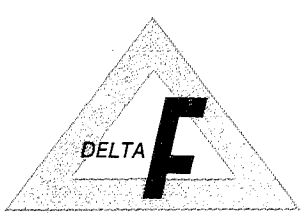
DELTA F OXYGEN ANALYZER MODEL XR7

INSTRUCTION MANUAL



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_____

_____

_____

STAB-EL™ is a registered trademark of Delta F Corporation.

II WARRANTY

Delta F warrants each instrument manufactured by them to be free from defects in material and workmanship at the F.O.B. point specified in the order, its liability under this warranty being limited to repairing or replacing, at Seller's option, items which are returned to it prepaid within one year from delivery to the carrier and found, to Seller's satisfaction, to have been so defective.

Delta F's five (5) year sensor warranty offers extended protection such that, if any sensor of a Delta F Oxygen Analyzer fails under normal use, within four years after the expiration of the one-year warranty, such sensor may be returned to Seller and, if such sensor is determined by Seller to be defective, Seller shall provide Buyer a replacement sensor at the then current purchase price multiplied by a fraction thereof in which the numerator is the number of months from the date of shipment by Seller of the defective sensor to the time it is received back at Delta F and the denominator of which is sixty (60).

In no event shall Seller be liable for consequential damages. NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY. Additionally, this warranty applies only if: (i) the items are used solely under the operating conditions and in the manner recommended in Seller's instruction manual, specifications, or other literature; (ii) the items have not been misused or abused in any manner or repairs attempted therein; (iii) written notice of the failure within the warranty period is forwarded to Seller and the directions received for properly identifying items returned under warranty are followed; and (iv) with return notice authorizes Seller to examine and disassemble returned products to the extent Sellers deems necessary to ascertain the cause of failure. The warranties stated herein are exclusive. THERE ARE NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, BEYOND THOSE SET FORTH HEREIN, and Seller does not assume any other obligation or liability in connection with the sale or use of said products.

III UNPACKING THE ANALYZER

IMPORTANT

Unpacking the oxygen analyzer should be consistent with procedures which are appropriate for handling sensitive instrumentation. ABSOLUTELY NO HOOKS or other penetrating implements should be used.

When the analyzer is received, make note of the condition of the package and the contents. If damage is apparent, it should be brought to the immediate attention of both the carrier and Delta F Corporation.

Also, check the contents to be certain that the shipment is complete. Use the information provided in Section I, Analyzer Specification Sheet, to verify that the correct analyzer, accessories and optional equipment items are received. All claims and shortages must be reported to Delta F Corporation within TEN DAYS (10) after receipt of shipment.

As a matter of convenience, avoid damaging the packing carton. In the event that the unit has to be re-shipped, for any reason, the original container can be used for this purpose.

Remove the analyzer enclosures from the shipping container(s). All auxiliary items, required to complete the assembly, are also packed in the shipping container(s). If there are a large number of accessories, an additional shipping box may be used. The large enclosure is the Electrical Control Chamber (ECC) and the small enclosure is the Remote Sensor Chamber (RSC).

After the ECC and the RSC have been unpacked and all items have been examined and accounted for, preparations for operation can begin.

IV PREPARATION FOR OPERATION

The Delta F analyzer can be made operational easily and quickly by following the instructions below:

A. Electrical Control Chamber (ECC)

The ECC is a complete assembly, as received from Delta F. It is only necessary to install the appropriate conduit fittings, and interconnection wiring, to prepare the ECC for operation. A Weidmuller terminal block is provided for all power and signal connections. Wiring between the ECC & RSC, and signal output wiring (0 - 10 VDC, 4 - 20 mA, Alarm Relay contacts) must be provided by the customer. In the event that the ECC is equipped with optional and /or accessory items, this equipment will have been listed in Section I, Analyzer Specification Sheet.

1. Installation

Remove the cover from the enclosure, and then remove the four screws that hold the front panel in place. Lift the front panel out of the enclosure. Remove any packing materials, tighten any hardware that may have become loose during shipment, and insure that each circuit card is fully seated in it's connector.

CAUTION! DO NOT TOUCH the adjustment knobs on the trim pots which are mounted on the P.C. board; these are factory-set calibration pots.

Check that the large connector connecting the wiring from the front panel to the chassis is plugged in securely.

The dimensions for mounting the ECC are shown in Section VIII, Page 35.

2. Electrical Connections

It is recommended that #20 AWG wire be used when making electrical connections between this terminal block and the Remote Sensor Chamber (RSC) for distances less than 50 feet. For distances of 50 to 600 feet, use #18 AWG and for distances of 600 to 2000 feet, use #16 AWG wire size. The oxygen sensor signal is a microamp D.C. current delivered at low voltage; thus, if the transmission line is exposed to electrical fields, use shielded cable up to the conduit seal fitting. Also, when the fittings are to be sealed and when 5 or more electrical leads are being installed, it is suggested that the single conductor diameter (wire and sheathing) not exceed .090". Conductor sizes larger than this may create too much cross-section in the fitting for good sealing between conductors.

Before preparing a cable for the connection of the ECC to the RSC, be sure to read the section Conduit Seal Fittings on Page 5.

a. Conduit Seal Fittings

The conduit seal (Part #: 66-000216) is a 3/4" Female Pipe Thread x 3/4" Female Pipe Thread fitting to be mounted in any of the three existing tapped holes. A 3/4" Male Pipe Thread nipple is included with the fitting, for coupling to the chamber. All holes come equipped with finger tight hole plugs. Be sure to tighten all permanent hole plugs, during installation.

SEALING THE FITTINGS

For applications where it is necessary to seal the fitting, a Chico Sealing Kit (Part #: DF-R024) has been provided. The fitting is a Crouse-Hinds Type EYS216 and sealing procedures, specified by Crouse-Hinds, should be followed carefully.

Section VIII, Pages 37 - 41, show reprints of the Crouse-Hinds installation instructions for preparing dams, as well as mixing and pouring the sealing compound. The sealing kit provides an excess of materials for preparing the fitting seal, thus the unused portions can be discarded.

b. Power Connections

The Weidmuller terminal block is designed to accept wires that have been stripped 1/8 of an inch. Stranded wires may be tinned with solder, if desired. The unit is equipped with a 1 Amp fuse located on the front panel. This fuse is 2 Amp if the analyzer is equipped with the sensor heater option.

The power connections are wired as follows:

Pin 11	120/240 VAC	Line
Pin 12	120/240 VAC	Neutral
Pin 13	120/240 VAC	Ground (Earth)

c. Signal/Relay Connections

The Weidmuller terminal block Analog Output Signal and Alarm Relay connections are as follows:

8	Not Used
9	Not Used
14	+ Analog Signal Output *
15	- Analog Signal Output *
16	Alarm Relay Contact (HI-Normally Closed)
17	Alarm Relay Contact (HI-Common)
18	Alarm Relay Contact (HI-Normally Open)
19	Alarm Relay Contact (LO-Normally Closed)
20	Alarm Relay Contact (LO-Common)
21	Alarm Relay Contact (LO-Normally Open)

*These analog output lines are normally 0 to 10 volts over the range selected on the front panel. If the optional 4-20 mA option is used, these same pins become 4-20 mA over the range selected. If an optional special analog output voltage is used these same pins represent the special voltage over the range selected. The standard signal output of 0-10 VDC is capable of driving equipment having an impedance as low as 2000 ohms.

Relay contacts which are included on optional relay meters (Part No. DF-M001 and DF-M002) are rated 5 Amps at 115/230 VAC. Wiring of contacts to the control system should be made with consideration of the current drawn by the control equipment.

d. Remote Sensor Signal Connections

See Wiring Arrangement For Remote Sensor Cable, Page 34, for additional details. The Weidmuller terminal block Remote Sensor Signal Connections are as follows:

1	Cell +
2	Cell -
3	STAB-EL +
4	STAB-EL -
5	AC Lo
6	Chassis Ground
7	Pump Power
10	Heater Power

B. Remote Sensor Chamber (RSC)

To make the RSC operable, gas and electrical connections must first be installed, followed by activation with electrolyte solution. For enclosure mounting details, see Customer Installation, R7 Sensor Assembly, Page 36.

1. Gas Connections

The Remote Sensor Chamber (RSC), as delivered, has hex head bushing assemblies at the inlet and outlet ports which accept 1/4" NPT male connections. These ports have been equipped with reducers to 1/8" compression fittings, which may be removed if direct connection to the NPT fittings is preferred. Use *Teflon(TM) tape thread sealant on male NPT fittings. IMPORTANT! When tightening the gas connector fittings, use a wrench to hold the 7/8" hex head bushings stationary. The bushings are aligned with the internal tubing, and damage will result if the alignment is altered.

Also, it should be noted that the bushings are not, and need not be, tightly sealed into the chamber.

The installation of the gas sampling system can be completed by connecting tubing from the process to be monitored to the inlet tube fitting which is positioned closest to the front, at the lower left hand side of the chamber.

As required, the gas sample outlet, which is at the lower left side of the chamber behind the inlet fitting, may be connected to an exhaust or return line.

2. Electrical Connections

Except for conduit and wire, the analyzer has been shipped with all materials necessary to complete the electrical hook-up of the RSC to the ECC.

a. Conduit Seal Fittings

The conduit seal (Part #: 66-000216) is a 3/4" Female Pipe Thread x 3/4" Female Pipe Thread fitting to be mounted on the right side of the chamber using a 3/4" Male Pipe Thread nipple, which is included with the fitting.

b. Remote Chamber Electrical Connection

The Remote Sensor Chamber (RSC) contains the oxygen sensor cell and may also contain optional items such as the STAB-EL electrolyte system, a diaphragm pump, a flow meter and a temperature controller. Within the RSC is a terminal block which is electrically wired to the internal equipment. Table VI, in Section VIII (Page 34), depicts the wiring arrangement used between the ECC and the RSC.

After wiring from the ECC to these terminals, wiring for the RSC is complete, and the unit is ready for activation.

*Teflon(TM) is a registered trademark of E.I. Dupont

3. Activating the Sensor

Two (2) 90 ml bottles of Electrolyte Solution have been provided with the analyzer. To activate the unit, first remove the aluminum plug at the top of the chamber. Then remove the electrolyte cap. Next, position the funnel supplied with the analyzer (Part #: 67-425265) into the electrolyte cavity and add the contents of (1) electrolyte bottle. Be certain to maintain the RSC in the upright position, henceforth. Make no other additions to the electrolyte cavity at this time.

TAKE PRECAUTION NOT TO SPILL ELECTROLYTE INTO THE CHAMBER

If spillage occurs, flush the chamber interior with water and then allow it to dry thoroughly.

After adding the electrolyte, reinsert the electrolyte cap and aluminum plug. The analyzer is now ready for operation.

C. IMPORTANT NOTICE FOR HAZARDOUS AREA INSTALLATIONS

The Delta F Remote Oxygen Analyzer has been constructed using an explosion-proof chamber to house the sensor cell, as well as optional equipment such as the STAB-EL electrolyte system, the diaphragm pump, the flow meter and the temperature controller. The chamber itself, according to National Electrical Code Standards, is rated Class I - Groups B, C, D; Class II - Groups E, F, G; and Class III. As well, Delta F uses fittings and other materials which are compatible with the box for the above-stated ratings.

Thus, within rated conditions, the chamber, when properly installed, provides protection against the propagation, to ambient, of the explosive conditions which may develop within the chamber.

It is MOST IMPORTANT that the user be aware that the rating pertains only to the protection against propagation from the interior of the enclosure to ambient and does not pertain to the possible propagation of an explosive condition in the gas sample stream.

The gas flow system materials within the chamber consist of 316 and 304 stainless steel, polyethylene, epoxy, and teflon. Pump materials include A.B.S. plastic and butyl-rubber. The gas inlet and outlet fittings on the chamber are equipped with snubbers. Each 3/4" fitting contains a 1/8" thick x .25" diameter sintered stainless steel disc. The fittings offer damping resistance to sudden pressure changes and, as well, provide a "quenching" effect on hot gases which might suddenly penetrate the sintered disc.

V OPERATING THE ANALYZER

After adding electrolyte, the analyzer is ready for operation.

