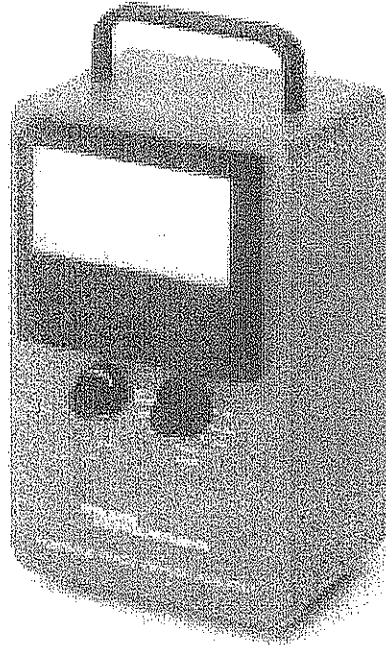

INSTRUCTION MANUAL

MODEL 311PC PERCENT OXYGEN ANALYZER



DANGER

HIGHLY TOXIC AND OR FLAMMABLE LIQUIDS OR GASES MAY BE PRESENT IN THIS MONITORING SYSTEM.

PERSONAL PROTECTIVE EQUIPMENT MAY BE REQUIRED WHEN SERVICING THIS SYSTEM.

HAZARDOUS VOLTAGES EXIST ON CERTAIN COMPONENTS INTERNALLY WHICH MAY PERSIST FOR A TIME EVEN AFTER THE POWER IS TURNED OFF AND DISCONNECTED.

ONLY AUTHORIZED PERSONNEL SHOULD CONDUCT MAINTENANCE AND/OR SERVICING. BEFORE CONDUCTING ANY MAINTENANCE OR SERVICING CONSULT WITH AUTHORIZED SUPERVISOR/MANAGER.

P/N M61392
10/28/09
ECO # 09-0172

 Teledyne Analytical Instruments

**Additional information
for your Portable
Oxygen Analyzer.**

Options Check-Off Sheet for Model 311 Series Oxygen Analyzer

TET/AI Sales Order Number: _____

The instruction manual included with your analysis system from Teledyne Electronic Technologies/Analytical Instruments (TET/AI) describes the standard features of the system. It is as accurate as possible in describing the standard theory, operation, maintenance and calibration. Refer to the manual for information regarding all standard features of the model that you have selected.

NOTE: All drawings that relate to your instrument are included in the drawing package at the rear of this manual.

Standard Options

The following options are available for the Model 311 Series Trace Oxygen Analyzers. Depending on the options that you selected at the time of purchase, these features may or may not be included as part of your instrument. A "✓" in a box indicates that your instrument has that feature and the adjacent description and instructions apply.

Model Selected

- Model 311 Portable Trace Oxygen Analyzer
- Model 311D Trace Oxygen Analyzer
- Model 311PC Percent Oxygen Analyzer
- Model 311TC Trace Oxygen Analyzer

CE Conformity

This TET/AI Model 311 Series Oxygen Analyzers meet or exceed all requirements of the Commonwealth of Europe (CE) for Radio Frequency Interference and Electromagnetic Interference (RFI/EMI) protection.

Battery Recharging (Power Requirements)

This instrument operates from rechargeable batteries. The battery recharging circuit requires the power source checked below.

100VAC @ 50/60Hz

NOTE: The standard battery charging time of 24 hours is based on a minimum voltage of 110VAC. With 100VAC as the recharging voltage, you must increase the battery recharging schedule to 28 hours every four weeks of continuous use (instead of 24 hours).

110VAC @ 50/60Hz

220VAC @ 50/60Hz

Other: _____

Analysis Ranges

If this box is checked, your instrument has non-standard analysis ranges and those ranges are listed below:

Range 1: _____

Range 2: _____

Range 3: _____

Range 4: _____

Cell Block (P/N B25589)

This instrument has a stainless steel cell block installed in place of the standard block.

Cell Block Fittings (P/N S615)

The quick disconnect fittings of the cell block are constructed of stainless steel.



Signal Output

This instrument generates a 0-1VDC output that represents the O₂ concentration in the sample (in the selected analysis range). Use the *Outline* and *Interconnection* drawings, at the rear of this document, to access this signal.

NOTE: Due to the modification required to provide the 0-1VDC output at the rear of the instrument case, this analyzer does not meet the requirements for the "Intrinsically Safe" classification. Therefore, this analyzer is not FM or CE approved.

Micro-Fuel Cell (P/N C-6689-A1)

A class A-1 micro-fuel cell (MFC) has been shipped separately replacing the standard cell. This cell is used where fast response is desired or required. The cell has an output of 1.0mA in air @ 25°C and sea level. The response time for this MFC is 90% in 4 seconds. The warranty is three months from the date of shipment and the expected lifetime is also three months in air (but varies with application).

