



**AGP-4000 / AGP-8000
Skid-Mounted Ozone Sanitation Systems**

OWNER'S MANUAL



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IMPORTANT SAFETY INSTRUCTIONS

READ AND FOLLOW ALL INSTRUCTIONS.

Read this manual completely before operation of AGP-4000/8000 Ozone Generator Equipment.

The High Voltage Transformers in this unit create 7,000 volts, with the outer jacket of the High Voltage lead reaching 3,000 volts.

- USE EXTREME CAUTION -

Operate the AGP-4000/8000 on a near level surface with safe access to electrical power.

Connect to a GFCI type receptacle.

Follow all applicable electrical codes.

Do not bury cord.

WARNING: To reduce the risk of electrical shock, replace damaged cord immediately.

ELECTRICAL SHOCK HAZARD: Turn OFF all power switches and disconnect power cord from power source receptacle before performing any service work. Failure to do so could result in serious injury or death.

SECTION 1 General Information

1A. Description

The DEL AGP-4000/8000 systems described in this manual recirculate ozone-enriched water through built-on 40 or 80 gallon contact tanks. They are designed to provide ozone-enriched water at a flow-through rate of 5 to 50 gallons per minute.

1B. Specifications

Ozone Output:

Ozone output ($\pm 10\%$): AGP-4070/8070: 7 g/hr
 AGP-4150/8150: 15 g/hr
 AGP-4250/8250: 25 g/hr

O₃ Flow rate (max): AGP-4070/8070: 7 scfh
 AGP-4150/8150: 13 scfh
 AGP-4250/8250: 18 scfh

% weight O₃: 2.5% - 4.2%

Power Requirements:

230 VAC, 60 Hz, 3-wire 20 Amp Circuit

Water Flow Rate:

Recirculation Rate: 10-15 gpm
 Flow-Through Rate: 5-50 gpm

Note: The purpose of the pump is to provide an independent recirculation loop that provides constant flow and pressure for the most efficient injector operation.

Inlet Water Requirements:

Temperature: 40°F - 90°F (4.5°C - 40°C)
 Pressure: 10-25 psi
 Water Quality: potable, mineral & chemical free water

Cooling Water Requirements (see Generator Manual):

0.1 GPM (0.4 lpm) of clean, filtered, fresh water.
 Inlet temperature: 50°F - 90°F (10°C - 32°C)
 Inlet pressure: 15.0 - 40.0 psi (100 - 270 kPa)

NOTE: The ozone generators on the AGP-4150/4250/8150/8250 must be water cooled. Refer to the ozone generator manual (CD-15G / CD-25G) for cooling line plumbing instructions.

Overall Dimensions:

AGP-4000: 74"H x 32"W x 50"D
 AGP-8000: 77"H x 32"W x 50"D

Shipping Weight w/Crate: Approx. 275 pounds

Dry Weight: Approx. 225 pounds

Ambient Temperature:

Operation: Ambient Temperature 40°F - 100°F
Not to exceed 100°F

SECTION 2 Installation

2A. Location

Place the AGP-4000/8000 on a flat and level surface. The unit should be protected from direct sunlight, rain, and from operating temperatures lower than 40°F and higher than 100°F. Failure to do so will void warranty.



Figure 1: AGP-4000/8000 Skid-Mounted Ozone Sanitation System

2B. Electrical

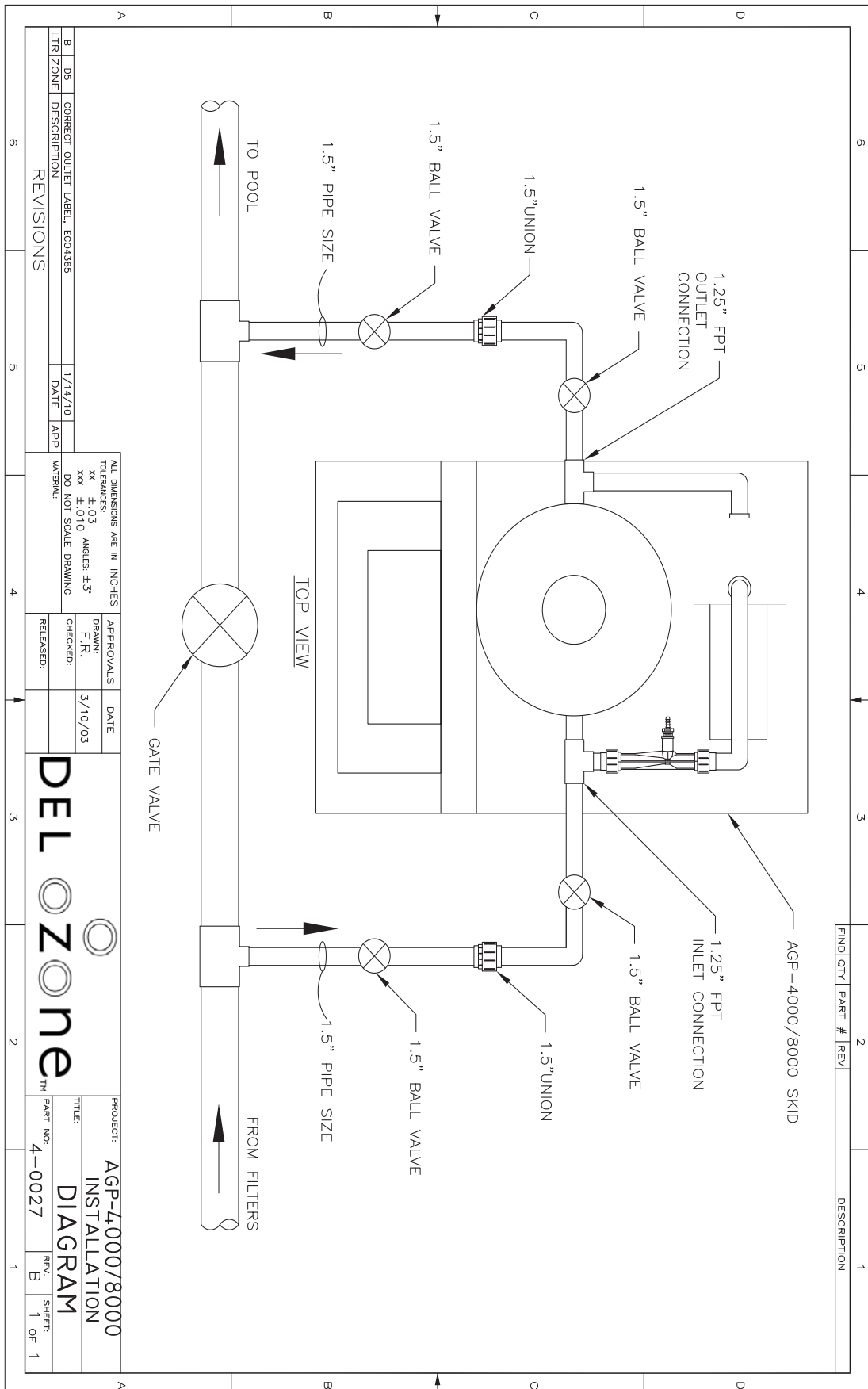
Main Power Supply Circuit: The AGP-4000/8000 is supplied with a standard 25 Foot power cord. Plug cord into standard 230 VAC (20 Amp) grounded receptacle.

