Ozone Delivery System (ODS)

User Manual

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Safety Messages

Important safety messages are provided throughout this manual for the purpose of avoiding personal injury or instrument damage. Please read these messages carefully. Each safety message is associated with a safety alert symbol and is placed throughout this manual; the safety symbols are also located inside the instrument. It is imperative that you pay close attention to these messages, the descriptions of which are as follows:

WARNING: Electrical Shock Hazard

HAZARD: Strong oxidizer

GENERAL WARNING/CAUTION: Read the accompanying message for specific information.

CAUTION: Hot Surface Warning

Do Not Touch: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.

Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION

This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

For Technical Assistance regarding the use and maintenance of this instrument or any other Teledyne API product, contact Teledyne API's Technical Support Department:

Telephone: 800-324-5190

Email: api-techsupport@teledyne.com

Access any of the service options on our website at: http://www.teledyne-api.com/

Consignes de Sécurité

Des consignes de sécurité importantes sont fournies tout au long du présent manuel dans le but d'éviter des blessures corporelles ou d'endommager les instruments. Veuillez lire attentivement ces consignes. Chaque consigne de sécurité est représentée par un pictogramme d'alerte de sécurité; ces pictogrammes se retrouvent dans ce manuel et à l'intérieur des instruments. Les symboles correspondent aux consignes suivantes :

AVERTISSEMENT : Risque de choc électrique

DANGER : Oxydant puissant

AVERTISSEMENT GÉNÉRAL / MISE EN GARDE : Lire la consigne complémentaire pour des renseignements spécifiques

MISE EN GARDE : Surface chaude

Ne pas toucher : Toucher à certaines parties de l'instrument sans protection ou sans les outils appropriés pourrait entraîner des dommages aux pièces ou à l'instrument.

Pictogramme « technicien » : Toutes les opérations portant ce symbole doivent être effectuées uniquement par du personnel de maintenance qualifié.

Mise à la terre : Ce symbole à l'intérieur de l'instrument détermine le point central de la mise à la terre sécuritaire de l'instrument.

MISE EN GARDE

Cet instrument doit être utilisé aux fins décrites et de la manière décrite dans ce manuel. Si vous utilisez cet instrument d'une autre manière que celle pour laquelle il a été prévu, l'instrument pourrait se comporter de façon imprévisible et entraîner des conséquences dangereuses.

Contents

1 INTRODUCTION

The ozone delivery system (ODS) is designed to produce high concentrations of ozone for a wide range of applications. This manual provides guidelines and instructions for using the ODS.

1.1 GENERAL NOTES

TAPI reserves the right to make changes to the product covered in this manual to improve performance, reliability or manufacturability. Make sure that this manual is used with the original product it was shipped with.

Although every effort has been made to ensure accuracy of the information contained in this manual, TAPI assumes no responsibility for inadvertent errors. Contents of the manual are subject to change without notice.

TAPI assumes no responsibility for the use of any measuring schemes describes herein.

This product is not intended or recommended by TAPI for use in (a) medical therapy or physical therapy of any kind whether as a direct or adjunct part of such therapy, including, without limitation, life support (i.e., critical medical) applications or (b) any nuclear facility applications. Use of the TAPI product in connection with medical or like treatment cannot be reasonably expected to produce accurate monitoring of therapy or treatment and may cause failure of the life support device or significantly affect its safety or effectiveness. Use by any direct purchaser or after-market purchaser in such applications whether or not known to TAPI shall absolve TAPI of any responsibility or liability to such purchaser (s) or to any person (s) subjected to or affected by such use knowingly or unknowingly.

1.2 USING THIS MANUAL

This manual provides safety information as well as installation, general operation, maintenance and troubleshooting information for the Ozone Delivery System (ODS).

For all other information and instructions, refer to the applicable manuals and documents contained in the system binder, which contains supplemental manuals, diagrams, schematics, and Safety Data Sheets (SDS) for ozone and for the mercury arc lamp, and one CD with electronic copies of the printed documents.

CAUTION

It is imperative that all users read and understand the information and instructions provided in this manual and in the system binder for all components of the ODS.

2 SAFETY

Each operator should read this manual and know all safety considerations presented herein. Maintenance personnel should also know all safety considerations presented herein, as well as have more in-depth training.

2.1 SAFETY AND OPERATION TRAINING

As with all equipment, basic operation procedures should be reviewed before operating or maintaining the equipment.

2.1.1 OPERATOR TRAINING

It is strongly advised that before working with the system, the user be trained in:

- identification of the recognized hazards associated with each task
- identification of, and appropriate responses to, usual operating conditions, and any emergency situations, including the use of all system controls, and the Emergency Machine Off (EMO) button
- an explanation of the functions and limitations of all safeguards and their design characteristics
- an explanation for function testing or otherwise assuring the proper functioning of safeguarding devices
- general safety
- system safety
- system/subsystem descriptions
- system shutdown procedures

2.1.2 MAINTENANCE PERSONNEL TRAINING

Prior to attempting to install, operate, or perform maintenance on the system, you must receive training that includes:

- a review of all applicable industry safety procedures and standards
- a review of all system safety recommendations
- a thorough understanding each subsystem and its operation
- a detailed explanation of the specific tasks and responsibilities of each person involved in the use of the ozone generator system
- the person or persons (by name, location and phone number – Section 2.1.3) to contact when the actions required are beyond the training and responsibility of the person being trained
- identification of the recognized hazards associated with each task
- identification of, and appropriate responses to, usual operating conditions, and any emergency
- situations, including the use of all system controls, and any EMO buttons
- an explanation of the functions and limitations of all safeguards and their design characteristics
- an explanation for function testing or otherwise assuring the proper functioning of safeguarding devices

2.1.3 MAINTENANCE ASSISTANCE CONTACTS

Fill in Names/Locations/Phone Numbers of those responsible for assisting:

_____

_____

_____

_____

_____

2.1.4 MAINTENANCE REVIEW

Maintenance personnel should review system documentation and know safety and system startup/shutdown procedures. Topics of focus would include:

- general safety
- system safety
- system/subsystem review
- system startup
- system interlock testing
- system shutdown
- lockout/tagout procedures
- basic maintenance procedures described in this manual and accompanying documentation

Such items are addressed in this manual and its related documents to support experienced maintenance personnel in safely and efficiently performing each task.

2.2 GENERAL SAFETY GUIDELINES

CAUTION

- **Always follow established industrial safety practices when operating any production equipment.**
- **Safety is designed into every TAPI system. When followed, these minimum guidelines provide an acceptable level of safety for operating and maintaining your system. They are not, however, a substitute for determining your own internal safety procedures.**
- **Use of controls, adjustments, or procedures other than those specified in this manual without consulting a competent safety professional may result in exposure to potential hazards. Always follow established industrial safety practices when operating production equipment.**
- **Failure to comply with the safety precautions or warnings indicated in this manual violates the safety standards that form a part of the intended use of the ozone generating equipment. TAPI assumes no liability for the user's failure to comply with these requirements.**

2.2.1 UNSAFE ACTS

- NEVER let elastomer seals such as Viton® or Buna® N come into contact with ozone.
- NEVER begin operation of the system until the proper process equipment has been linked to the System, and has been signed-off and is ready for processing and receiving inputs from this system.
- NEVER defeat a safety interlock unless you are certified to perform the procedure and have been specifically directed to defeat the interlock.
- NEVER open a system panel when electrical power is turned on to the system.
- NEVER operate or service this system without a thorough knowledge of the dangers involved and the precautions to be followed for safe and efficient operation.
- NEVER disregard instructions to lockout/tagout the system.
- NEVER permit unauthorized or untrained personnel to access, use, or perform maintenance on the system.
- NEVER STAND IN WATER OR ON A WET SURFACE WHILE OPERATING ANY ELECTRICALLY POWERED EQUIPMENT.
- NEVER remove a warning label from the equipment.
- NEVER operate damaged or leaking equipment.
- NEVER allow any foreign material to enter the ozone generator.
- NEVER substitute any feedstock gases not specified in this manual without explicit permission of TAPI.

2.2.2 RECOMMENDED PRACTICES

- Connect all input gas and electrical lines according to the manufacturer specifications or best commercial practice.
- Always check the fittings of all ozone, oxygen, compressed dry air and water lines before operating.
- Use the “Buddy System”: ALWAYS perform maintenance procedures in teams of two or more people to monitor the surrounding systems, the maintenance environment, and your actions and to ensure all documentation and safety steps are followed.
- ALWAYS observe all warning labels.
- ALWAYS avoid all unsafe acts. See all safety guidelines, this section.
- Whenever possible, make sure that both gases and power are turned OFF at the source prior to beginning any maintenance task.

2.2.3 ASSISTANCE

Always work in teams of two or more when performing any tasks that require the removal of system panels. Always seek additional help when:

- You are instructed by any procedure.
- You see an emergency or dangerous situation.
- You are not trained or qualified/certified to perform a task.
- You feel uncomfortable performing a task.
- You need assistance lifting heavy or awkward panels or equipment. ALWAYS seek help when lifting any item that weighs more than 40 lbs.

2.3 REQUIRED AND RECOMMENDED SAFETY ITEMS

2.3.1 SAFETY DATA SHEETS

You must make sure that Safety Data Sheets (SDS) covering all hazardous material used in or for the system are easily available for review in the immediate vicinity of the equipment. The SDS for each hazardous chemical should be consulted in case of exposure.

TAPI provides SDSs covering those chemical substances which are inherent in, or shipped with this equipment, and can be found within the system documentation provided; these include:

- Ozone
- Mercury Arc Lamp

For those gas or chemical substances that are used with the system or for processing, maintenance, or service of equipment, but are not provided in or with the equipment, you must obtain the SDSs from their suppliers. These can include but are not limited to:

- Oxygen
- Nitrogen

2.3.2 SAFETY EQUIPMENT

All safety equipment should be clearly marked, easily accessible, and located in the immediate vicinity of the equipment. We recommend that you have the following additional safety equipment readily available to you:

- First aid kit
- Fire protection equipment (proper fire extinguisher, etc.)
- Protective clothing, including glasses rated for UV protection as noted in the Personal Protective Equipment subsection below.
- Also make sure that all personnel are both familiar with and trained in the use and handling of the safety equipment in your area.

NOTE: Approval of these items for use at the customer facility is not the responsibility of TAPI. The procurement, installation, operation, and maintenance of all safety equipment is the sole responsibility of the customer.

The safety equipment described in this guide is not intended to provide protection for all hazards. Protection of the customer's property, employees, and guests is the sole responsibility of the customer.