NOTE: Due to the modification necessary for the use of a Class A-1 MFC versus the standard MFC, this analyzer does not meet the requirements for the "Intrinsically Safe" classification. Therefore, this analyzer is not CENELEC approved.

Micro-Fuel Cell (P/N C-6689-A2C)

A class A-2C Micro-Fuel Cell has been shipped separately replacing the standard cell. The A-2C cell is designed for applications involving trace oxygen analysis in gases containing 5-100% CO₂ and highly mobile background gases such as hydrogen (H₂), helium (He) and ethylene (C₂H₄).



Options Check-Off Sheet for Model 311 Series Oxygen Analyzer

A clamp (identified by the "C" suffix) is used as a restraining device. This clamp keeps the cell's sensing membrane from separating from the cathode when excessive back-pressure is created by the diffusion of H_2 , He and/or C_2H_4 into the electrolyte.

The cell has an output of $0.462mA \pm 40\%$ in air @ $25^\circ C$ and at sea level. The response time for this cell is 90% in 30 seconds (0-100ppm range). The warranty is six months from the date of shipment.

It is recommended that the sensor be continuously purged with sample gas containing CO_2 or maintained in an atmosphere containing CO_2 for maximum sensor life.

Micro-Fuel Cell (P/N C6689-B1C)

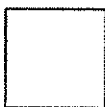


A class B-1C micro-fuel cell has been shipped separately replacing the standard cell. This cell is a general service, fast response cell used for measuring percent levels of oxygen (O_2). The cell is used where highly mobile background gases such as hydrogen (H_2), helium (He) and ethylene (C_2H_4) are being monitored for O_2 on a continuous basis.

A clamp (identified by the "C" suffix) is used as a restraining device for the sensing membrane. This clamp keeps the cell's sensing membrane from separating from the cathode when excessive back-pressure is created by the diffusion of H_2 , He and/or C_2H_4 into the electrolyte.

The typical response time for this cell is 90% in seven seconds. The cell has an output of $.50mA$ in air @ $25^\circ C$ and sea level. The warranty is six months from the date of shipment and the expected lifetime is eight months.

Micro-Fuel Cell (P/N C-6689-B2C)



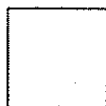
B-2C Micro-Fuel Cell is a standard Sensor
Micro-Fuel Cell Upgrade/Replacement

A class B-2C micro-fuel cell (MFC) has been included and upgraded from the standard B-2 cell. This MFC is used for monitoring trace levels of O_2 in CO_2 -free gas streams.

A clamp (identified by the "C" suffix) is used as a restraining device. This clamp keeps the MFC's sensing membrane from separating from the cathode when excessive back-pressure is created by the diffusion of H₂, He and/or C₂H₄ into the electrolyte, and also acts as a physical barrier to protect sensor membrane from puncturing.

The cell has an output of .462mA ±40% in air @ 25°C and sea level. The response time 90% in less than 45 seconds. The warranty is six months and the expected lifetime is eight months.f shipment.

B-3 Micro-Fuel Cell



A class B-3 Micro-Fuel Cell (P/N C6689-B3) has been shipped separately replacing the standard B-1 cell. The B-3 cell is a general purpose, intermittent response, personnel safety monitoring cell for percent O₂ analysis. The response time for this micro-fuel cell is 90% in 13 seconds.

Instrument Modification



A panel has been added to each side of the 311D. The left-side panel holds a sample flowmeter (P/N F392) and the right-side holds a needle valve (P/N V416).

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Warranty

This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgments provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by Teledyne or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

Important Notice

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface, with the process being measured, be properly trained in the process itself, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of Teledyne at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

Teledyne Analytical Instruments (TAI, the manufacturer of this instrument, cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.

Addendum - Analyzer Model 311PC

The following delineates a complete list of operating faults:

Failure to Calibrate

- Verify sensor is installed in unit.
- Verify span gas concentration.
- Verify Sensor is within warranty period.
- Install another sensor.
- Verify that the batteries installed are fully charged by setting the unit to the "Test Battery" mode as indicated on the front panel.

Batteries Failing to Charge

- Verify connection of AC Power. Charge unit only in a safe area.
- If batteries are several years old, they may need to be replaced.

Inaccurate Analysis Results

- Check unit calibration
- Check adequacy of sample gas flow into the instrument
- Check for leaks in the sample delivery system.

