained. If the unknown gas flow must be interrupted, as is the case when discrete samples are being analyzed, airflow at the same rate should be substituted between samples to maintain steady state conditions. In this way, a motor-driven syringe can be used to inject 5-10 ml samples at a constant flow rate.

2.2.6 Pump Fluctuations

For some users, slight pump fluctuations have interfered with very accurate measurements. If this is a problem, insert a surge tank (bottle) in the line between the flowmeter and the pump. A bottle volume of 1000 ml is suitable.

2.3 ELECTRICAL CONNECTIONS

The P-61B sensor is connected via cable to the 17-pin circular connector on the rear of the CD-3A. It is most important that the connectors be securely mated to ensure good electrical contact. Carefully push the connectors together as far as they will go and then turn the threaded sleeve until it feels tight. Repeat each of these steps in turn until about two threads remain visible or until the sleeve will not tighten further. The readout/control should be plugged into a 117VAC (230VAC for Model COV) grounded three-terminal receptacle. The flow control can be plugged into a similar

receptacle.

CAUTI0N: This instrument must be electrically grounded. Do not use an ungrounded adaptor of any kind.

2.4 START-UP

Make the necessary gas and electrical connections as described in the preceding two sections. Turn the power switch ON. The Display will light up and may display unusual values for several seconds. It will then begin to read the value of the gas in the sensor. The instrument should be allowed to warm-up for approximately 30 minutes before use, and for the most accurate measurements a warm-up time of at least 4 hours is recommended.

The FAST/SLOW switch should be set to the desired position.

2.5 CALIBRATION AND LEAK TEST

2.5.1 Calibration Gas

There are a variety of grades of bottled calibration gases available on the market today. We strongly recommend that only Primary Laboratory Standard gases, certified gravimetrically, be used to calibrate the AEI Technologies gas analyzers. This grade of gas is normally delivered either with a very specific label or an attached certificate stating its contents out to two decimal places. Specified accuracy should be +/- 0.02% absolute or better for concentrations over 2%, +/- 10% of component for lower concentrations. Naturally, utilization of the most precise calibration gases assures you of the most accurate calibration possible for your AEI Metabolic Systems gas analyzers.

It is strongly reccommended that 2 calibration gas cylinders be used for gas analyzer calibration: typically 21.00%O2 and 0.03% CO2 for one cylinder; and typically 16.00%O2 and 4.00% CO2 for the other. This assures accurate measurement of expiratory gas and for accurately measuring inspiratory [ambient] gas concentration values.

The AEI Technologies Calibration Gas Module is designed to meet these stringent requirements.

Room air is a suitable and convenient choice of the “low end” calibration gas for some non-critical applications. It must be dried, free of contaminants, and well ventilated with fresh outside air.

2.5.2 Calibration Procedure

1). Set the ZERO POT and the SPAN POT to mid-range (**“**5” in the window of the vernier counter).

2). Turn the CALIBRATE/SAMPLE SWITCH to the CALIBRATE position.

3). Flow “low end” calibration gas through the cell in the same manner that the unknown gas will be sampled. (Allow ample time for reading to stabilize). This is typically the lowest concentration the CD-3A will sample.

4). Adjust the ZERO POT to obtain the exact calibration gas value on the Display.

NOTE: If you run out of range on the ZERO POT: set the CALIBRATE/SAMPLE

SWITCH in the SAMPLE position; turn the ZERO POT all the way back in the opposite direction; set the CALIBRATE/SAMPLE SWITCH in the CALIBRATE position; adjust the ZERO POT. Repeat until the display reads correctly.

5). Flow "high end" calibration gas through the cell in the same manner that the unknown gas will be sampled. (Allow ample time for reading to stabilize). This is typically equivalent to the nominal maximum CO2 concentration of the sample gas.

6). Adjust the SPAN POT to obtain the exact calibration gas value on the Display.

NOTE: If you run out of range on the SPAN POT: set the CALIBRATE/SAMPLE SWITCH in the SAMPLE position; turn the SPAN POT all the way back in the opposite direction; set the CALIBRATE/SAMPLE SWITCH in the CALIBRATE position; adjust the SPAN POT. Repeat until the display reads correctly.

7). Repeat Steps 3-6 until no further adjustment is necessary.

8). Turn the CALIBRATE/SAMPLE SWITCH back to the SAMPLE position. The unit is now calibrated and ready for operation.

