WATERZONE SERIES

OZONE INJECTION SYSTEM

MODEL: WZ-100, 150, 200

INSTALLATION & OPERATIONS MANUAL

OZONE SOLUTIONS®

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CONTENTS

IMPORTANT SAFETY INSTRUCTIONS, READ AND FOLLOW ALL INSTRUCTIONS.

Read this manual completely before attempting installation.

SAVE THESE INSTRUCTIONS.

SECTION 1

SAFETY PRECAUTIONS

Ozone is a powerful oxidizing agent. Observe strict operating procedures while using ozone equipment. **It is imperative that only ozone compatible materials are used in conjunction with the ozone system.**

NOTE: If the operator has asthma, he or she must not enter an airspace that has a significant ozone concentration. Ozone can induce an asthma attack.

Ensure that the Ozone Generator is in a well-ventilated area. Do not allow rain or condensation to contact the Ozone Generator. The Ozone Generator is not weather proof. The unit must be operated indoors or in an enclosure in a non-condensing environment.

Carefully review and familiarize yourself with the following important safety information concerning the Ozone Generator:

1. Ozone is an extremely aggressive and powerful oxidizer. The Occupational Safety and Health Administration (OSHA) 8-hour exposure limit is 0.10 PPM. The OSHA 15 minute exposure limit for ozone is 0.3 PPM. Above 0.3 PPM, there is the risk of damage to respiratory tissues.
2. People who have no sense of smell should not operate this equipment.
3. Never attempt to verify ozone production by directly breathing or smelling the ozone outlet.
4. The Ozone Generator contains high voltages. Unauthorized entry can result in serious injury or death. For service instructions, contact Ozone Solutions.
5. Make sure all tubing connections between the Ozone Generator and the injection point are secure and in good working condition. Failure to do so could result in the discharge of ozone into an undesired space.

INTRODUCTION

The Waterzone series ozone systems are a complete oxygen preparation, ozone generation, and injection system that include the integrated oxygen sieves, ozone generator, pump, injector, and contact Tank. External compressed air may be required.

This skid has a control system to control all functions of the ozone generator and ozone injection system automatically. Each of these functions will be described in this manual. Please read and familiarize yourself with this and other related operation manuals before use.

THEORY OF OPERATION

The purpose of this system is to use ozone as a disinfectant for water. Ozone is a very reactive gas that must be produced on site. Ozone in the gaseous form is also very unstable and difficult to manage in an effective way for any reliable disinfection processes. Because of these factors, the ozone is dissolved into water whereby it can be applied effectively to the surface of any food product or other item that may require disinfection.

The ozone is produced using ozone generator cells. The ozone generator produces 100-200 g/hr (depending on model) of ozone from oxygen feed gas. This oxygen feed gas is concentrated from compressed air supplied by the internal oil-free air compressor, if equipped, or the provided plant air. The oxygen concentrators use pressure swing adsorption (PSA) technology with a zeolite material to purge the nitrogen from the compressed air leaving 90-95% oxygen feed gas for the ozone generator. This oxygen is passed through ozone generator cells which uses a controlled high voltage, high frequency spark, called a corona, to convert as much oxygen (O_2) into ozone (O_3) as possible. The result is 5-8% ozone in an oxygen stream of 32-64 SCFH leaving the Ozone Generator at pressures up to 14 PSI.

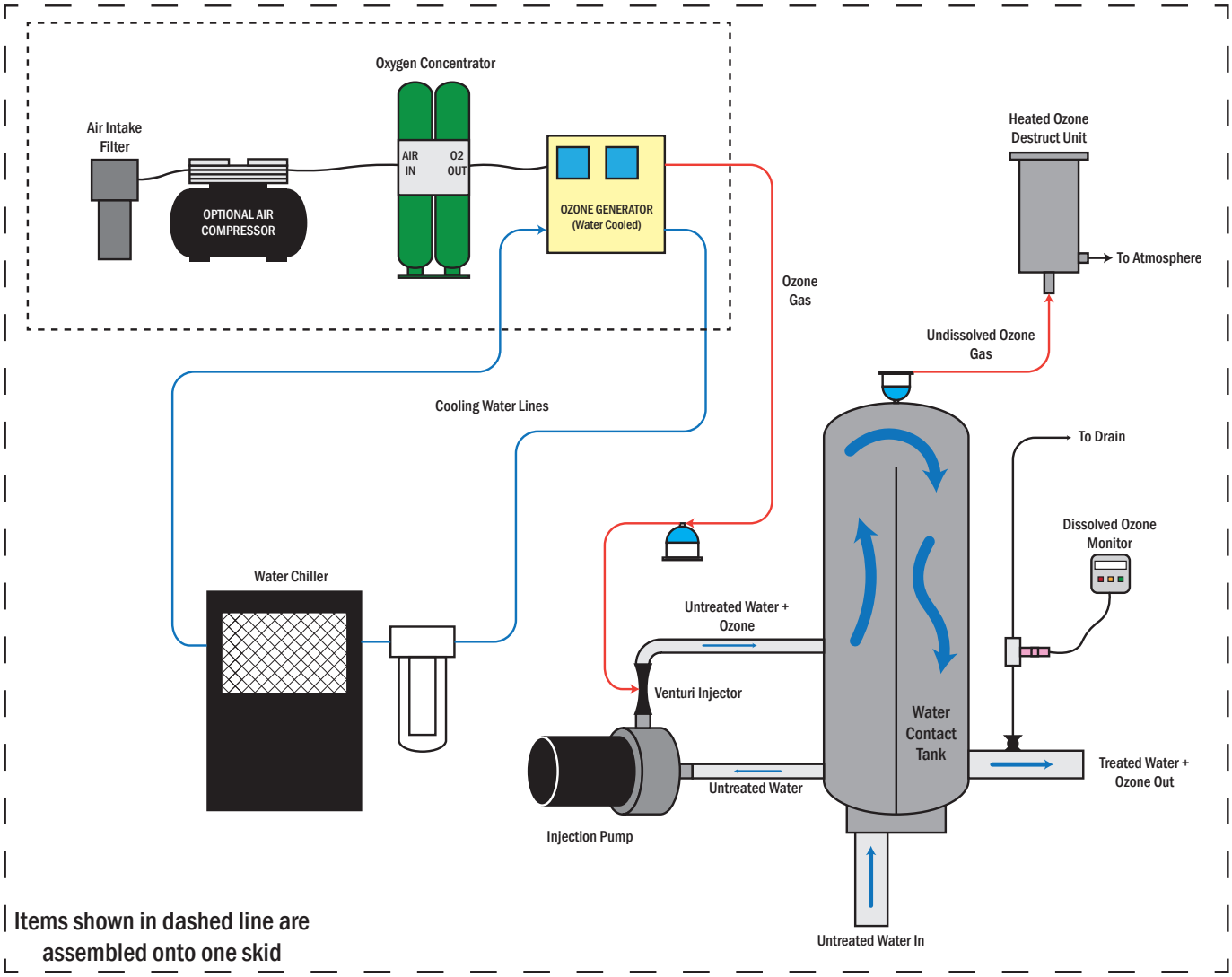
The process of converting oxygen into ozone is an energy intensive process that generates a large amount of heat. This heat must be removed from the ozone generating cell for efficient and reliable operation. The ozone generator in this system uses water cooled cells and a water chiller to remove this heat. The water chiller has an onboard pump to operate the cooling circuit.