A. Start-up

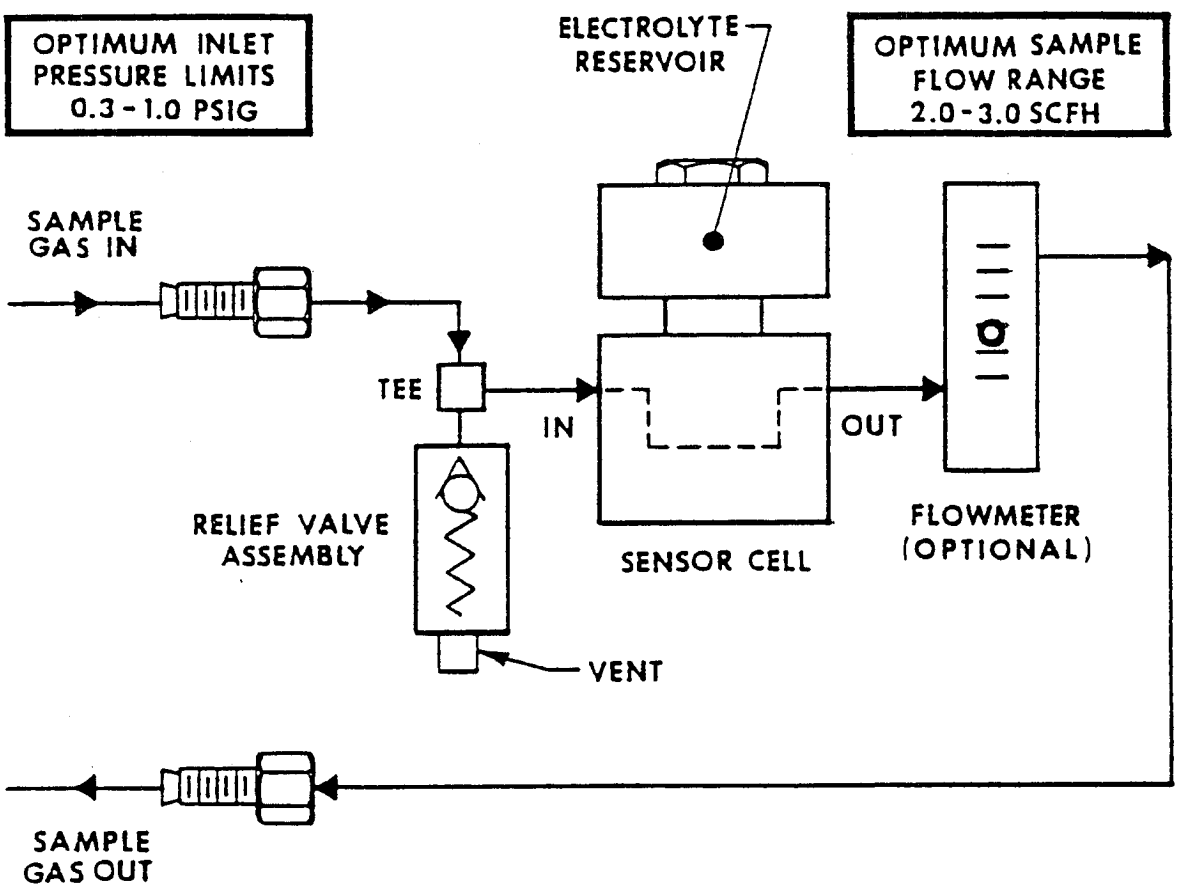
The front control panel contains all of the controls necessary to operate the analyzer. Both the ZERO adjust and SPAN adjust potentiometers are set to values which were determined by factory calibration of the sensor. Normally, there should be no need to make adjustments to either potentiometer. However, if adjustments become necessary at any time, procedures for recalibration are given in Section VII, Maintenance, Page 21.

1. Sample Flow Adjustment

The first step in start-up is to establish the gas sample flow through the analyzer. FIGURE 1 on Page 10 shows the gas flow schematic for the instrument. At the upper left hand corner of this figure are stated the recommended inlet sample pressure limits of 0.3 to 1.0 PSIG. Once the inlet pressure has been adjusted, the flow control valve, which was previously checked to be in the closed position, can be slowly opened to adjust the sample flow to the recommended rate of between 2.0 and 3.0 SCFH.

Because the sensor utilizes Delta F's "Bi-Strata"^{TM} diffusion barrier, the analyzer has the ability to provide accurate readings over a wide flow range (.5 to 3.0 SCFH). However, for best results, the high side of this range is preferable. This is the case since the higher flow rate allows for rapid and efficient cleaning of the gas delivery lines which, in turn, results in quicker equilibrium times. It should be noted that factory calibration settings are made using standardized gases delivered to the sensor at 2.0 SCFH.

One very useful advantage of the diffusion type flow control system is the ability to identify leakage in the plumbing by observing the analyzer read-out as a function of flow rate. For example, if the plumbing which delivers the gas sample to the sensor is, in fact, gas tight and free of permeable materials such as rubber, plastic, etc., then a change in flow rate from 2.0 to 1.0 SCFH will not result in any noticeable change in oxygen read-out. (In fact, a very slight drop in reading might be noted due to a reduction in turbulence at the outer edge of the diffusion barrier). However, if leakage or permeability does exist in the plumbing, then the reduction in flow from 2.0 to 1.0 SCFH will result in an increase in oxygen read-out. It is possible that the plumbing within the analyzer can develop leakage due to rough handling during shipment. However, in most instances, problems arise from the use of non-qualified items such as rubber diaphragm regulators, plastic and rubber tubing, or from dirty tube connections.



GAS FLOW SCHEMATIC

FIG. 1

2. The Relief Valve

FIGURE 1, on Page 10, shows a tee fitting directly downstream of the flow control valve. One of the tee outlets is directed to the sensor cell while the other connects to a relief valve assembly. The relief valve has been installed in the gas flow system to protect the sensor against accidental over-pressure. The relief valve will open at approximately 2-3 PSIG. Therefore, the operator must be certain that the inlet pressure is controlled properly to avoid operating the analyzer with the relief valve forced into the open position. Once a proper flow has been established, the operator can verify that the relief valve is closed by placing a finger firmly against the over-pressure vent which is located within the remote sensor enclosure. As the vent is covered and uncovered, there should be no change in the flow rate, as indicated by a flowmeter.

It is important that the relief valve be closed during operation. Despite the fact that leakage in the valve would normally be from inside to outside during positive pressure operation, it is possible, particularly when monitoring gases at very low PPM oxygen levels, to experience oxygen moving upstream, so to speak, and mixing with the sample gas being delivered to the sensor. In the event that corrective measures become necessary in order to seal the relief valve, information is provided in the Maintenance Section on Page 22.

3. Power-On

The POWER switch is located on the front of the control panel. Before switching the power on, verify that the range selector is in the OFF position. To turn the power on, move the toggle switch to the up position. The instrument is protected by an internal fuse rated at 1 Amp @ 115 VAC, 1/2 Amp @ 230 VAC. If added optional equipment should necessitate a larger fuse, it will be so specified in the Analyzer Specification Section.

4. Optional Pump Control

If the instrument is equipped with the optional internal pump, used to provide sample flow to the sensor, there will be a toggle switch labeled PUMP on the front panel. To turn the pump on, move the toggle switch to the up position.

5. Range Selection

Turn the Range Selector Switch to the highest range. The panel meter immediately responds and holds a position beyond up scale. Normally, within a minute or two, the meter reading falls within scale and continues toward the equilibrium point. Switching to the lower scales should be done only when the meter is able to read within range on that scale. Allowing the meter to remain over-scale on the lower ranges will only delay the time to equilibrium.

In general, time to equilibrium increases as the oxygen level in the sample gas decreases.

6. Optional Quick Start

If the instrument is equipped with the optional Quick-Start feature, this option can be initiated by pressing the ECC front panel push-button labeled QUICK-START. The QUICK-START indicator light will illuminate and an automatic 15 - 20 second quick start cycle will begin.

The Quick-Start feature is to be used in situations where it is desirable to obtain low PPM (Parts Per Million) readings with the analyzer in short periods of time. This feature rejects oxygen within the sensor cell which would otherwise desorb slowly as the sample gas reaches the lowest levels of oxygen content. Use the Quick-Start only when the gas sample tested is expected to be below 10 PPM. For gas compositions above 10 PPM, the Quick-Start feature has little or no effect.

After the Quick Start sequence finishes, the instrument automatically returns to normal operation and the meter indicates the actual O_2 reading again. In some cases, the meter indicates a negative reading immediately following a Quick-Start sequence. This essentially means that the sensor electrode is filled with an excess amount of hydrogen as a result of the Quick-Start sequence. This condition, however, should correct itself in minutes as incoming oxygen from the gas sample stream neutralizes the hydrogen.

7. Optional STAB-EL™

A Delta F Oxygen Analyzer, equipped with the patented STAB-EL electrolyte system, can be used on gases that contain acid components such as Cl_2, HCl, SO_2, H_2S, etc. To determine if a Delta F Analyzer has a STAB-EL system, check the option list in Section I-E, Optional Equipment.

For many applications, the STAB-EL electrolyte system, together with Delta F's unique non-depleting electrochemical sensor, eliminates the necessity of removing the acid components prior to making the oxygen measurement. The STAB-EL electrolyte system consists of a second pair of electrodes placed within the oxygen sensor. The STAB-EL anode is in the electrolyte reservoir; the cathode is in the sensor cavity (Figure 2, Page 17). A current of approximately 10 mADC is applied to the electrodes, which, in turn, establishes an electrolytic path via the electrolyte solution.

Anions (anions are negatively charged ions), formed by the reaction of the acid gases with the electrolyte, migrate to the anode; cations (positive ions) are attracted to the cathode. If the sample does not contain acid gas, the hydroxyl ions in the electrolyte migrate to the anode and potassium ions to the cathode; a modest water electrolysis reaction results. Since the

potassium is unstable in an aqueous solution, it reacts to form KOH, thus allowing the sensor to maintain an adequate population of hydroxyl ions to transport oxygen between electrodes.

In a STAB-EL equipped oxygen sensor, acid-forming components are prohibited from excessive build-up within the electrolyte. Instead, they are induced to migrate towards the STAB-EL anode, where they concentrate.

In situations where the sensor is exposed to carbon dioxide (acid gas), carbonate ions are formed by reaction with the electrolyte. The anions migrate to the STAB-EL anode, where they increase in concentration. When the solubility limit of the carbonate ion is reached, CO_2 begins to effervesce from the reservoir solution. This mechanism is enhanced by the fact that the electrolyte solution close to the anode is normally acidic.

For gases such as chlorine, fluorine, etc., the anionic species formed upon entering the sensor also migrate to the anode. However, unlike the carbonate ion, they participate directly in an oxidation reaction and evolve as a gas. For anionic species (such as the sulfate ion, which cannot be released from the reservoir either by effervescence or by direct oxidation), a gradual accumulation results. Eventually, the reservoir must be emptied to remove the product. For these situations, changing the electrolyte every 1-2 months is usually effective. Consult the factory for specific recommendations.

The electrolyte flow path in the STAB-EL sensor prevents back diffusion of anionic species to the sensor cavity. Providing further protection is the fact that the electrolyte solution in the sensor cavity is of greater density than that of the reservoir. The construction of the sensor also helps reduce back diffusion of the acid components.

CAUTION

The STAB-EL sensor furnishes the ability to measure oxygen (O_2) in sample gases containing varying amounts of acid gases. As a general guide, Table 1 (Page 14) shows the maximum allowable limits of acid gases tolerable with the STAB-EL option.

There are applications where the acid-gas components may exceed the upper limits of the STAB-EL system. In such circumstances, the inherent capabilities of the sensor can be enhanced by using a scrubber system so that the shortcomings of both components are lessened. First, by using the scrubber to remove the bulk of acid constituent(s), the analyzer is now capable of continuous stable performance. This is despite the fact that, even during normal operation, a significant fraction of acid gas carries through the scrubber to the oxygen sensor. Second, on those occasions when breakthrough occurs and greater amounts of acid are released by the scrubber, the sensor's ability to tolerate high levels of acid gas for limited periods will avoid catastrophic loss of performance - assuming the scrubber is properly maintained.

TABLE 1

MAXIMUM ALLOWABLE ACID GAS LIMITS USING THE STAB-EL SENSOR

Measuring range of Analyzer*	CO_2 %**	SO_2 ppm	H_2S ppm	NO_x ppm	CL_2 ppm	HCL ppm
0-100 ppm	0.1	100	100	100	50	50
0-500 ppm	0.1	100	100	100	50	50
0-1000 ppm	0.2	250	250	250	100	100
0-5000 ppm	0.3	500	500	500	200	200
0-10,000 ppm	0.4	750	750	750	400	400
0-2%	0.6	1000	1000	1000	500	500
0-5%	1.0	1300	1300	1300	700	700
0-10%	2.0	2000	2000	2000	1000	1000
0-25%	3.0	3000	3000	3000	1500	1500

Consult Delta F for recommendations on using the STAB-EL sensor with acid gases other than those mentioned above.

* Represents the highest range for multiple range analyzers.
** Concentrations of CO_2 are in percent. One percent is equivalent to 10,000 ppm.

8. Electrolyte Condition Alarm

The Electrolyte Condition Alarm detects low electrolyte level or loss of electrolyte effectiveness due to contamination. This alarm turns on an LED on the analyzer's front panel.

9. Optional Sensor Enclosure Heater

This option should be used when the sensor enclosure is going to be installed in an area where ambient temperatures reach 32^oF (0^oC) or below. If the instrument is equipped with the optional heater there will be a toggle switch labeled HEATER on the front panel. To turn the heater on, move the toggle switch to the up position.

10. Optional Scale Factor Control

This option permits read-out of oxygen in background gases having significantly different diffusivities compared to nitrogen. This front panel control is particularly useful when background gas is either helium or hydrogen. Refer to Table II, Page 19, for the background gas correction factors of several commonly used gasses.

11. Optional Sample Line Filter

This option consists of a high capacity borosilicate glass coalescing filter element with a 316 stainless steel housing. This option should be used with samples having solid particles in excess of $2mg/ft^3$ or with oil/solvent mist in excess of $0.5mg/ft^3$.

12. Optional Pressure Regulator

This option should be used when the sample pressure is above 60 PSIG, or if the sample pressure is between 1.0 to 60 PSIG and a flow control valve is not used. The optional Pressure Regulator has a 3000 PSIG capacity and a 0-5 PSIG adjustable outlet pressure.