2C. Plumbing

Water Inlet Connection: 1.25" FPT
 Water Outlet Connection: 1.25" FPT

SECTION 3 System Configuration/Installation Diagrams

The following page includes a diagram for the following:
 3A. Side-Stream Application



SECTION 4 Operation

4A. Control Panel Overview

4A-1. Indicator Lights (see figure 3)

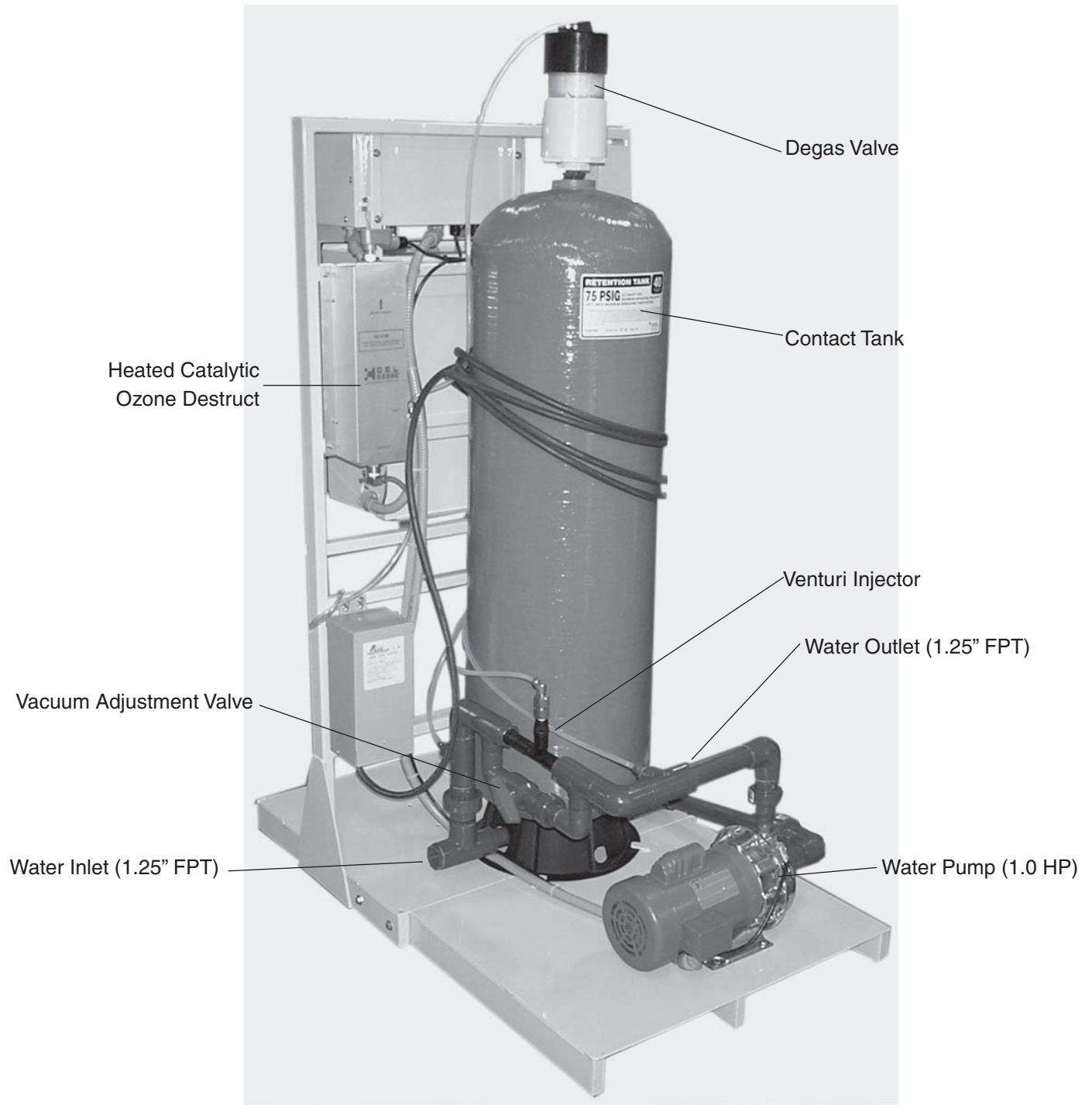
- a. Green Lights
 - 1) **Main Power (Ozone Generator):** indicates that power is being supplied to the Ozone Generator.
 - 2) **Ozone Power:** indicates that power is being supplied to the high voltage Corona Discharge circuits and that ozone is being produced (see Sections 4B and 4C).
 - 3) **Pump On:** indicates that the pump is running.
- b. Red Lights (Ozone Generator)
 - 1) **Vacuum:** indicates that vacuum is out of range. The light will be lit for low vacuum conditions.
 - 2) **High Coolant Temperature:** indicates that water temperature is over 110 °F. (Not shown. Not present on some units.)
 - 3) **Water Back Flow Detected:** indicates that water back flow from the injector into the generator has been detected. (Not shown. Not present on some units.)

4A-2. Other External Components

- a. **Main Power Switch:** Activates water pump and supplies power to ozone generator.
- b. **Injector Vacuum Gauge:** Indicates Vacuum of the ozone in the injector system.
- c. **Vacuum Adjustment Valve:** Controls Vacuum by adjusting the flow of water to the ozone injector.
- d. **Back-Pressure Gauge:** Indicates back-pressure in the main flow loop (after the injector).
- e. **Inlet Pressure Gauge:** Indicates inlet pressure in the main flow loop (before the injector).
- f. **ORP Monitor/Controller:** Displays ORP level (mV) in water and can be set for ozone generator to maintain desired ORP level. (See Appendix A for further information.)



Figure 2: AGP-4000/8000 Control Panel



AGP-4000/8000 Components/Connections

4B. System Start-Up

Read completely before starting system.

1. Once the AGP-4000/8000 has been installed properly, turn inlet water on. **WARNING: Allow unit to fill completely with water before turning pump on – failure to do so will ruin the pump seal and damage the pump.**
2. Switch Main Power ON (pump will turn on and Pump On green light will illuminate).
3. Switch Ozone Power ON (4015/8015 & 4025/8025 only).
4. Check System Vacuum Gauge. Adjust Vacuum Adjustment valve until gauge reads approximately -5 in. Hg. vacuum. Ozone On green light will illuminate upon reaching approximately -5 in. Hg.
NOTE: This unit is controlled by the ORP monitor/controller. See ORP operation instructions (Appendix A) for the ORP set point adjustment and monitor calibration. The pump will remain on at all times when the system is operating and the Main Power switch is turned ON. The ozone generator will shut down once the preset ORP level has been reached.