2.5.3 Leak Test

This test should be performed before any measurements are taken on the initial setup of the system and frequently thereafter. Gas leaks are one of the most common sources of error in gas measurement. The simplest method to test for leaks in the system is as follows:

- Turn on the R-1 Flow Control.
- Block the sample gas input using a clamp or your finger. It should initially be blocked at the farthest point upstream in the sample gas tubing path from the R-1. In other words, blocked as close to the source of the sample as possible.
- Observe the balls on the R-1 flowmeter. Both balls will slowly drop to "0" and stay there without any bouncing if there is no leak. Even a slight movement of the balls indicates a leak.
- If the balls do not drop or they are bouncing, there is a leak in the system. The source of the leak can be further located by blocking the sample gas flow at other locations in the sample gas tubing path.

2.6 END TIDAL

Pushing the END TIDAL BUTTON on the front panel sets up the instrument to display consecutive peak C02 values of 1% or greater. A new peak value is displayed each time the C02 concentration falls again below 0.9%. It is generally reccommended that the FAST/SLOW switch should be set to the FAST position.

When the instrument is put into the END TIDAL MODE by pushing the END TIDAL BUTTON, the END TIDAL LAMP will start flashing. As soon as the first peak value is displayed, after about 2 breaths, the blinking stops and the END TIDAL LAMP will stay lit until the instrument is put

back into the continuous update mode by again pushing the END TIDAL BUTTON.

The ANALOG OUTPUT is unaffected by the END TIDAL button and will provide a continuous indicating of the value of the gas being sampled.

2.7 ANALOG SIGNAL OUTPUT FOR RECORDING

The analog output provides 0-7.5 Volts for 0—15.00% carbon dioxide. Connect to the BNC Coax connector labeled ANALYZER OUTPUT on the back panel of the CD-3A. A shielded cable should be used. The shield of the cable should be connected to the low input of the recording device. It is recommended that the recording device have a differential input. This will avoid ‘ground loops’ that result in increased noise.

Normally, the RESPONSE TIME switch is set to the SLOW position. The output is then updated every 800ms, which corresponds to the front panel display.

Only for breath-by-breath and similar fast response measurements, the FAST position of the RESPONSE TIME switch is used. The output will then be updated every 24ms. The front panel display is not affected by this change.

2.8 HIGH ACCURACY MEASUREMENTS

The CD-3A Oxygen Analyzer can be used for high accuracy measurements. The carbon dioxide content of the gas used for calibration must be known to at least the same accuracy. A Primary Laboratory Standard gas is recommended.

Measurements of this accuracy will be sensitive to small changes with time in the composition of the reference air in the sensor cabinet. More frequent calibration checks may be necessary.

2.9 OVERRANGE

The Display over ranges at CO2 concentrations of approximately 15.99%.

III

PRINCIPLES OF OPERATION

3.1 SENSOR

The Sensor contains an infrared source, the IR optics with the filters, a chopper and a cooled lead selenide detector with a preamplifier. Power is received from and signals are transmitted to the CD-3A Readout/Control Unit through the special sensor cable. It connects to the 17-pin connector at the side of the sensor. The Sensor cabinet is hermetically sealed to prevent room ambient air from contaminating the optical light path.

The front of the P-61B Sensor has an IN and an OUT connection for the gas to be analyzed.

3.2 READOUT/CONTROL

The Readout/Control unit contains the analog and microprocessor electronics and the power supplies for the CD-3A and the P-61B Sensor.

The front panel of the Model CD-3A Readout/Control contains a 0.00 - 15.00% digital display, the ZERO and SPAN potentiometers and the END TIDAL switch and lamp.

The right side of the rear panel contains the AC power receptacle and On/Off switch. A 3 Amp fuse for 115V operation protects the Readout/Control unit.

The left side of the rear panel contains the 17-pin sensor input connector for the sensor cable, the ANALOG OUTPUT CONNECTOR (BNC), and the RESPONSE TIME switch.

IV

MAINTENANCE AND REPAIR

4.1 INTRODUCTION

This equipment has been designed for reliable long-term operation with a minimum of maintenance. No regular maintenance procedure is required. If difficulty is experienced, the gas handling system should be checked carefully as flow problems constitute the most probable source of error. It is recommended that AEI Technologies be contacted before any servicing or repair of the instrument itself is attempted.

4.2 FLOW SYSTEM

An unstable or malfunctioning pump is frequently the source of signal instability. This instability can easily be differentiated from that caused by electronic malfunction (which is much less likely) by simply disconnecting the sensor from the sample source and flow system. The carbon dioxide concentration reading should be followed on the Display or analog output. If a smooth curve tending toward the carbon dioxide content of room air is obtained, the problem is with the flow system, not the sensor or the electronics.