Precautionary Statements

- This apparatus is not intended to be exposed to dust conditions.
- This unit has been designed such that it does:
 - Not give rise to physical injury or other harm due to contact.
 - Not produce excessive surface temperatures or infra red energy, electromagnetic radiation or ionizing radiation.
 - Not have non-electrical dangers.
- The unit should not be installed where it may be subjected to mechanical and thermal stresses or where it may be attacked by existing or foreseeable aggressive substances.
- This unit cannot be repaired. It must be replaced by an equivalent unit in the event of unit failure.

Table of Contents

1 Introduction

| | |
|--------------------------------|-----|
| 1.1 Description | 1-1 |
| 1.2 Method of Analysis | 1-1 |
| 1.3 Outstanding Features | 1-2 |

2 Installation

| | |
|------------------------------|-----|
| 2.1 Sampling Equipment | 2-1 |
| 2.2 Power Service | 2-1 |

3 Operation

| | |
|---|-----|
| 3.1 Introduction | 3-1 |
| 3.2 Cell Installation | 3-1 |
| 3.3 Positive Pressure Sampling | 3-2 |
| 3.4 Atmospheric Pressure Sampling | 3-2 |
| 3.5 Calibration | 3-3 |
| 3.4.1 Calibration Procedure Using Air | 3-3 |
| 3.4.2 Calibration Procedure Using Calibration Gas | 3-4 |

4 Maintenance

| | |
|---|-----|
| 4.1 Battery Power Supply Service | 4-1 |
| 4.2 Routine Maintenance | 4-2 |
| 4.3 Cell Replacement | 4-2 |
| 4.4 Cell Warranty | 4-3 |
| 4.5 Transduction and Temperature Compensation | 4-3 |

Appendix

| | |
|--|-----|
| Specifications | A-1 |
| Recommended Spare Parts List for Model 311PC | A-2 |
| Drawing List | A-2 |
| Material Safety Data Sheet | A-3 |

Introduction

1.1 Description

The Teledyne Analytical Instruments (TAI) Model 311PC is a portable, intrinsically safe percent oxygen analyzer which can be operated without an external power source and reliably calibrated without the use of cumbersome, questionable, so-called "certified" calibration gases.

The instrument provides for percent oxygen analysis in the ranges 0–25%, 0–10%, 0–5%, 0–2.5% and 0–1% oxygen.

Sample oxygen is read from an extremely accurate integral meter (0.5% linearity) whose range of measurement is determined by the position of the range selector switch. The 0–2.5% range is read on the 0–25% scale and the 0–1% range is read on the 0–10% scale. The linear 4.5 inch scale (mirror equipped to eliminate parallax) provides excellent resolution and accuracy.

Sample gas is introduced and vented via a pair of quick disconnect fittings that feature integral shutoff valves which automatically close when the mating male fitting is withdrawn. The fittings are an integral part of the measuring cell manifold so that internal sample passage volume is at an absolute minimum. Sample flow control, although not critical (0.1 to 10 liters/min.), must be accomplished with accessory equipment.

1.2 Method of Analysis

The sample oxygen is measured by a unique electrochemical transducer which functions as a fuel cell; in this instance, the fuel is oxygen. Oxygen diffusing into the cell reacts chemically to produce an electrical current that is proportional to the oxygen concentration in the gas phase immediately adjacent to the transducers sensing surface. The linear signal produced by the transducer is amplified by a two stage amplifier. The dual stages of amplification provide enough gain to drive the 0-100 microampere meter and thermistor controlled network utilized to compensate for the positive temperature coefficient of the transducer.

1.3 Outstanding Features

The following unique features are incorporated into the Model 311PC:

- **Micro-Fuel Cell**

The Micro-fuel Cell (U.S. Pat. Nos. 3,767,552 and 3,668,101) is a sealed electrochemical transducer with no electrolyte to change or electrodes to clean. When the cell reaches the end of its useful life, it is merely thrown away and replaced, as one would replace a worn out battery in a flashlight. The life of the cell is warranted by TAI (see Section 4.4) in a fashion similar to that employed by the manufacturers of automobile batteries. This procedure guarantees the customer compensation for failure of a given cell to perform as specified.

- **Reliable Calibration**

The unique qualities of the Micro-fuel Cell allows the user to calibrate the instrument with the most economical, reliable, abundant, standardization gas there is — atmospheric air.

The 0–25% range should be used for air calibration; the indicator needle of the meter is brought into coincidence with the cal mark at 20.9% during air calibration. By drawing air through the instrument (see the sample calibration procedure in Section 3.2) reliable calibration can be achieved.

The electronics have been properly zeroed (a onetime factory operation), so that the instrument does not produce an output indication in the absence of oxygen. Refer to Section 3.2 if readjustment is required.