2.3.3 PERSONAL PROTECTIVE EQUIPMENT

The following personal protective equipment is required for the safe maintenance of this equipment:

- Safety goggles with permanent side shields meeting ANSI Z87.1 requirements.
- Safety goggles with UV protection rated for up to 40 µW/cm^2.

2.4 EMERGENCIES

This section presents guidelines for emergency situations and first aid for toxic exposure. While evacuations are always an emergency, not all emergencies require evacuation.

CAUTION – FACILITIY EMERGENCY PROCEDURES

This manual provides basic emergency guidelines; refer to your facility policies for site-specific emergency procedures.

2.4.1 EVACUATIONS

In case of an emergency evacuation:

- EXIT the building through the nearest exit and report to your assigned evacuation area.
- DO NOT stop to turn off any machines.
- DO NOT move any carts or equipment during evacuation.
- Obey all commands from the emergency response team.
- Return to the building ONLY AFTER being instructed to do so by the emergency response team.

2.4.2 DISABLING POWER TO THE SYSTEM

WARNING

An EMO button removes power from the system from the main circuit breaker to the system subassemblies. LIVE feed voltage remains in the main electrical box. Use extreme caution at all times and follow all safety instructions when working on or near the system.

Even after you have pressed an EMO button, disabling power to the system, there is still AC power to the system at the input side of the main power contactor. High voltage power to the system is turned off only when the main power remote feed to the system is turned off.

2.4.2.1 EMERGENCY OFF (EMO) BUTTON

1. Press the EMO button to immediately turn OFF all system components.
2. Notify applicable parties at minimum.
3. Follow your facility's procedures for emergency shutdown.
4. If safety permits follow additional procedures include:
   - turning off the Main breaker at rear of unit
   - shutting off gas feed lines and cooling water lines

2.4.2.2 EMO BUTTON RESET/RECOVERY PROCEDURE

1. Determine the cause of the EMO shutdown and correct the problem.
2. Verify that no hazardous conditions exist and that the system can be safely restarted.
3. Turn the EMO button to the right to reset the button.
4. Follow the system start-up procedures in the System Startup section.

2.4.3 STANDARD FIRST AID FOR TOXIC EXPOSURE

If exposure to a toxic substance occurs:

1. Protect yourself from the hazard by wearing appropriate protection equipment before assisting others.
2. Contact an emergency assistance partner, group or agency to assist you.
3. Remove the victim from the immediate area and place him/her in an uncontaminated area.
4. If the victim has stopped breathing, administer artificial respiration.
5. Administer oxygen if required.
6. Contact the local poison control center or other emergency medical assistance (identify, if possible, the chemical that the person was exposed to).
7. Keep the victim calm and warm until medical assistance arrives.
8. Describe the chemical or gas that the person was exposed to, to the attending physician or medical personnel.

2.4.4 EMERGENCY TELEPHONE CONTACTS

Make sure that you have a list of emergency telephone numbers for your locality displayed outside of the immediate area of the equipment. The list should contain emergency numbers for the following:

Contact	Telephone Number(s)
Poison Control Center	
Ambulance	
Hospital	
Fire Department	
Internal Safety Personnel Contact	

NOTE: Since your local poison control center is more familiar with the toxic substances used in the semiconductor industry, this should be your primary contact for these types of situations prior to a local physician or hospital.

2.5 SYSTEM SAFETY GUIDELINES

The following important messages are provided for personal safety and for protection of equipment:

WARNING – Electrical Shock Hazard

When performing any maintenance to the unit, make sure all AC power is disconnected from the unit.

HAZARD – Strong Oxidizer

- **Ozone (O_3) is a toxic gas. High concentrations of ozone are dangerous and harmful to humans. Take reasonable steps to avoid exposure. The current maximum 8-hour exposure limit for ozone is 0.1 PPM (according to U.S. OSHA).**
- **Install appropriate safety monitoring equipment wherever high concentrations of ozone are used. (TAPI manufactures several ozone monitors for workplace safety applications).**
- **Never attempt to open ozone catalyst canisters (if supplied). The contents of the canisters can be hazardous if not handled properly.**

CAUTION – UV EXPOSURE

The ozone monitor contains an ultraviolet (UV) lamp. Never remove the lamp from its housing while the unit is powered on. Eye exposure to UV light is extremely dangerous.

CAUTION – Hot Surface Warning

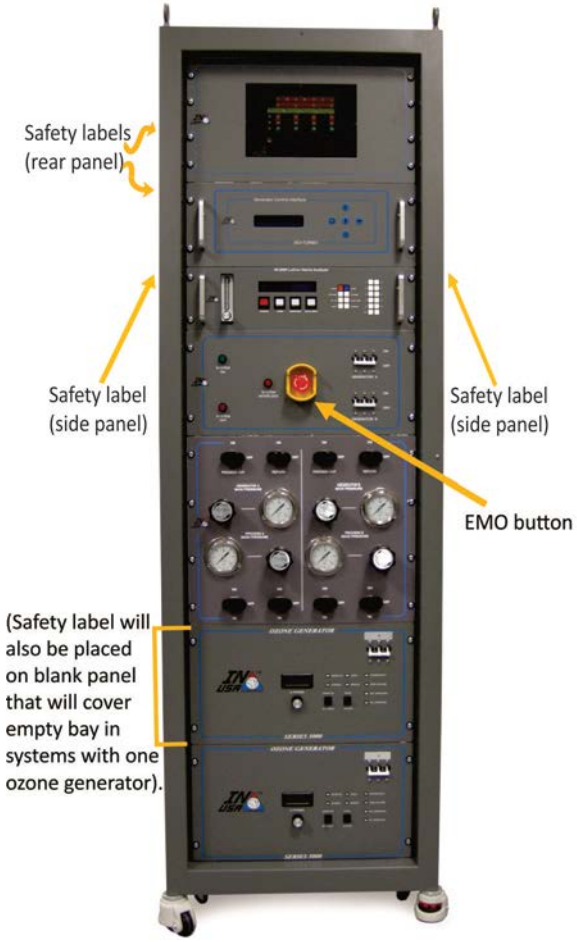
Certain components may be hot to the touch. Please allow proper cooling time before working with these components.

CAUTION

- **Materials in contact with high concentrations of ozone should be suitable for such use. Stainless Steel (316L), Teflon®, Chemraz® and Kynar® are recommended.**
- **Use only *TAPI* recommended spare parts. Substitution parts could result in damage to the equipment, may create hazardous conditions and will void the warranty.**
- **Use this equipment as recommended in this manual. Use of the equipment in ways other than specified by TAPI may create hazardous conditions.**
- **Do not subject the unit to extreme physical or thermal shock. Use care in handling the unit and any of its components.**

2.6 SYSTEM SAFETY LABELS AND LOCATIONS

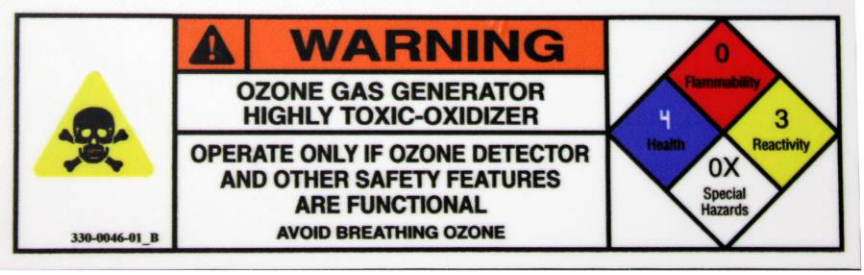
Safety-warning labels are intended to warn the users about the toxicity and danger of ozone gas and electrical dangers. They are applied where appropriate on the outside covers of components and panels.



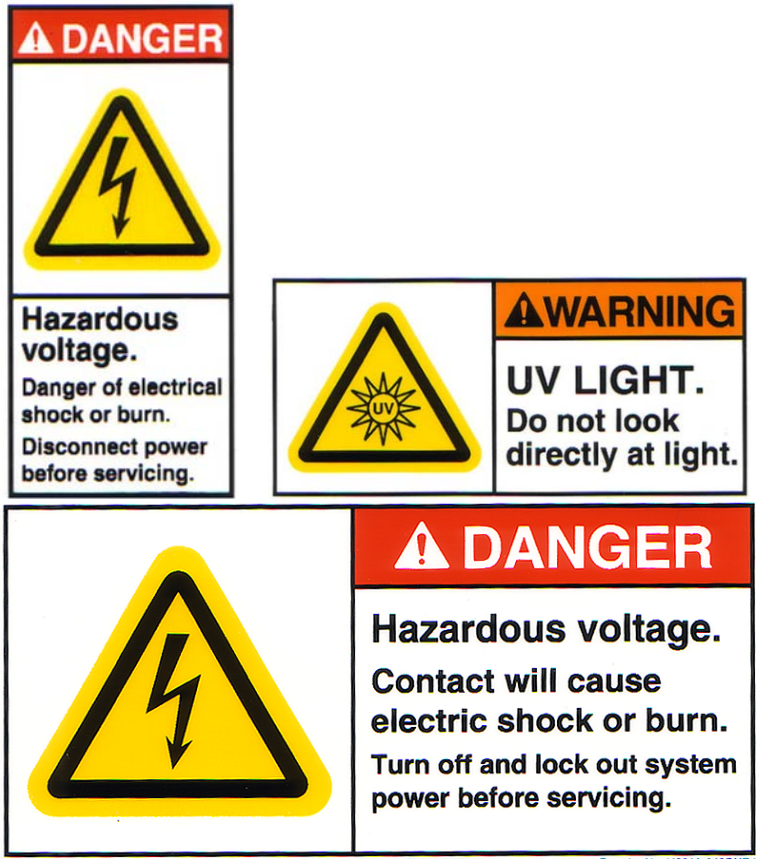
FRONT VIEW

Typical Location of Labels
(Actual system may vary from that shown).

Exterior and interior System labels include:



1 Ozone Warning – sides of system and on ozone generator(s) front panel(s).



2.7 HIGH-VOLTAGE HAZARDS

WARNING – ELECTRICAL SHOCK HAZARD

The ODS uses high voltages that can cause injury or death by electrical shock. Personnel working with or near high voltage equipment should be thoroughly familiar with emergency equipment, procedures, and resuscitation methods as well as electrical safety work practices and procedures for the control of hazardous energies.

Although safety interlocks protect the operator from hazard areas during normal operation, regard all safety precautions and carefully follow all procedures and safety instructions.