4C. System Shut-Down / Freeze Protection

1. Turn OFF Ozone Power switch (4015/8015 & 4025/8025 only).
2. Turn OFF Main Power switch.
3. Disconnect inlet and outlet connections and allow water to drain from system (a small amount of water will remain in the ozone degas chamber).
4. **Freeze Protection:** It is recommended that the AGP-4000/8000 be protected from freezing temperatures. If this is not possible, the pump must be drained by removing the 1/2" drain plug located underneath the pump (see page 8). **WARNING: Pump damage will occur if pump is not drained before unit is stored in freezing temperatures or for extended periods of time.** A small heater may be used to prevent remaining water in the system from freezing.

SECTION 5

Maintenance and Service

5A. Preventative Maintenance Schedule (also refer to Ozone Generator manual)

DAILY:

1. Check ozone generator for proper operation.
- Make sure no red indicator lights are lit.

MONTHLY:

1. Remove & clean ozone generator cabinet air filter.
2. Perform general cleaning of cabinet exterior.
3. Using clean/dry compressed air, blow out the interior of the ozone generator cabinet taking special care around small components and wiring.

ANNUALLY:

1. Remove and replace compressor air filter cartridge using DEL P/N 8-0061.

EVERY 10,000 HOURS

(refer to Ozone Generator Manual):

1. Every 10,000 Hours: rebuild compressor. See COMPRESSOR SERVICING section 5B.
2. Replace circulation pump seal using DEL P/N 5-0987.

EVERY 18,000 HOURS

(refer to Ozone Generator Manual):

1. Replace the CD ozone cells using DEL P/N 9-0927 (one required for AGP-4070/8040, two required for AGP-4150/8150, four required for AGP-4250/8250).

5B. Air Compressor Servicing

Air compressor requires a rebuild every 10,000 hours of operation.

- a. Purchase appropriate Compressor Rebuild Kit (DEL P/N 2-1007 for AGP-4070/8070 or 2-1025 for AGP-4150/8150 and AGP-4250/8250). See Section 6 for ordering information.
- b. Follow instructions in Compressor Rebuild Kit to rebuild compressor.

5C. Trouble Shooting (also refer to Ozone Generator manual)

Knowledge of electrical applications is required for trouble shooting. Contact a certified electrician if you are unsure of your ability to service the equipment. If any condition persists, call 800-676-1335 or for international call 805-541-1601 for technical assistance.

I. Symptom: "PUMP ON" green indicator light out when MAIN POWER switch is in the "ON" position.

1. No power to the AGP-4000/8000 from the power supply.
 - a. Check the circuit breaker at the facility power distribution box.
 - b. Check for loose connections or wiring breaks from the power distribution box to the AGP-4000/8000.

II. Symptom: "OZONE POWER" green indicator light out when OZONE POWER switch is in the "ON" position.

1. a. Check cable & connectors. Reconnect if in good condition.
2. ORP Monitor/Controller may have shut-down the ozone generator when the dissolved ozone level reached set point.
 - a. Wait for dissolved ozone to come down below set point. Generator will restart when dissolved ozone is below set point.
3. Abnormal operating conditions exist.
 - a. Check red fault lights. Refer to corresponding symptom and corrective action.
4. Cabinet door ajar.
 - a. Close and latch door.

III. Symptom: "VACUUM" red indicator light is on indicating out of range vacuum is being supplied.

1. Injector not supplying adequate vacuum.
 - a. Check pump and ensure water is flowing through injector.
 - b. Check vacuum gauge & adjustment valve. Adjust if necessary to obtain proper reading on vacuum gauge (-5 in. Hg).
2. Another abnormal condition exists causing the ozone output solenoid to be closed.
 - a. Check red fault lights. Refer to corresponding symptom and corrective action.
 - b. Check hose connections.
 - c. Solenoid valve may be stuck in closed position. Free plunger and return system to normal operation.

IV. Symptom: "HIGH COOLANT TEMP" red indicator light is on indicating ozone generator temperature is over 110°F.

1. Coolant water flow has been interrupted.
 - a. Check all tubing connections insuring tight leak-free connections
 - b. Trace tubing and look for flow blockage.
 - c. Re-establish proper coolant water flow.
2. System is left in self-recirculation mode too long.

V. Symptom: "WATER BACKFLOW DET." Red indicator light is on indicating possible water in ozone line.

1. Water has flowed back from injector to the ozone generator module.
 - a. Re-establish proper water flow through injector and correct vacuum.
 - b. Drain Backflow Preventer by first routing drain tubing out of the cabinet and opening ¼" stainless steel ball valve.
 - c. After water has completely drained, close valve, secure cabinet door and restart system.

VI. Symptom: CD Module is not operating. Ozone output has dropped.

1. No power to the generator module from the power supply.
 - a. Check high voltage (HV) cables for breaks or loose connections, replace if required.
 - b. Check for power at input terminals of the HV power supplies.*
 - c. Check ozone power relay for loose connections or faulty operation.

***CAUTION:** HIGH VOLTAGE (7,000 V)

VII. Symptom: No oxygen flow through the ozone generator.

1. Air compressor is not operating properly.
 - a. Listen for air compressor operation.
 - b. Check all tubing connections from the air compressor through the system for leaks. Repair as required.

SECTION 6

Replacement Parts and Order Information

6A. Ordering information:

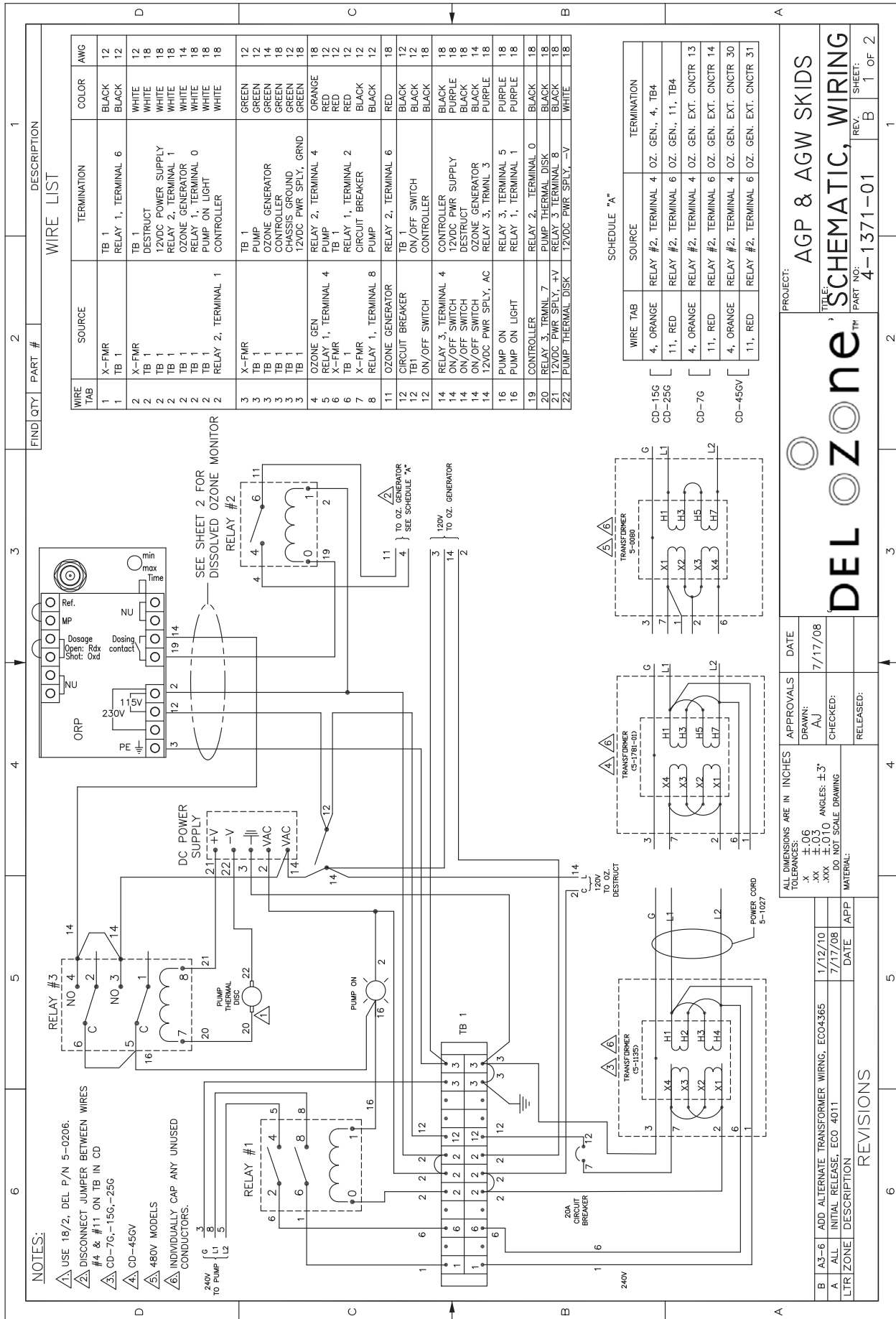
For replacement parts call DEL at **1-800-676-1335** or for international call **805-541-1601**.

Be prepared with the following information:

- Customer Name · Customer Address
- DEL Model Number · DEL Serial Number
- Date Purchased · Proof of Purchase

6B. Standard replacement parts list:

1. CD Ozone Cell9-0927
 - a. AGP-4070/8070 - one cell required
 - b. AGP-4150/8150 - two cells required
 - c. AGP-4250/8250 - four cells required
2. Compressor rebuild kit
 - a. AGP-4070/80702-1007
 - b. AGP-4150/8150 & AGP-4250/82502-1025
3. Cabinet Air Filter Cartridge7-0615
4. Compressor Air Filter Cartridge8-0061
5. Ozone Tubing, Teflon.....7-0126
6. Power Cable, 25 Ft (230 V only)5-0898
7. Pump Seal5-0987
8. Check Valve8-0330



DEL OZONE

PROJECT: AGP & AGW SKIDS

TITLE: SCHEMATIC, WIRING

PART NO: 4-1371-01

REV: B

SHEET: 1 OF 2

APPROVALS: DRAWN: AJ 7/17/08

CHECKED: DATE: 1/12/10

RELEASED: DATE: 7/17/08

REVISIONS

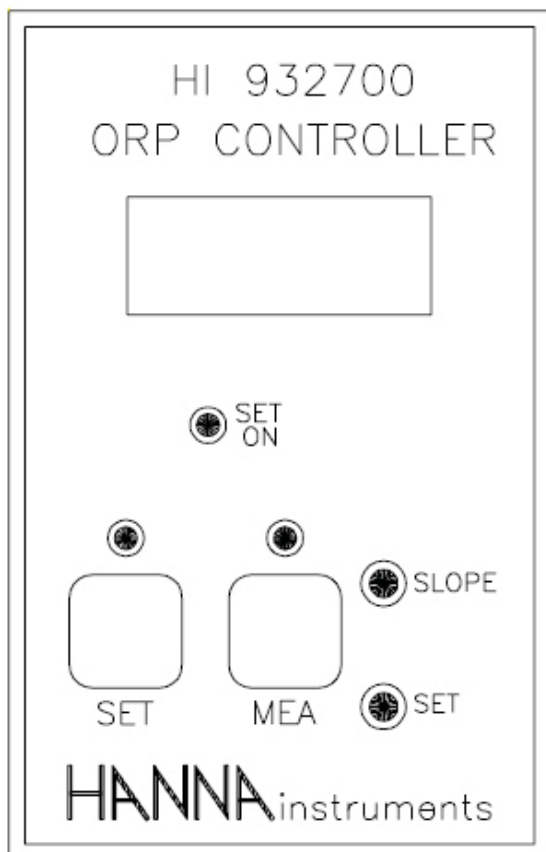
REV	DESCRIPTION	DATE	APP
B	A3-6 ADD ALTERNATE TRANSFORMER WIRING, ECO4365	1/12/10	
A	ALL INITIAL RELEASE, ECO 4011	7/17/08	

APPENDIX A

ORP MONITOR/CONTROLLER

SPECIFICATIONS

Range:	-1000 to +1000 mV, at 25 C
Resolution:	1 mV, at 25 C
Accuracy:	±5 mV, at 25 C
Typical EMC Deviation:	±2 mV, at 25 C
Calibration:	Slope: 90 to 110% by slope trimmer.
Readout:	4- digit liquid crystal display
Recorder Output:	4 to 20 mA
Operating Temperature:	-10°C to 50°C
Weight:	4.58 oz
Power:	110/220 Volt, 50/60 Hz
Size:	DIN Standard (48.8mm x 76.5mm)



OPERATION

Installation

1. Attach the ORP Controller to wall or fixture using two #8 x 3/4" zinc sheet metal screws (included).
2. Connect the ORP electrode cable to the BNC connector at the bottom of unit.
3. Plug in existing ozone generator into ORP Controller plug receptacle located at the bottom of unit.
4. Plug ORP Controller into 120V AC plug receptacle.

Operation

1. The setting of the various parameters are made via the front panel keys and trimmers. When each key is pressed the LED is lighted indicating to the user that the function is in operation. Make sure that the meter and electrodes are calibrated before operating the instrument (see below).
2. To set the working point of ORP dosage, press the "SET" key. The display will show the set value for the dosage. Use a small screwdriver to adjust the "SET" trimmer until the desired set value is displayed.
3. After setting the ORP value immerse the electrode in the test solution and press the "MEASURE" key. The actual ORP value of the test solution is displayed. When the chemicals are dosed, the "SET ON" LED will be lit.

Calibration

Make sure the meter is in the measurement mode (MEASURE LED light is on) before starting the calibration procedure.

1. Immerse the electrode in ORP solution.
2. Adjust the calibration trimmer until an ORP value from 200 mV and 275 mV is displayed.
3. The calibration is now complete and the instrument is ready for use.