- **Integral Power Supply**

The differential power requirement (plus and minus 3.6 volts D.C.) of the instrument amplifier is furnished by two internally mounted 750 milliampere hour nickel cadmium batteries. Fully charged, these batteries will provide enough power to operate the instrument continuously for a period of about thirty-five (35) days. Furthermore, an overnight charge on a one-month duty

cycle should keep the original batteries supplied usable for many years.

An integral charging circuit and a detectable power cord are provided so that the batteries may be recharged from any 50 or 60 cycle, 105 to 125V (or with option, 220/240V) convenience outlet.

The instrument is designed to either sample or have its batteries recharged. Both operations cannot be carried out simultaneously. TAI has deliberately interlocked the circuitry so that both operations cannot be carried on at the same time.

Only when the selector switch is placed in the **OFF** position will the neon lamp on the back plate of the Model 311PC light up to indicate power to the battery charging circuit.

A current limiting resistor is potted into the end of each battery. This assures that under no circumstances can more than 25 milliamperes (100 milliwatts) be switched or drawn from either battery supply. This means that the Model 311PC may be used in explosive atmospheres where arcs of 100 milliwatts or less can be tolerated. The Model 311PC meets CENELEC approval requirements as intrinsically safe for Group IIC Temperature Class T3, hazardous locations as approved by BASEEFA EX86B2228/3.

CAUTION: This safety feature does not apply when the instrument is being charged (AC power cord connected and selector switch in the "OFF" position). The instrument should not be used in explosive atmospheres when the batteries are being charged.

To determine the state of the rechargeable batteries, turn the range selector knob counterclockwise to the battery test position and hold there. The knob is a spring loaded switch. Observe that the meter indicator stays within the battery limits. If it does not, then recharge or replace the batteries. Release the Range Selector Switch, it will automatically return to the OFF position.

- **Accuracy and Response**

The Model 311PC provides monitoring accuracies of $\pm 2\%$ of full scale at constant temperature. A $\pm 5\%$ of full scale accuracy is achievable throughout the operating temperature range of 0 to 50°C.

With a sample flowrate of 1–2 liters/min. 90% response is achieved in 10 seconds.

- **Compact Packaging**

The instrument is housed in 6-¹/₈ X 9-¹/₂ X 5-⁵/₈ in aluminum case that is equipped with a carrying handle and foot pads. When in use, the analyzer should be placed in an upright position on a level surface (off level positioning will detract from meter accuracy).

Access to the instrument interior is gained by loosening (ccw) the three (3) ¹/₄ turn screw driver type fasteners on the back of the outer case. The case may then be detached from the control panel assembly. Further disassembly may be accomplished by removing the back plate assembly from its four (4) mounting standoffs and laying the two separated assemblies out as illustrated on the analyzer wiring diagram. The diagram is included among the drawings at the rear of the manual.

- **Analysis Ranges**

This instrument is equipped with 5 oxygen analysis ranges: 0–25%, 0–10%, 0–5%, 0–2.5% and 0–1% oxygen. The oxygen concentrations are read from an accurate integral meter with appropriate scales for the included analysis ranges.

Note: The 0–2.5% range is read on the 0–25% scale and the 0–1% range is read on the 0–10% scale.

The orange tinted portion of the scale applies only to the 0–25% range of analysis. It indicates an oxygen rich environment and a region unsuitable for measurement using this instrument.

Caution: Do not use this instrument for analysis in oxygen rich environments. This instrument is approved as "intrinsically safe" only when used in environments containing 21% oxygen or below.

Installation

2.1 Sampling Equipment

The customer must provide a means of controlling the pressure and flowrate of the sample gas. For positive pressure applications, TAI suggests a simple throttle valve installed in the sample line between the sample point and the analyzer. The flowrate should be limited to between **0.1 and 10 liters/min.**

For atmospheric pressure sampling, connect a pump and flow control valve downstream from the analyzer and draw (rather than push) the sample through the instrument.

TAI supplies three (3) male disconnect fittings with the instrument: one for installation of the customer's sample line; one to be used to open the vent fitting of the instrument; and one (equipped with a plastic tube) for drawing air through the unit for calibration purposes.

2.2 Power Service

A source of single phase, 105 to 125 volt, 50 or 60 Hz power, capable of delivering a maximum of $\frac{1}{4}$ ampere of current will be periodically required to recharge the instrument's battery power supply. An internationally approved 3 wire detachable power cord is provided with the instrument and should be stored in a safe place when not in use.



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Operation

3.1 Introduction

The Model 311PC is supplied completely assembled and ready for instant use. The Micro-fuel Cell is packaged separately and should be installed prior to use (see Section 3.2). The integral shut-off valves in the quick disconnect sample fittings, if not disturbed, will provide a seal from oxygen in the air and extend the life of the Micro-Fuel cell when the instrument is not used for extended periods of time (week—months).