2.7.1 HIGH-VOLTAGE HAZARD LOCATIONS

High voltages are used in the process of generating ozone; however, all circuits of the generator are either covered or isolated. The generator cannot be opened without tools. The ozone generator power connection is also covered. The ozone generator does not need to be opened for any routine maintenance. In the event that the unit needs to be serviced, all work should be completed by trained/certified and authorized personnel only.

WARNING – ELECTRICAL SHOCK HAZARD

Prior to working on the ozone generator, remove electrical power by disconnecting the electrical power connector. Wait at least 10 minutes before touching any part inside the generator after de-energizing! Electrical charge may be stored in capacitors.

2.7.2 HIGH-VOLTAGE HAZARDS DESCRIPTIONS

High-voltage Hazard	Location	Voltage	Description/Safety Interlocks
Main power distribution panel	Inside the power distribution box	Voltage can vary among instruments: see instrument tag for specific voltage configuration	Lockout on circuit breaker
Power distribution panel	Inside cabinet		Power-cord plug-in component
Controller			
Ozone Generator			

2.7.3 ELECTRICAL WORK TYPE

All maintenance procedures should be performed with the system fully de-energized. In accordance with the *Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment* (SEMI S2-0703aE), section 13, each maintenance procedure has been assigned an electrical work type code. The codes are from 1 to 4 with 4 being the most hazardous task. See *Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment* (SEMI S2-0703aE) for additional information.

Electrical Work Type	Energy Magnitude	Condition	Safety Buddy Required
1	0 Volt amps	Fully de-energized and locked and tagged out.	No
2	Energized with covers in place	Energized, but live circuits are covered or insulated to prevent accidental shock. Type 2 work includes tasks where the energized circuits are or can be measured by placing probes through suitable openings in the covers or insulators.	No
3	<240 Volt amps and <60 Volts	Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are no greater than 30 Vrms, 42.4V peak, 60 VDC or 240 VA in dry locations.*	No
4	>240 Volt amps and >60 Volts	Energized and live circuits are exposed and acci-dental contact is possible at greater than 30 Vrms, 42.4V peak, 60 VDC or 240 VA in dry locations.* Potential exposure to radio-frequency currents.	Qualified Energized Electrical Work Buddy

* A dry location can be considered to be one that is not normally subject to dampness or wetness.

2.7.4 OZONE GENERATOR ELECTRICAL HAZARDS

The ozone generator produces high voltages inside its housing. An ozone generator cannot be opened without tools. Its electrical connections are also covered. The ozone generator should never be opened except by service technicians who are specifically trained/certified and authorized to serve the generators.

WARNING – ELECTRICAL HAZARD

The ODS uses high voltages that can cause injury or death by electrical shock. Wait at least 10 minutes before you touch any part inside the generator after de-energizing! Electrical charge may be stored in capacitors.

2.8 MECHANICAL HAZARDS

CAUTION – CRUSH OR PINCH HAZARD

Although there are no moving parts in the system that can be a crush or pinch hazard, moving/relocating the system or removing panels or other system components can cause such risk.

QUALIFIED TECHNICIAN

You MUST be trained on the use the system to prior to attempting to install, operate or perform maintenance on the system. (See training requirements outlined in Section 2.1.2**).**

2.9 CHEMICAL HAZARDS

This section provides information regarding the chemical risks associated with an ODS.

CAUTION

Safety Data Sheets (SDS) are required for immediate availability near the equipment. Section 2.3.1 **has information on SDSs associated with the ODS.**

2.9.1 REQUIRED PROCESS CHEMICALS

Chemical	Location
Nitrogen (N_2)	Facility supplied, rear of system
Oxygen (O_2)	Facility supplied, rear of system
Ozone (O_3)	Created by the system.
Mercury	Trace amounts in the system UV lamps.

2.9.2 OZONE SAFETY

Ozone has the potential to cause damage or death.

HAZARD: STRONG OXIDIZER and POTENTIAL FOR EXPLOSION

- **Ozone has the potential to injure humans and damage the equipment and facilities by corrosion or explosion.**
- **Understand and implement the OSHA and locally required safety laws involving the generation of ozone gas using high-voltages. Failure to do so may lead to personnel injury. Do not use this system without an ozone leak monitor. TAPI assumes no liability for the user's failure to comply with these requirements. Ensure that every action is done under attention of all safety regulations!**
- **Observe the necessary safety measure when working with high ozone concentrations. (Refer to the website for your governing agency for specifics).**
- **Ozone has a readily identifiable odor recognizable in extremely minute quantities. Observe the safety thresholds for ozone concentration. Concentrations above 0.1 ppm can cause headaches, eye irritation, respiratory problems, dizziness, and nausea. At much higher concentrations it can cause death.**
- **An alternative method to locate small leaks on tubing and fittings that contain ozone is the use of commercially available potassium iodide starch paper. When moistened with distilled water, it indicates the presence of gaseous oxidizers.**
- **Never use materials which catalyze the decay of ozone within the gas lines. DO NOT use silver plated gaskets for VCR fittings since they catalyze the decay of ozone severely. Use non-plated stainless steel gaskets only.**

TAPI has available a low concentration ozone monitor, which can be used to monitor for the presence of Ozone leaks. The ozone monitor is typically connected to the Ozone Delivery System (ODS) to stop all ozone generation and close the outlet valve if an ozone leak is detected. Consult TAPI for recommendations for your installation location.

2.9.3 OXYGEN SAFETY

CAUTION - FIRE/EXPLOSION HAZARD

Non-flammable materials may become flammable in the presence of high oxygen and/or ozone concentrations.

The feed gas for the ozone generator is oxygen gas spiked with traces of nitrogen. If the exhausting of the cabinet fails, an accumulation of oxygen may occur if there is a leak in the oxygen tubing. It is recommended to install a flow-limiting device in your facility oxygen tubing; however, a small leak may not trigger the flow-limiting device and oxygen can still accumulate.

2.9.4 NITROGEN SAFETY

CAUTION - INHALATION HAZARD

Inhalation of nitrogen in high concentrations causes suffocation.

If there is a leak in Nitrogen tubing, an accumulation of Nitrogen may occur may occur near or adjacent to the leak location or at a remote area where the gas is allowed to flow.

2.9.5 EXHAUST SAFETY

CAUTION – INHALATION HAZARD

Inhalation of exhaust gases can cause serious injury or suffocation.

All ozone generating equipment should be housed in an area with proper exhaust and with proper sweep of the installation location/cabinet; an ozone leak detector should be installed to detect any leaks. A flow sensor with interlock on an exhaust port should be installed to ensure that insufficient exhaust will trip the exhaust interlock and turn off the ozone generators.

2.9.6 CHEMICAL RESIDUES

CAUTION - CHEMICAL EXPOSURE

Ensure that the system is properly purged and shutdown prior to performing maintenance. Avoid direct contact with any residues.

Trace amounts of mercury are contained in the UV bulbs. Protective glasses and gloves, at a minimum, should be worn when replacing UV bulbs.

2.10 OTHER HAZARDS

2.10.1 ULTRAVIOLET (UV) LIGHT HAZARDS

CAUTION - UV HAZARD

DO NOT look directly at a UV light as permanent eye damage may result. Use appropriate protection for eyes and for skin.

- UV lamp is located inside the Ozone Safety Monitor.
- UV lamp is located inside the In-Line Ozone Sensor.
- The' UV lamp frequency is 254 nm. The power is 4 W
- Lamp life is typically 12-24 months.

The lamps are shielded by multiple cabinet and component covers and present no exposure hazards to the operator during system operation. Follow lamp replacement instructions to avoid exposure to any UV light during system maintenance.

2.10.2 ERGONOMIC HEIGHT HAZARDS

CAUTION –TRIP or FALL HAZARD

Never install the system components in a location where it is difficult or dangerous to reach.

2.10.3 NOISE HAZARDS

The system emits less than 50db and presents no noise hazard.

2.11 LOCKOUT/TAGOUT PROCEDURES

WARNING - RISK OF SERIOUS INJURY or DEATH

If you do not lockout and tagout the system, you risk serious injury or death from contact with or exposure to hazardous energies such as electricity, hazardous materials/gases, and moving mechanisms.

QUALIFIED TECHNICIAN REQUIRED

Perform work on the equipment in a safe manner. Only complete work on the system if you are trained and authorized, and if you have applied your own lockout/tagout device.

A lockout/tagout program helps to prevent injury from unexpected energization, start-up, or release of stored energy from the equipment during maintenance or service. A lockout/tagout program controls hazardous energies (electrical, mechanical, chemical, physical, etc.). The lockout/tagout procedure isolates the energies from the service area and locks the isolation device to ensure that the energy is not reapplied to the equipment during maintenance and service.

You must use lockout/tagout procedures (or an alternative which provides effective protection) when:

- a safety device is bypassed
- any part of your body is close to any point of operation or associated danger zone of the equipment.

You are responsible for your own safety. If you are authorized to perform maintenance, you must apply your own personal locks and tags at required energy isolation points prior to working on the equipment. You must not share locks and tags. If more than one person is performing maintenance on the equipment, each person's lock and tag must be placed at each energy isolation device. If necessary, use a lock-extender clamp which can typically support up to six individual locks.

You are not required to lockout/tagout cord-and-plug connected equipment provided that the plug remains under your control at all times.

Electrical Lockout/Tagout Sites

Circuit Breaker	Location	Previous Lockout
Main	Power entry module on rear panel	Facilities

Chemical (Gas) Lockout/Tagout Sites

Gas	Location	Previous Lockout
Nitrogen	Rear of system	Facilities
Oxygen	Rear of system	Facilities

Except for the locations, the lockout/tagout procedures are the same for both gas and electrical:

1. Notify Affected Personnel

   Before starting the maintenance procedures, notify anyone who may be affected.

2. Prepare for Shutdown

   Before shutting down the equipment, determine the energies present, their hazards, and the means for controlling them. Also, collect the following:

   - Any written maintenance procedures
   - Proper maintenance tools
   - Appropriate locks, tags, and other energy isolating devices

3. Apply the Lockout/Tagout

   If you are working on the equipment, apply your own lock and tag to each energy isolating device. Always make sure lockout devices are tagged with the name(s) of the individual(s) who is(are) applying the lock and/or performing any of the tasks, as well as the reason for the maintenance procedure. Apply the lockout so that the energy isolating devices are held securely in the “SAFE” or “OFF” position.