This ozone/oxygen mix is dissolved into the water using the Ozone injection system. To efficiently dissolve this ozone into the water, a Venturi Injector is used to pull the ozone into the water. The water pump is used to increase water pressure prior to the venturi. The pressure at the outlet of the venturi must be at least 20 PSI lower than the inlet pressure. This pressure differential creates a vacuum that will pull the ozone

into the venturi. This forceful action along with the added mixing vanes in the venturi injector provides for an extremely efficient method of dissolving the ozone gas into water.

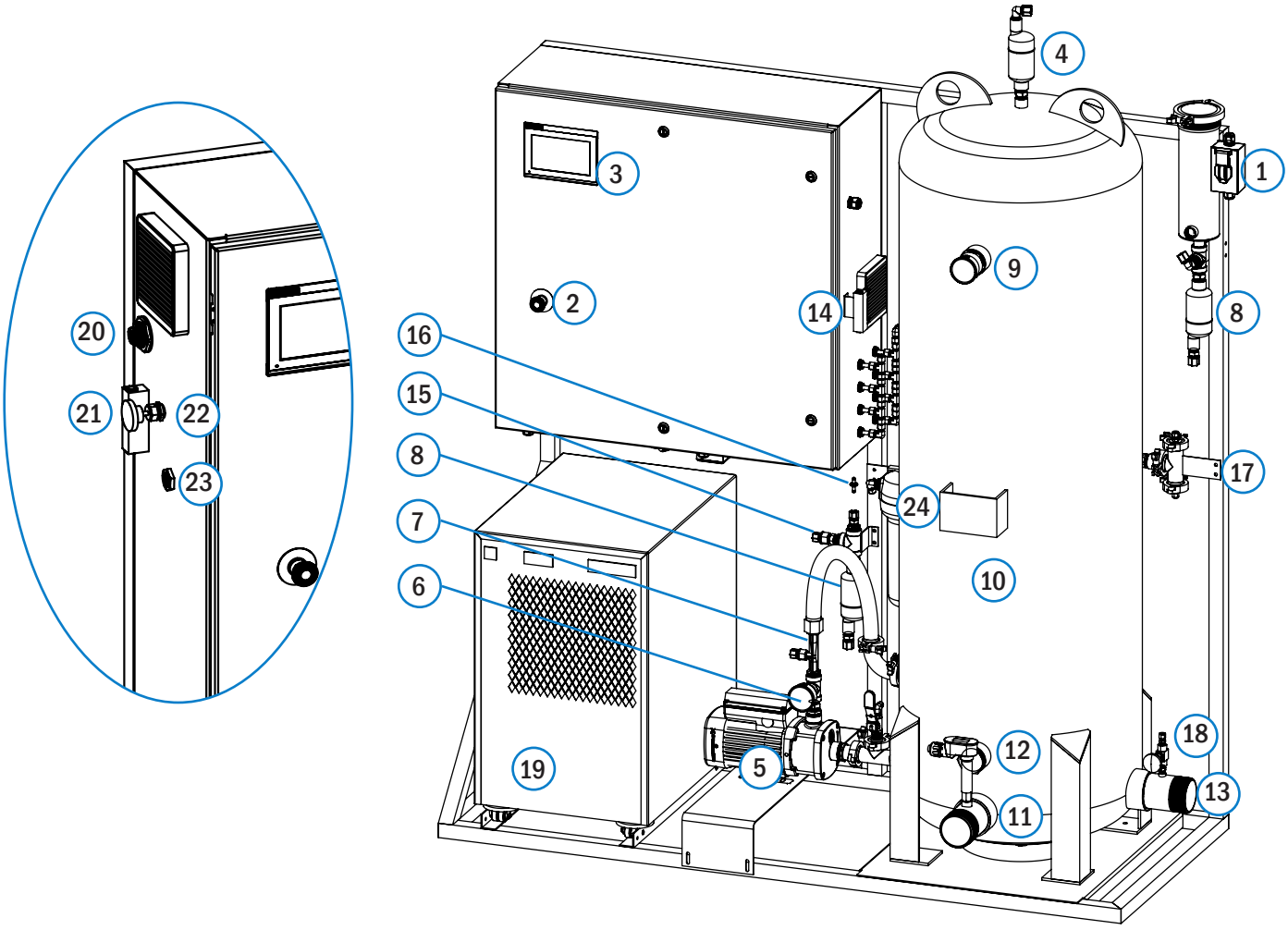
Naturally, the excess oxygen and a small amount of undissolved ozone must be removed from the water; this occurs in the contact tank located on the skid. Baffles inside this skid ensure that no oxygen/ozone gas will escape with the water. All of the undissolved oxygen/ozone is removed through the vent on the top of the contact tank so that it can be safely destroyed or removed from the location.

The water passing through the ozone injection system is unimpeded and will flow at the desired rate at the point of use. Water with dissolved ozone levels necessary for proper disinfection can be used for any purpose desired.



SECTION 2

COMPONENT DIAGRAM



COMPONENTS DESCRIPTION

1. Ozone Destruct Unit: Safely converts off-gassed ozone into oxygen using a catalyst material. The destruct unit uses a heater band to keep the catalyst bed warm. This is to ensure no moisture condensates on the catalyst. As long as the Waterzone is connected to electrical power, this canister should be warm (sometimes hot) to the touch.