When the range selector is advanced from the “OFF” position, power to the instruments circuitry is established. The meter will instantly respond to the residual oxygen within the integral sample passages. Depending on the length of time since the last usage occurred, the reading will be somewhere between 0 and 21%.

3.2 Cell Installation

No tools are required to install the cell in the instrument. Simply unscrew (ccw) the plug at the bottom of the analyzer. Remove the new cell from its package and carefully remove the shorting device.

Note: Do not touch the gold colored sensing surface of the cell. It is covered with a delicate Teflon membrane that can be ruptured in handling.

Place the cell on the end of the manifold plug so that the sensing surface of the cell is in contact with the plug and the electrical contact plate end of the cell is facing upwards. Insert the cell and plug in the manifold cavity, and screw the plug back into place. Apply as much pressure as you can with your fingers, but use no tools.

3.3 Positive Pressure Sampling

When connecting the instrument to a positive pressure sample source, **always** proceed as follows:

- 1) Before making **any** connections to the instrument, establish a flowrate in the sample line of from 0.1–10 liters/min using a throttle valve between the positive pressure source and the instrument inlet (1–2 liters/min is suggested).
- 2) Install the vent fitting **first**, and then the sample source fitting.

When disconnecting the instrument, reverse the procedure: source fitting **first**, and then vent fitting.

The objective of the connection — disconnection procedure is to refrain from pressurizing the manifold.

Note: If a flowing sample was connected to the manifold without the vent fitting in place, the pressure in the manifold would rise and equilibrate to the sample pressure almost immediately.

In such a situation, depending on the magnitude of the sample pressure, leaks in the manifold could result.

Caution: If the meter reads in the orange portion of the scale while on the 0–25% oxygen scale after being calibrated, turn off the instrument and disconnect the source fitting followed by the vent fitting. This instrument is not approved for service in oxygen rich (oxygen concentration greater than 21%) environments.

3.4 Atmospheric Pressure Sampling

If the sample is at atmospheric pressure (or **slightly** negative), a sample pump will be required **downstream** from the analyzer. The inlet side of the pump should also be equipped with a throttle valve so that sample flow can be reduced to between 0.1 and 10 liters/min (1–2 liters/min is suggested). If pump loading is a consideration, the inlet side of the pump will have to include a bypass path that is open to the atmosphere through an additional throttle valve. The sample path and bypass path may then be balanced by manipulating the two valves, so that sample flow is within the prescribed limits without loading the pump.

Note: Under no circumstances should there be any restrictions in the line between the sample point and the analyzer.

If this should occur, a partial vacuum would be drawn on the cell. Since the cell is a partial pressure sensitive device, any oxygen readings taken under these conditions would be erroneous. Pressure less than 0.3 atm. could damage the cell.

Caution: If the meter reads in the orange portion of the scale while on the 0–25% oxygen scale after being calibrated, turn off the instrument and disconnect the source fitting followed by the vent fitting. This instrument is not approved for service in oxygen rich (oxygen concentration greater than 21%) environments.

3.5 Calibration

The inherently constant output of the cell during its useful life eliminates the need for frequent calibration. TAI feels that the interval between calibrations should be dictated by the customer's application.

The Model 311PC should be calibrated using a span gas with a known oxygen concentration. Ambient air (20.9%) is recommended for calibration.

The analyzer can be calibrated on any range using a span gas. The span gas concentration should be within 70% to 90% of full scale of the range selected.

Note: Using a span gas with a concentration greater than 100% of full scale will put you in the next range and result in a reduced accuracy.

3.4.1 Calibration Procedure Using Air

To calibrate the instrument with atmospheric air as a standard, use the following procedure:

- 1) Stand the instrument upright on a level surface, and with the range switch in the "OFF" position, check the alignment of the meter pointer with the zero mark on the scale. Use the mirror to eliminate parallax, and adjust the screw on the face of the meter, if necessary, until the pointer and zero mark are in precise coincidence.
- 2) Advance the range switch to the 0–25% position.

- 3) Install the plastic tube equipped male disconnect fitting in either of the analyzer's sample ports, and a blank disconnect fitting in the other port (direction of sample flow is of no importance). A pump is recommended on the plastic tube. Pump the tube until the meter reading is stable.

CAUTION: Do not use your mouth as a siphon. The micro-fuel cell could leak. This cell contains potassium hydroxide solution (KOH) which is caustic and extremely hazardous.

- 4) Unlock and adjust the span control until the meter pointer is in coincidence with the "CAL" mark on the meter scale (20.9%).

Note: Be sure that you relock the control after the adjustment is made.