Measurements with Redox Electrodes

Oxidation reduction potential (redox) measurements express in numbers the oxidizing or reducing power of any given solution. During oxidation, a molecule or ion loses electrons; during reduction, a molecule or ion gains electrons. The “redox” potential is a type of potentiometric measurement. The chemical composition of the measure sample shows negligible change.

To measure redox potential, you need an electrode that absorbs or yields electrons without causing chemical reactions with the elements with which it comes into contact. Electrodes with gold and platinum surfaces are often used for redox measurement: platinum is preferred for general applications and oxidizing solutions containing halides; gold is preferred for strong oxidation applications because it has a higher resistance than platinum.

When a platinum electrode is immersed in an oxidized solution, its surface develops a monomolecular layer of oxygen. Although this layer does not prevent the electrode from malfunctioning, it does increase the response time. The layer can maintain the potential at a more positive level than the solution’s real level. The opposite effect is obtained when the platinum surface absorbs hydrogen in the presence of reducing mediums. When this occurs, the surface of the electrode becomes rough.

When measuring redox, be sure to follow these steps:

1. Keep the surface of the electrode clean and smooth.
2. Provide a pretreatment to the surface of the electrode, depending on whether the solution has oxidizing or reducing characteristics.
3. Before the treatment of the electrode, carefully clean the platinum surface by rinsing the electrode briefly in turpentine, then washing it thoroughly in water. For a final treatment, apply a light abrasive polish if necessary, but do not scratch the surface. Then remove all traces of the polish.

SECTION 7 Ozone Overview & Safety Procedures

7A. Ozone Use and Technology Overview

7A-1. Relative Strength of Ozone

The following compares the strengths (electron oxidation potential) of several common oxidizing reagents:

<u>Oxidizing Reagent</u>	<u>EOP vs. Cl₂</u>
Elemental Fluorine	2.25
Hydroxyl Radical.....	2.05
Ozone	1.52
Hydrogen Peroxide	1.30
Hypochlorite	1.10
Chlorine	1.00
Chlorine Dioxide	0.93
Bromine	0.57

The following compares the CT values for water of ozone versus forms of chlorine:

Microorganism	Disinfectant			
	Ozone (pH 6 - 7)	Preformed Chloramine (pH 8 - 9)	Chlorine Dioxide (pH 6 - 7)	Free Chloride (pH 6 - 7)
<i>E. coli</i>	0.02	95-180	0.4-0.75	0.034-0.05
Polio 1	0.1-0.2	770-3740	0.2-6.7	1.1-2.5
Rotavirus	0.006-0.06	3810-6480	0.2-2.1	0.01-0.05
<i>G. lamblia</i> cysts	0.5-0.6	--	--	47->150
<i>G. muris</i> cysts	1.8-2.0	1400	7.2-18.5	30-630

7A-2. Materials Selection

Materials	Aqueous Ozone 0-3 ppm Freshwater
<u>Metals:</u> Copper Brass 316L Stainless Steel	Not Recommended Not Recommended Very Good
<u>Plastics:</u> ECTFE (Halar) PTFE (Teflon) PVC (rigid) PVC (flexible) PVDF (Kynar)	Very Good Very Good Good Good Very Good
<u>Elastomers:</u> FPM (Viton)	Good (gasket)

7A-3. Micro-Flocculation and Oxidation

Ozone oxidizes the following metals (know as micro-flocculation), enabling their removal via filtration:

- Iron
- Copper
- Manganese
- Zinc
- Arsenic

Ozone neutralizes “nuisance” compounds - most commonly, hydrogen sulfide.

7A-4. Factors Affecting Sanitation

The following factors will affect the ability of ozone to effectively act as a sanitizer:

- Type and level of contaminant
- Physical/chemical parameters of the environs
- Exposure time
- Temperature
- Concentration
- Water chemistry and pH
- Cleanliness
- Microbial attachment

7B. General Safety Information

7B-1. Ozone Properties

- Colorless to blue gas (greater than -169°F)
- Characteristic odor often associated with electrical sparks or lightning in concentrations of less than 2 ppm
- Severe irritant above 1-2 ppm
- Generally exists as a gas
- Highly chemically reactive
- Non-flammable, non-carcinogenic
- Hazardous polymerization can occur
- Spontaneously decomposes to oxygen gas

7B-2. Ozone Uses

- Air and water disinfection
- Surface sanitation
- Water treatment plants
- Bottled water, irrigation, community water supplies, swimming pools/spas, etc.
- Aquariums/life support
- Agricultural wash water
- Wastewater treatment
- Mold and bacteria control in cold storage

7B-3. AGP-4000/8000 Safety Features

The AGP-4000/8000 produce ozone which is automatically and immediately injected into the water flow. Any ozone which does not dissolve into the water is separated off in the degas chamber and eliminated in the heated catalytic ozone destruct. The design of this self-contained system eliminates the release of gaseous ozone from the unit. In addition to ozone safety, the following general safety features are built-in to the AGP-4000/8000:

- Ozone Generator door safety interlock switch - disables high voltage power supply when open or improperly latched
- Circuit Breaker, Fuse
- Vacuum Switch - stops operation in the event of low water flow
- Ozone cell high temperature indicator
- Interlocked sensors and regulating devices
- Startup/shutdown sequences and fault protection
- Multistage water pump to control flow rate
- Ozone is supplied under negative pressure (induction - i.e. a leak will draw air into the system).

Slight off-gassing of ozone can occur from the water that is produced by the AGP-4000/8000 (the physical properties of ozone make this unavoidable). Laboratory and field testing in varying environments indicate that ozone off-gas levels from the water produced by the AGP-4000/8000 do not exceed 0.1 PPM (the permissible exposure level (PEL) or time weighted concentration for gaseous ozone to which workers may be exposed averaged over 8 hours, 5 days a week (OSHA)). Gaseous ozone concentrations above 0.02 PPM are detectable by humans.

Inasmuch, sections 7C through 7H of this manual discuss relative issues regarding safety and monitoring of gaseous ozone.

7C. Hazards

7C-1. Health Hazards - Detection Levels

Gaseous ozone can be detected in air by its distinctive odor at concentrations of about 0.02 ppm. Although each nose varies, olfactory fatigue occurs quickly. Initial small exposure may reduce cell sensitivity and/or increase mucous thickness producing a resistance to low gaseous ozone levels. As a result, **DO NOT RELY ON ODOR AS A WARNING OF HIGH OZONE CONCENTRATIONS.**

The permissible exposure level (PEL) or time weighted concentration for gaseous ozone to which workers may be exposed is 0.1 ppm averaged over 8 hours, 5 days a week (OSHA). The short term exposure limit is 0.3 ppm averaged over 15 minutes. The concentration of 5 ppm ozone in air is generally accepted as Immediately Dangerous to Life or Health (IDLH).