13. Optional One Or Two Setpoint Alarm Meter

Single setpoint meters are equipped with a high alarm. The dual setpoint meters have one high (right knob) and one low (left knob) alarm. For greatest flexibility, both normally-open and normally-closed relay contacts are available on the Weidmuller terminal block, for each alarm. The contacts operate as follows:

HIGH ALARM (RIGHT KNOB)

CONDITION	ALARM CONTACTS	WEIDMULLER TERMINAL BLOCK
POWER OFF	N.C. CLOSED	16(COM) & 17(NC)
METER NEEDLE ABOVE SETPOINT	N.C. CLOSED	16(COM) & 17(NC)
METER NEEDLE BELOW SETPOINT	N.O. CLOSED	16(COM) & 18(NO)

LOW ALARM (LEFT KNOB)

CONDITION	ALARM CONTACTS	WEIDMULLER TERMINAL BLOCK
POWER OFF	N.C. CLOSED	16(COM) & 17(NC)
METER NEEDLE ABOVE SETPOINT	N.C. CLOSED	16(COM) & 17(NC)
METER NEEDLE BELOW SETPOINT	N.O. CLOSED	16(COM) & 18(NO)

See Page 6 for full wiring information.

B. Gas Monitoring

The Delta F oxygen analyzer is designed and constructed to provide continuous oxygen monitoring capability with a very minimum of operator attention. Since the sensor has no depleting components and utilizes a stabilized electrolyte, routine adjustments are not required to retain analyzer accuracy. However, at the time of installation it is important to verify that the Gas Conditioning Limits (sample temperature, particulate/mist levels, delivery pressure and flow rate) will not be exceeded. See Gas Conditioning Limits, Page 32 for full details.

VI THE DELTA F CALIBRATION METHOD

A. Outline Of The Sensor Concept

The Delta F oxygen sensor is an electrochemical cell with the ability to measure the oxygen content of a gaseous mixture (See FIGURE 2.) The oxygen, delivered to a cathodic electrode through a diffusion barrier, is reduced, ionically transported, and re-oxidized to it's elemental state at the anode.

The "Bi-Strata" diffusion barrier is an effective meter which secures accurate measurement of oxygen content in a gas stream without the necessity of maintaining a precise and constant sample flow.

A direct current potential (approximate 1.30 VDC) is applied to the cell and constitutes the driving force necessary to accomplish the reduction/oxidation reactions as well as the transport of ionic species (hydroxyl ions, OH^-) between electrodes.

The electronic circuit is designed to supply the D.C. voltage to the sensor. Subsequently, the cell output current is directed to an operational amplifier which is linked to a resistive feed-back loop network.

An important feature of the Delta F sensor is its ability to generate a linear current response to oxygen over the entire analyzer range(s). As a result, the electronics can be constructed using simple linear amplification, avoiding the need for complicated and less accurate linearization circuits.

Due to the inherent linearity, the accuracy of the analyzer across the entire range(s) can be determined by one properly executed span-gas calibration check combined with verification that the zero oxygen point is precise.

At the factory, each sensor is tested for linearity using at least five (5) standard gas compositions. These gases contain oxygen at various levels which, typically, are spread uniformly over the full analyzer range. Only those sensors which meet the specified accuracy for all tests are accepted. In addition, each sensor must demonstrate stability at the adjusted zero point for at least 72 hours. The zero adjust calibration is performed using either hydrogen gas or a mixture of 2% hydrogen/balance nitrogen. In either case, the gas is passed through platinum and/or palladium catalyst beds immediately prior to being introduced into the analyzer. The catalyst has excellent capabilities to react hydrogen with any oxygen present in the gas. Thus, the zero adjustment is corrective for only the minimal non-ideal factors that exist within the sensor structure and the analyzer's internal plumbing.

Acid

$HCl + KOH \rightarrow KCl + H_2O$

net current flow

SECONDARY CATHODE: $2H_2O + 2e^- \rightarrow 2H_2 + 2OH^-$

" ANODE: $2OH^- \rightarrow \frac{1}{2}O_2 + H_2O + 2e^-$

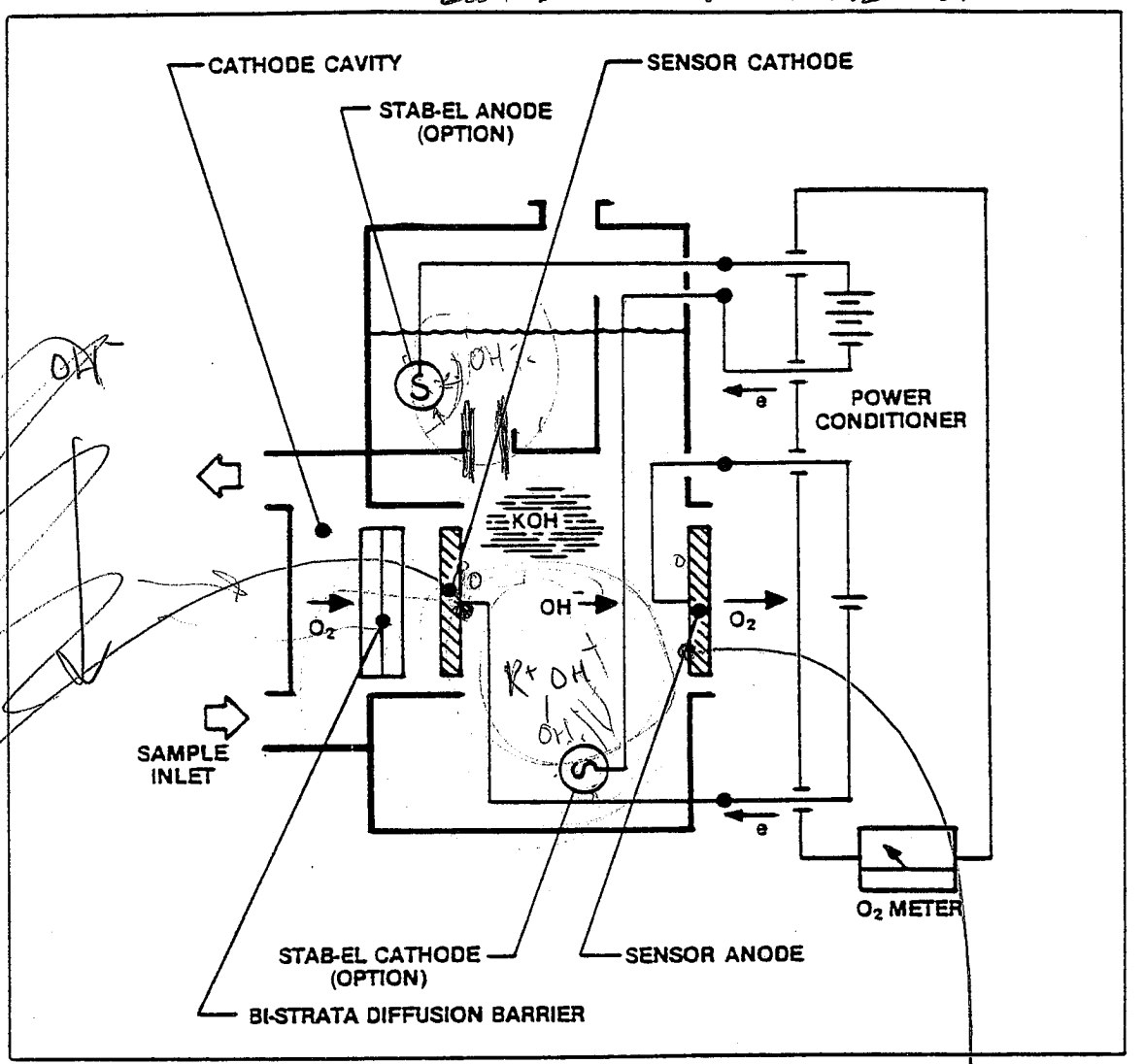


FIGURE 2 Coulometric principle of the Delta-F Cell. Oxygen is reduced at the cathode to OH^-, which migrates to the anode through the KOH electrolyte. The electrodes are nondepleting.

CATHODE: 3-phase interface; liquid; solid conductor

$O_{2\,gas} + 2H_2O + 4e^- \rightarrow 4OH^-$

ANODE:

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

1.3V

+

B. Factory Settings

The analyzer is calibrated at the factory and, unless otherwise specified, the span adjust setting represents the calibration for oxygen in a nitrogen background gas. If the unit is ordered with calibration in a background gas other than nitrogen, it will be so noted in Section I-D, Calibration Data.

The control panel is equipped with both ZERO and SPAN adjustment potentiometers. Each potentiometer is a ten-turn type and uses a counting dial for the purpose of displaying the set point. There are 100 divisions per revolution of the dial; each setting is accurate to the second decimal point.

Prior to shipment of each analyzer from the factory, the calibration set points for both ZERO and SPAN adjust are determined. These setpoints can be verified by comparing the dial settings with the values listed in Section I-D, Calibration Data. Always check these potentiometer dial settings upon receipt of equipment and periodically thereafter to insure they have not been inadvertently moved.

C. Background Gas Correction Factors

As standard procedure during factory calibration, tests are performed to measure oxygen in a background of nitrogen gas. If the background gas is to be other than nitrogen, it is so noted in Section I-D, Calibration Data.

In simplest terms, the background gas has significance in the measurement of oxygen due to its effect on the transport rate as oxygen moves through the diffusion barrier into the electrochemical cell. The diffusion barrier consists of apertures which become occupied by the background gas. Since the oxygen must migrate through the background gas, it meets with resistance which is predominantly a function of the molecular weight of the gas through which it travels.

As a benefit, the typical background gases encountered in practice form stable and predictable resistance paths for the diffusion of oxygen. It is possible to develop coefficients for the various gases, as they relate to nitrogen.

It is important to note that an oxygen analyzer, that is calibrated using a specific background gas, can be used to monitor oxygen in a wide variety of other gases by using the appropriate coefficient which is more suitably termed the background gas correction factor or scale factor.

Correction factors for several gases have been experimentally determined and are listed in Table II, on Page 19.

TABLE II

BACKGROUND GAS CORRECTION FACTORS

GAS TYPE	MULTIPLIER	
Argon	1.01	Within ±1% accuracy of analyzer
Ethylene	1.00	
Nitrogen*	1.00	
Carbon Monoxide	.99	
Methane	.96	
Hydrogen	.41 .62**	
Helium	.35 .54**	

* Analyzer has been calibrated using nitrogen as the background gas.

** Used for analyzers with full scale ranges of 500 ppm or less.

VII MAINTENANCE

A. Routine Procedures

1. Electrolyte Level Check

Once readied for operation, the Delta F analyzer requires no routine maintenance in most applications. Only when dry gas streams (low dew point gases) are monitored for an extended time does it become necessary to periodically attend the unit. The dry gas stream, which passes across the diffusion barrier, gradually extracts water from the sensor; consequently, it is necessary to periodically replenish the water.

The sensor cell assembly consists of two interconnected chambers. The lower section actually contains the sensing electrodes, and, is the critical portion requiring total immersion in electrolyte to be operable. The upper chamber is the reservoir; its purpose is to hold excess liquid, making it available to the sensing chamber as the dry sample gas extracts moisture through the diffusion barrier. As long as there is any water or electrolyte in the reservoir, the sensor operates satisfactorily.

The reservoir will hold at least 65 ml. of liquid. (The sensor cavity holds an additional 15-20 ml.). Since a very dry gas continuously passing through the cell will extract no more than 10-15 ml per month, checking the reservoir water level only every 2-3 months is adequate.

It is important to note that once the cell has been charged with electrolyte, no further addition of electrolyte solution is required. The dissolved components in the electrolyte are neither consumed nor converted during operation; only periodic replenishment of water is necessary.

When adding water to the reservoir, use, preferably, distilled or de-ionized water. Use of good quality tap water is acceptable.

Finally, avoid filling the reservoir to capacity. When adding water, it is good practice not to fill beyond 2/3 capacity. By limiting each addition to 30-35 ml of water, problems from overfilling can be prevented.

B. Servicing of Sample Conditioning Equipment

If the analyzer is used to monitor non-ideal gas streams, make sure that proper sample conditioning equipment is installed to protect the sensor. Table IV, Section VIII, Page 32 lists the important parameters and the suggested limits.

The filtration of particulate and condensable materials is the most frequently encountered sample conditioning requirement. Accordingly, proper maintenance of filtration equipment is the most important factor in securing long-term stability in analyzer performance. For this reason, it is recommended that a servicing program for the sample conditioning system be developed that is commensurate with the quality of the gas to be handled.

C. Frequency of Calibration Checks

Except for applications where periodic water replenishment is required, there is no routine maintenance necessary to keep the analyzer operable over extended periods; the reason for this is that the sensor system has no consumable or depleting components. As a result, the frequency of calibration check becomes a matter of judgment, reflecting the importance of the process being monitored. Regardless of the type of application, it is recommended that some form of calibration check be performed at least once every two months for any continuous operation.

D. Recalibration

1. Preliminary System Check-Out

In the event that the analyzer read-out shows deviation when checked with certified calibration gases, follow the preliminary check-out procedures prior to making any adjustments to the ZERO adjust or SPAN adjust potentiometers.

a. External & Internal Plumbing

If the analyzer read-out is reading low, and the flow rate of sample gas is proper, then it is unlikely that plumbing leakage is the problem. High read-out error is commonly caused by leakage in the plumbing system.