Leaks (see Section 2.5.4), contamination, or line blockage can result in error in carbon dioxide measurement. These problems may be subtle and difficult to find. Factors involved in setting up the gas handling system are discussed in Section 2.2.1 through 2.2.6 of the operating instructions. These sections should be read if flow problems arise. For low carbon dioxide concentration, leakage of air into the system will cause high instrument readings; while at high carbon dioxide concentrations, air leakage will dilute the sample and lower readings.

Line blockage will decrease gas flow and can be detected by lowered flowmeter readings. If the gas lines become blocked on the input side of the sensor and the sample is being drawn through the sensor, the effect will be to partially evacuate the sensor and lower the reading.

If the same mode of flow (i.e., drawing or forcing the gas through the cell) is not used for calibration and unknown gases, erroneous readings may result. If the calibration gas is drawn through the sensor and the unknown gas forced, high instrument readings may result. Forcing the calibration gas through the sensor while drawing the unknown gas will cause low readings.

4.3 SENSOR

The sensor should require no maintenance. Erroneous readings which might be thought to result from sensor malfunction are usually caused by flow problems and this possibility should be considered first. However, if liquid droplets or particulates are allowed to enter the sensor erroneous readings can occur. Leaks in the sensor can be diagnosed by the Leak Test procedure in Section 2.5.4.

If the sensor is believed to be malfunctioning, do not attempt to dismantle it. Contact us for repair or replacement instructions. You may be asked to perform one of the following:

4.3.1 CELL CLEANING

With use the windows of the sample cell in the Sensor may become contaminated. This cell should be cleaned out using the following procedure when instructed to do so by AEI Technologies:

1. Using a syringe or bulb, flush warm dishwashing detergent and water solution through the Sensor cell. Flush from input to output and from output to input.
2. Flush the cell with clean water, preferably distilled.
3. Flush the cell with a drying agent such as alcohol.
4. Flow clean dry air for at least one hour before using.

4.3.2 PURGING

A change of C02 concentration in the sensor enclosure may affect the ZERO and SPAN controls. If this happens the proper balance may be restored by the following method when instructed to do so by AEI Technologies:

1. Remove the “U” tubing that is connected between the PURGE “IN” and “OUT” fittings.
2. While the sensor is warmed up and working, flow clean DRY air into the “IN” fitting for about thirty minutes at a flow rate of 100 ml/mm.
3. Remove the air flow and restore the fittings to their original configuration, leaving the PURGE “IN” and “OUT” fittings loose for about two hours while the new air fully heats up.
4. Tighten the PURGE “IN” and “OUT” fittings firmly.

4.4 READOUT/CONTROL UNIT

The electronics of the CD-3A have been designed for maximum stability and should not need maintenance. If you run out of range on the ZERO or SPAN POT: set the CALIBRATE/SAMPLE SWITCH in the SAMPLE position; turn the POT all the way back in the opposite direction; set the CALIBRATE/SAMPLE SWITCH in the CALIBRATE position; adjust the POT. Repeat until the display reads correctly.

VI

R-1/R-2 FLOW CONTROL

1.1 INTRODUCTION

The Model R-1 (R-2) Flow Control is frequently used as an integral part of any gas measurement system. The Flow Control is frequently used in conjunction with the S-3A Oxygen analyzer and CD-3A Carbon Dioxide analyzer. The Model R-1 Flow Control contains the flow meter, pump, and needle valve in a single cabinet. The Model R-2 Flow Control contains 2 flow meters, pump, and 2 needle valves in a single cabinet.

1.2 FLOW DIAGRAM

The preferred flow arrangement is to draw the gas through the gas analyzer with the pump and then vent it to the room or into a hood. Flow meter calibration curves are shown below.

1.3 CONTROLS/INDICATORS

The front panel controls/indicators are:

ON/OFF SWITCH: All power to unit switched on and off.
FLOWMETER: Displays the flow rate. See Flow Rate Graph below for conversion to ml/min.
FLOW ADJUST: Adjusts the flow rate.

The rear panel controls/indicators are:

POWER SUPPLY FUSE: 0.25 Amp for 230 VAC units. No fuse on 117VAC units.