7C-2. Health Hazards - Effects on Humans

Gaseous ozone acts as a primary irritant, affecting mainly the eyes, upper respiratory tract and the lungs. Inhalation produces various degrees of respiratory effects from irritation to pulmonary edema (fluid in lungs). Short exposure to 1-2 ppm concentrations causes headache as well as irritation to the respiratory system but symptoms subside when exposure ends. High concentrations of ozone produce severe irritation to the eyes and respiratory system. Exposure above the ACGIH/OSHA limits may produce nausea, chest pain, coughing, fatigue, reduced visual acuity and pulmonary edema. Symptoms of edema from excessive exposure can be delayed one or more hours. There is no threshold limit and so no exposure (regardless of how small) is theoretically without effect from ozone's strong oxidative ability.

TOXIC EFFECTS OF GASEOUS OZONE	
OZONE	
CONCENTRATION (PPM)	EFFECT
0.01 - 0.10 Range of odor threshold
0.1 Permissible concentration (8 hour work day)*
0.3 Permitted short-term exposure (15 min.)*
0.01 - 1.0 Headaches, irritation to respiratory tract, severe irritation to eyes
1.0 - 10.0 Nausea, chest pain, coughing, fatigue, reduced visual acuity, pulmonary edema
5.0 Immediately Dangerous to Life or Health (I.D.L.H.)*
>20.0 Can be fatal after 1 hour
>50.0 Can be fatal after 1/2 hour
<i>*Regulatory Levels</i>	

7C-3. Hazards - Electrical

Turn OFF all power switches and disconnect power cord from power source receptacle before performing service work. Failure to do so could result in serious injury or death. Operate the AGP-4000/8000 on a near level surface with safe access to electrical power. Connect the AGP-4000/8000 to a GFCI type receptacle. Do not bury the electrical cord. To reduce risk of electrical shock, replace damaged cord immediately.

7C-4. Hazards - Fire

Ozone is nonflammable. Decomposition of ozone into oxygen gas, O₂, can increase strength of fire. Ozone is unstable at room temperature and spontaneously decomposes to oxygen gas. Avoid ignition sources such as heat, sparks, and open flame. Keep away from strong reducing agents and combustible materials such as grease, oils, and fats.

7C-5. Hazards - Chemical Action

Ozone is chemically incompatible with all oxidizable materials, both organic and inorganic.

7D. Precautions for Safe Handling & Use

7D-1. Ozone Monitors

Ambient ozone monitoring equipment should be installed in the areas where ozone is being generated or applied. See Monitoring section 7G.

Self-adhesive ozone monitor badges, such as the Chromair® System by K&M Environmental (Virginia Beach, VA, www.kandmenvironmental.com), may be used for personal or area monitoring for exposure times ranging from 5 minutes to 10 hours.

7D-2. Ventilation

It is mandatory that general and local exhaust ventilation be provided to dilute and disperse small amounts of ozone into the outside atmosphere. Federal, state, and local regulations must be followed.

7D-3. Emergency Procedure

Due to the short life of ozone, evacuation and ventilation is all that is generally required in the event of a high ambient ozone alarm. All ozone generating and delivery equipment should be shut down (manually or automatically by alarm) and a high speed fan activated to dilute and disperse ozone to the atmosphere. Personnel should evacuate the affected area until levels are returned to below 0.1 ppm.

7D-4. Respiratory Protection

A disposable respirator (3M #N95 8214/8514 - Minneapolis, MN, www.3m.com) is recommended for relief against ozone levels up to 10 times the OSHA PEL or applicable government occupational exposure limits, whichever is lower.

7D-5. Education & Training

The education and training of workers is the responsibility of the employer. An effective training program must be practical, based on written work procedures and be specific to both the job-site and the tasks to be performed. Training shall also include the responsibilities and responses of workers in an emergency. The employer shall ensure, through the education and training program, that all workers are able to work without risk to themselves or others around them. All workers must clearly understand their responsibilities with regard to not only specific work procedures, but also the need to report all hazards, accidents or incidents and injuries.

All routine work and emergency procedures shall be reviewed jointly by management and employees at least annually.

7E. System Operation & Maintenance

7E1. Safety Precautions & Equipment

Repair and maintenance of the ozone system shall be done under the direction of qualified personnel. Qualification shall consist of instruction and training by the equipment supplier in the safeguards and procedures necessary for safe performance of the work. A certificate of completion of such training shall be provided.

All equipment in an ozone plant (ozone generator, piping, pumps, tanks,...) coming in contact with gases containing ozone must be maintained free of oil and grease.

Monitoring equipment and alarm system shall be tested and serviced according to the manufacturer's instructions.

The planned maintenance of all safety equipment is essential to worker safety.

7E-2. Maintenance Requirements

It is the joint responsibility of the designer, supplier and installer of the ozone generating and handling equipment to conduct the commissioning to determine whether or not the system is working properly. The operation and maintenance manual provided with the equipment outlines the operating procedures and maintenance requirements.

7E-3. Maintenance Schedule

Once the system is operational, it becomes the responsibility of the owner or contract operator to maintain it. A maintenance schedule shall be developed using the information contained in the operation and maintenance manual. The schedule shall include:

1. A list of equipment that requires daily, weekly, monthly or annual inspection
2. Regular and preventative maintenance
3. A troubleshooting guide
4. Safety precautions, such as lock-out, that must be observed during maintenance and repair

The owner or contracted operator shall ensure that the regular maintenance outlined in the schedule is carried out. Records of all replacement and repairs shall be kept in a log-book, including:

1. Date of replacement
2. Reason for replacement and hours of service prior to replacement
3. Specifications of any replacement part used, if different from that specified in the maintenance section of the operation and maintenance manual.

7F. Monitoring

7F-1. Location of Monitors

Ambient ozone detection monitors shall be located to monitor ozone room air and production/plant room air for indoor applications.

7F-2. Monitoring Equipment

OZONE IN AIR

Electronic Ambient Ozone Monitor

- a. Shall measure the level of ozone present in the room where ozone equipment is located.
- b. The monitor shall include both visible and audible alarms. The EcoZone™ Model EZ-1 portable ambient ozone analyzer by EcoSensors, Inc. is recommended for use with the AGW-4015/4025.

b-1. EcoZone™ Model EZ-1 features:

- Constantly monitors work environment
- O₃ concentration shown by a multi-color display from green (safe) to yellow (caution) to red (danger)
- No installation required
- Easily understood by non-technical personnel
- Field work and “walk around” analyses possible via power from internal rechargeable batteries
- Compatible with EcoSensor VOC and O₃ sensing, monitoring, and control products

b-2. EcoZone™ Model EZ-1 specifications:

- Range: 0.02-0.14 ppm O₃
- Bar graph display: normally green, yellow at 0.05 ppm (caution), red at 0.1 ppm (danger)
- Response time: with a few seconds of O₃ reaching the sensor
- Accuracy: within 20% in the 0.05-0.1 ppm range
- Recommended calibration check annually
- Temperature Range: 18-37°C (65-100°F)
- Measurement principle: HMOS (Heated Metal Oxide Semiconductor) sensor
- Size: 85 x 35 x 60 mm (3 1/4" x 1 3/8" x 2 3/8")
- Weight: 154 grams (6 oz.)
- Power Requirements: 12-24 volts DC at 300-500 mA. AC adapters available worldwide.
- Batteries: self-contained NiMH. Approximately 2 hour capacity. Recharged by AC adapter overnight.