A simple test can be performed that in most cases identifies leakage of oxygen into the gas stream. By observing the read-out at two flow levels, i.e., at 1.0 and 2.0 SCFH, only a very slight increase, if any, in read-out would be expected in a tight system as the flow was increased to 2.0 SCFH. Conversely, if leakage in the plumbing system exists, then the increase of flow from 1.0 to 2.0 SCFH likely results in a substantial decrease in oxygen read-out (typically dropping in level by as much 25 to 50%).

A leak in the flow system will not always adversely affect analyzer read-out. In fact, by-pass connections, which in essence create controlled leakage conditions, are commonly installed in gas delivery lines to reduce lag time in analyzer response. When installing by-pass connections, provisions should be made to avoid the possibility of oxygen, from ambient air, leaking into the gas delivery lines, particularly in those systems where step changes in conditions occur periodically.

Whenever flow sensitivity is observed, as described above, check and test the external plumbing for leaks. If the gas delivery lines are tight, disconnect the analyzer and remove the chassis from the cabinet so that the internal connections can be checked. (The analyzer's internal gas lines and connections are minimal so as to reduce the potential for leakage.) Be certain to include the stem on the flow control valve when checking for internal leaks; the valve depends on a metal to polycarbonate seal that may relax over an extended period of time.

Internally, the analyzer gas flow system also includes a relief valve assembly. The check-out of this assembly is covered separately in the following sub-section.

b. Relief Valve Assembly

A relief valve is installed in each analyzer in a position immediately upstream of the sensor cell; it protects the analyzer from accidental overpressure in the gas entering the inlet port. FIGURE 3 provides an exploded view of the Relief Valve Assembly. A spring compresses the plunger against the O-ring which accomplishes the seal. At a pressure of 2-3 psig, the plunger begins to unseat, allowing the sample stream to vent to ambient air.

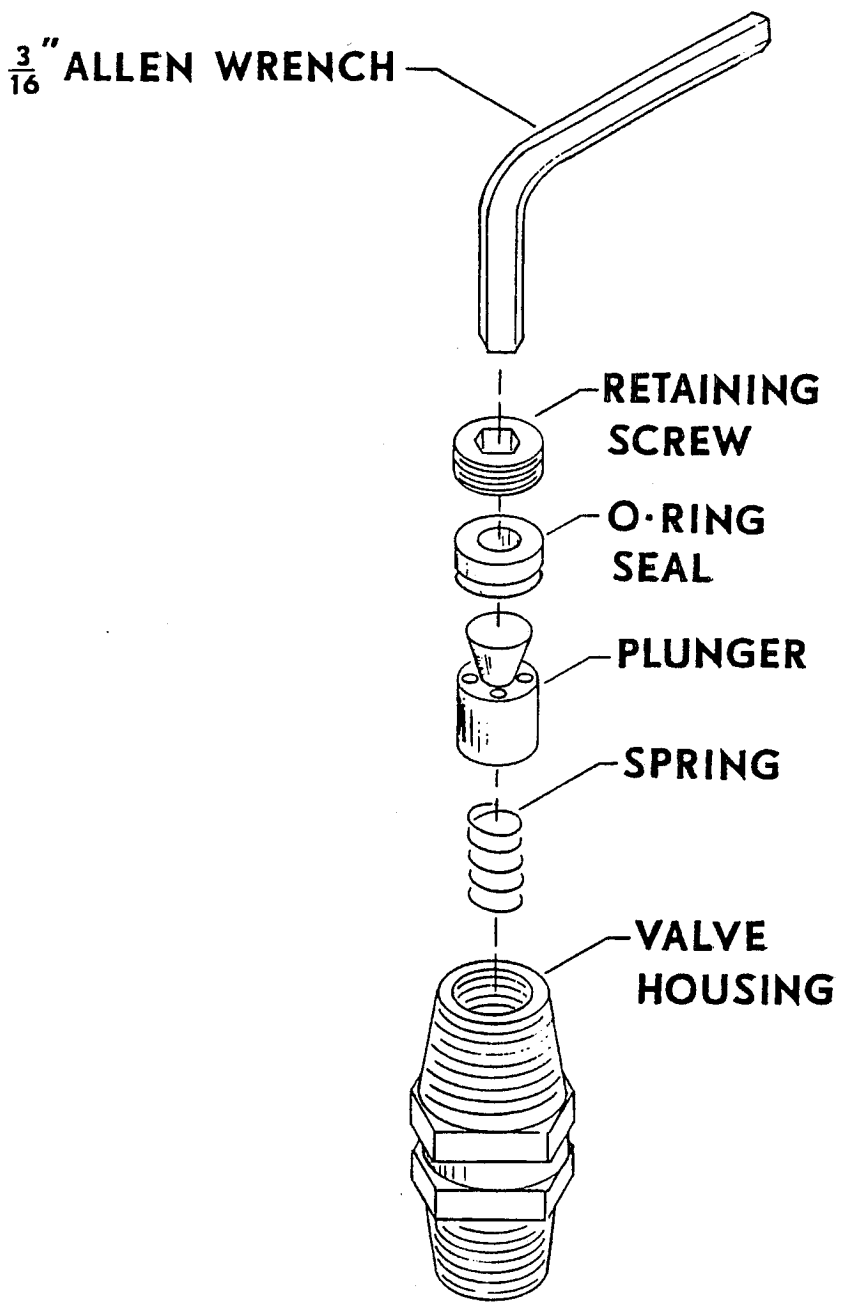
It is possible for leakage to develop in the relief valve and, generally, if it does, it is for one of two reasons.

First, if the valve has been overpressured, the plunger may not reseat properly. Leaks due to the plunger not reseating properly can, as a rule, be corrected simply by inserting a rod into the vent and tapping gently against the back end of the plunger. In the standard plumbing configuration it is possible to access the vent without removing the pressure relief valve. In the pump equipped version the valve must be removed. The rod should have a diameter no greater than 1/8 inch.

If leakage is due to a dirt build-up between the O-ring and plunger, disassemble the valve. It is necessary to disconnect the analyzer and remove the chassis from the cabinet. The relief valve can then be disconnected from the gas line by using a 9/16 inch open-ended wrench to loosen and unscrew the relief valve from the tee fitting. Once loosened, pull the assembly toward the rear of the unit freeing it from the tee.

To reach the O-ring, open the valve assembly using a 3/16 inch hex wrench to loosen the retaining screw.

When the valve is disassembled, clean the components and examine the sealing surfaces to insure that there are no permanent marks or grooves. Pay particular attention to the O-ring, verifying the fact that it is in no way distorted or cracked or otherwise deteriorated.



RELIEF VALVE ASSEMBLY

As the valve is being reassembled, apply a very thin film of grease (preferably a silicone vacuum sealing grade) onto the O-ring. Wipe off any visible excess.

When recoupling the valve to the elbow fitting, use a thread sealant (teflon tape is recommended). It is important to secure a tight seal on this thread joint since it is upstream of the valve and within the confines of the gas sample flow system.

Finally, when the valve assembly is remounted in the unit, be certain that the fitting is free of dirt, oil, or other foreign matter.

c. Sensor Input Voltage

In function, the Delta F oxygen sensor reacts in a manner similar to a variable resistor. As the cathode of the sensor is exposed to greater amounts of oxygen, the conductivity of the sensor increases. A direct current voltage is applied to the sensor and is the driving force to complete the electrode reactions. This voltage must be regulated within reasonably strict limits. For example, if the voltage is too low (less than 1.20 VDC), then the cell lacks sufficient potential to maintain a linear response to oxygen, particularly at the highest levels. If the voltage input to the sensor is too high (above 1.34 VDC), the short term effect is to drive the read-out in a negative direction. In fact, when monitoring gas on the lowest range, high sensor voltage may produce a negative peg on the meter. In the long term, high input voltage is corrosive to the sensor and may cause premature failure.

For satisfactory performance, maintain a sensor input voltage between 1.24 and 1.33 VDC and, preferably, between 1.25 and 1.31 VDC.

The sensor input voltage can be measured as follows:

* Disconnect the white/black/red wire (positive input voltage lead to the sensor.) The readings to be taken are open circuit values.

* Acquire a D.C. voltmeter with the ability to read to 2 decimal points (3 1/2 digits on a 2 volt scale).

* Observing polarity, connect the voltmeter to the sensor voltage leads. The white/yellow wire is negative (-) and may remain connected to the cell. The white/black/red wire is positive (+).

* Switch the analyzer power ON. Turn the range selector switch to each range position and observe the open circuit input voltage. The values at each position should be the same (within .01 VDC) and should be within 1.24 and 1.33 VDC.

  If the sensor voltage is not proper as discussed above, consult the factory.

d. Open Circuit Offset Voltages (Zero adjustment is described in a later section.)

To verify that the open circuit offset voltage has not been disrupted by an alteration or failure in the electronics, make the following tests:

Disconnect the white/black/red electrical lead that is located at the right on the lower front section of the sensor cell. Turn the Range Selector Switch to the most sensitive range and observe the needle position on the panel meter. It should be to the left of zero. This negative reading constitutes the offset voltage. The object of this test is to measure its magnitude and polarity using a voltmeter with the capability of reading D.C. voltage to at least two decimal places (0.01 VDC).

Verify that the ZERO adjust and SPAN adjust potentiometers are set at the values given in Section I-D, Calibration Data; then compare the DC voltage taken on the panel meter terminals with the adjusted offset voltage which is also listed in Section I-D, Calibration Data. A slight difference between values (less than 0.20 volts on ranges greater than 0-3 ppm O_2) is not of sufficient magnitude to place the analyzer in significant error. This voltage can also be measured at the standard 0 to +10 output at the rear panel of the instrument (Recorder/Relay Connector).

The unadjusted offset voltage can be verified by taking the same reading as above after resetting the ZERO adjust potentiometer to 10.00. Again, the reading should be compared with the value listed in Section I-D, Calibration Data.

Once the above tests have been completed, be certain to reconnect the white/black/red lead to the sensor. Also, reset the ZERO adjust potentiometer to the factory set value.

2. Resetting the Control Panel Potentiometers

a. Background Information

The Delta F sensor uses a two section diffusion barrier (trademark name "Bi-Strata"). This design was developed to resist the problems commonly encountered with membranous barriers, namely, foreign matter accumulation and heat and

pressure distortion. Maintaining the analyzer within prescribed ambient conditions and ensuring appropriate gas conditioning (filtration, temperature and pressure control, etc.) are imperative to realize the long-term stability of the sensor.

If it becomes necessary to make adjustments in calibration, both the ZERO and SPAN potentiometers on this analyzer are accessible so that it is a simple task to make corrections.

b. ZERO Adjustment

In factory calibration, the ZERO adjust potentiometer is used to compensate for two inherent sensor characteristics. The first is a trickle current within the sensor caused by the imposed DC voltage as it maintains the electrodes in a polarized condition. The second factor is the penetration by oxygen (in air) into the sensor and plumbing system.

Typically, the combination of the two effects requires that an offset in reading be made equivalent to approximately 0.1% of the top scale value (i.e. an analyzer with ranges of 0-10, 0-100, 1-1000 ppm O_2 would likely require an offset of 1 ppm or less).

The offset required to compensate for the current generated within the sensor does not change to any noticeable degree over the life of the sensor. However, shock, vibration, temperature and pressure cycling, aging, and other wear and tear effects may change the rate of oxygen penetration from ambient.

Note that the oxygen penetration factor may actually diminish slightly. In fact, this effect is sometimes more noticeable in the first six months of operation when it appears that the sealing joints in the sensor cell actually become tighter.

After verifying that the loss of accuracy at the zero oxygen point is not due to either circuit malfunction or plumbing leakage, perform the following procedure to reset the ZERO adjust potentiometer located on the front panel of the ECC.

Select a sample gas that either has no oxygen or that contains oxygen in an amount less than 1% of the analyzer's lowest range; i.e., if the analyzer has a lowest range of 0 to 10 PPM O_2, then for the purpose of resetting the zero point, the sample gas should contain no more than 0.1 PPM O_2.

For trace oxygen analyzers, Delta F recommends a cylinder gas composition of 2% hydrogen with a balance of nitrogen. If the gas includes a few PPM of oxygen, it is not important as long as a catalytic hydrogen reaction chamber is installed directly at the inlet of the analyzer. The oxygen that is in the gas or which may be picked up from any imperfections in the gas

delivery system reacts with the hydrogen to form water. Water in the gas stream, of course, has no effect on the analyzer reading. Reaction chambers are commercially available - Engelhard markets a chamber called a "DEOXO" catalytic hydrogen purifier.

For percent oxygen analyzers or for any analyzer with a lowest range of 0-0.1% O_2 or more, standard pre-purified nitrogen (with O_2 level at approximately 5 ppm) is more than sufficient for resetting the zero point. No catalytic reactor is required. It is only necessary to insure that the gas is delivered to the analyzer free of contamination.

Set a flow rate of approximately 2.0 SCFH when using pre-purified nitrogen. If 2% H_2/balance N_2 with a catalytic reactor is used, set a flow between 0.5 and 1.0 SCFH and safely dispose of the analyzer exhaust.

Maintain the flow conditions established in the previous step until the analyzer exhibits a steady reading. The time required to establish a reliable zero point depends primarily on the analyzer range(s). The lower the range, the longer the period necessary to reach stability. Typically, resetting of the zero point for a 0 to 25% range should not take more than 10 to 15 minutes. However, reaching stability at zero for the very lowest range of 0 to 1.0 ppm may require as long as 10 to 12 hours. It is recommended that, where possible, a recorder be used to chart the zero point, especially for low trace units. Charting the zero point is helpful in avoiding a premature readjustment.