- 5) Immediately after step 4 has been accomplished, disconnect the tubing equipped calibration fitting, and plug in either the sample or a source of zero gas.

If the instrument is to be used for sampling after the calibration procedure has been completed, follow the decreasing oxygen reading by positioning the range switch so that the meter gives the best possible resolution of the oxygen. **Do not attempt to take a reading until the meter indication stabilizes.**

Always disconnect the source fitting first followed by the vent fitting.

3.4.2 Calibration Procedure Using Calibration Gas

To calibrate the instrument using a gas source with a known concentration of oxygen, select a calibration gas with an oxygen concentration between 70–90% of full scale on the range of interest. For example, if you anticipate your sample gas will contain 0–0.5% oxygen, obtain a calibration gas with 0.7–0.9% oxygen and calibrate the instrument on the 0–1% range.

To calibrate the instrument using a lab analyzed calibration gas use the following procedure:

- 1) Stand the instrument upright on a level surface, and with the range switch in the "OFF" position, check the alignment of the meter pointer with the zero mark on the scale. Use the mirror to eliminate parallax, and adjust the screw on the face of the meter, if necessary, until the pointer and zero mark are in precise coincidence.
- 2) Advance the range switch to the range position containing the concentration of the calibration gas.

- 3) Connect the calibration gas to either of the instrument's sample port using a quick disconnect fitting. Use a blank quick disconnect fitting on the other port to open the seal.

Always connect the vent fitting first followed by the source fitting.

The analyzer is insensitive to flow rate, however for calibration, use a flow rate similar to the sample flow you will be using. If the flow rate will vary or is unknown, use a flowrate between 1–2 liters per minute. Allow sample to flow for several minutes to flush the sample line. Watch the output of the meter for the reading to stabilize.

- 4) Unlock and adjust the span control until the meter pointer is in coincidence with the concentration of the calibration gas.

Note: Be sure that you relock the control after the adjustment is made.

- 5) Immediately after step 4 has been accomplished, disconnect the calibration source gas fitting at the analyzer sample port, and plug in either the sample or a source of zero gas.

Always disconnect the source fitting first, immediately followed by the vent fitting.

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Maintenance

4.1 Battery Power Supply Service

The Model 311PC is designed to be intrinsically safe, and therefore is for use **only when it is not connected to the AC power line**. TAI suggest that an overnight recharge be accomplished every four (4) weeks of continuous use. To recharge the batteries, place the range switch in the "OFF" position and connect the power cord to a convenient outlet.

Note: The amber charge lamp (back of case) will be lit during charging.

The integral charging circuit will automatically energize and regulate the battery charging current when the switch is in the "OFF" position and the AC cord is plugged into the power line.

CAUTION: *Do not turn the range switch either to "BATT TEST" or to any other operating position while the unit is connected to a power line. Doing so may damage the equipment.*

When recharging is completed, unplug the unit from the AC outlet. Turn the range switch to the operating position and then to the "BATT TEST" position.

Note: The "BATT TEST" position will not give a reliable indication of the battery charge immediately after a charge cycle. Allow the unit to run for several minutes before testing the batteries.

In the "BATT TEST" position, the meter should indicate between the 6 and the 8 on the 0-25% scale.

If the instrument is stored with the range switch in the "OFF" position (charge cord disconnected), the period of time between charge periods is extended from one month to four months. However, do not leave it longer than this time period.

4.2 Routine Maintenance

Beyond adhering to a battery recharge schedule, no routine maintenance is required, as there are no moving parts in the instrument other than the meter movement. The Micro-fuel Cell is a sealed, modular component that should be replaced only when faulty.

4.3 Cell Replacement

The characteristics of the Micro-fuel Cell are similar to those of a mercury battery in that both provide an almost constant output through their useful life, and then fall off sharply towards zero at the end. If the sample being analyzed has a low oxygen concentration, cell failure will probably be indicated by the inability to properly calibrate the analyzer. The user will find that very little adjustment of the 10-turn span potentiometer will be required to keep the analyzer calibrated properly during the duration of a given cell's useful life. If large, many turn adjustments (cw) are required to calibrate the instrument, or calibration cannot be achieved within the range of the control, the cell should be immediately replaced (read section 5.4 before replacing cell).

To offset the possibility of not having a replacement cell available when it is needed, TAI recommends that a spare cell be purchased shortly after the instrument is placed in service, and each time the cell is replaced thereafter.

The spare cell should be carefully stored in an area that is not subject to large variations in ambient temperature (75°F nominal), and in such a way as to eliminate any possibility of incurring damage. **Under no circumstances, disturb the integrity of the cell package until the cell is to be actually used.** If the cell package is punctured and air permitted to enter, the cell will immediately start to react to the presence of oxygen.