1.4 INSPECTION AND INSTALLATION

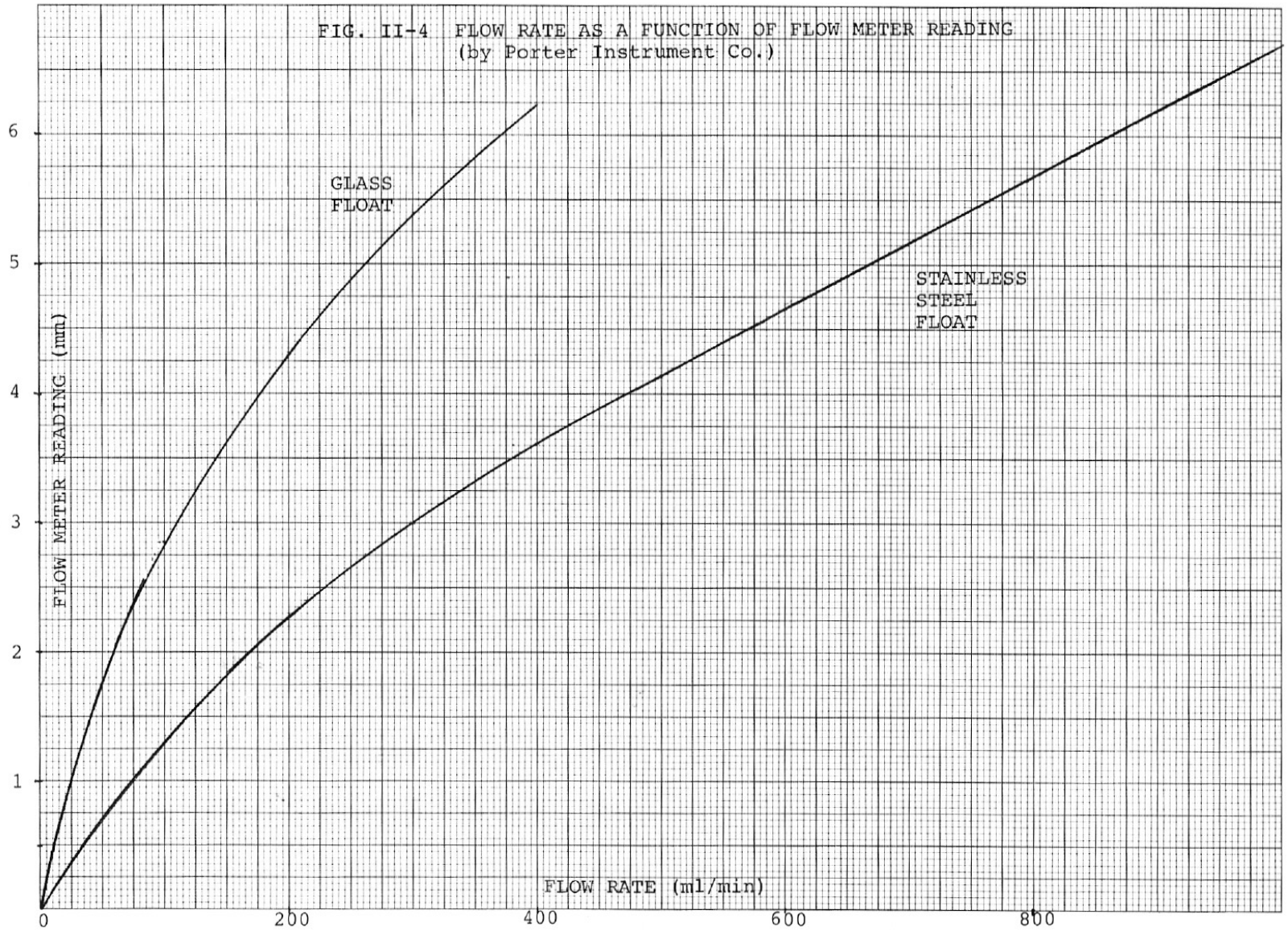
1.4.1 Inspection

The Model R-1 (R-2) Flow Control has been thoroughly inspected and carefully packed prior to shipment. When the instrument is received, it should be examined both before and after unpacking for any physical damage that may have occurred in transit. Install and operate the instrument as soon as possible to check for any internal damage. Save all packing materials until this inspection is complete. If damage is found, a claim should be filed promptly with the carrier and AEI Technologies should be notified so that we can arrange for any repair or replacement necessary.

1.4.2 Installation

The Flow Control is shipped ready for use.

FIG. II-4 FLOW RATE AS A FUNCTION OF FLOW METER READING
(by Porter Instrument Co.)



R-1/R-2 OPERATING INSTRUCTIONS

2.1 INTRODUCTION

The following sections provide much of the information necessary to Connection and Use the R-1 (R-2) Flow Control.

2.2 GAS CONNECTIONS

2.2.1 General

The tubing on the Model R-1 (R-2) Flow Control is 1/8 inch O.D. For normal use connect the OUT port of the Sensor to the IN port of the R-1 (R-2) Flow Control using 1/8 inch I.D. soft PVC tubing. As shipped, the Flow Control inputs are protected by flexible tubing that should be removed. The gas supply system must be free of leaks, water, and sources of contamination.