Badge-Type Ambient Ozone Monitor

- a. Shall measure the level of ozone present in the room where ozone equipment is located.
- b. The ChromAir® System ozone badge (K&M Environmental P/N 380010-10; www.kandmenvironmental.com; 1-800-808-2234) may be used for personnel or area monitoring for exposure times ranging from 5 minutes to 10 hours. For higher resolution, the ChromAir ozone badge may be used in conjunction with the ChromAir ozone color comparator.

b-1. ChromAir System features:

- Constantly monitors work environment
- Accurate measurements
- Ease of use - requires minimal training
- Cost effective - offers the most inexpensive air sampling solution available

b-2. ChromAir System specifications:

- Color change: blue to white
- Exposure range: 0.08–1.6 ppm•hr
- Max. sampling time: 10 hours
- Min. sampling time: 5 minutes
- Relative humidity range: 20% - 90%
- Face velocity range: 10-165 cm/sec
- Temp. range: 16°C - 30°C (61°F - 86°F)
- Light effect - sunlight: not recommended
- Light effect - visible: no effect
- Dimensions: 10.5 cm x 5.5 cm x 0.25 cm
- Weight: 11 g
- Refrigerated shelf life: 1 year

Other ambient ozone monitors are also available. Contact DEL for further information.

OZONE IN WATER

The ozone concentration in water can be measured in different ways.

1. Oxidation Reduction Potential (ORP) monitor measures the effective biocidal activity of dissolved ozone in water in millivolts and can be converted to mg/l (ppm). NOTE: ORP is an **ineffective** measurement of ozone concentrations greater than about 0.5 ppm.
2. Dissolved Ozone monitors measure levels of dissolved ozone in water (mg/l or ppm). The HACH Indigo Blue AccuVac high range dissolved ozone test kit (DEL P/N 6-0116) is an inexpensive colorimetric test. Electronic, in-line dissolved ozone monitors are also available. Contact DEL for further information.

7G. First Aid Procedures

7G-1. General

First Action:

1. DO NOT PANIC.
2. If exposure to gaseous ozone causes headaches or shortness of breath, immediately remove the patient to a fresh air environment.

Second Action:

1. Ensure there is no more danger to yourself or the victim.
2. Workers who have been exposed to low concentrations of ozone should be given oxygen to breathe while under the observation of trained personnel.
3. If exposure is severe, send for medical assistance immediately.

7G-2. Inhalation

First Action:

1. Assess patient's breathing.
2. All unconscious patients must be placed in the drainage position (on their sides), so that fluids can drain from the airways once breathing has been restored.
3. Check pulse.

Second Action:

1. If breathing has ceased, start artificial respiration (rescue breathing is the most effective) method until breathing has been restored.
2. Send for medical assistance immediately.
3. If breathing and/or pulse is not detected, begin cardiopulmonary resuscitation (CPR).

7G-3. Eye Contact

First Action:

1. Effective irrigation should start immediately. Eyes should be irrigated for 30 minutes by the clock with running tap water or preferably normal saline.

Second Action:

1. Effective irrigation must be continued while enroute to hospital.

7G-4. Precautions

Workers with a previous cardiopulmonary (heart and lung) condition must consult their physician prior to working in an area in which they may be exposed to ozone. Significant alterations in cardiopulmonary functions have been documented when such workers have been exposed to low concentrations of ozone.

7G-5. Emergency Information Form

An emergency information form (see Page 17) should be filled out prior to operation of ozone generator.

7H. MSDS

See Pages 18-20 for full Material Safety Data Sheet

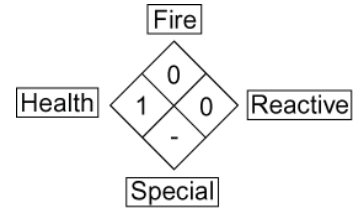
Material Safety Data Sheet

This MSDS complies with OSHA's Hazardous Communication Standard 29 CFR 1910.1200 and OSHA form 174.

DEL Ozone
3580 Sueldo Street
San Luis Obispo, CA 93401
 Product Information 805-541-1601

NFPA 704 Designation Hazard Rating

4 = Extreme
 3 = High
 2 = Moderate
 1 = Slight
 0 = Insignificant



Product Name		AQUEOUS OZONE SOLUTION			
Chemical Name		DISSOLVED OZONE GAS IN WATER 0 TO 2 PPM			
Product Description		AQUEOUS SOLUTION OF OZONE DISSOLVED IN POTABLE WATER			
D.O.T. Shipping Classification		NON REGULATED			
I PHYSICAL DATA					
Boiling Point	212 F	Freezing Point	32 F		
Specific Gravity	1.0	Solubility in Water	COMPLETE		
Evaporation Rate	APPROX 1	Physical Form	LIQUID		
Appearance & Odor	COLORLESS (CLEAR) WATER WITH FRESH, ASEPTIC ODOR				
II HAZARDOUS INGREDIENTS					
MATERIAL	HAZARD	CAS #	% BY WT	ACGIH TLV	OSHA PEL
None					
III FIRE AND EXPLOSION HAZARD DATA					
Flash Point	NA	Method NA	Auto Ign. Temp.	NA	
Flammable Limits in Air	NON APPLICABLE		Lower NA	Upper NA	
Extinguishing Media	NON APPLICABLE				
Unusual Fire & Explosion Hazards	NONE				
Special Fire Fighting Procedures	NONE				

Material Safety Data Sheet Cont.Product Name **AQUEOUS OZONE SOLUTION**

IV HEALTH HAZARD DATA	
Threshold Limit Value	NOT DETERMINED
Route of Exposure	<input type="checkbox"/> Inhalation <input type="checkbox"/> Ingestion <input type="checkbox"/> Skin <input checked="" type="checkbox"/> Eye <input checked="" type="checkbox"/> Not Hazardous
Eye Contact Hazard	Exposure may cause mild eye irritation, but is not expected.
Ingestion Hazard	Not Hazardous
Inhalation Hazard	Inhalation is not likely to be a primary route of exposure but could become irritating if aerosols are exposed to individual for extended period of time.
Skin Contact Hazard	No skin irritation is expected from short term exposure.
Skin Absorption Hazard	No published data indicates this product is absorbed through the skin.
Effects of Acute Exposure	Mild skin or eye irritation.
Effects of Chronic Exposure	Repeated exposure of the skin to concentrated product should be avoided to prevent irritation and drying of the skin.
V EMERGENCY AND FIRST AID PROCEDURES	
Eye Contact	If exposure to water containing aqueous solution of ozone causes irritation to eyes, flush eyes with plenty of clean, ozone free, running water for at least 15 minutes, lifting the upper and lower lids occasionally. Remove contact lenses if worn. Seek medical attention if irritation persists.
Skin Contact	Not likely to become irritated unless repeatedly exposed to large volumes of material. If irritation develops, rinse affected area with ozone free potable water. If irritation continues seek medical advice.
Inhalation	Inhalation of mists could lead to irritation of lungs. If symptoms develop, move individual away from exposure and into fresh air. If symptoms persist, seek medical attention.
Ingestion	NA
VI REACTIVITY DATA	
Incompatibility (Materials to Avoid)	Natural rubber (may degrade, or "dry", rubber components over extended periods of exposure)
Conditions to Avoid	NONE KNOWN
Hazardous Decomposition	NONE
Stability	<input checked="" type="checkbox"/> STABLE <input type="checkbox"/> UNSTABLE Hazardous Polymerization <input type="checkbox"/> MAY OCCUR <input checked="" type="checkbox"/> WILL NOT OCCUR