4. Release Stored Energy

   Dissipate any hazardous energy which remains in the equipment after you have applied the isolating device and the locks and/or tags. Make sure you are authorized to release the energy and you release it in a safe manner. Gas hazardous energies can include pressure, suffocation potential, poison potential, etc. Ensure that hazardous energies do not re-accumulate.

5. Verify the Isolation

   Before beginning work on a locked-out system equipment, verify that the equipment is in a zero energy state by attempting to turn ON the controls designed for that purpose. You should also verify the isolation with an appropriate meter. After verifying that the lockout/tagout is working, return the system to the “OFF” or “NEUTRAL” state.

6. Perform the Task

7. Inspect the Equipment

   Following completion of the work, inspect the equipment to ensure that is has been

properly reassembled and is fit for operation. All guards, interlocks, and other safety devices must be in place. Verify that all tools, used parts, cleaners, and wipes have been removed from the equipment.

8. Notify Affected Personnel

   Clear the area of all personnel before re-starting the equipment.

   Inform anyone affected that the locks and/or tags are about to be removed from the equipment.

9. Remove your lock(s) and tag(s) Remove the locks and/or tags only if:

   - You are authorized to remove them
   - You applied the locks and tags
   - Energy isolating devices are ready to be restarted

10. Re-start the Equipment

    Monitor the start-up of the equipment for malfunctions from an appropriate, safe position. If the system malfunctions, you must shut down the equipment and repeat the lockout/tagout process.

2.12 SAFETY INTERLOCKS

The system is equipped with interlocks for your protection and should not be defeated without a qualified technician first resolving the cause. Safety interlocks typically include:

- EMO button interlocks for operator protection
- ozone leak detection
- cooling water flow
- panel/covers/equipment access

TAPI highly recommends using one of our ozone monitors to detect leaks, as well as our Model CAT-O3 Ozone Destruct Unit.

More about system interlocks is presented in the System Overview section of this manual.

3 SYSTEM OVERVIEW

CAUTION

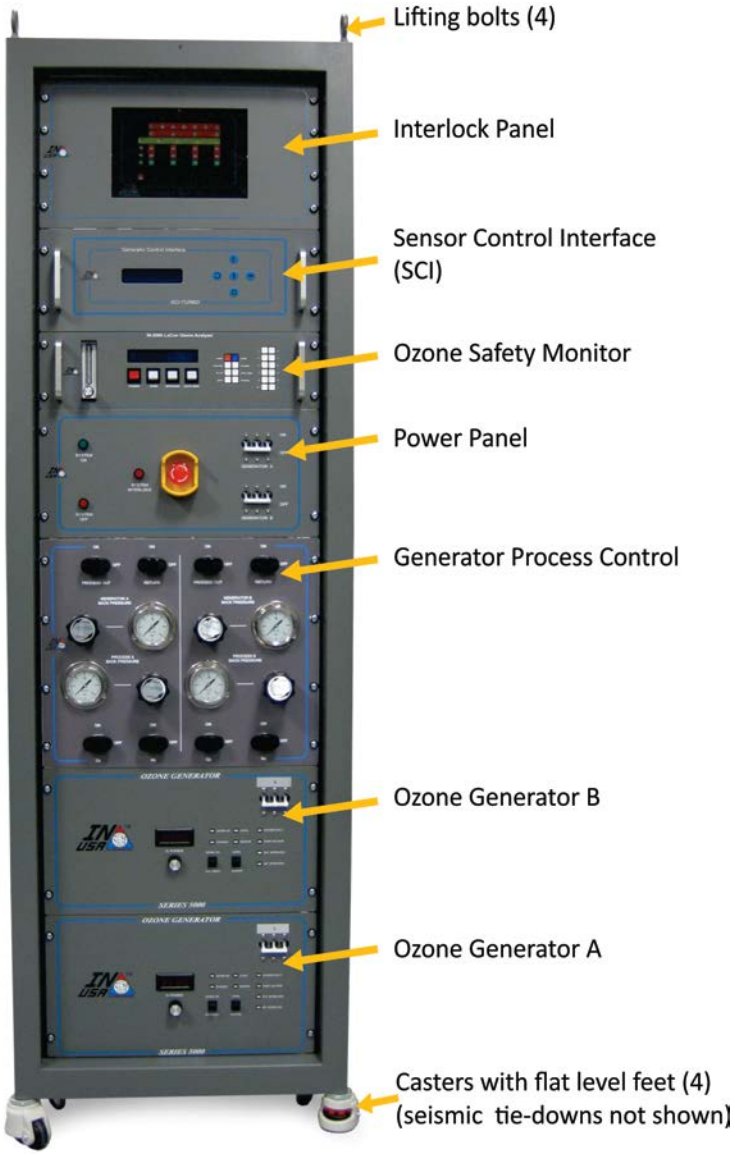
Ensure that you are thoroughly familiar wiith all contents of this manual before applying power, oxygen, or nitrogen to the ODS.

CAUTION

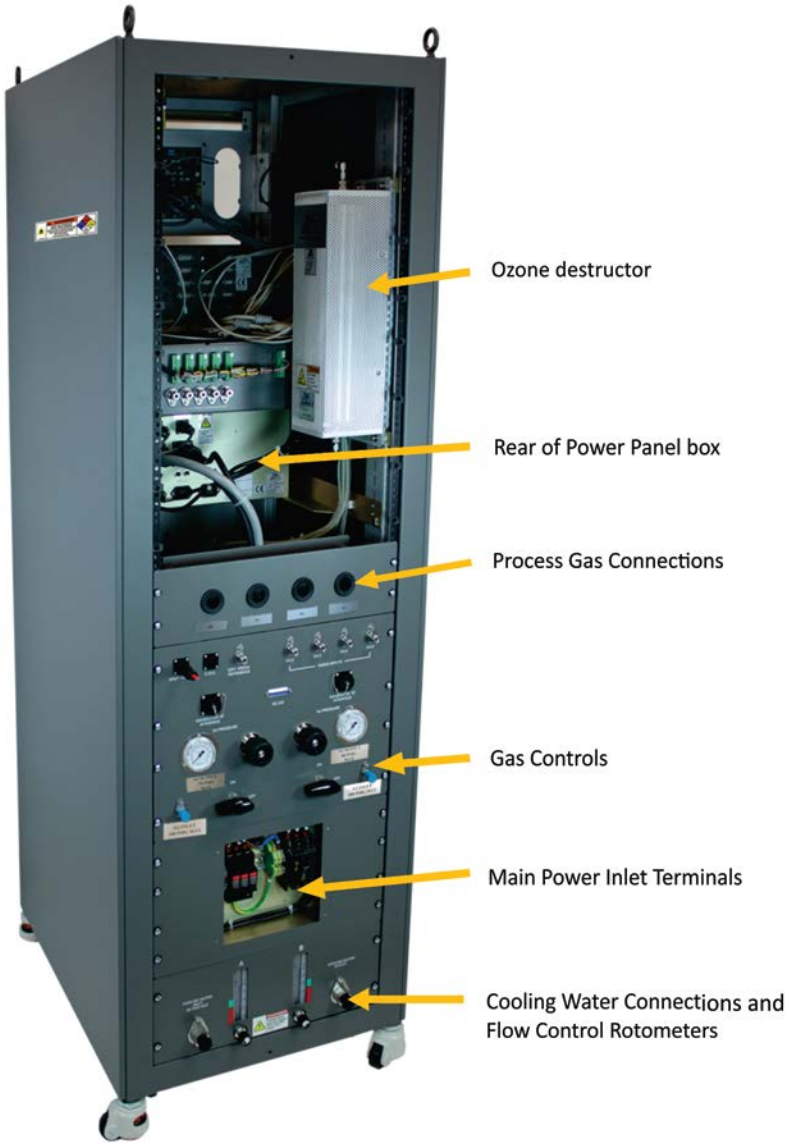
The ODS is shipped with the ozone output ports capped-off. Remove these caps and connect the system to appropriate plumbing before running the system.

3.1 SYSTEM GENERAL DESCRIPTION

The Ozone Delivery System converts oxygen to ozone and delivers the ozone at a controlled flow rate as programmed. The system contains two ozone generators, an ozone flow controller, a controller and gas, facility, and power panel to support the production and precision delivery of ozone. Main components are identified in the following figures:



Representative Front View
(actual configuration varies with system configuration)



Representative Rear View
(actual configuration varies with system configuration)

The following table provides a brief description of the major and other components of the system.

Component	Function
Generator(s)	Uses high voltage energy to convert oxygen to ozone.
Controller	Used to manage process gas flow rate and concentration.
Process Ozone Sensor	Measures process ozone.
Safety Ozone Monitor	Checks for ozone leaks.

Component	Function
Ozone Destruct	Destroys excess ozone.
Power Panel (Power Distribution Module)	Provides power for components. Contains the EMO button.
Interlock Board	Provides alarm signals for the ozone safety monitor channels, loss of pressure or of vacuum, and water leaks.
Mass Flow Controllers	(MFC) Controls user-set flow rates of nitrogen (N_2) and oxygen (O_2); typically, N_2 MFC is slaved to O_2 MFC.
EV Valves	One per ozone generator, “on” state allows process flow, and “off” state stops the flow.