No tools are required to replace the cell in the instrument. Simply unscrew (ccw) the plug at the bottom of the analyzer and the cell will drop out of the manifold cavity.

Remove the new cell from its package, and carefully remove the shorting clip.

Note: Do not touch the gold colored sensing surface of the cell. It is covered with a delicate Teflon membrane that can be ruptured in handling.

Place the cell on the end of the manifold plug so that the sensing surface of the cell is in contact with the plug and the electrical contact plate end of the cell is facing upwards. Insert the cell and plug in the manifold cavity, and screw the plug back into place. Apply as much pressure as you can with your fingers, but use no tools.

4.4 Cell Warranty

The Class B-1 cell employed in the Model 311PC is warranted for six (6) months of service.

With regard to spare cells, service time starts when the cell is removed from its shipping package. The customer should stock only one spare cell per instrument at a time. Do not attempt to stockpile spare cells.

The Model 311PC should not be used in applications where CO_2 is a major component in the sample. Concentrations of 1,000 ppm or less will not effect the cell performance. Figure 4-1 is a graph showing the effects of CO_2 on cell life.

If a cell was working satisfactorily, but ceases to function before the warranty period expires, the customer will receive credit, on a prorated basis, toward the purchase of a new cell.

If you have a warranty claims must return the cell in question to the factory for evaluation. If it is determined that failure is due to faulty workmanship or material, the cell will be replaced at no cost to the customer.

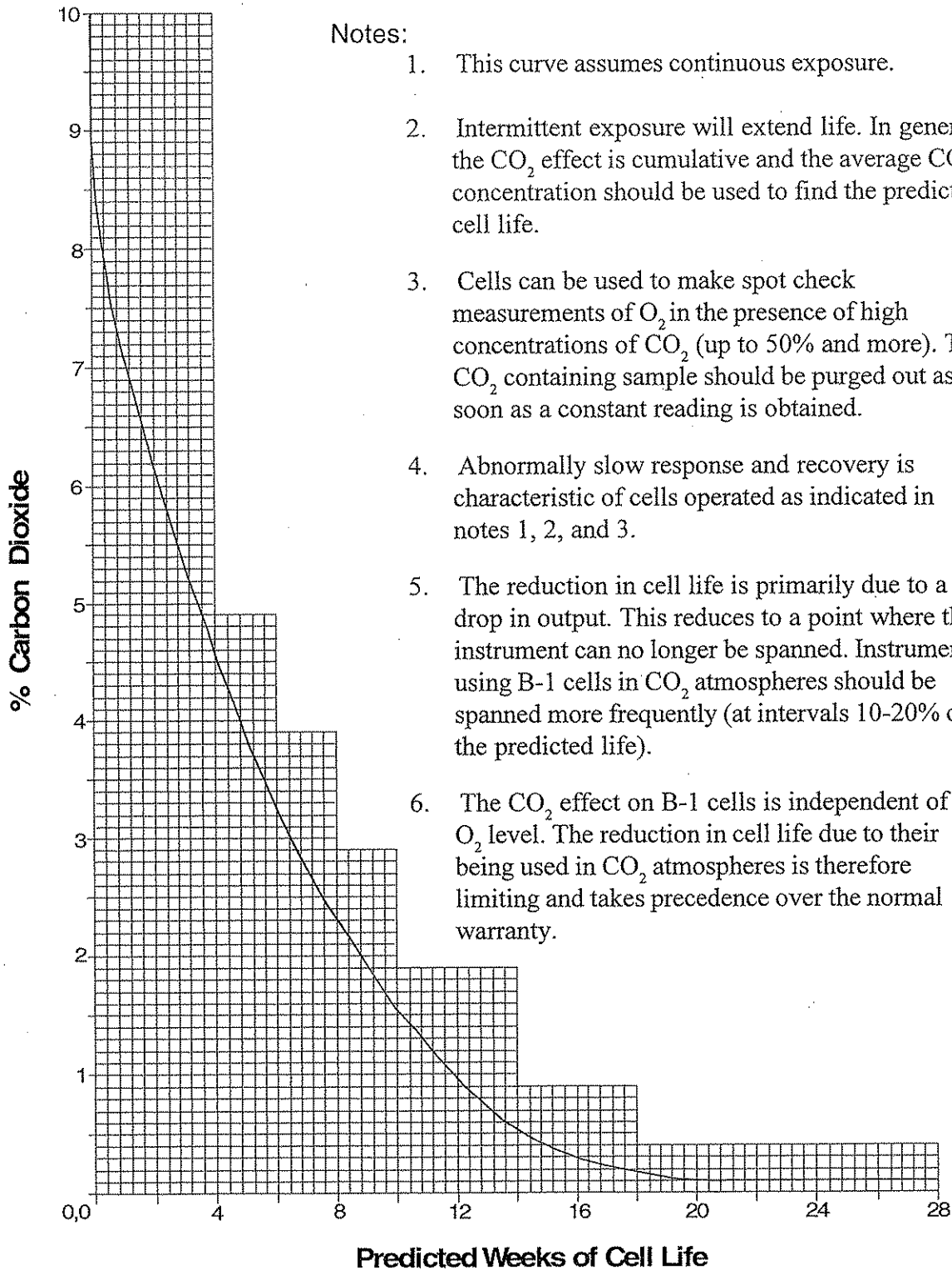
Note: Evidence of damage due to tampering or mishandling will render the cell warranty null and void.