Turn the ZERO adjust dial to reset the zero point. Set the zero reading an increment above exact zero; this avoids a negative reading due to meter hysteresis. Record the ZERO dial reading and the zero reset is complete.

c. SPAN Adjustment

The SPAN adjust potentiometer is located on the front panel of the ECC. At the factory, span calibration is performed using a minimum of 5 separate oxygen compositions in the chosen background gas. Since the sensor output is linear in response to oxygen content in the gas sample, each test after the first is basically a verification of the initial span set point.

To reset the span, then, only a single calibration gas cylinder is required as long as the test is performed accurately.

The oxygen level in the calibration gas can be any amount within the range of the analyzer. It is customary to select an oxygen content (in the proper background gas) that approximates either the oxygen limit or level encountered in the process to be monitored. Although this is a valid method, it takes longer as the lowest levels of oxygen are approached.

To check span or make a span adjustment, a calibration gas with an oxygen content between 10% and 90% of the high range scale is recommended. Compositions within these limits make possible the most accurate calibration determinations in the shortest time.

Reset of the span for an analyzer of 0-25% range can be accomplished in 10 to 15 minutes, while at a range of 0-10 PPM, the time required for the sensor to reach equilibrium and thus be ready for span reset may be as much as 1 hour.

When it is necessary to recalibrate the span, the following procedure is recommended:

* Select a certified cylinder of appropriate background gas in which the oxygen content has been accurately determined.

* Pay particular attention to the next step, which is the connection of the certified cylinder gas to the analyzer. If the oxygen level in the cylinder gas is above 1%, then it is permissible to use standard plumbing equipment which may include plastic and rubber components. If the oxygen content in the certified cylinder gas is less than 1%, and particularly, if below 0.1% (1000 PPM), elimination of all plastic and rubber components is imperative. Do not neglect the selection of a proper pressure regulator for the cylinder, that is, one with a metal diaphragm. Once the gas delivery system is complete, perform a thorough leak check.

* Turn on the analyzer. Set a flow of 2.0 SCFH on a flowmeter. This is the exact rate at which all factory calibrations are performed. If, however, the application in which the analyzer is being used requires a flow other than 2.0 SCFH, then best accuracy is achieved by matching the certified gas flow to the process level.

* Monitor the analyzer response to the certified gas until a stable reading is obtained. The use of a chart recorder is beneficial in verifying that the sensor has reached an equilibrium point.

* If necessary, reset the SPAN dial until the analyzer read-out corresponds to the oxygen level listed for the certified cylinder. Record the SPAN dial reading and the recalibration for span is complete.

3. Resetting the Sensor Heater Temperature

The proportional temperature controller board is located in the RSC enclosure. For normal applications the sensor is maintained at a temperature of $80^{o}F$. The controller is set at the factory, and should not require readjustment unless controller components have been replaced.

* Turn on the analyzer and turn on the heater. Allow at least one hour for the sensor temperature to stabilize.

* Obtain a temperature measurement device capable of measuring the desired operating temperature to an accuracy of $\pm 2^{o}F$.

* Remove the RSC cover. Attach the temperature measurement device probe to the side of the Oxygen Sensor. If possible, it is recommended that the opening of the enclosure be covered to prevent cooling. The Sensor temperature should be $80^{o}F \pm 5^{o}F$.

* If adjustment is required, locate the Temperature Adjustment Potentiometer mounted on the Sensor Mounting Plate. The potentiometer should be adjusted clockwise to increase the temperature, or counter-clockwise to decrease the temperature.

* Following each adjustment, replace the cover on the RSC and allow 15 minutes for the new temperature to stabilize.

4. In Case Of Difficulty

The Delta F Service Department is ready to help if operation or application problems are encountered. They may be contacted via telephone, letter, Telex or FAX. Please see the front page of this manual for the appropriate numbers.

If it becomes necessary to return the analyzer to Delta F, please consult the Shipping Instructions section, Page 53. Also, to expedite assessment and repair, please photocopy and fill out the Customer Instrument Evaluation Form on Page 54.

PAGE NUMBER

VIII DATA SECTION

A. General

1. SPECIFICATIONS

TABLE III

WEIGHT:	Electrical Control Chamber < 55 lbs Remote Sensor Chamber < 27 lbs
ELECTRICAL CHAMBER :	NEMA 7, National Electrical Code Class I - Groups B,C,D; Class II - Groups E,F,G; and Class III
SENSOR CHAMBER :	NEMA 7, National Electrical Code Class I - Groups B,C,D; Class II - Groups E,F,G; and Class III
RESPONSE TIME:	O_2 Increase - Instantaneous, Plus System Adsorption Time O_2 Decrease - Instantaneous, Plus System Desorption Time
ACCURACY:	±1 % Of Full Scale, except ±5 % of Full Scale on ranges below 0-2.5 PPM
POWER INPUT:	Standard; 115 VAC, 50/60 Hz Optional; 230 VAC, 50/60 Hz
OUTPUT SIGNAL:	Standard; Linear 0 - 10 VDC, 2K minimum load impedance Optional; 0-1 VDC, 0-5 VDC, 0-5 mVDC, 0-10 mVDC, 0-100 mVDC, 4-20 mADC.
DISPLAY:	Standard; 3" Analog Meter, 10 major divisions, 50 total divisions Optional; 3 Digit LED Meter Optional; 1 or 2 Setpoint Alarm Meter, with relays
GAS FITTINGS:	1/4" Female Normal Pipe Thread on inlet and outlet snubbers, supplied with reducer to 1/8" tube compression fitting

2. GAS CONDITIONING LIMITS

TABLE IV

PARAMETER	OPERATING RANGE	SUGGESTION
GAS SAMPLE TEMPERATURE	BELOW 0 DEGREES F	USE COIL HEATING
	0 - 150 DEGREES F	**STANDARD LIMITS**
	ABOVE 150 DEGREES F	USE COIL COOLING
PRESSURE	BELOW -0.5 PSIG	USE BELLOWS COMPRESSOR
	-0.5 PSIG TO 0.2 PSIG	USE DF-P013 PUMP
	0.2 PSIG TO 1.0 PSIG	**STANDARD LIMITS**
	1.0 TO 60 PSIG	USE CONTROL VALVE OR REGULATOR
	ABOVE 60 PSIG	USE DF-PR1-5 REGULATOR
FLOW RATE	0.3 TO 3.0 SCFH	STANDARD LIMITS
	2.0 TO 3.0 SCFH	**PREFERRED RANGE**
MOISTURE	NO LIMITS (AVOID CONDENSATION)	
OIL/SOLVENT MIST	**<0.5 MG/FT^3**	**STANDARD LIMITS**
	ABOVE 0.5 MG/FT^3	USE DF-F2S FILTER
SOLID PARTICLES	**<2 MG/FT^3**	**STANDARD LIMITS**
	ABOVE 2 MG/FT^3	USE DF-F2S FILTER

3. ELECTROLYTE DATA SHEET

TABLE V

ELECTROLYTE TYPE.....E-05

CONTAINER.....BOTTLE

* TYPE.....POLYETHYLENE
* CAPACITY.....4 OZ
* BOTTLES/SHIPMENT.....2

INITIAL CHARGE
* ELECTROLYTE.....90 ML
  PLUS
* WATER.....NONE

ELECTROLYTE
REPLENISHMENT
(ADD WATER ONLY)

* QUALITY.....DISTILLED OR DEIONIZED WATER PREFERRED
  GOOD QUALITY TAP WATER IS ACCEPTABLE
* FREQUENCY.....AS REQUIRED
* QUANTITY.....30 - 35 ML

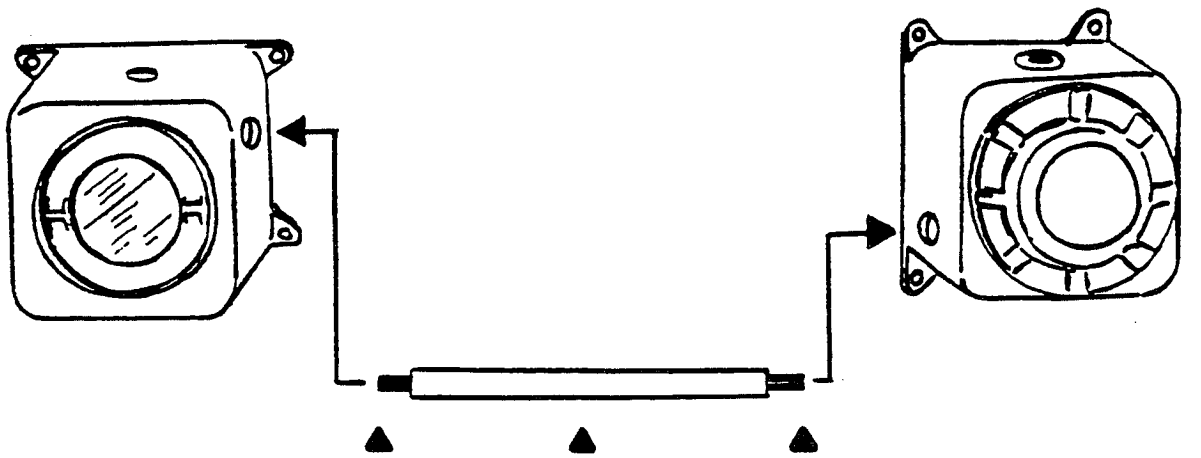
CAUTION

THIS ELECTROLYTE CONTAINS A STRONG CAUSTIC INGREDIENT AND CAN BE HARMFUL IF IT COMES INTO CONTACT WITH THE SKIN AND, MOST PARTICULARLY, THE EYES. BEFORE USING CAUSTIC MATERIALS, BECOME FAMILIAR WITH PROPER PROCEDURES. REVIEW THE MATERIAL SAFETY DATA SHEET, ON PAGE 43, IN THIS MANUAL.

B. INSTALLATION

1. WIRING ARRANGEMENT FOR REMOTE SENSOR CABLE

TABLE VI



FOR CONNECTION TO ELECTRICAL CONTROL CHAMBER WEIDMULLER TERMINAL STRIP(3)

WIRE ARRANGEMENT TO BE INSTALLED BY CUSTOMER(1)

FOR CONNECTION TO REMOTE SENSOR CHAMBER WEIDMULLER TERMINAL STRIP(3)

ECC TERMINAL STRIP NUMBER	FUNCTION	DELTA F COLOR(2)	RSC (R7) TERMINAL STRIP NUMBER
1	CELL (+)	WHITE-BLACK-RED	1
2	CELL (-)	WHITE-YELLOW	2
3*	STAB-EL (+)	WHITE-RED	3
4*	STAB-EL (-)	WHITE-BLUE	4
5*	AC LO	WHITE	5
6	CHASSIS GND	GREEN	6
7*	PUMP AC	WHITE-BLACK	7
10*	HEATER AC	RED	10

NOTES

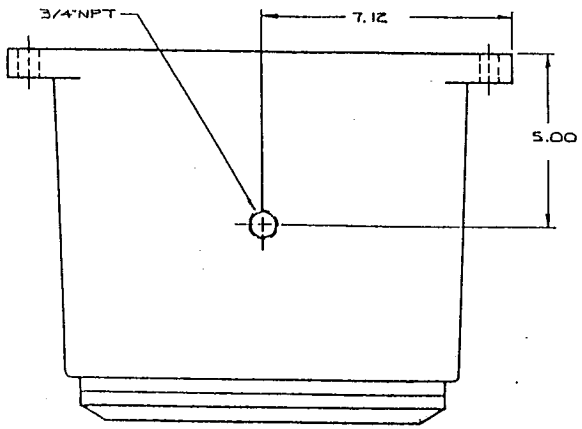
* USED ONLY IF EQUIPPED WITH APPROPRIATE OPTIONS

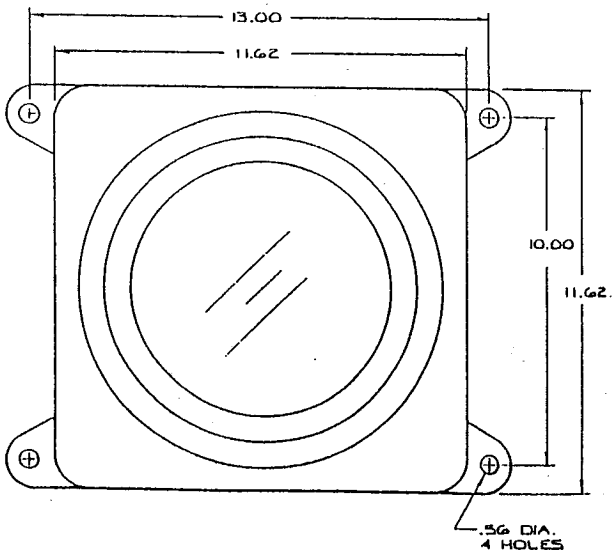
(1) WIRE SIZE RECOMMENDATIONS FOR REMOTE SENSOR CABLE ARE AS FOLLOWS:

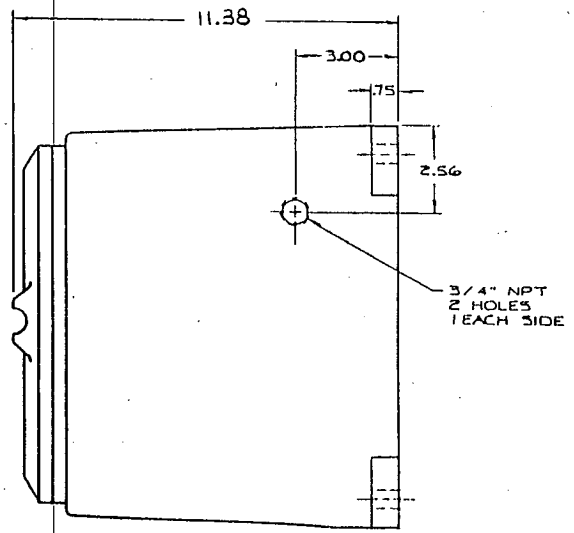
DISTANCE (FEET)	WIRE GAUGE (AWG)
0 TO 50	#20
50 TO 600	#18
600 TO 2000	#16

(2) COLORS LISTED REFER TO DELTA F'S STANDARD WIRING, ONLY. CUSTOMER MAY UTILIZE WIRE COLORS OF PREFERENCE.