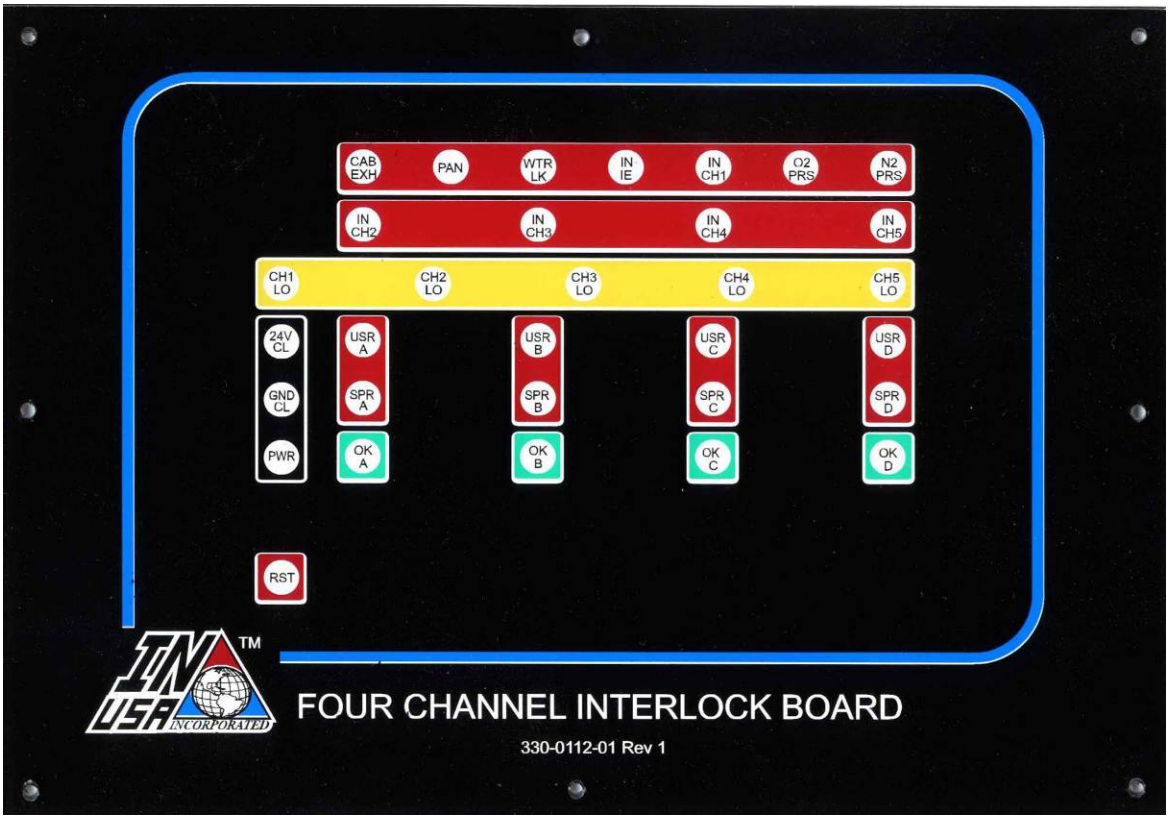
3.2 GAS FLOW AND OZONE CONCENTRATION

The Ozone Delivery System uses proprietary ozone generators to convert oxygen to ozone. The ozone flows through a TAPI gas phase full-flow ozone sensor which provides ozone concentration information to the Sensor Control Interface (SCI). The SCI then sends and appropriate control signal to the ozone generator. The ozone concentration can be programmed via a remote interface or locally via the SCI.

3.3 SYSTEM INTERLOCKS

Refer to the Interlock Board documentation included in the System Binder for a description of the alarms, their triggers, and their functions, and operation of the Interlock Board.

Refer to Section 7.2 in the Troubleshooting section of this manual for alarm-clearing instructions.



Mask over the Four Channel Interlock Board

System LED Illuminated	System Reaction
RED	Ozone generators will be powered off should any red alarm become active.
YELLOW	A warning (low alarm) was received from the ozone safety monitor. The generators will NOT shut down.
GREEN	For each generator: No alarms. Generator can be powered ON.
Other	User and Spare alarms, if used, will shut down only the associated generator.

3.4 SYSTEM INTERFACE AND SPECIFICATIONS

Refer to the Facilities Interface and Specifications document in the system binder for details.

Item	Requirements	Verified
Environmental	• The system should not be installed in the vicinity of equipment that produces continuous vibrations such as large pumps/compressors.	
	• The system should not be installed near blowers, HVAC ducts and other sources of heat and/or temperature fluctuations.	
	• Indoor Use Only • Temperature 5-40 degrees Celsius • Altitude 2000 m • Non-condensing humidity is required: o Humidity 80 % for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C • Mains Supply Tolerance ±10% • Overvoltage Category II • Pollution Degree 2	
Dimensions **Weight** **Electrical** **Oxygen Supply** **Nitrogen Supply** **Ozone Generator Output** **Cooling Water** **Cabinet Exhaust**	Provided in the Facilities Interface and Specifications document.	

4 INSTALLING THE SYSTEM

This section first addresses planning considerations and then installation and connections.

4.1 SITE PLANNING AND SETUP

This section provides system dimensions for planning purposes.

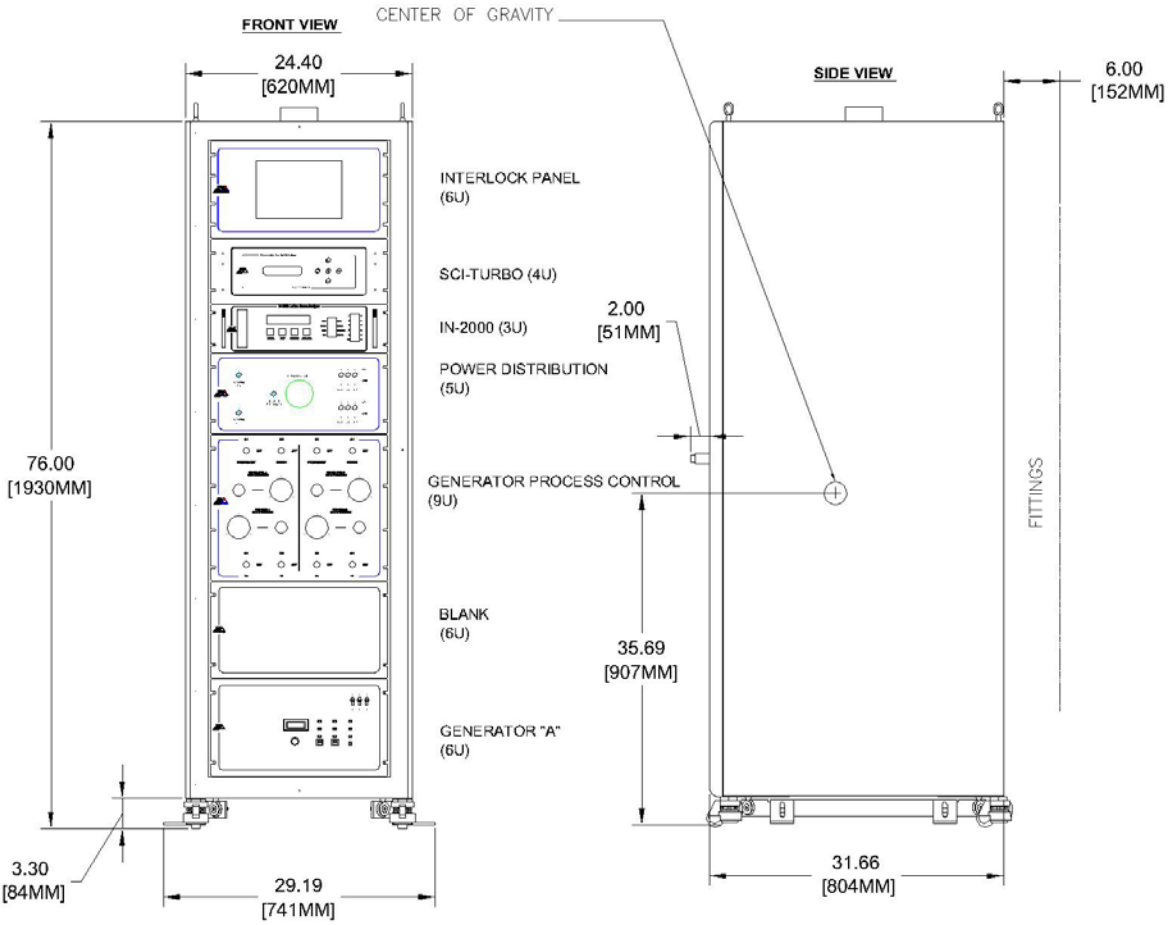
4.1.1 Door and Hallway Widths

Minimum doorway and hallway height clearance: 80” [203 cm]

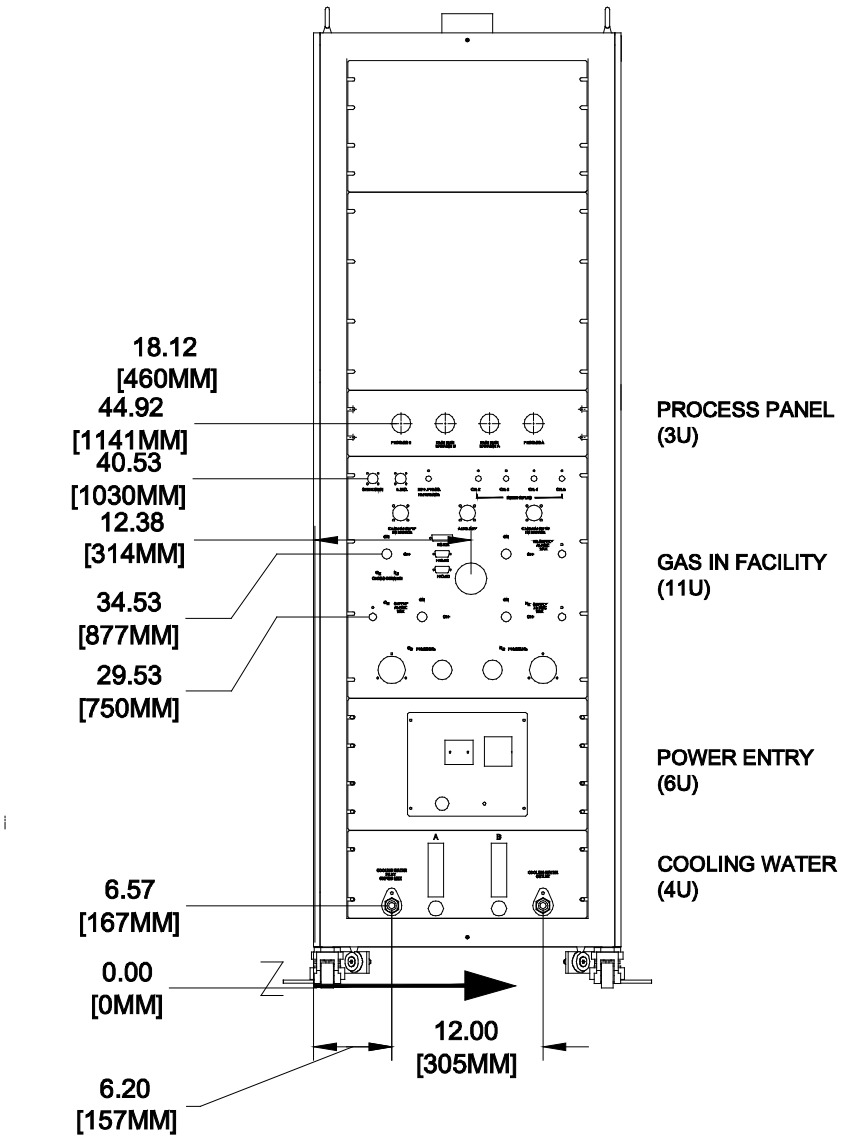
Minimum doorway and hallway width clearance: 30” [76 cm]