2. Emergency Stop Push Button: Allows you to easily turn the system off quickly by pushing this switch.

3. HMI: This touch screen allows workers to control the machine and view alarm conditions

4. Air Vent: Safely removes all off-gassed ozone/ oxygen from the system. The gas flow from this vent must be vented to a safe outdoor location or into an ozone destruct unit.

5. Ozone Injection Pump: This pump creates the pressure differential necessary across the venturi injector for ozone injection. This pump should be operating any time the Green Pump light on the control panel is ON.

6. Injection Inlet Pressure Gauge: Indicates water pressure on the inlet side of the venturi injector. This pressure should be at least 20 PSI higher than the injector outlet pressure gauge. Any time the ozone injection pump is running this pressure gauge should be higher than the injector outlet pressure gauge.

7. Venturi Injector: A Venturi Injector is used to pull the ozone into the water using a vacuum and mix this ozone gas into water very efficiently. For the venturi action to occur, a minimum pressure differential of approximately 20 PSI must be maintained. The differential is determined by figuring the difference between the pressures indicated at the inlet and outlet of the Venturi Injector. The outlet pressure is equal to Contact Tank pressure, and basically indicates the pressure exerted on the Ozone injection system by the outside source. The inlet pressure will increase or decrease along with this pressure, but a constant differential will be maintained as long as the Injector Pump is operating properly.

8. Water Trap: These units prevent water from flowing with the gas stream to the ozone destruct unit, and potentially the ozone generator (in a reverse flow situation). Any water that may flow with these gas streams will be trapped in the bowl of the water trap and safely drained out via tubing to a floor drain.

9. Tank Pressure Gauge: Indicates water pressure on the outlet side of the Venturi Injector. This pressure will be equal to the contact tank pressure and basically indicates the pressure exerted on the ozone injection system by an outside source. This pressure should be at least 20 PSI lower than the injector inlet pressure gauge.

10. Contact Tank: This tank mixes the ozone gas with the water to be treated. Using baffles and specific inlet/outlet design, maximum mass transfer efficiency of the gas to water is achieved. While most ozone is dissolved into the water, some ozone/oxygen will off-gas through the vent in the top of this contact tank.

11. Water Inlet: Connection for incoming water.

12. Flow Switch: The Flow Switch recognizes there is water flowing through the tank and tells the controls in the system.

13. Water Outlet: Connection for effluent water.

14. Cooling Water Flow Meter: Indicates water flow rate through the cooling water loop of the ozone generator. This flow can be regulated with the integrated flow control knob on the flow meter. Flow should be 30-40 GPH.

15. High Pressure Check Valve: This check valve is to make sure that water does not flow back up the ozone line.

16. Low Pressure Check Valve: This check valve is a secondary to the high pressure check valve

17. Dissolved Ozone Monitor: Flow cell with remote mounted sensor probe.

18. Flow Cell Needle Valve: This valve regulates the flow of ozonated water across the dissolved ozone monitor probe

19. Water Chiller: This unit chills the cooling water through the ozone cells.

20. Ethernet Port: This port allows connection to the PLC system

21. Oxygen Flow Meter: Indicates the flow of oxygen through the Ozone Generator.

22. Ozone Flow Regulating Valve: Turn this knob to regulate oxygen flow through the Ozone Generator, Flow is indicated through the oxygen flow meter adjacent to the valve.

23. Compressed Air Inlet

24. Cooling Water Filter: This filter protects the water chiller from particulate.

SPECIFICATIONS

Waterzone	Ozone Production (g/hr.)	Oxygen Flow Rate (SCFH)	Dimensions HxWxD (in)	Max Flow Rate (GPM)	Voltage (Volts)
Waterzone-100	100	32	83x78x34	200	220 4-wire Single phase
Waterzone-150	150	50	89x78x33	300	220 4-wire Single-phase
Waterzone-200	200	64	89x78x33	300	220 4-wire Single-phase

INSTALLATION

IMPORTANT: Keep in mind that the intake of the pump(s) must be flooded with water (water level above pump head) every time the pumps are started or running, as they are not self-priming. Operating the pumps dry will cause pump damage. Be sure to have the pump head flooded with water anytime the pumps are started or running.

IMPORTANT: Proper floor drainage is required to prevent water damage in case of water leak or overflow.

Ventilation: The system should be installed in a well ventilated area, in accordance with the environmental specifications outlined in the individual Operation Manuals associated with this system.

LOCATION AND MOUNTING

The ozone injection system should be installed in such a way that all components of the system are accessible for future maintenance. Working area required around the system must be made available on three sides. A minimum of 30 inches should be left for working area around the front and both sides. The rear of the system can be mounted against a wall or another object.

The ozone injection system is not rain or drip proof, and therefore should be protected from rain and splashing water. Filtered cooling inlets provide a level of protection against dust; however for maximum longevity the system should be located in a clean, dry area.

If the system is to be mounted in a mobile unit (such as a trailer or movable building), mechanical shock and vibration prevention measures need to be taken to protect the system from damage during relocation of the mobile unit.

Ensure that the location chosen ensures a maximum temperature of 95°F and a maximum relative humidity of 85%. If the parameters above cannot be maintained, cooling and/or dehumidification equipment must be installed. There may be exceptions to the environmental guidelines for certain system configurations, contact Ozone Solutions if the environmental conditions are not as prescribed above, or otherwise in question.

MECHANICAL CONNECTIONS

Connect water piping at the fittings provided at the edge of the skid. Ball valves at the inlet and outlet of the system are required to allow isolation, configured in such a way that the system can be isolated and/or bypassed for maintenance purposes.

Process Water In

Water is supplied to the tank fitting near the front-center of the system. The water flow switch is also installed in this tee.

Process Water Out

Ozonated water exits the tank fitting on the right side of the tank. If different plumbing connections are required, adapters can be provided.

Water Sample Port

Ozone residual in the water must be checked periodically to ensure proper operation of the ozone injection system. This is also used to calibrate the dissolved ozone sensor (if applicable). After the output of the Ozone injection system, a small tee with a ball valve should be placed in the water line. This will allow for samples of water to be pulled to verify the dissolved ozone level in the water.