(3) USE CONDUIT SEAL, DELTA F PART NUMBER 66-000216. SEE PAGES 37 TO 41 FOR INSTRUCTIONS.







REV	ECO	DESCRIPTION	DATE	APPR
		REVISIONS		

NEXT ASSY	USED ON

TOLERANCE UNLESS NOTED
.X± DRAWN DATE 11 FEB 05
.XX± CHECKED DATE
.XXX± APPROVED DATE
∠±
UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN INCHES AND DRAWING IS NOT TO SCALE

MATERIAL
NELSON TFW-10108
FINISH

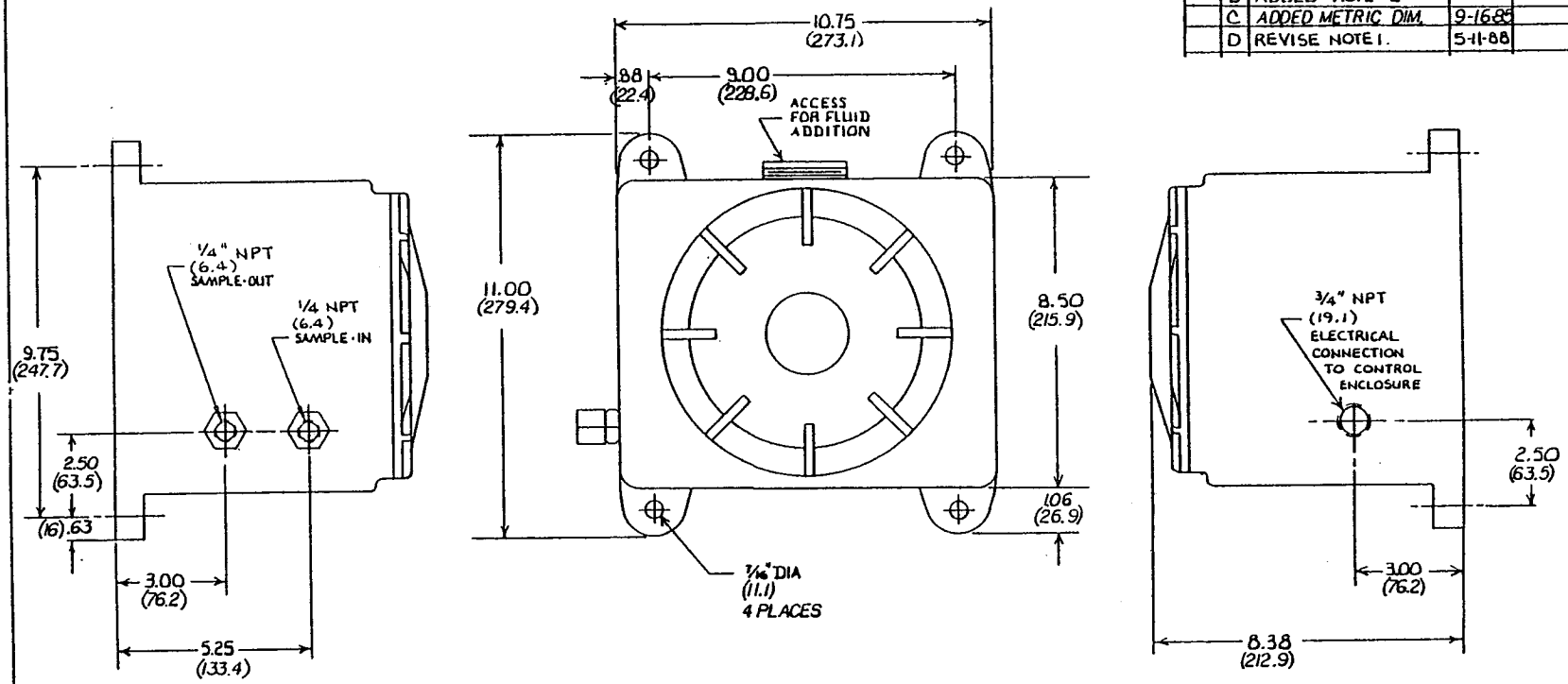
DELTA F CORPORATION

CUSTOMER INSTALLATION
EXPLOSION PROOF
ENCLOSURE

SIZE	DRAWING NUMBER	REVISION
D	12401200	A

SCALE 1/2 X SHEET 1 OF 1

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	INITIAL RELEASE	10-17-84	JMG
	B	ADDED NOTE 2	10-28-84	
	C	ADDED METRIC DIM.	9-16-85	
	D	REVISE NOTE 1.	5-11-88	



ALL METRIC DIMENSIONS ARE IN MILLIMETERS
AND LOCATED IN PARENTHESIS BELOW
ENGLISH DIMENSIONS

NOTES:
1. ENCLOSURE IS UL & CSA LISTED FOR HAZARDOUS LOCATIONS: CLASS I GROUPS B,C,D DIV. 1, NEMA 7
CLASS II GROUPS E,F,G
2. MAXIMUM WEIGHT (WITH ALL OPTIONS INSTALLED) IS 25 POUNDS.

ITEM NO	QTY REQ	DRAWING NO. OR IDENTIFYING NO.	PART	MATERIAL

LIST OF PARTS

MATERIAL	DRAWN dd 10/84	DELTA F CORPORATION
	CHECKED JMG 10/17/84	CUSTOMER INSTALLATION
FINISH	APPROVED	R7 SENSOR ASSEMBLY
USED ON	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	SIZE C — DRAWING NO. 12300330 — REVISION D
NEXT ASSY	DECIMAL .XX ± .010, .XXX ± .005; FRACTIONAL ± 1/64; ANGULAR ± 1°	SCALE 1/2 X — SHEET 1 OF 1
	FINISHED SURFACES UNLESS OTHERWISE SPECIFIED 125	

IMPORTANT

Class I, Group B Hazardous (Classified) Location Enclosures Having Screw Thread Covers And Using A Device That Could Be Spark Producing

Devices that may be considered as having a spark producing potential are switches, relays, circuit breakers, motor controllers, pilot lights, etc.

Generally a transformer is not considered spark producing. However, a potential danger exists if the transformer is abused by overloading. Overloading would create overheating that could cause the transformer to fail with a potential for spark production.

WARNING

All conduit runs connected to the enclosure *must* be sealed with approved sealing fittings installed *immediately adjacent* to (within 1½") the enclosure.

Cover(s), conduit(s), and any plug(s) threads *must* engage a minimum of five full threads with their mating threads and be *securely* tightened.

All threaded joints in the enclosure, and any operating shaft threads have been treated at the factory with Crouse-Hinds STL screw thread lubricant which acts as a lubricant and anti-seize agent as well as aiding the raintight construction. Whenever any threaded joint(s) are disassembled the threads should be re-treated with STL and care *must* be exercised in mating threads properly and *securely* tightening the threaded joints.

NOTE

Before assembling any mating threads make certain that there is no dirt or other foreign material on, or in, either set of threads.

CROUSE-HINDS
ELECTRICAL
CONSTRUCTION
MATERIALS
Division of Cooper Industries, Inc.
Syracuse, New York 13221 • U.S.A.

IF360-Rev. 6/86
Supersedes IF52, 56, 57, 58, 76

CONDUIT SEALING IN HAZARDOUS LOCATIONS USE ONLY CROUSE-HINDS CHICO X FIBER FOR DAMS AND CHICO SEALING COMPOUND FOR SEALING

The National Electrical Code in Article 501, Section 501-5, Class I, Divisions 1 and 2, requires that seals be installed in specific places. This is to prevent the passage of gases, vapors, or flames through the conduit from one portion of the electrical installation to another portion.

While not a Code requirement, it is considered good practice to sectionalize long conduit runs by inserting seals not more than 50 to 100 feet apart, depending on the conduit size.

The Code in Section 502-5 requires seals in Class II locations under certain conditions. Crouse-Hinds sealing fittings can be used to meet this requirement.

In humid atmospheres or wet locations, where it is likely that water can gain entrance to the interiors of enclosures or runs, the runs should be inclined so that water will not collect in enclosures or on seals but will be led to low points where it may pass out through ECD explosion-proof drains.

Frequently the arrangement of runs makes this method impractical if not impossible. In such instances types EZD drain seal fittings should be used. These fittings prevent harmful accumulations of water above the seal. See Section 501-5c5.

In locations which usually are considered dry, surprising amounts of water frequently collect in conduit systems. No conduit system is airtight; therefore, it may "breathe." Alternate increases and decreases in temperature and/or barometric pressure due to weather changes or due to the nature of the process carried on in the location where the conduit is installed will cause "breathing."

Outside air is drawn into the conduit system when it "breathes in." If this air carries sufficient moisture it will be condensed within the system when the temperature decreases and chills this air. The internal conditions being unfavorable to evaporation, the resultant water accumulation will remain and be added to by repetitions of the breathing cycle.

In view of this likelihood, insure against such water accumulations and probable subsequent insulation failures by installing EZD drain seals or EZD inspection seals even though conditions prevailing at the time of planning or installing do not indicate their need.

Sealing fittings are listed by Underwriters' Laboratories, Inc., for use in Class I hazardous locations with Chico compound only. This compound, when properly mixed and poured, hardens into a dense, strong mass which is insoluble in water, is not attacked by petroleum products, and is not softened by heat. It will withstand, with ample safety factor, pressure of the exploding trapped gases or vapor.

Conductors sealed in the compound may be approved thermoplastic or rubber insulated type.

Only experienced, careful workmen should be entrusted with making the dam, mixing and pouring the compound. Improperly made seals are worthless. Mixing vessel must be cleaned thoroughly before mixing new compound.

Type EYS

EYS sealing fittings can be installed in vertical or horizontal conduit runs.

Type EYS29 (¾") is intended for use with a combination vertical and horizontal conduit run. (Pouring spout is in vertical run.)

EYS1 series (½" to 1"), for vertical sealing only, have a filling opening one conduit size larger than the hub size.

EYS4 and 11 series (½" to 6"), for horizontal or vertical sealing, have separate filling and damming openings.

Sealing Instructions for EYS4 Series and EYS11 Series

When sealing vertical conduits, compound is poured through the pipe plug opening above the cover. (See instructions provided with Chico X Fiber.)

For horizontal sealing of the ½" through 6" sizes remove both threaded plugs from EYS.

Construct dams, per instructions provided with Chico X fiber, in both ends of the EYS.

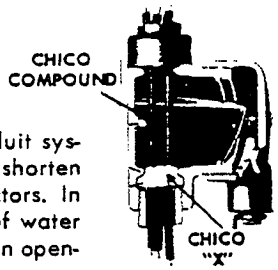
Prepare Chico sealing compound in accordance with instructions provided with Chico sealing compound. Pour the compound through the large opening.

Replace plugs, and screw in flush with body, forcing excess sealing compound to exert pressure against fiber dams at each end of seal.

Type EZS

EZS sealing fittings are for use with conduits running at any angle — vertical, horizontal, or in between.

Sizes ½ to 3-inch inclusive have round threaded cover openings of ample size for placing of dams in one or both conduit hubs. The covers have filling openings through which the compound is poured. The filling opening can be brought into position for pouring by turning the cover, regardless of the angle of the conduits. Pour sealing compound and replace pipe plug.



Type EZD

Accumulations of water in conduit systems are apt to cause trouble and shorten the life of insulation on conductors. In ordinary locations accumulation of water usually can be prevented by drain openings located at low points.

However, in hazardous locations this procedure can be followed only if the drain openings are flame-tight, that is, explosion-proof. The National Electrical Code requires that conduit systems in Class I hazardous locations be provided with means by which the systems can be drained of water, if there is likelihood of water accumulation.

Type EZD drain seals (½" to 2") and type EZD inspection seals (½" to 2") are designed so that the covers can be removed readily, permitting inspection during installation or at any time thereafter.

These fittings are for use only in vertical conduit runs. After the fittings have been installed in the conduit run and conductors are in place, the cover and baffle are removed. After the dam has been made in lower hub opening with "Chico X" fiber the baffle must be snapped into place in the groove in the opening before the "Chico" sealing compound can be poured into the sealing chamber.

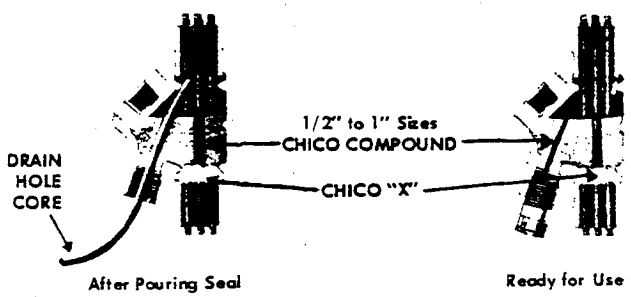
Type EZD Drain Seal Fittings provide continuous draining and thereby prevent water accumulation.

