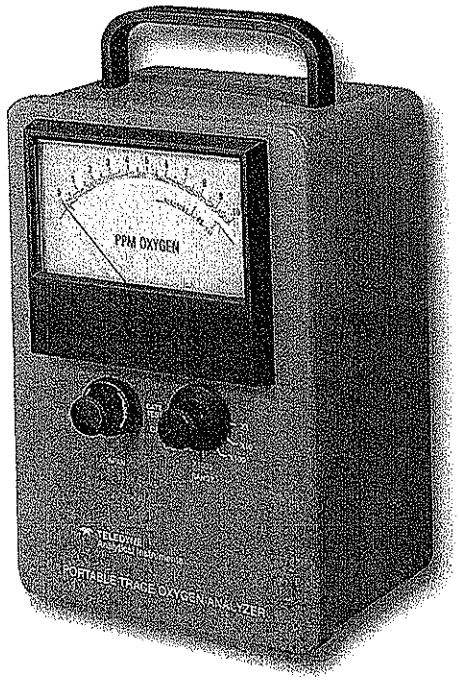
INSTRUCTION MANUAL

MODEL 311TC

TRACE 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 M37928
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 O_2 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 <u>not</u> 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 <u>not</u> 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% CO_2 and highly mobile background gases such as hydrogen (H_2), helium (He) and ethylene (C_2H_4).

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 ±40% in air @ 25°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°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 H_2, He and/or C_2H_4 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 O_2 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).

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.

RFI Immunity

The Teledyne Model 311TC has been tested to the standard required by the European Community for CE marking, EN 60601-1-2.

The sample subjected to testing passed all sections of this testing with the exception of the following:

> From 150KHz to 16MHz no problems were observed. From 16MHz to 80MHz the meter needle deflected to full scale and then dropped to zero. The equipment under test required a power cycle to fully reset.

Addendum - Analyzer Model 311TC

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 intrument.
- Check for leaks in the sample delivery system.

Precautionary Statements

- This apparatus is not intented 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

Introduction

1.1 Description

The Teledyne Analytical Instruments (TAI) Model 311TC is a portable, intrinsically safe trace 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 trace oxygen analysis in decade steps ranging from 0-10 to 1-10,000 ppm (full scale) plus a special calibration range that encompasses the known oxygen concentration of atmospheric air (209,000 ppm).

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 100 division meter scale and the multiplying factor indicated by the position of the range switch determine the full scale oxygen sensitivity of the instrument. 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, but minute, signal produced by the transducer from trace oxygen 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 311TC:

- **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 special "CAL" range of the instrument features a mark that coincides with the 209,000 ppm oxygen concentration of air. 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, 220/240V (or with option, 105 to 125V) 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 311TC 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 311TC may be used in explosive atmospheres where arcs of 100 milliwatts or less can be tolerated. The Model 311TC meets CENELEC approval requirements as intrinsically safe for Group IIC Temperature Class T3, hazardous locations as approved by BASEEFA EX86B2228.

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 311TC provides monitoring accuracies of ±2% of full scale or ±1 ppm, whichever is greater, at constant temperature. A ±5% of full scale accuracy is achievable throughout the operating temperature range of 0 to 50 deg C.

With a sample flowrate of 150 cc/min. 90% response is achieved in 10 seconds in the X10, X100, X1000, and CAL range switch

positions. When in the X1 (0-10 ppm) range, 90% response is realized in 60 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.

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/AI 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.**

Note: If a pressure regulator is necessary or desirable, it must have a metallic diaphragm. Regulators with organic or plastic diaphragms are permeable to oxygen and, if used in the sampling system, will lead to high oxygen readings.

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/AI 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 ¼ 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 311TC is supplied completely assembled and ready for instant use. The Micro-fuel Cell is in place within the manifold, and prior to shipment the manifold was purged with an inert gas to eliminate all but traces of oxygen from the internal sampling system. The integral shut-off valves in the quick disconnect sample fittings, if not disturbed, will maintain this inert atmosphere within the manifold indefinitely. This can be demonstrated by advancing the range selector switch to the X100 (0-1,000 ppm) position.

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.

It is impossible to achieve a "perfect" seal of the internal sample system, and what the meter is indicating is the diffusion — consumption balance point of the internal sample system and the Micro-fuel cell.

This "balance" point, with a properly calibrated instrument, is always within the limits of the X100 range. If the reading climbs off the limits of this scale, a leak in the manifold assembly is indicated.

Note: To extend the cell life and minimize the time required to make the next analysis, the instrument should always be purged with the sample or inert gas prior to being taken out of service for standby or storage.

3.2 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). Allow the sample to vent to atmosphere long enough to purge the line free of air.

2) Install the vent fitting **first**, and then the sample source fitting. Be prepared to make the connections in rapid order, so that atmospheric diffusion time through the vent fitting is held to a minimum.

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.

3.3 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.

3.4 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.

Note: Do not calibrate the instrument unless there is a trace oxygen gas readily available for purging immediately following the calibration procedure.

The Model 311TC should be calibrated using a span gas with a known oxygen concentration. Ambient air (20.9% or 209,000 ppm) may be used for calibration, but air calibration requires a longer cell stabilization period before the analyzer can be used for trace analysis. This waiting period can be minimized by calibrating with a span gas having a low oxygen concentration. Air calibration is not recommended in cases where the analysis will be performed in ranges of 0-100 ppm or less. This is due to the long stabilization period required for the instrument to recover from the 209,000 ppm oxygen in air.