Flow rates of 50—500 ml/min are typically used. The Model R-l Flow Control provides a convenient means of maintaining suitable constant flow rates. **IMPORTANT: The Sample (unknown) and Calibration gases should be flowed at the same rate so that the total gas pressure in the system remains the same.** Some variation in flow rate is permissible if the total system pressure is not altered within the accuracy required. If separate lines are used for the calibration and unknown gases, the lengths and diameters of the tubing should be the same to insure equal pressure drops. The same mode of flow (i.e., forcing or drawing the gas through the system) must be used for both calibration and unknown gases.

2.2.2 Preferred Gas Flow Arrangement

To adjust the flow rate partially close the flow meter needle valve by turning it clockwise until the desired flow rate is achieved; but do not over tighten.

With the single-channel R-1, the inlet and outlet of the pump are independent of those of the needle valve and flow meter. This permits the flow control to be used in three modes of operation below. The R-1 is shipped as in Arrangement (A) below.
The Model R—2 Flow Control handles two independent gas streams (e.g., unknown and reference gases through a double-cell sensor, or two unknown gases). It contains two needle valves, two flow meters, and one pump. Only Arrangement (A) below can be used with the R-2.
NOTE: The OUT port of the flowmeter has been connected at the factory to the IN port of the pump with a piece of tubing.

Arrangement (A) With the R-1, connect meter OUT to pump IN using the short piece of tubing provided). Turn the pump ON with the toggle switch and turn the needle valve(s) off to finger tightness (do not overtighten). Connect sensor(s) OUT to meter(s) IN and the sample gas(es) to sensor IN(S). Slowly open the needle valve(s) until the desired flow rate is achieved. (100 ml/min is suitable for most applications).

Arrangement (B) Disconnect the tubing between meter OUT and pump IN. Turn the pump on and the needle valve off (do not overtighten). Connect pressurized sample gas to meter IN and adjust gas flow rate to desired value with the needle valve. Again turn the needle valve off and connect meter OUT to sensor IN. Carefully turn the needle valve on until the flow meter reads the desired value.

Arrangement (C) Disconnect the tubing between meter OUT and pump IN. Turn the pump on and needle valve off (do not overtighten). Connect sample gas to pump IN and connect pump OUT to meter IN. Connect meter OUT to sensor IN. Open the needle valve until the desired flow rate is achieved.

2.2.3 Pump Fluctuations

For some users, slight pump fluctuations have interfered with very accurate measurements. If this is a problem, insert a surge tank (bottle) in the line between the flowmeter and the pump. A volume of 1000 ml is suitable.

2.3 ELECTRICAL CONNECTIONS

The Model R-1 (R-2) Flow Control should be plugged into a 117VAC (230VAC for Model R-1V) grounded three-terminal receptacle.

CAUTI0N: **This instrument must be electrically grounded. Do not use an ungrounded adaptor of any kind.**

R-1/R-2 MAINTENANCE AND REPAIR

4.1 INTRODUCTION

This equipment has been designed for reliable long-term operation with a minimum of maintenance. If difficulty is experienced, the gas handling system should be checked carefully as flow problems constitute the most probable source of error. It is recommended that AEI Technologies be contacted before any servicing or repair of the instrument itself is attempted.

4.2 FLOW SYSTEM

Leaks (see Section 4.3), contamination, or line blockage can result in error in measurement. These problems may be subtle and difficult to find. Line blockage will decrease gas flow and can be detected by lowered flowmeter readings. NOTE: Regularly check the system for leaks.

If the same node of flow (i.e., drawing or forcing the gas through the cell) is not used for calibration and unknown gases, erroneous readings may result.

4.3 LEAK TEST

This test should be performed before any measurements are taken on the initial setup of the system and frequently thereafter. Gas leaks are one of the most common sources of error in gas measurement. The simplest method to test for leaks in the system is as follows:

- Turn on the R-1 Flow Control.
- Block the sample gas input using a clamp or your finger. It should initially be blocked at the farthest point in the sample gas tubing path from the R-1. In other words, blocked as close to the source of the sample as possible.
- Observe the balls on the R-1 flowmeter. Both balls will slowly drop to “0” and stay there without any bouncing if there is no leak. Even a slight movement of the balls indicates a leak.
- If the balls do not drop or they are bouncing, there is a leak in the system. The source of the leak can be further located by blocking the sample gas flow at other locations in the sample gas tubing path.

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