Dissolved Ozone Monitor

Measures the dissolved ozone level exiting the contact tank. The black cap needs to be pulled off of the tip for it to work. Read and understand the provided sensor instructions. The manual will inform you of the maintenance and calibration of this probe.

Ambient Ozone Monitor

This type of monitor is to display an ozone reading measured from the ambient air. The most common monitor chosen is the F12 unit. This monitor can be installed remotely from the Waterzone unit to ensure safe conditions for employees working in the same room as the unit, or near the ozone point of use. The output of the monitor can be tied into the PLC system of the Waterzone to allow automatic shut down procedures.

Air Vent

The air vent is located on the top of the Contact Tank. The 1/2 inch port exiting the air vent will need to be plumbed outdoors away from human contact or to a suitable ozone destruct unit, as it will be off-gassing small amounts of high-concentration ozone. Ozone-compatible tubing and fittings should be used for this purpose.

Waterzone systems are configured with an Ozone Destruct Unit installed on the skid. The gas exiting this ozone destruct unit should still be plumbed to a safe location in the event the destruct unit fails for any reason. It is important that this gas is removed from human contact and vented to a safe location.

Water Trap Drain

The Water Trap is located on the Ozone Injection Skid. This water trap will drain any water that may be pushed from the Venturi Injector toward the Ozone Generator; this is a protection device for the Ozone Generator. There may also be a water trap installed to drain any water from the off-gas vent outlet prior to the ozone destruct unit.

These water traps may collect a small amount of water that will need to be plumbed away to a drain. Any drain tubing must be run DOWNHILL in order to freely drain. Use tubing with an ID of no less than 3/8 inch, with a maximum of 5 feet.

ELECTRICAL POWER CONNECTIONS

The system requires a 220 Volt, 4 wire, 30 Amp, 60 Hz single phase circuit. The unit is installed with a NEMA cord end for easy power up.

OPTIONAL ELECTRICAL CONNECTIONS

CAUTION: Voltage may be present at connection terminals! Disconnect all power before servicing.

Terminals are provided for connection of external contacts to control and monitor the system. The terminals are located inside the System Controller. Drill holes in the System Controller as necessary for connection of external control wiring.

These connections may be used optionally as desired. Some terminals are jumpered from the factory to allow the system to operate without external connections. On terminals which are jumpered, the jumper must be removed upon connection of remote contacts. If control wires are used in the terminals currently, these can be run in series with any remote control device of your choice to power the system remotely.

SECTION 3

SYSTEM OPERATION

IMPORTANT: Read and understand the “Personal Safety” section of this manual before operating the Ozone System.

Water Flow

Water flow through this ozone injection system will be dependent upon the supply water connection to maintain pressure on the system. The ozone injection will occur regardless of the rate of flow through the contact tank, as long as the tank remains full of water.

Higher water usage will result in lower dissolved ozone levels, while lower water usage will result in higher dissolved ozone levels. This is due only to the ratio of ozone to water. Keep this in mind when specific dissolved ozone levels are required for your operation.

Water Pressure

This ozone injection system will not operate effectively with water pressures exceeding 50 PSI. If water pressures are higher, then water pressure should be regulated ahead of the ozone system so that it can be adjusted to maintain lower pressures.

If the water will be used for spraying or washing purposes, the water pressure should be kept below 30 PSI. This is to ensure that the ozone will remain

dissolved into the water. Higher spray pressures will off-gas a large amount of the dissolved ozone from the water in the spraying process. This is not a desirable situation for the disinfection process, or for human safety.

Injector Pump

The Injector Pump is a dedicated pump to mix the ozone with the water. This pump will create the necessary pressure differential across the Venturi Injector to create the necessary vacuum to draw ozone into the water stream. This pump will also mix the ozone with the water in the contact tank by recirculating this water through the injector at a flow rate necessary for injection. This pump will start and stop automatically.

Water Chiller

The water chiller is a standalone chiller with a sole purpose of cooling the ozone cells. Be sure that the chiller's main power switch is ON whenever the main system is on. Failure to do so will result in overheating of the cells, which will cause poor ozone production and will damage the cells.

System Control

Read the "Ozone System Controls and Indicators" to become familiar with the individual components before attempting to operate the system. The system can be operated from a remote location if the optional external control connections are used. For more information see the "Installation: Optional Electrical Connections: section in this manual.

Local Operation

For normal day-to-day operation, the initial startup procedure may be followed. The system can be started by pressing the START button on the screen; all other controls will automatically start as necessary.

Remote Operation

There are external connection terminals located inside the system controller that can START or STOP the system from a remote location. The external push buttons can START or STOP the system by momentarily closing the contacts. This may be convenient when there is another control system that will be starting other equipment associated with the ozone system.

OZONE SYSTEM INITIAL STARTUP PROCEDURE

IMPORTANT: Read and understand the "Caution, Warnings and Hazards" section of this manual before operating the ozone system!

1. As a safety measure, ensure that the Variable Ozone Output is set to "0" during initial setup and first starting of the system (so that ozone is not produced).

2. Remove the black protective cap from Dissolved Ozone Monitor probe before filling with water.

3. Open the water valves on the piping system to allow water flow into the system and fill the Contact Tank. The Contact Tank is full when the tank pressure gauge reads equal to the supply water pressure. This system check also ensures that the pumps are primed with water. IMPORTANT: Do not start the system unless it is full of water, as equipment damage may result in the event of a dry start.

4. Inspect all water connections for leaks.

5. Allow water to flow through the system by opening a valve upstream of the system.

6. Connect clean, dry, compressed air to air-in bulkhead on enclosure, if not equipped with internal compressor option.

7. Start the ozone injection system by pressing the Start button on the screen. When set to AUTO, the injection pump and oxygen concentrator will start. Verify that the pump outlet pressure rises to indicate the pump is working.

8. Ensure that the Ozone Generator oxygen flow does not exceed the limits outlined in the manual. Setting the flow to about 8-10 LPM is a safe starting point for this flow, and can be slowly increased once the system stability is verified. This flow is adjusted manually using the flow control valve near the flowmeter, and may be affected by varying water pressures. Normally if adequate water pressure is applied to the contact tank the oxygen flow will not exceed its limits.

9. Ensure that air bubbles are escaping from the air vent; this will indicate the oxygen is being introduced into the water and off-gassed effectively. Normally, a small amount of water will periodically exit the air

vent along with the air. If adequate off-gassing does not occur, the tank will eventually fill with oxygen/ ozone gas and cause injection pump cavitation and result in low dissolved ozone levels. It may take a matter of minutes or hours for such a problem to become obvious.