4.5 Transduction and Temperature Compensation

The Micro-Fuel Cell has an inherent positive temperature coefficient, the effects of which have been minimized through the implementation of a calibrated thermistor compensation circuit.

Internal electronic calibration is accomplished by TAI. However, should there be any doubt concerning it, the following procedure can be used to recalibrate. Refer to the schematic.

1. Disconnect cell
2. Move range switch to "cal" position.



Notes:

1. This curve assumes continuous exposure.
2. Intermittent exposure will extend life. In general, the CO₂ effect is cumulative and the average CO₂ concentration should be used to find the predicted cell life.
3. Cells can be used to make spot check measurements of O₂ in the presence of high concentrations of CO₂ (up to 50% and more). The CO₂ containing sample should be purged out as soon as a constant reading is obtained.
4. Abnormally slow response and recovery is characteristic of cells operated as indicated in notes 1, 2, and 3.
5. The reduction in cell life is primarily due to a drop in output. This reduces to a point where the instrument can no longer be spanned. Instruments using B-1 cells in CO₂ atmospheres should be spanned more frequently (at intervals 10-20% of the predicted life).
6. The CO₂ effect on B-1 cells is independent of the O₂ level. The reduction in cell life due to their being used in CO₂ atmospheres is therefore limiting and takes precedence over the normal warranty.

Figure 4-1: The Effect of CO₂ on B-1 Cell Life

3. Adjust R1 (designated as R1 on schematic C37936 and designated on the A1 PCB module assembly as R28) such that the output of A1, pin 6, measures between 0 and +0.5 mV, ideally +0.3 mV.
4. Adjust R2 (designated as R2 on schematic C37936 and designated on the A3 PCB module assembly as R28) for 0 ± 1 mV at output of A2, pin 6.
5. Verify that the offset is the same on all ranges.
6. Reconnect cell.

Left intentionally blank

Appendix

Specifications

TBE/AI Sales Order Number:

Instrument Model Number: 311PC

Instrument Serial Number:

Micro-fuel Cell Class: B-1

Accuracy: $\pm 2\%$ of scale at constant temperature;
 $\pm 5\%$ of full scale over the operating
temperature range.

Operating Temperature Range: 30°F to 125°F

Response and Recovery: At the specified flowrate (1–2 l/min)
90% in 10 seconds.

Ranges of Analysis: 0–25% Oxygen
0–10% Oxygen
0–5% Oxygen
0–2.5% Oxygen
0–1% Oxygen

Recommended Span Gas: Atmospheric air, or span gas 70–90%
of full scale on range of interest.

Recommended Spare Parts List for**Model 311PC**

| QTY | PART NO. | DESCRIPTION |
|-----|-----------|-------------------------------------|
| 1 | F1122 | IEC Fuse, 1/4 Amp. (for 220V units) |
| 1 | F1123 | IEC Fuse, 1/2 Amp. (for 110V units) |
| 1 | C06689-B1 | Micro-fuel Cell, Class B-1 |
| 2 | B-83256 | Battery |
| 1 | L79 | Lamp |

A minimum charge is applicable to spare parts orders.

IMPORTANT: Orders for replacement parts should include the part number (if available) and the model and serial number of the system for which the parts are intended.

Send Orders to:

Teledyne Analytical Instruments

16830 Chestnut St.

City of Industry, CA 91749-1580

Phone (626)934-1500, FAX (626)961-2538

Web: www.teledyne-ai.com

Drawing List**Model 311PC**

| | |
|---------|-----------------------|
| C-62685 | Pictorial Diagram |
| C-37936 | Schematic |
| C-37938 | Wiring Diagram (220V) |
| C-41661 | Wiring Diagram (110V) |

NOTE: The MSDS on this material is available upon request through the Teledyne Environmental, Health and Safety Coordinator. Contact at (626) 934-1592

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