Using a span gas, the analyzer can be calibrated on any range. 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.

Prior to calibration, allow the oxygen reading to come to a reasonably stable value with zero or sample gas flowing through the analyzer.

3.4.1 Calibration Procedure Using Calibration Gas

It is recommended to calibrate the instrument using a gas source with a known concentration of oxygen, preferably with a concentration between 70–90% of full scale on the range you are primarily interested in. For example, if you anticipate your sample gas will contain 0–50 ppm oxygen, obtain a calibration gas with 70–90 ppm oxygen and calibrate the instrument on the 0–100 ppm 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.

The benefit of using this procedure is that less time is required to recover to zero from the calibration source gas.

3.4.2 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 "CAL" 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.

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.** If the sample oxygen content lies within the limits of the X1 range (0-10 ppm), an overnight purge is recommended for the instrument to recover sufficiently from the effects of the **209,000** ppm oxygen concentration of air (over four decades of range differential). Recovery time is proportionally less in the coarser ranges.

If, on the other hand, the instrument is not to be used immediately after calibration, and a low ppm oxygen gas is being employed as a purge, allow the manifold to be purged overnight, and then disconnect both male fittings. **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 311TC 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 needle should indicate at or above the 8ppm mark on the meter dial. For best results, the batteries should be recharged should the needle read below 8ppm.

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 Micro Fuel Cell

The Class B-2C cell employed in the Model 311TC is warranted for six (6) months from the date of shipment.

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 stockpile spare cells.

The standard Model 311TC is equipped with a Class B-2C Micro-Fuel cell installed. This particular Micro-Fuel cell is a general purpose sensor for use in inert gas and hydrocarbon streams and 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. Other Micro-Fuel cells are available for applications with sample gases containing carbon dioxide.

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

If you have a warranty claim, you 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.

4.4 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 (X1 range) 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.

To offset the possibility of not having a replacement cell available when it is needed, TAI/AI 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 deg. 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 device.

Note: Do not touch the silver 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.

After the cell has been installed, purge the instrument with an inert gas (or the sample), and then proceed as directed in Section 3.2.1.

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.
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.

4.6 Leak Testing

Note: If a leak is suspected in the unit, do not attempt to tighten the disconnect fittings. The fittings are potted in epoxy and tightening them will break the seal.

To check for leaks, TAI recommends one of the following procedures:

Procedure 1.

1. Purge the instrument down as low as possible.
2. Place the vent line in water and disconnect the sample.
3. Next, disconnect the vent line and place the range switch on the X100 range.
4. The unit should stay on the X100 range if there are no leaks.

Procedure 2.

1. Purge the instrument with nitrogen at the sample port.
2. Note the reading once is has stabilized (at least 24 hrs. on the 0–10 ppm range) and increase the flow rate.
3. If the reading goes down, the unit, or the tubing to the unit, has a leak.

SENSOR CLASS (P/N)	TYPICAL BACKGROUND	APPLICATION NOTES	WARRANTY
A-2C (C6689-A2C)	5-100% CO_2	The Class A-2C Micro-Fuel Cell is ideal for measuring oxygen from low to 5,000 ppm oxygen in gases containing CO_2. The level of CO_2 may vary over a wide range, and will not affect the sensor performance. The sensor should not be exposed to air for extended periods of time as this will shorten its useful life.	6 months
A-2CI (C6689-A2C-I)	1-30% CO_2	The Class A-2CI Micro-Fuel Cell is recommended for applications where CO_2 levels are low (less than 30%). Sensor will take about 1 to 2 days to equilibrate with the CO_2. Can be used in mixtures of H_2 and CO_2.	6 months
B-2C (C6689-B2C)	H_2, He, C_2H_4	The Class B-2C Micro-Fuel Cell is recommended for applications involving lighter gases.	6 months

Table 4-1: Micro-Fuel Cell Applications

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Appendix

Specifications

Customer Order Number:	
Instrument Model Number:	311TC
Instrument Serial Number:	
Micro-fuel Cell Class:	B-2C
Accuracy:	±2% of scale or ±1 PPM (whichever is greater) at constant temperature; ±5% of full scale or ±1 PPM (whichever is greater), over the operating temperature range.
Operating Temperature Range:	30°F to 125°F
Response and Recovery:	At the specified flowrate (0.25 scfh) 90% in 10 seconds on the X10, X100, and X1000 ranges, and 90% in 60 seconds on the X1 range.
Ranges of Analysis:	X1 : 0–10 ppm Oxygen X10 : 0–100 ppm Oxygen X100 : 0–1,000 ppm Oxygen X1000 : 0–10,000 ppm Oxygen
Recommended Span Gas:	Atmospheric air, or span gas 70–90% of full scale on range of interest or 1–2 decades higher

Recommended Spare Parts List for

Model 311TC

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-B2C	Micro-fuel Cell, Class B-2C
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 311TC

C-41712	Pictorial Diagram
C-37936	Schematic
C-37938	Wiring Diagram (220V)
C-41661	Wiring Diagram (110V)