10. The Variable Ozone Output may be turned up at this time to begin producing ozone. IMPORTANT: Verify that the water chiller is turned on and operating before producing ozone.

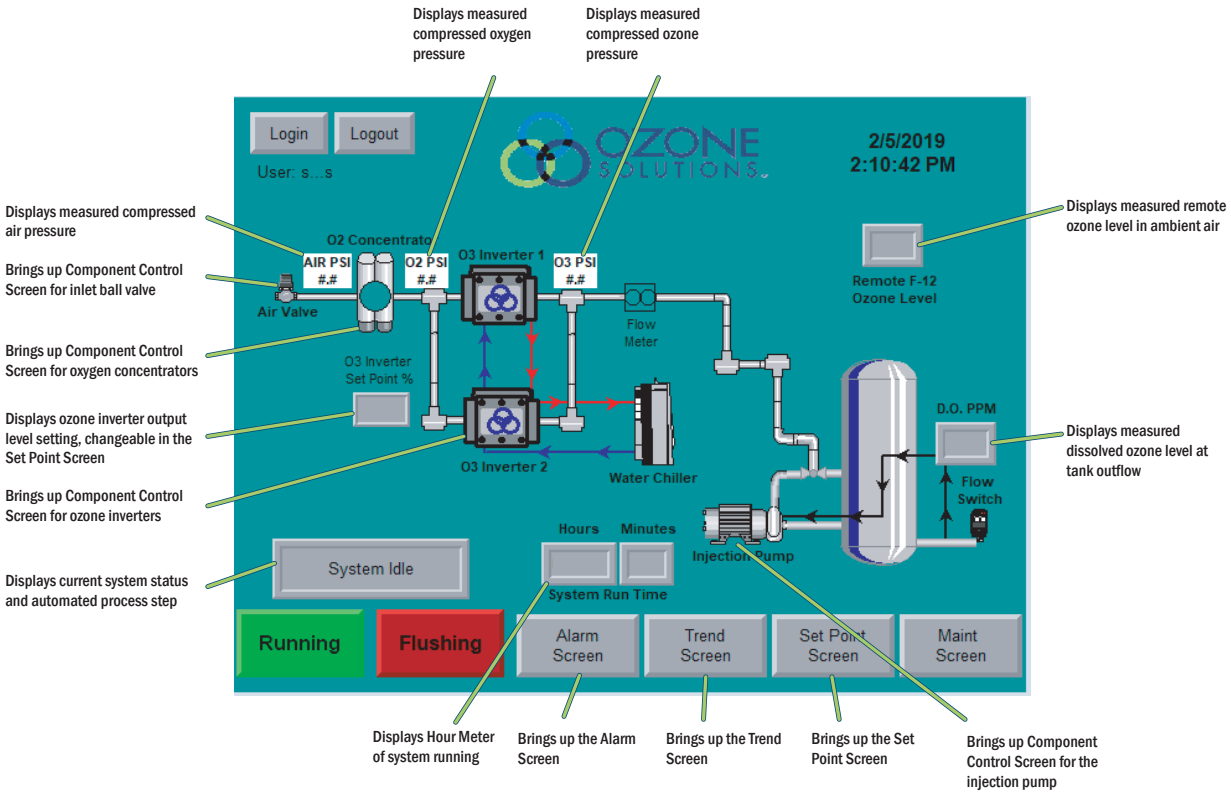
11. The Dissolved Ozone Level on the Dissolved Ozone Monitor should being to rise within five (5) minutes of startup. NOTE: The dissolved ozone sensor will require time to stabilize in the process before full accuracy is reached. Normally this occurs within a few hours, but may require more time. See AS-500, AV88, Q45H, or Q46H Dissolved Ozone Monitor and Sensor operation manuals for details.

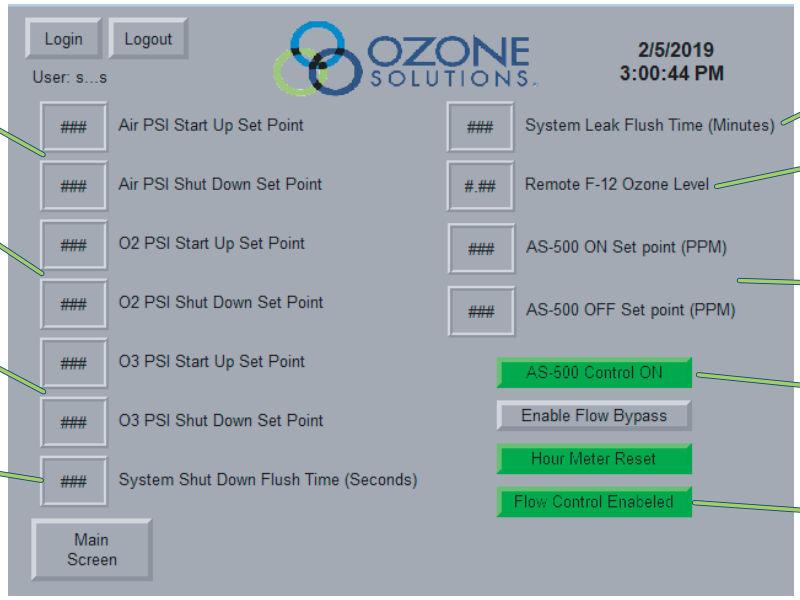
12. Depending on the application, the Dissolved Ozone Monitor settings may need to be adjusted for the HIGH and LOW alarms. See the System Operation section of this manual.

13. To stop the system simply press the STOP button on the screen. The system will automatically enter a flush cycle then shut down.

SECTION 4

HMI CONTROL DISPLAY - OVERVIEW





Controls upper and lower conditions for air pressure. System will start when inlet air pressure exceeds Start Up Set Point, and shut down when below Shut Down Set Point.

Controls upper and lower conditions for oxygen pressure. System will start when oxygen pressure exceeds Start Up Set Point, and shut down when below Shut Down Set Point.

Controls upper and lower conditions for ozone pressure. System will start when ozone pressure exceeds Start Up Set Point, and shut down when below Shut Down Set Point.

Controls the length of time that the system runs, with inverters off, during shut down operation.