4.1.2 System Dimensions

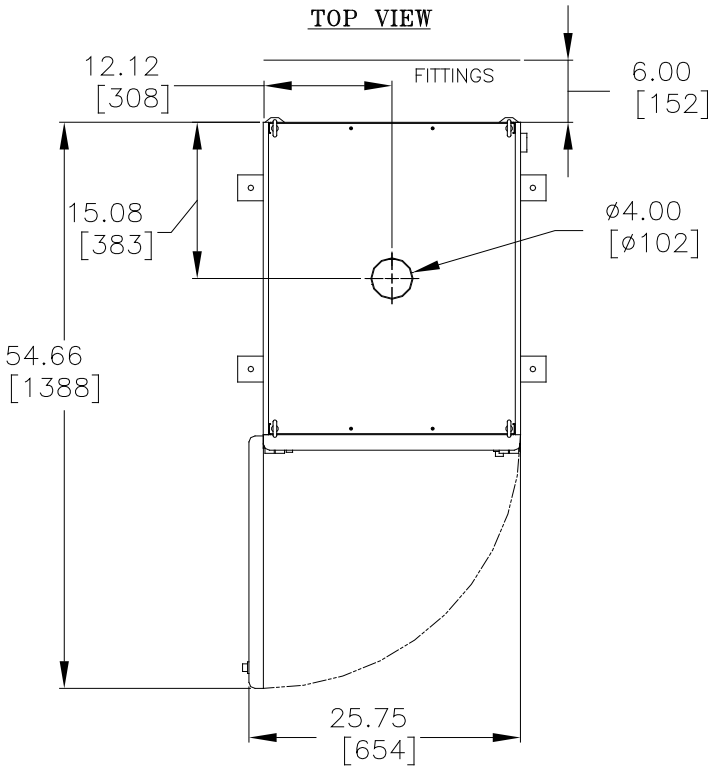
Sample system overall dimensions are shown below. Please refer to your system Installation Drawing for specific details.



Sample System Dimensions, Front/Side Views (blank panel covers empty bay in single ozone generator systems)

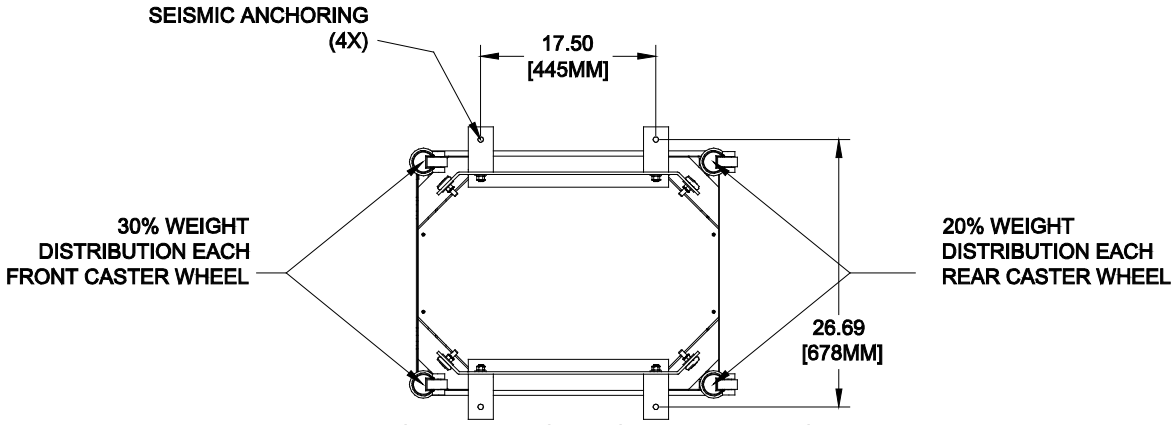


Sample System Dimensions, Rear View



TOP VIEW
FRONT

Sample System Dimensions – Top View



Sample System Dimensions – Bottom View

NOTE: The system is equipped with heavy-duty casters to ease installation. DO NOT remove the casters.

4.1.3 Recommended Service Clearances

It is important to provide enough space surrounding the system to perform any required service procedures.

- Front clearance: minimum of 24” (61 cm)
- Rear clearance: minimum of 32” (81 cm)
- Side clearance: not required for maintenance or service
- Clearance space can be shared space with other equipment.
- Refer to the installation drawing for specific system dimensions.

4.1.4 Site Preparation Prior to System Arrival

1. Use the installation drawing as a reference and mark the outline of the equipment on the floor. The system has four heavy-duty casters. Check installation drawing for load conditions and locations. Strengthen the floor where necessary.
    - Total system weight is 225 lbs for a single generator system, 300 lbs for two generator systems.

2. Check that the floor can bear the load at the appropriate locations for the casters and for the seismic tie-downs. Strengthen as necessary.
    - Two tie-down brackets are required: one for each side of the system. The brackets include holes for 1/2” diameter anchors in four places, with vertical reaction of 240 lbs, and side load of 130 lbs for each anchor.

3. Verify that all system facilities are installed:
    - Nitrogen feeds and shutoff valves
    - Oxygen feeds and shutoff valves
    - Water Leak Sensor and Water Solenoid are internal. A user-installed water isolation valve should be installed on the inlet water port.
    - Main power feed and shutoff panel
    - Ozone leak detectors in system exhaust and in desired protection areas

4.1.5 Utilities Summary

Refer to Facilities Interface and Specifications document in the system binder for:

- Gas feed and outputs information.
- Water connections
- Exhaust connections

4.2 RECEIVING AND PLACING THE SYSTEM

4.2.1 MOVING THE SYSTEM

CAUTION – CRUSH OR PINCH HAZARD

The system is heavy, and moving/relocating the system or removing panels or other system components can cause crush or pinch hazards.

1. Remove the system from the shipping crate.
2. Remove any packing materials.
3. Report any shipment damage.
   Make note of any shipment damage. Notify and then file a damage claim with the transportation carrier immediately. Contact TAPI immediately.
4. Gently roll the system into location. If necessary attach appropriate chains to the lifting bolts at the top of the system cabinet and lower the system into place.

CAUTION – FRAGILE COMPONENTS

Do not drop or rattle or shake the system at any time.

4.2.2 STORING YOUR SYSTEM (BEFORE USE)

If the system must be stored be sure to store it in:

- the original shipping containers
- an area with a nominal ambient temperature of approximately 21°C (70°F)
- an area with less than 50% non-condensing relative humidity

4.2.3 STORING YOUR SYSTEM (FOR PROLONGED PERIODS)

- Shut down and disconnect the ODS. (Refer to Section 5).
- Blow out the Generator Water Lines, using low pressure CDA.
- Place ODS in original shipping container.
- Store in place or other environmentally appropriate location, described above.

4.2.4 CONNECT FACILITY EXHAUST CONNECTIONS

Connect a 4” [100 cm] diameter toxic gas feed exhaust duct to the cabinet exhaust port at the top of the cabinet.

Review the “Exhaust Contents” listing (below), as well as the Safety Notice/Recommendation, and then connect the system exhaust as per the recommendations and any local/national and safety codes and regulations which pertain to your installation location.

Exhaust Contents

Normal exhaust will not contain any hazardous gases. In the event of a fitting leak, exhaust contents may contain: Oxygen, Ozone and Nitrogen.

The exhaust does NOT contain any elevated temperatures beyond the minimal heat that is generated by the system electronics.

CAUTION – POTENTIAL FOR HAZARDOUS CONDITIONS

TAPI recommends the connection of the system exhaust to an appropriate toxic waste exhaust system with sufficient flow to ensure proper detection of any hazardous condition (oxygen leak, ozone leak, etc.). Please consult TAPI for recommendations. The customer is responsible for providing any appropriate interlocks and safety devices to properly respond to any potential system hazards.

Connect the ozone destruct exhaust port to an appropriate toxic waste exhaust system. During normal operation, the destruct exhaust should not emit ozone, however the port should be connected to an exhaust which is capable of properly handling ozone should a system malfunction occur.

CAUTION – POTENTIAL FOR HAZARDOUS CONDITIONS

TAPI recommends the connection of the ozone destruct exhaust to an appropriate toxic waste exhaust system with sufficient flow to ensure proper detection of any hazardous condition (oxygen leak, ozone leak, etc.). Please consult TAPI for recommendations. The customer is responsible for providing any appropriate interlocks and safety devices to properly respond to any potential system hazards.

4.2.5 ELECTRICAL CONNECTIONS

Electrical connections include Main Power and Control Power. Refer to Facilities Interface and Specifications document in the system binder for power ratings information and for connector details.

4.2.5.1 MAIN POWER

1. Remove access panel on the rear of the ODS.
2. Using the supplied strain relief feed power cable, (facility supplied) capable of handling the specified voltage and current, through and connect wire ends to input breaker and supplied terminal blocks for neutral (if used) and protective ground.
3. Install access cover and tighten strain relief.

4.2.5.2 CONTROL POWER

1. A shutdown connector is provided at the rear of the system. Wire the shutdown connector to any remote connection as required. This can be done with a wire, as done at the factory, or by connecting it to a PLC.
2. An EMO connector is provided at the rear of the system for connection to your remote process chamber and/or facility EMO loop. Wire the EMO to any remote control/EMO loop as required.
3. The Interlock for this system requires an external power supply. Connect a 24-volt supply to the P400[A or B] connector. (Refer to the system specification document for the pinout). The current required is about one amp. This power connection is galvanically isolated from the rest of the system and can be applied without regard to the other power systems.

4.2.5.3 CONTROL SIGNALS

1. Determine which specific signals provided on the P400 connectors are required for the site specific requirements.
2. Install proper mating pins, strain relief and connector to facilities wire bundle.
3. If the unit is equipped with the Dry Contact Adaptor (DCA Option), remove the right side panel by lifting strait up to expose the DCA screw terminals.

CAUTION – CRUSH OR PINCH HAZARD

Removing panels or other system components can cause injury.

4. Route the facilities alarm signal wire bundle through the rear panel opening labeled WIRE ACCESS
5. Terminate the wires to the appropriate screw terminal.
6. Replace the side panel

4.3 CONNECT COOLING LINES

1. Refer to Facilities Interface and Specifications document in the system binder for chilled water temperature, flow rate and pressure requirements. The supply and return lines need to be sized accordingly for the ODS to operate properly. The ODS is equipped with female pipe thread connections for the cooling line connections.
2. Install an applicable water pressure regulator and shutoff valve before the ODS
3. Connect the facility chilled water supply plumbing to the COOLING WATER INLET port on the rear panel. Be sure to use pipe sealing compound or tape on the mating threads.
4. Connect the facility chilled water return pipe or tube to the COOLING WATER OUTLET port on the rear panel. Be sure to use pipe sealing compound or tape on the mating threads.
5. Perform the applicable leak check to all connections.