Material Safety Data Sheet Cont.Product Name **AQUEOUS OZONE SOLUTION**

VII SPILL OR LEAK PROCEDURES				
Steps To Be Taken If Material Is Released Or Spilled		NONE		
Waste Disposal Method		DISPOSE OF THE SAME AS POTABLE RINSE WATER		
VIII SPECIAL PROTECTIVE INFORMATION				
Respiratory Protection (Specify Type)		NOT REQUIRED FOR NORMAL USE OF THIS PRODUCT		
Ventilation	Local Exhaust	PREFERABLE	Special	NA
	Mechanical (general)	OK	Other	NA
Protective Gloves	NOT REQUIRED			
Eye Protection	NOT REQUIRED			
Other Protective Equipment	NOT REQUIRED			
IX SPECIAL PRECAUTIONS				
Precautionary Labeling	Certified testing of DEL Ozone systems by NSF (National Sanitation Foundation) has shown that under normal conditions of use, aqueous solutions containing low levels of ozone gas dissolved in potable water do not present a safety hazard when contact to the individual is incidental. When used in a room with normal ventilation, levels of ozone gas being released into the air have been shown by NSF to be well below the periodic exposure levels established by OSHA for worker safety through the use of DEL's ozone management technology.			
Precautions To Be Taken In Handling	Aqueous solutions of ozone in potable water should not be sprayed as an aerosol (i.e. >20psi) to avoid releasing higher levels of ozone gas into the work area. The decay rate of ozone gas is a function of temperature and exposure to organic material. Certified testing has shown that when ozone gas has been properly dissolved in ambient temperature (or colder (33 – 70 °F)) potable water at a level not exceeding 2 mg/l (ppm) using DEL's ozone management technology, the rate at which ozone is released from the water as ozone gas is below the PEL established for gaseous ozone.			
Rev. Date 03/26/09				
This material safety data sheet is provided as an information resource only. It should not be taken as a warranty or representation for which the preparer assumes legal responsibility. While we believe the information contained herein is accurate and compiled from sources believed to be reliable, it is the responsibility of the user to investigate and verify its validity. The buyer assumes all responsibility of using and handling the product in accordance with applicable federal, state, and local regulations.				

DEL OZONE COMMERCIAL PRODUCT LIMITED TWO YEAR WARRANTY

The limited warranty set forth below applies to products manufactured by DEL OZONE – 3580 Sueldo Street, San Luis Obispo, California 93401, and sold by DEL OZONE or its authorized dealers. This limited warranty is given only to the first retail purchaser of such products and is not transferable to any subsequent owners or purchasers of such products. Systems sized 65 grams or greater require factory commissioning and startup to maintain warranty as set forth below.

DEL OZONE warrants that DEL or DEL authorized dealers will repair or replace, at DEL's option, any part of such products proven to be defective in materials or workmanship within two (2) years of the date of receipt. Parts are covered under the two (2) year warranty when and only when the stated maintenance requirements are met. Contact Tanks and degas valves have a ninety (90) day warranty. Compressor(s) must be maintained per operation and maintenance manual. Required maintenance includes a compressor rebuild after one (1) year or every 8,760 hours, whichever ever is reached first. Warranty does not include parts for compressor(s) rebuild kit(s), or other consumable items. See owner's manual for complete maintenance details. This Warranty specifically excludes any components not manufactured by DEL OZONE that are external to the products covered, such as pumps, air compressors, monitors, tanks, or related components. DEL OZONE will assist with warranty claims for such components purchased through DEL OZONE; limited to the extent of the manufacturer's standard warranty. **ANY REPAIR OR REPLACEMENT WILL BE WARRANTED ONLY FOR THE BALANCE OF THE ORIGINAL TWO (2) YEAR WARRANTY PERIOD**

NOTE: USE ONLY DEL AUTHORIZED DEL REPLACEMENT PARTS. USE OF ANY OTHER PART(S) WILL VOID THIS WARRANTY.

Any replaced parts must be returned to DEL OZONE for warranty evaluation.

THIS LIMITED WARRANTY DOES NOT INCLUDE ANY OF THE FOLLOWING:

- (a) Any labor charges for troubleshooting, removal, or installation of such parts.
- (b) Any repair or replacement of such parts necessitated by faulty installation, improper maintenance, improper operation, misuse, abuse, negligence, accident, fire, flood, repair materials, and/or unauthorized accessories.
- (c) Any such products installed without regard to required local codes and accepted trade practices.
- (d) Damage to unit caused by water backflow;
- (e) Any implied warranty of merchantability or implied warranty of fitness for particular purpose, and such warranties are hereby disclaimed.
- (f) DEL Ozone shall not be liable under any circumstances for loss of use of such product, loss of profits, direct damages, indirect damages, consequential damages, and / or incidental damages.

This warranty gives you specific legal rights. You may have other rights which vary from state to state.

Extended Warranties and Service Agreements are available. Contact DEL for additional details.

TO OBTAIN WARRANTY SERVICE:

DEL OZONE Commercial Department
PO Box 4509, San Luis Obispo, CA 93403
Customer Service Number: (800) 676-1335
Fax Number: (805) 541-8459
E mail: service@delozone.com

PROVIDE:

1. Project, contact name, mailing address and telephone.
2. Installer/Mechanical Contractor.
3. Unit Part Number, Serial Number, and date of purchase.
4. The date of failure.
5. A description of the failure.

After this information is provided, DEL Ozone may release a *RETURN GOODS AUTHORIZATION (RGA) NUMBER*. After receiving the RGA number the part in question must be returned to DEL Ozone, freight prepaid, with the RGA number clearly marked on the outside of the package. All preauthorized defective parts must be returned to DEL Ozone within thirty (30) days. Under no circumstances may any product be returned to DEL Ozone without prior authorization. Returns without the assigned RGA number on the outside of the package will be refused and shipped back to the sender at their expense. Upon receipt of preauthorized returned goods, DEL Ozone will repair or replace, at DEL Ozone's option, the defective product(s) and return them (freight prepaid for products under warranty). Buyer's acceptance of the product and use thereof constitutes acceptance of these terms