Controls the length of time that the system runs, with inverters off, when a leak is detected.

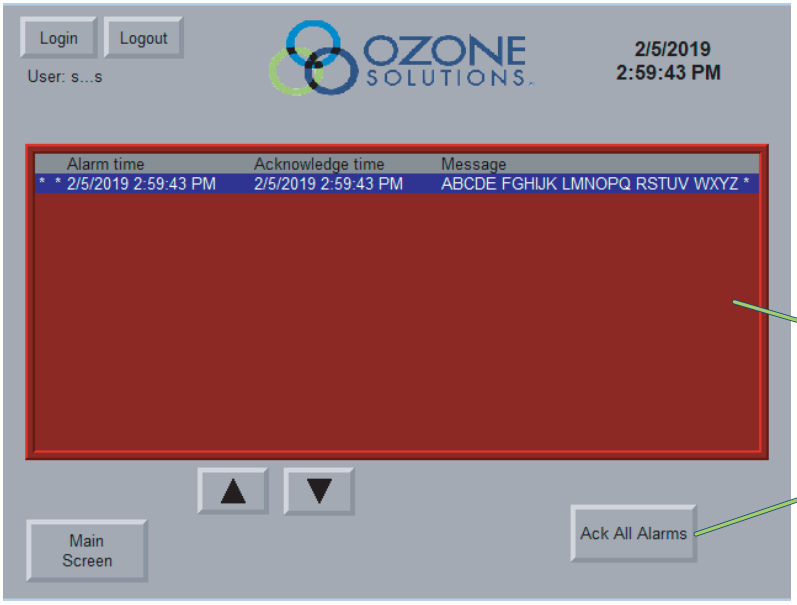
Controls the maximum measurement level acceptable in ambient conditions. If measured levels exceed this point, the system enters a leak flushing cycle.

Controls upper and lower conditions for dissolved ozone. System will start when dissolved ozone is below ON set point, and shut down when below OFF Set Point.

Allows the system to automatically control output based on readings from the dissolved ozone monitor.

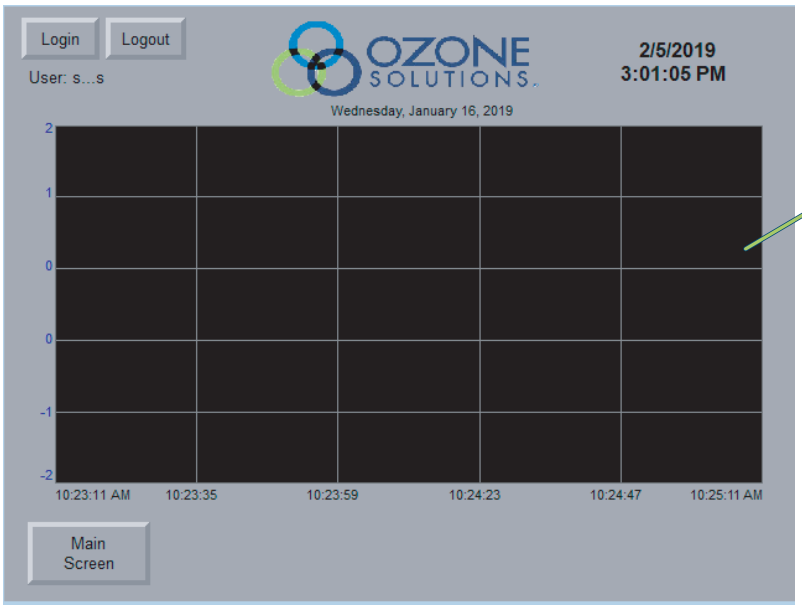
Allows the system to automatically control flow through the system.

Important: Changing set points requires the user to be logged in as supervisor



Displays active and acknowledged alarms.

Acknowledges all alarms displayed



SECTION 5

PERSONAL SAFETY

Flushing ozone from the system

Safety warnings regarding ozone gas are found at the beginning of this manual. The Ozone System produces a large amount of ozone, which can be inadvertently "stored" within the Ozone Generators, manifolds, and ozone lines.

NOTE: In most circumstances, a very small amount of ozone will be contained within the system after shutdown and therefore exposure will be minimal.

Eventually the ozone (even while in the system) will safely revert back to oxygen, but in the right conditions the ozone can remain in the system for 24 hours or even longer. In the event that maintenance must be performed on the components in contact with ozone, the following is recommended for reducing the possibility of exposure to the ozone.

Whenever possible it is recommended that the machine run with maximum permissible air and oxygen flow for at least 10 minutes with the Ozone Generator OFF in order to flush out most residual ozone.

If the machine cannot be operated prior to maintenance or repair, a waiting period of 12 to 24 hours (if ozone has been produced recently) is recommended to allow the ozone to decay by reverting back into oxygen.

Isolating energy sources

The Ozone Generator has electrical and mechanical hazards, and maintenance or repair should not take place unless all energy sources have been turned off, disconnected, and/or drained. Energy sources include, but are not limited to:

- Electrical power
- Oxygen Concentrator sieve beds
- Ozone Generator internal capacitors

WARRANTY

Ozone Solutions warrants all new equipment assembled, manufactured, and sold to be free from defects in material and workmanship under normal use and service for a period of one (1) year after date of sale to the original purchaser.

Some products may have a specific warranty period other than what is outlined in this document. For such products, the manufacturer warranty will supersede this warranty. Ozone Solutions will honor the manufacturer's warranty, but if and when advised by the manufacturer, may have the customer deal directly with the manufacturer.

This warranty covers all parts that are not outlined in a product maintenance schedule. This warranty will be void if any piece of the equipment is used in a manner other than what is explicitly outlined in the product manuals.

If any part of the equipment manufactured by Ozone Solutions proves to be defective during the warranty period, please contact Ozone Solutions at 712.439.6880 or service@ozonesolutions.com.

Prior authorization is required before working on or shipping a product back to us. Failure to get prior authorization may result in denial of your claim. Once authorized, you may return the defective equipment to Ozone Solutions with the transportation charges prepaid. If Ozone Solutions finds the equipment to be defective, it will be repaired or replaced at our discretion, free of charge, to the original purchaser (F.O.B. factory).

This warranty shall not place any liability on Ozone Solutions for any transportation charges, labor, or cost for, or during the replacement of any parts. The replaced part (s) or product will then continue the original warranty duration. The replaced parts will not start a new one (1) year coverage period.