4.4 CONNECT GAS LINES

CAUTION – INHALATION HAZARD

Review all ozone and exhaust precautions in the Safety section.

1. Connect the oxygen, and nitrogen gas inlet lines using standard gas connection techniques for the VCR® fittings.

CAUTION – LEAK HAZARD

DO NOT use silver plated gaskets for VCR® fittings since they catalyze the decay of ozone severely.

Use non-plated stainless steel gaskets only!

NEVER re-use gaskets.

2. Perform appropriate leak checking on each line prior to flowing gas.
3. Connect the oxygen supply gas to the appropriate input fitting.

NOTE: ***Verify that the output pressure of the Oxygen supply is set for a maximum pressure not higher than 100 psig.***

4. Connect the ozone output to your system as required. Exhaust equipment must be installed as part of the customer's system.

4.5 CONNECT OZONE SAFETY MONITORING LINES

The Ozone Safety Monitor provides five channels of monitoring, described below:

1. Allocation of ozone safety monitor channels High Alarms.

Channel	High Alarm Location
1	Ported to inside of cabinet.
2	Customers Location.
3	Customers Location.
4	Customers Location.
5	Customers Location.

2. **Location of Monitoring Lines.** The location of the actual monitoring line is determined and applied by the user. Four external monitoring lines are available. Any unused line should be capped off with a compression plug at the rear of the system, and the Channel should be disabled in the Ozone Safety Monitor software (refer to the specific component manual in the binder).

4.6 PERFORM A SYSTEM SAFETY CHECK

Prior to normal operation, perform a check of all system safety features including facility installed safety devices and detectors (blank lines provided to be filled in per your facility).

Item	Description	Signoff (Date/Initial)
System installation	• Appropriate location (away from heat/cooling ducts, high sources of vibration, etc.) • Adequate service space • Proper floor loading • Proper attachment of seismic tie-downs • _____ • _____ • _____ • _____	
Power inlet	Meets input requirements per Facilities Interface and Specification document.	
Facility exhaust	Meets draw/flow and ozone handling ability per facility requirements	
Destruct exhaust	Meets handling ability per system manual	
Gas supplies	Meet input requirements per system manual	
Gas line integrity	Leak check performed on all applicable gas lines	
Cooling water supply	Meet input requirements per system manual	
Cooling water integrity	Leak check performed on all applicable water lines	
System EMO button	Turns off ozone delivery system	
Facility remote EMO connection (optional)	Turns off ozone delivery system	
Facility remote Shutoff connection (optional)	Turns off ozone delivery system	

5 SYSTEM STARTUP/SHUTDOWN/OPERATION

5.1 OPERATION WARNINGS

CAUTION

Review all safety content in the Safety section of this manual.

Review cautionary messages in the System Overview and Installation sections.

5.2 INITIAL SYSTEM STARTUP – LOCAL OR REMOTE MODE

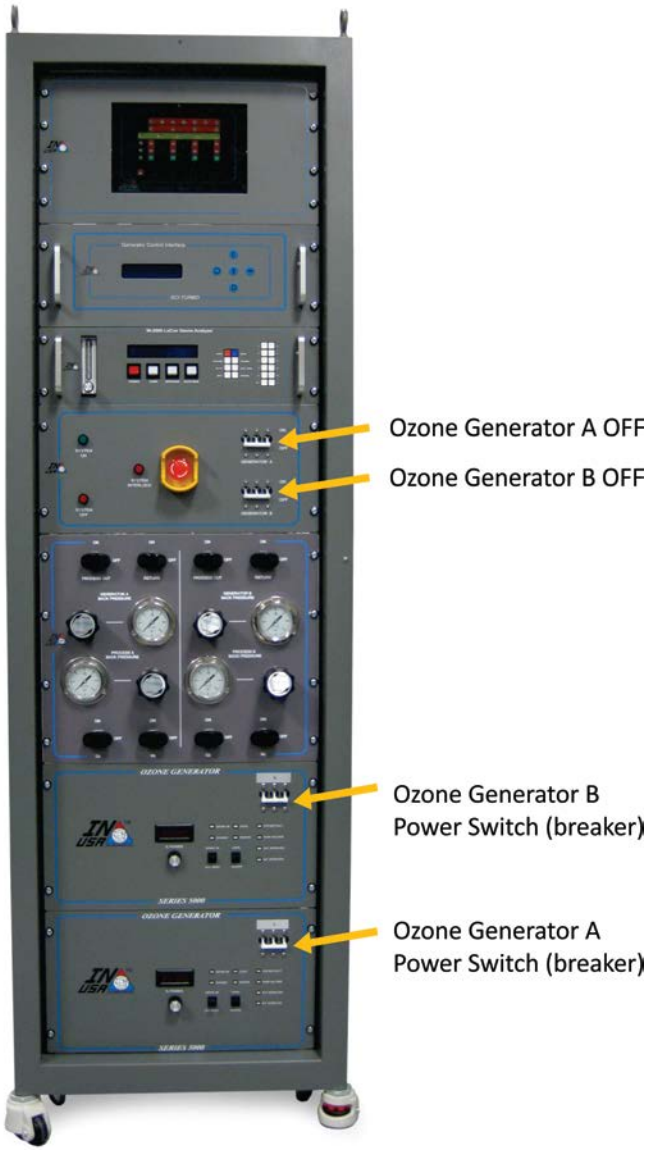
You can operate the system via either of two methods:

- Manual controls on SCI
- Remote RS-232 signals

1. Verify that the system has been properly installed and safety checked per the Installing the System section of this manual.

NOTE: The power switch for the SCI is located internal to the system cabinet, at the rear of the SCI controller, and is set to ON at the factory. The SCI should power-on automatically when the main power breaker is turned on.

2. Verify that the Generator(s) breaker is off.



3. Turn on the main power breaker on the power panel at the rear bottom of the system.

4. Verify that the control power fed through the P400[A or B] connector is operational.

5. Verify that either the Shutdown jumper plug is installed or is properly connected to the facility control device.

6. Turn ON the facility Oxygen feed and set the pressure to 70 psig.

7. Turn ON the facility Nitrogen feed and set the pressure to 75 psig.

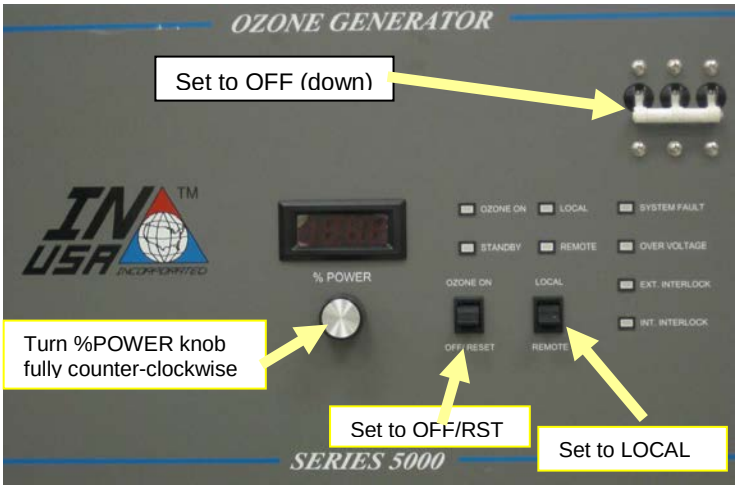
8. Open Shutoff Valves A and B. This will allow O_2 and N_2 to flow through the generator to purge it. These valves (total of four) are on the bottom of the center panel in front.

9. Open Process Out Valves A and B. This will allow purging of the entire system. If purging of the process chamber is not desired, isolate the process chamber and open the valves to allow process gases to return to the Destruct Input (A and B).

10. Press the green SYSTEM ON button – check light is ON.

NOTE: The SCI takes approximately 3 minutes to warm up, and the ozone safety monitor takes about 30 minutes to warm up. Refer to their respective user manuals for operation.

11. Set the O_3 Generator switches as follows:
    a. Set the power switch to the DOWN (OFF) position.
    b. Set the control switch to LOCAL.
    c. Set the ozone switch to OFF/RESET
    d. Turn the % Power knob fully counter-clockwise.



12. Make sure the oxygen MFC is set to zero prior to opening the oxygen supply valve. You can set the various system parameters in two ways:

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands

13. Turn ON the O_2 feed to the system and set the pressure to 70 psig.

14. Turn ON the N_2 feed to the system and set the pressure to 75 psig.

15. Set the O_2 MFC full scale value to 5 slm. Note that 5.000 volts equals Full Scale or 5 slm for this system. All further references to flow will assume a conversion to volts.

16. Set the N_2 MFC full scale value to 25 sccm. Note that 5.000 volts equals Full Scale for 25 sccm for this system. All further references to flow will assume a conversion to volts

17. Set the oxygen MFC to 5 slm (full-scale).

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands

18. Open the EV valve.

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands – “V1x” to open
P400 Connector	Apply +24 VDC to the EV Pin

19. Verify the MFC reading’s matches the O_2 and N_2 setpoints just entered.

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands – “U” to read MFC flow rate

20. Let the oxygen flow for 10 minutes. (Purges the lines in preparation for zeroing the sensor.

21. Zero the ozone sensor.

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands

22. Set the MFCs to the required flow rate.

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands – “U” to read MFC flow rate

23. Verify that the actual flow is close to the value entered.

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands – “U” to read MFC flow rate

24. Set the generator backpressure to 30 psig.

25. After the warm up period for the Ozone Safety monitor, make sure the warm up notice is clear and press the SYSTEM INTERLOCK button on the front panel of the Power Distribution Module. This should allow the generators to power up but not produce ozone.

26. Turn the Generator breaker ON. Verify that the LEDs above the knob read '00'. Verify that the fault LEDs are OFF.

5.3 LOCAL MODE OPERATION

1. Perform the startup sequence from previous page.

2. Turn the OFF/RST switches to ON to turn on the selected ozone generators (switches are located on the Ozone Generators)

3. Enter an ozone concentration as either a % of power for each ozone generator (open loop), or as a setpoint in GNM^3 or %wt per the closed-loop control operation:

Control Interface	Setting Method
SCI and Ozone Generator	Refer to SCI manual - turn the knob on the Ozone Generator to reach the desired ozone concentration. Note the LEDs above the knob indicate power level.