The covers should be positioned so that the drain will be at the bottom. A set screw is provided for locking the cover in this position.

Type EZD Inspection Seal Fittings are identical with those above described providing all inspection, maintenance and installation advantages except that the cover is not provided with an automatic drain. Water accumulations can be drained periodically by removing the cover. The cover must be replaced immediately.

Type EYD

EYD Drain Seal Fittings, for use in vertical conduit runs, prevent accumulation of water above seals in conduit systems. Continuous draining guards against insulation failure and other defects caused by the presence of water in the conduit system.



Install EYD and pull conductors through.

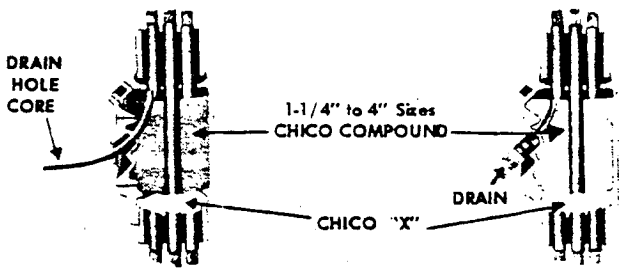
Remove pipe plug and dam the lower hub opening.

Insert rubber drain-hole-core through drain opening and washer (provided) high enough so inner end will be above sealing compound in completed seal. Make sure that the rubber drain-hole-core does not touch any of the conductors.

Pour sealing compound and replace pipe plug.

After about two hours remove drain-hole-core.

Thread ECD drain fitting into the opening and tighten securely.



Remove large cover and pipe plug and dam the lower hub opening.

Replace large cover, threading as far as possible into body, with arrow pointing directly down.

Insert rubber drain-hole-core through hole in large cover high enough so inner end will be above sealing compound in completed seal. Make sure that rubber drain-hole-core does not touch any of the conductors.

Pour sealing compound and replace pipe plug.

After two hours remove drain-hole-core.

Thread ECD drain fitting into cover drain opening and tighten securely.

CAUTION: Type EZD and EYD fittings are suitable for sealing vertical conduit runs between hazardous and non-hazardous areas, but must be so located that hazardous gases or vapors will not vent into the non-hazardous area. Conduits leaving the hazardous area from the top should have the fitting located in the non-hazardous area. Conduits leaving the hazardous area from the bottom should have the fitting located in the hazardous area.

CAUTION: Sealing compound to be mixed **ONLY** at temperatures above freezing and **ONLY** poured into fittings that have been brought to a temperature above freezing. Seals must **NOT** be exposed to temperatures below freezing for at least 12 hours.

If any batch of compound starts to set before pouring do **NOT** try to thin by adding water or stirring. This will spoil seals. Discard the batch and make a new one.

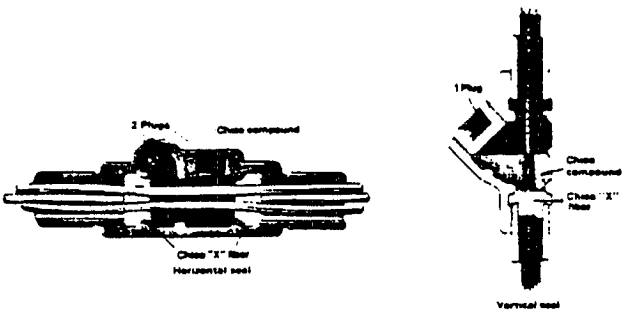
Keep compound dry by having container cover tightly closed when not in use.

BE SURE TO RETAIN THIS INSTRUCTION SHEET FOR FUTURE USE

IF287-Rev. - 4/80

CHICO® X FIBER
For Crouse-Hinds Seals
for Hazardous Locations

PREPARATION OF CHICO X DAMS



1. Remove plugs(s) from sealing fitting.
2. Make dam in hub(s) of sealing fitting using Chico X in following manner:

NOTE

Vertical fittings need dam only in bottom hub. Horizontal fittings need dam in both hubs.

a) Using a hardwood stick, force conductors toward filling opening. DO NOT USE METAL TOOLS.

b) Pack Chico X fiber into conduit hub(s) behind conductors.

c) Push conductors away from filling opening and force them apart.

d) Pack fiber between AND around conductors in hub(s).

NOTE

If conductors are stiff insert temporary wooden wedges between conductors to aid in holding them apart. It is important that conductors be separated from each other so sealing compound will surround each conductor.

e) Pack fiber into hub(s) in front of conductors. Completed dams should be flush with conduit bushing.

CAUTION

Don't leave shreds of fiber sticking to walls or conductors. Such shreds form channels that allow leakage.

3. Mix and pour Crouse-Hinds Chico sealing compound in accordance with instructions furnished with compound.

Amount of NEW CHICO X for one* hub of CROUSE-HINDS sealing fitting:

Hub Size (inches)	CHICO X Required (ounces)
1/2	1/32
3/4	1/16
1	1/8
1-1/4	1/4
1-1/2	1/2
2	1
2-1/2	1-1/4
3	1-3/4
3-1/2	2-3/4
4	3-3/4
5	5-3/4
6	8-1/4

*Quantities are for seals in vertical conduit. For seals in horizontal conduit two dams are needed, so double these amounts for quantity needed.

IF582-8/75 CROUSE-HINDS

CROUSE-HINDS ELECTRICAL CONSTRUCTION MATERIALS
Division of Cooper Industries, Inc. Syracuse, New York 13221 USA
 IF281 3/84

MIXING CROUSE-HINDS CHICO SEALING COMPOUND INTRAPAK
(PART NUMBER 0100901)

CAUTION: Prepare dam(s) before mixing compound. After pouring close immediately.

DIRECTIONS

Using one hand, grip package at arrows and squeeze to break inner liquid container.

Knead pouch until compound and liquid are thoroughly mixed.

Cut or tear off corner of pouch and pour into fitting.

THIS 3-3/4 OZ. PACKAGE WILL FILL:

a. Four EYS 1, 11, 16, or 116 fittings, or
b. Two EYS 2, 21, 26, or 216 fittings, or
c. Two EYS 1, 11, 16, or 116 fittings, and one EYS 2, 21, 26, or 216 fittings, or
d. One EYS 3, 31, 36, or 316 fitting.

CROUSE-HINDS COMPANY
Syracuse, N.Y. 13201

I.F.297 - REV. 9/70

C. RECOMMENDED SPARE PARTS

The following list identifies those parts that Delta F recommends a user have on hand if repairs to an analyzer must be made on location and in the shortest possible time. (WHEN ORDERING SPARE PARTS, ALWAYS MENTION THE ANALYZER SERIAL NUMBER.)

1. ELECTRONICS CHAMBER ASSEMBLY SPARE PARTS LIST

TABLE VII

DELTA F PART NUMBER	PART DESCRIPTION
DFC-02-510-002	Amp PC Board Assembly (Without Power Supply)
DFC-02-510-003	Amp PC Board Assembly (With Power Supply)
47-000915	Power Supply
153-07580	Optional STAB-EL/4-20 PC Board Assembly (Without STAB-EL, without 4-20 mA Module)
152-01980	Optional STAB-EL Daughter Board, for above
47-000223	Optional Isolated 4 - 20mA Module, for above

2. R7 ASSEMBLY SPARE PARTS LIST

TABLE VIII

DELTA F PART NUMBER	PART DESCRIPTION
CONTACT DELTA F	Delta F Oxygen Sensing Cell
DF-P013	Optional Sample Pump
152-05960	Optional Temperature Controller PC Board
DFC-02-410-263	Optional Flowmeter

D. ELECTROLYTE SOLUTION MSDS SHEET
MATERIAL SAFETY DATA SHEET

THE INFORMATION BELOW IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO DELTA F CORP. HOWEVER, WE MAKE NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, WITH RESPECT TO SUCH INFORMATION, AND WE ASSUME NO LIABILITY RESULTING FROM ITS USE. USERS SHOULD MAKE THEIR OWN INVESTIGATIONS TO DETERMINE THE SUITABILITY OF THE INFORMATION FOR THEIR PARTICULAR PURPOSES.

SUBSTANCE IDENTIFICATION

SUBSTANCE: **POTASSIUM HYDROXIDE SOLUTION 1N

CHEMICAL FAMILY: INORGANIC BASE

MOLECULAR FORMULA: MIXTURE

CERCLA RATINGS (SCALE 0-3):
HEALTH=U FIRE=0 REACTIVITY=1 PERSISTENCE=0

COMPONENTS AND CONTAMINANTS

PERCENT: 5.0-6.0 COMPONENT: POTASSIUM HYDROXIDE

PERCENT: 94.0-95.0 COMPONENTS: WATER & NEUTRAL SALTS

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS: POTASSIUM HYDROXIDE: 2 MG/M^3 ACGIH CEILING

PHYSICAL DATA

DESCRIPTION: COLORLESS LIQUID BOILING POINT: NOT AVAILABLE

MELTING POINT: NOT AVAILABLE SPECIFIC GRAVITY: 1.05

SOLUBILITY IN WATER: COMPLETE

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD: NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FLASH POINT: NON-COMBUSTIBLE

FIREFIGHTING MEDIA: DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR FOAM (1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL FOAM (1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FIREFIGHTING: MOVE CONTAINERS FROM FIRE AREA IF POSSIBLE. COOL CONTAINERS EXPOSED TO FLAMES WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT (1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

EXTINGUISH USING AGENTS INDICATED; DO NOT USE WATER DIRECTLY ON MATERIAL. IF LARGE AMOUNTS OF COMBUSTIBLE MATERIALS ARE INVOLVED, USE WATER SPRAY OR FOG IN FLOODING AMOUNTS. USE WATER SPRAY TO ABSORB CORROSIVE VAPORS. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER FROM AS FAR AS A DISTANCE AS POSSIBLE. AVOID BREATHING CORROSIVE VAPORS; KEEP UPWIND (BUREAU OF EXPLOSIVES, EMERGENCY HANDLING OF HAZARDOUS MATERIALS IN SURFACE TRANSPORTATION, 1981).

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49CFR172.101: CORROSIVE MATERIAL

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49CFR172.101 AND 172.402: CORROSIVE

TOXICITY

POTASSIUM HYDROXIDE: 5 MG/24 HOURS SKIN-RABBIT MODERATE IRRITATION; 1 MG/24 HOURS EYE-RABBIT MODERATE IRRITATION; CARCINOGEN STATUS: NONE. CONCENTRATED POTASSIUM HYDROXIDE SOLUTION IS A SEVERE EYE, MUCOUS MEMBRANE, AND SKIN IRRITANT.

HEALTH EFFECTS AND FIRST AID

INHALATION: IRRITANT.

ACUTE EXPOSURE - CONCENTRATED SOLUTION MAY CAUSE IRRITATION, SORE THROAT, COUGHING, DYSPNEA, AND PULMONARY EDEMA.

CHRONIC EXPOSURE - REPEATED OR PROLONGED EXPOSURE TO CONCENTRATE MAY CAUSE BRONCHIAL IRRITATION, COUGHING, BRONCHIAL PNEUMONIA, AND GASTROINTESTINAL DISTURBANCES.

FIRST AID - REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION.

SKIN CONTACT: IRRITANT.

ACUTE EXPOSURE - MAY CAUSE IRRITATION, AND SOFT NECROTIC DEEPLY PENETRATING BURNS ON CONTACT. PENETRATION MAY CONTINUE FOR SEVERAL DAYS.

CHRONIC EXPOSURE - REPEATED OR PROLONGED EXPOSURE MAY CAUSE DERMATITIS.

FIRST AID - REMOVE CONTAMINATED CLOTHING WHILE RUNNING STREAMS OF WATER UNDER CLOTHING. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OR CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). IN CASE OF CHEMICAL BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION.

EYE CONTACT: IRRITANT.

ACUTE EXPOSURE - CONTACT WITH VAPORS AND/OR FUMES MAY CAUSE IRRITATION, REDNESS, PAIN, BLURRED VISION, CONJUCTIVITIS AND BURNS. DIRECT CONTACT MAY CAUSE CONJUNCTIVAL EDEMA AND DAMAGE AND CORNEAL AND EPISCLERAL DAMAGE OR DESTRUCTION.

CHRONIC EXPOSURE - REPEATED OR PROLONGED EXPOSURE TO VAPORS AND/OR FUMES MAY CAUSE CONJUCTIVITIS AND CORNEAL BURNS.

FIRST AID - WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). IN PRESENCE OF BURNS, APPLY STERILE BANDAGES LOOSELY WITHOUT MEDICATION. GET MEDICAL ATTENTION.

INGESTION:
ACUTE EXPOSURE - SEVERE PAIN IN MOUTH, THROAT, AND ABDOMEN, VOMITING, HEMATEMESIS, DIARRHEA, ANOREXIA, DIZZINESS, COLLAPSE, COMA AND DEATH ARE POSSIBLE. IF DEATH DOES NOT OCCUR IN THE FIRST 24 HOURS, GASTRIC OR ESOPHAGEAL PERFORATION MAY CAUSE SEVERE ABDOMINAL PAIN, RIGIDITY AND SUDDEN HYPOTENSION AFTER 2-4 DAYS. ESOPHAGEAL STRICTURE MAY OCCUR LATER, EVEN AFTER SEVERAL YEARS.