The purchaser by acceptance of the equipment will assume all liability for the consequences of its use or misuse by the purchaser, employees, or others. This warranty shall not apply to any piece of equipment, or part thereof sold by this company which has been subject to any accident caused in transit, alterations by unauthorized service, negligence, abuse, or damage by flood, fire, or act of God.

This warranty shall constitute the entire warranty and/or agreement between Ozone Solutions and the original purchaser, and in lieu of all other warranties, expressed or implied, either oral or written, including the warranty of merchantability and fitness for a particular use and of all other obligations or liabilities on our part. Ozone Solutions neither assumes nor authorizes any other person or entity to assume for us any liability associated with the sale of its products or equipment.

The term "original purchaser," as used in this warranty, means whom the product was originally sold to by Ozone Solutions or by an authorized dealer.

Ozone Solutions reserves the right to make changes in its products without notice. Because of this, Ozone Solutions is not obligated to replace warranty defective part (s) and/or product with the same original part or product.

CONTACT INFORMATION

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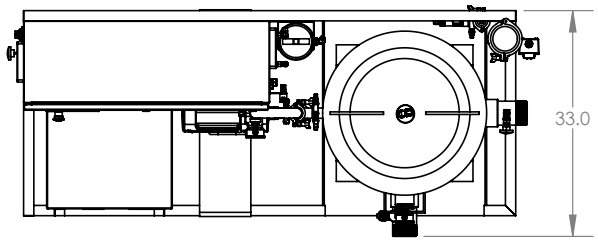
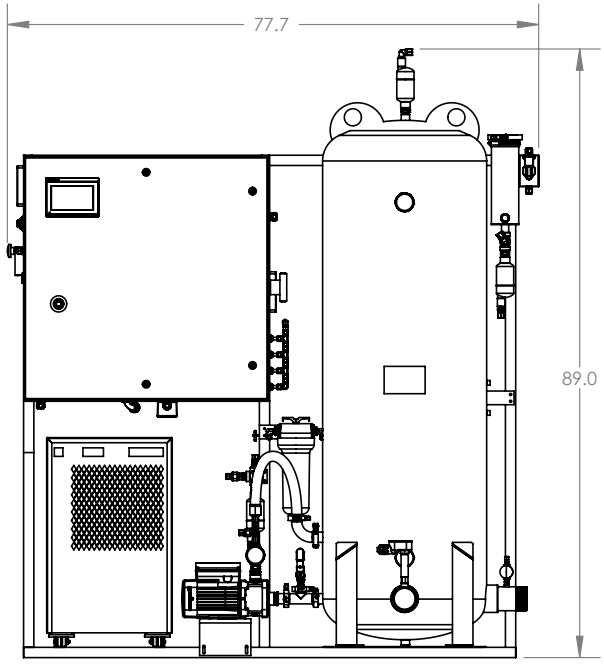
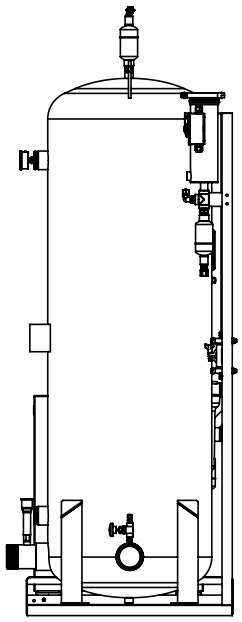
APPENDIX A - CAD DRAWING







OZONE SOLUTIONS

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APPENDIX B - MAINTENANCE

All major components requiring maintenance have guidelines listed in the respective operation manuals. Refer to those individual operation manuals for other preventative maintenance and regular maintenance information.

Maintenance Table

COMPONENT	ACTION	TIME INTERVAL	PART NUMBER(S)
Compressed Air Filter	Replace the filter element	3 months/as needed	PR-8: Replacement filter
Compressed Air Filter	Replace the filter element	3 months/as needed	CF-8: Repl. Filter
Water Chiller Filter	Replace the filter element	3 months/as needed	Ecopure EPW2C Filters
Dissolved Ozone Sensor	Replace the Electrolyte	6 months, dependant on water quality	AS-500 Electrolyte
Dissolved Ozone Sensor	Replace the flat cap	1 year	AS– Membrane Cap Flat
Ozone Leak Sensor	Replace the sensor	1 year	OEM-3: RME-1.0
ORP Sensor if equipped	Replace the sensor	1 year	ORP-Sensor
Check Valve-High PSI	Replace	1 year	CVHP-8
Check Valve-Low PSI	Replace	1 year	CVLP-4
Destruct Unit	Replace the Catalyst	1 year	ODS-Catalyst
Oxygen Concentrator	Replace the 02 module	2-5 years	ATF-23
Injection Pump-3/4hp.	Replace/rebuild pump	3-5 years	CM5-G-3 Rebuild (exchange pumps)

APPENDIX C - TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	REPAIR
System does not run	Alarm Condition - Message in alarm log	Resolve alarm condition
	No Power	Check and repair incoming power
	External stop contacts	Ensure external contacts are open
	Flow less than 5 gpm flow switch not active	Increase water flow
Low dissolved ozone levels	Water is contaminated	Check water quality, repair upstream deficiencies
	Water is too warm	Lower water temperature
	Dissolved ozone reading is inaccurate	Check dissolved ozone level against another standard
	Oxygen flow is too low	Increase oxygen flow
	Water flow is too high	Decrease water flow
	Ozone Output is low	Increase ozone generator output
	ORP high	Check ORP Set-points
	Low outlet pressure	Increase inlet flow/pressure or decrease outlet flow
Low O2 flow	Low O2 Pressure	See “Low O2 pressure”
	Flow restriction	Open needle valve or dislodge restriction
	Venturi pressure differential too low	Operation water pressure too high
	Damaged O2 Regulation Valve	Replace regulation valve
Low air pressure	Air leak inside ozone generator	Find and repair air leak
	Pressure regulator requires adjustment	Adjust pressure regulator
Low O2 pressure	O2 or O3 Leak	Find and repair leak
	Air Pressure Low	See “Low air pressure”

APPENDIX D - SAFETY DATA SHEET

OZONE SOLUTIONS

SAFETY DATA SHEET FOR OZONE

FORMERLY MSDS

1. PRODUCT IDENTIFICATION

PRODUCT NAME: Ozone

COMMON NAME / SYNONYMS: Triatomic Oxygen, Trioxygen, O3

OZONE GENERATOR MANUFACTURER / SUPPLIER: Ozone Solutions
451 Black Forest Road / Hull, Iowa 51239
712.439.6880 / www.ozonesolutions.com / tinfo@ozonesolutions.com

PRODUCT USE: This SDS is limited to ozone produced in gaseous form on site by an ozone generator, in varying concentrations, in either air or aqueous solutions, for the purposes of odor abatement, oxidation of organic compounds or antimicrobial intervention, in a variety of applications.

2. HAZARD IDENTIFICATION

GHS CLASSIFICATIONS

PHYSICAL	HEALTH	ENVIRONMENTAL
Oxidizing Gas	Skin Irritation - Category 3 Eye Irritation - Category 2B Respiratory System Toxicity - Category 1 (Single & Repeated)	Severe

WHMIS CLASSIFICATIONS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM, CANADA): C, D1A, D2A, D2B, F
Source: CCOHS CHEMINFO Record Number 774

3. COMPOSITION

CHEMICAL NAME	Ozone
COMMON NAMES	Triatomic Oxygen, Trioxygen
CHEMICAL FORMULA	O_3
CAS REGISTRY NUMBER	10028-15-6

4. FIRST AID MEASURES

ROUTE OF ENTRY		SYMPTOMS	FIRST AID
Skin Contact	Yes	Irritation	Rinse with Water
Skin Absorption	No	NA	NA
Eye Contact	Yes	Irritation	Rinse with Water, Remove Contacts
Ingestion	No	NA	NA
Inhalation	Yes	Headache, Cough, Heavy Chest, Shortness of Breath	Remove to Fresh Air, Provide Oxygen Therapy as Needed

For severe cases, or if symptoms don't improve, seek medical help.

5. FIRE FIGHTING MEASURES

Ozone itself is not flammable. As a strong oxidant if may accelerate, even initiate, combustion or cause explosions. Use whatever extinguishing agents are indicated for the burning materials.

6. ACCIDENTAL RELEASE MEASURES

Turn off the ozone generator and ventilate the area. Evacuate until ozone levels subside to a safe level (<0.1 ppm).

7. HANDLING AND STORAGE

Ozone must be contained within ozone-resistant tubing and pipes from the generation point to the application point.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

OSHA PERMISSABLE EXPOSURE LIMIT	8 hour TWA 0.1 ppm
ANSI / ASTM	8 hour TWA 0.1 ppm, STEL 0.3 ppm
ACGIH	8 hour TWA 0.1 ppm, STEL 0.3 ppm
NIOSH	ELCV 0.1 ppm Light; 0.8 ppm Moderate; 0.5 ppm Heavy; Light, Moderate, Heavy Work TWA <=2 Hours, 0.2 ppm Immediately Dangerous to Life or Health 5.0 ppm

RESPIRATORY PROTECTION: Use full face self-contained breathing apparatus for entering areas with a high concentration of ozone.

ENGINEERING CONTROL: Use ozone destruct unit for off gassing of ozone.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Gas	pH	NA
MOLECULAR WEIGHT	48.0	Decomposition Temperature	NA
APPEARANCE	Clear at Low Concentration, Blue at Higher Concentration	Evaporation Rate	NA
ODOR	Distinct Pungent Odor	Flash Point	NA
ODOR THRESHOLD	0.02 to 0.05 ppm; Exposure Desensitizes	Auto-Ignition Temperature	NA
MELTING POINT	-193° C / -315° F	Relative Density	NA
BOILING POINT	-112° C / -169° F	Partition Coefficient	NA
VAPOR PRESSURE	> 1 atm	Flammability	NA
VAPOR DENSITY	1.6 (Air = 1)	Explosive Limits	NA
SOLUBILITY IN WATER	570 mg / L at 20° C 100% O3; 0.64 at 0° C	Viscosity	NA

10. STABILITY AND REACTIVITY

Ozone is highly unstable and highly reactive. Avoid contact with oxidizable substances. Ozone will readily react and spontaneously decompose under normal ambient temperatures.

11. TOXICOLOGY INFORMATION

ROUTES OF EXPOSURE	Inhalation, Eyes, Skin Exposure
EFFECTS OF ACUTE EXPOSURE	Discomfort; including headache, coughing, dry throat, shortness of breath, pulmonary edema; higher levels of exposure intensify symptoms. Possible irritation of skin and / or eyes.
EFFECTS OF CHRONIC EXPOSURE	Similar to Acute Exposure effects, with possible development of schronic breathing disorders, including asthma.
LC_{50}	Mice 12.6 ppm for 3 hrs / Hamsters 35.5 ppm for 3 hrs
IRRITANCY OF OZONE	Yes
SENSITIZATION TO OZONE	No
CARCINOGENICITY (NTP, IARC, OSHA)	No
REPRODUCTIVE TOXICITY, TERATOGENICITY, MUTAGENICITY	Not Proven
TOXICOLOGICALLY SYNERGISTIC PRODUCTS	Increased susceptibility to allergens, pathogens and irritants

12. ECOLOGICAL INFORMATION

The immediate surrounding area may be adversely affected by an ozone release, particularly plant life. Discharge of ozone in water solution may be harmful to aquatic life. Due to natural decomposition, bioaccumulation will not occur and the area affected will be limited.

13. DISPOSAL CONSIDERATIONS

Off-gassing of ozone should be through an ozone destruct unit which breaks ozone down to oxygen before release into the atmosphere.

14. TRANSPORT INFORMATION

NOT APPLICABLE, as ozone is unstable and either reacts or decomposes and must be generated at the location and time of use.

15. REGULATORY INFORMATION (Source: EPA List of Lists)

SARA TITLE III SECTION 302 EHS TPQ	100 lbs
SARA TITLE III SECTION 304 EHS RQ	100 lbs
SARA TITLE III SECTION 313	> 10,000 lbs used / year

16. OTHER INFORMATION

Half-life of ozone in water at 20° C = 20 minutes; in dry still air at 24° C = 25 hour; decreases significantly with increase in humidity, presence of contaminants, air movement and / or increase in temperature.

Preparer: Tim McConnel and Stacey Eben, Ozone Solutions 5/1/2012 (layout revision (2/13/2018)

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