CHRONIC EXPOSURE - NOT REPORTED IN HUMANS.

FIRST AID - DILUTE THE ALKALI BY GIVING WATER OR MILK IMMEDIATELY AND ALLOWING VOMITING TO OCCUR. EXAMINE VICTIM FOR POSSIBLE CORROSIVE INJURY TO MOUTH AND THROAT AND IRRIGATE AFFECTED AREAS WITH 1% ACETIC ACID UNTIL ALKALI IS COMPLETELY NEUTRALIZED. DO NOT USE GASTRIC LAVAGE OR EMESIS. GET MEDICAL ATTENTION. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

ANTIDOTE: NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
EXOTHERMIC REACTION WITH WATER. IT GENERATES CONSIDERABLE HEAT AND FORMS CORROSIVE FUMES.

INCOMPATIBILITIES:
POTASSIUM HYDROXIDE
NITRIC TRICHLORIDE: EXPLOSIVE REACTION
PHOSPHORUS: EXPLOSIVE REACTION
CHLORINE: EXPLOSIVE REACTION
N-METHYL-N-NITROSOUREA & METHYLENE CHLORIDE: EXPLOSIVE REACTION
N-NITROSOMETHYLENE: EXPLOSIVE REACTION
NITROBENZENE: EXPLOSIVE REACTION ON HEATING
MALEIC ANHYDRIDE: EXPLOSIVE REACTION
TETRAHYDROFURAN: POSSIBLE EXPLOSIVE REACTION
CHLORINE DIOXIDE: POSSIBLE EXPLOSIVE REACTION
ACROLEIN: VIOLENT POLYMERIZATION
ACRYLONITRILE: VIOLENT POLYMERIZATION
CHLOROFORM AND METHANOL: INTENSE EXOTHERMIC REACTION
BENZOYL CHLORIDE AND SODIUM AZIDE: VIOLENT EXOTHERMIC REACTION
O-NITROPHENOL (MOLTEN): VIOLENT REACTION
POTASSIUM PEROXODISULFATE: IGNITION REACTION
POTASSIUM PERSULFATE AND WATER: IGNITION REACTION
2,2,3,3-TETRAFLUOROPROPANOL: IGNITION REACTION
HYPONITROUS ACID: IGNITION REACTION
TETRACHLOROETHANE: IGNITION ON HEATING
THORIUM CARBIDE: INCANDESCENT REACTION ON HEATING
AMMONIUM HEXACHLOROPLATINATE: FORMATION OF EXPLOSIVE PRODUCT
1,2-DICHLOROETHYLENE: FORMATION OF EXPLOSIVE PRODUCT
NITROPARAFFINS (NITROETHANE; NITROMETHANE): FORMATION OF EXPLOSIVE PRODUCT
NITROALKANES: FORMATION OF EXPLOSIVE PRODUCT
CALCIUM CARBIDE AND CHLORINE: FORMATION OF EXPLOSIVE PRODUCT
2,4,6-TRINITROTOLUENE & METHANOL: FORMATION OF EXPLOSIVE PRODUCT
TRICHLOROETHYLENE: FORMATION OF EXPLOSIVE PRODUCT ON HEATING
TETRACHLOROETHANE: FORMATION OF FLAMMABLE PRODUCT
ACIDS: REACTS VIOLENTLY
METALS: CORROSIVE REACTION WITH FORMATION OF FLAMMABLE HYDROGEN GAS

GERMANIUM: INCANDESCENT REACTION

DECOMPOSITION:
THERMAL OR CHEMICAL DECOMPOSITION MAY RELEASE TOXIC FUMES OF POTASSIUM OXIDE WHICH CAN REACT WITH WATER OR STEAM TO PRODUCE HEAT AND FLAMMABLE HYDROGEN.

POLYMERIZATION:
NOT KNOWN TO OCCUR.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. FLAMMABLE, POISONOUS GASES MAY ACCUMULATE IN TANKS AND HOPPER CARS. MAY IGNITE COMBUSTIBLES (WOOD, PAPER, OIL, ETC.)

SPILL AND LEAK PROCEDURES

SOIL SPILL:
DIG A HOLDING AREA SUCH AS A PIT, POND OR LAGOON TO CONTAIN SPILL AND DIKE SURFACE FLOW USING BARRIER OF SOIL, SANDBAGS, FOAMED POLYURETHANE OR FOAMED CONCRETE. ABSORB LIQUID MASS WITH FLY ASH OR CEMENT POWDER.

ADD DILUTE ACID TO NEUTRALIZE.

AIR SPILL:
APPLY WATER SPRAY TO KNOCK DOWN AND REDUCE VAPORS. KNOCK-DOWN WATER IS CORROSIVE AND TOXIC AND SHOULD BE DIKED FOR CONTAINMENT.

WATER SPILL:
NEUTRALIZE WITH DILUTE ACID OR REMOVABLE STRONG ACID.

OCCUPATIONAL SPILL:
DO NOT TOUCH SPILLED MATERIAL. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR SMALL DRY SPILLS, WITH CLEAN SHOVEL PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER. MOVE CONTAINERS FROM SPILL AREA. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA AND DENY ENTRY.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION SYSTEM TO MEET PERMISSIBLE EXPOSURE LIMITS.

RESPIRATOR:
HIGH LEVELS - SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE, HELMET, OR HOOD. SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.

FIREFIGHTING - SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - DELTA F CORPORATION
CREATION DATE: 7/24/86

ADDITIONAL INFORMATION

THE INFORMATION ABOVE IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. HOWEVER, WE MAKE NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, WITH RESPECT TO SUCH INFORMATION, AND WE ASSUME NO LIABILITY RESULTING FROM ITS USE. USERS SHOULD MAKE THEIR OWN INVESTIGATIONS TO DETERMINE THE SUITABILITY OF THE INFORMATION FOR THEIR PARTICULAR PURPOSES.

PAGE NUMBER

A.

STRIP CHART RECORDER FOR DELTA F OXYGEN ANALYZER (Part Number DF-R010)

GENERAL DESCRIPTION

Delta F Corporation offers the Esterline Angus "Minigraph" Strip Chart Recorder for recording purposes. This recorder employs a permanent-magnet, moving-coil measuring system and rectilinear inkless writing element. Inkless recording is accomplished by a dot tracing on pressure-sensitive chart paper.

The basic recorder consists of a d'Arsonval-type measuring element, a drive motor, and a chart transport assembly. The recorder operates on 110 VAC, 50-60 Hz.

When the recorder is purchased with a Delta F Oxygen Analyzer, it is equipped to accept the standard 0-10 VDC input signal. A cord is also provided which delivers the input signal and AC. power from the analyzer to the recorder. This permits the recorder to be turned on and off automatically by the analyzer.

Replacement chart paper is available in 6-pack boxes. Order by Part Number DF-R018.

B. FILTER CARTRIDGE - DF-F2R

TABLE IX

FIBER MATERIAL:	Borosilicate Glass
BINDER:	Epoxy Resin
DIMENSIONS:	.50 inch I.D. x 2.25 inch L.
MAXIMUM TEMPERATURE:	400 degrees F
EFFICIENCY:	90% Retention of 0.6 micron particles
RATED FOR:	Particulate Matter (solids) - excellent
	Hydrocarbon Mists - excellent

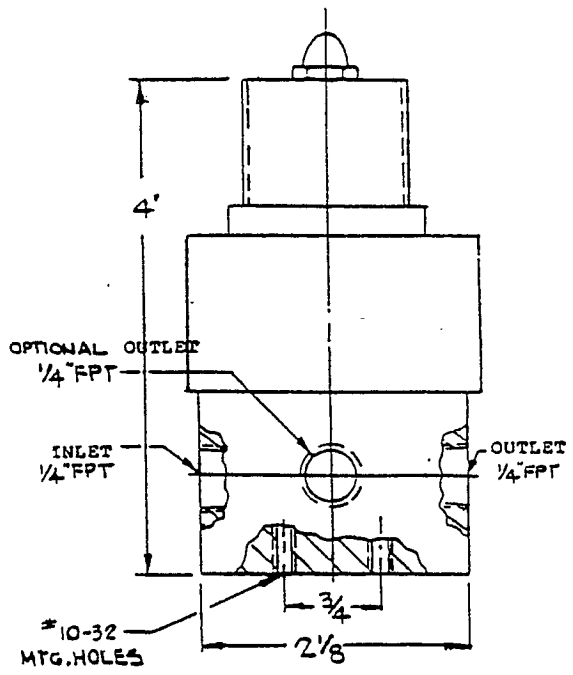
C. OUTBOARD PRESSURE REGULATOR - DF-PRI-5

FEATURES:

* All 316 Stainless Steel or Teflon™ coated 316 stainless steel in flow stream
* Inlet pressures to 3000 PSIG
* Outlet pressure adjustable 0-5 PSIG

IMPORTANT:

The outlet pressure of the regulator varies slightly with changes in the inlet pressure. Changes in outlet pressure will cause variation in the flow to the oxygen sensor. For best results, it is recommended that the regulator setting be adjusted such that the flow thru the analyzer is maintained at 2-3 SCFH if possible. Flow rates to the analyzer as low as 0.3 SCFH are acceptable but the higher flow rates are preferred and provide superior results.



D. SCALE FACTOR ADJUSTMENT

BACKGROUND GAS DIFFUSIVITY CORRECTION

This analyzer may be equipped with a scale factoring potentiometer that allows direct meter read-out of oxygen in background gas mixtures such as NITROGEN AND HYDROGEN*. When so equipped the analyzer face panel has a ten turn potentiometer identified as $\%H_2$. If the background gas composition of a N_2-H_2 mixture is known, the potentiometer can be set to the hydrogen percentage. Since the potentiometer dial spans from 0.00 to 10.00, the setting multiplied by ten represents the actual hydrogen percentage in the mixture. The table below provides an example of the appropriate scale factor potentiometer settings for several N_2-H_2 mixtures.

$\%H_2$ POTENTIOMETER SETTING	MIXTURE COMPOSITION $\%H_2$	$\%N_2$
0.00	0	100
2.00	20	80
4.00	40	60
6.00	60	40
8.00	80	20
10.00	100	0

* Scale factor adjustments are available for a number of gases. Please consult Table II, on Page 19, or Delta F Corporation.

X SHIPPING INSTRUCTIONS

TO AVOID DAMAGE TO THE ANALYZER, THE SENSOR CELL MUST BE DRAINED AND FLUSHED PRIOR TO SHIPMENT. WE CANNOT EMPHASIZE THIS ENOUGH. DAMAGE INCURRED, DURING SHIPMENT, DUE TO AN UNDRAINED SENSOR IS NOT COVERED BY THE WARRANTY. CARRIERS WILL NOT ACCEPT CLAIMS FOR SUCH DAMAGE. PLEASE PROCEED AS FOLLOWS:

ELECTRONICS CONTROL CHAMBER

1 Remove the enclosure cover, and then remove the four screws that secure the front panel in place. Use shipping tape to hold the PC board(s) in place, or wedge styrofoam between the top of the PC board(s) and the enclosure bracket. Reinstall the front panel and replace the enclosure cover.

REMOTE SENSOR CHAMBER

Remote sensors used with the Typed R7 enclosure may or may not be equipped with drain valves. Regardless, the sensor must be removed from its enclosure prior to draining. To remove the sensor proceed as follows:

1 Disengage all sample lines and electrical connections to the sensor.

2 Loosen and/or remove the supporting hardware from the sensor and remove the sensor from the enclosure being sure to keep it upright.

3 The drain toggle valve at the rear of the sensor should be in the closed (vertical) position. Place the toggle in the open (horizontal) position while allowing the electrolyte to drain into a suitable receptacle. If the sensor is not equipped with a drain valve, remove the fill cap and invert the sensor to drain.

4 Add deionized water to the sensor, to rinse, being careful not to overfill, and drain the water.

5 Reattach the fill cap at the top of the sensor, or place the toggle valve in the closed (vertical) position.

6 Reinstall the sensor into the Remote Sensor Enclosure.

7 When preparing the analyzer for shipment, be sure to check that all internal components, such as the sensor, panel meters, printed circuit boards, etc. are adequately secured. Install bubble packing or other suitable material in the voids within the analyzer to help dampen vibration during shipment.

8 If possible, use the shipping carton originally sent by Delta F. Nearly all of the instruments damaged during return shipment are found to be poorly packed in non-original containers. Clearly, discretion must be used, if the original container is in poor shape.

9 In the interest of expediting evaluation and repair it would be appreciated if a photocopy could be made of the Customer Instrument Evaluation Sheet, (See next page) and all pertinent information provided.

DELTA F CORPORATION
CUSTOMER INSTRUMENT EVALUATION FORM

Please provide complete descriptions of application, and problems observed with the instrument. (Form to accompany instrument being returned.)

Company: _____

Address: _____

_____

Contact: _____ Tel. _____

Model No. _____ Serial No. _____

Problem(s) observed: _____

_____

_____

_____

_____

_____

What type of process is the instrument being used on? _____

_____

_____

_____

What type of environment is the unit operating in (location, temperature, etc.)? _____

_____

_____

Gas Constituents: Max. Conc. Min. Conc. Normal Conc.

1. Oxygen _____

2. _____

3. _____

4. _____

5. _____