NOTE:
Entering MFC Setpoints in the SCI for 0-5 volt systems:
The full scale flow is obtained by entering 5.000 volts.
For lower flows, enter the value calculated by the formula

$$\frac{\text{desired flow} * 5.000}{\text{full scale flow}}$$

EXAMPLE:
For 4 slm,
4 * 5 / 5 = 20/5= 4.00 volts.

For 2.5 slm
2.5 * 5 / 5 = 12.5/5 = 2.50 volts

NOTE:
Entering Ozone Generator Setpoint, SCI only:
Enter voltage setpoints of 0 – 10V which corresponds to 0 – 100% power.

5.4 REMOTE MODE OPERATION

1. Perform the startup sequence from the previous pages.

2. Turn the Local/Remote Switch to REMOTE.
   This overrides the front panel switches and the control knob on the SCI and allows operation through the keypad or RS-232 interface only.

3. Set the desired ozone generator power level or delivery concentration:

Control Interface	Setting Method
RS-232 Interface	refer to RS-232 commands

5.5 SERVO CONTROL OF CONCENTRATION

1. Perform the startup sequence from the previous pages.

2. Turn the OFF/RST switch to ON to turn on the ozone generators.

3. Turn on the Servo control then set the desired concentration level:

Control Interface	Setting Method
SCI	refer to SCI manual
RS-232 Interface	refer to RS-232 commands

5.6 USING THE HANDSHAKE BOARD TO TURN THE GENERATORS ON/OFF

The generators can be turned on and off, when they are powered, by using the Handshake in the P400 cable connections: P400A for Generator A and P400B for Generator B (see P400A table in the Facilities Interface and Specifications document).

Note that the 24-volt signals are derived from the external power supply, already connected to pin 1 and pin 4 of the P400A connector.

Generator ON. Apply 24 volts, relative to the ground pin of the P400A/P400B connector, to the Ozone Generator A Remote ON pin of P400A/P400B. This will turn on the respective Generator, which will begin to make Ozone at the appropriate power setting (remote only). The generator will respond with a 24 volt STATUS signal on the Ozone Generator A/B ON Status pin of the P400A/P400B connector. This is the Handshake.

Generator OFF. Disconnect the 24-volt signal from the Ozone Generator Remote ON pin of the P400A/P400B connector. This will turn off the respective Generator and remove the Handshake.

5.7 DRY CONTACT ALARM ADAPTOR (DCA OPTION)

This section describes the alarms and the EV control associated with the Interlock Board.

Alarms

The Interlock Board provides alarm signals that deliver +24VDC or an OPEN circuit. The system has been modified to provide isolated Form C relay contacts for each of the following Alarms:

- ozone safety monitor Channel 1 High
- ozone safety monitor Channel 2 High
- ozone safety monitor Channel 3 High
- ozone safety monitor Channel 4 High
- ozone safety monitor Channel 5 High
- Interlock A OK
- Interlock B OK (for systems with a second generator)

Form C contacts are a set of three terminals: Common (C), Normally Open (NO) and Normally Closed (NC). When the relay is not operated (de-energized), the C and NO terminals are open and the C and NC terminals are closed. Since the alarm signals from the Interlock Board are +24V when there is no alarm, the associated relays will be operated. That means that in the no alarm condition, the Form C contacts C and NO will be closed for no alarm and open for an alarm.

EV Control

The design of the adaptor provides for an OR control – either the SCI can turn on the EV valve or the process chamber can do it. The relays in the adaptor provide for galvanic isolation between the SCI, Process chamber and EV valve. Power for the EV valve is derived from the Power Distribution Box, via the Interlock Board, using J38.

5.8 ADAPTOR INSTALLATION

Adaptor

The Dry Contact Alarm Adaptor has been incorporated into the ODS.

Alarms

- The Terminal Blocks are labeled for easy field wiring connections. The wires from the P400 Cables are connected to the Alarm Adaptor at J1.
- The connections from the Form C relay outputs are labeled accordingly on J2 and J3. Refer to the picture below. The field wiring connectors can be removed for easy wire installation.
- **Instrument Error**. If the self-diagnosis of the ozone safety monitor detects a malfunction, the IE Alarm is activated which shuts down the Ozone Generator.
- **High Alarm**. A High Alarm on any of the channels will shut down the Generator.
- **Low Alarm**. A Low Alarm on any of the channels will not shut down the Generator; however, the alarm is displayed on the Interlock Display on the front panel.
- **Dry Contacts Alarm Adapter.** The Alarm Adapter Dry Contact outputs (for each ozone safety monitor channel high alarm) are available at the internal assembly

Channel and Pin Descriptions	
Channel 1 NO	J2 pin 1
Channel 1 C	J2 pin 2
Channel 1 NC	J2 pin 3
Channel 2 NO	J2 pin 4
Channel 2 C	J2 pin 5
Channel 2 NC	J2 pin 6
Channel 3 NO	J2 pin 7
Channel 3 C	J2 pin 8
Channel 3 NC	J2 pin 9
Channel 4 NO	J3 pin 1
Channel 4 C	J3 pin 2
Channel 4 NC	J3 pin 3
Channel 5 NO	J3 pin 4
Channel 5 C	J3 pin 5
Channel 5 NC	J3 pin 6
A OK NO	J3 pin 7
A OK C	J3 pin 8
A OH NC	J3 pin 9
B OK NO	J3 pin 10
B OK C	J3 pin 11
B OH NC	J3 pin 12

EV Control

The picture at the end of this subsection is for the EV control. The design of the adaptor provides for an OR control – either the SCI can turn on the EV valve or the process chamber can do it. The relays in the adaptor provide for galvanic isolation between the SCI, Process chamber and EV valve. Power for the EV valve is derived from the Power Distribution Box, via the Interlock Board, using J38.

- The EV valve will be ON if there is 24VDC from either the process chamber **OR** the SCI.
- The EV valve will ONLY be OFF if both the process chamber and the SCI take away the 24VDC.

NOTE: You will not be able to turn the EV valve OFF from the SCI if the process chamber is still sending 24VDC.

A400	SCI	EV valve status
0	0	OFF
0	1	ON
1	0	ON
1	1	ON

The ODS will trigger an EXTERNAL INTERLOCK when turning off the O_2 flow which would require a manual reset via the "SYSTEM INTERLOCK" button located at the front of the ODS. To counter this, adhere to the following sequence:

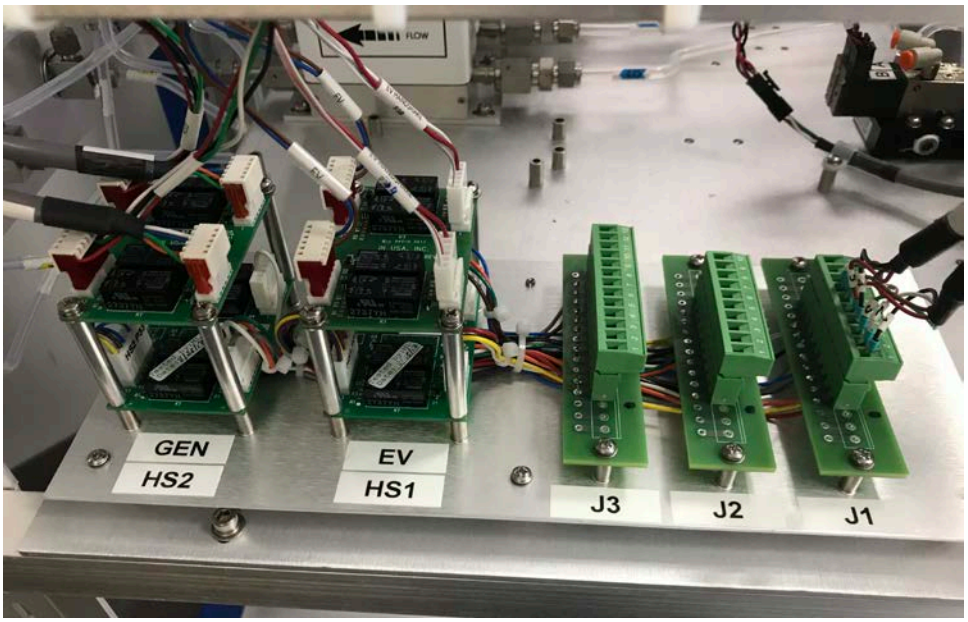
Shutting off Ozone Generation and O_2 Flow via P400[A or B]

1. The generator must be turned OFF *first,* by taking away the 24VDC from its respective pin on P400[A or B] (Generator [A or B] ON). This will put the generator in **STANDBY** mode.
2. After the generator has been turned OFF (Generator in STANDBY), take away the 24VDC from its respective pin on P400[A or B] (EV valve ON) to turn **OFF** the O2 flow.

Starting O_2 Flow and Ozone Generation via P400[A or B]

1. Supply 24VDC to its respective pin on P400[A or B] (EV valve ON) to turn **ON** the O2 flow. The generator will be in **STANDBY** mode.
2. Supply 24VDC to its respective pin on P400[A or B] (Generator [A or B] ON) to turn **ON** Generator A.

In the event that there are some issues with the P400 and the ODS is to be started, you will be able to activate the O_2 flow by setting the EV Valve to "ON" with the SCI TURBO controller. The EV Valve should always be set to "OFF" in the SCI if the P400 is to control the operation of the EV valve.



5.9 EMERGENCY SYSTEM SHUTDOWN

1. Press the EMO button to immediately de-energize the system and to stop producing ozone.
2. Follow your facility's procedures for emergency shutdown notification.

(Regularly review your facilities procedures for lockdown-tagout and for emergencies).

5.9.1 MAIN POWER DISCONNECT SWITCH/POWER CABINET COVER

WARNING – ELECTRICAL HAZARD

The power cabinet panel must only be opened by trained/certified and authorized service technicians. The facility main power circuit breaker must be locked and tagged out prior to removing the power cabinet cover.

The Main Power Disconnect Switch (picture below) is located at lower rear of the rack, on the Power Entry Module, and is equipped with an integral lockout/tagout device.

Main Power Disconnect Switch

1. Push the switch DOWN to turn OFF system power.
2. Slide the lockout device UP.
3. Insert a lock.

NOTE: For added safety, the lockout device is also designed to only lock the switch in the OFF position. It cannot lock the switch in the ON position.

Removing the Power Cabinet Cover

The ODS uses voltages that could be dangerous if you come into contact with these live circuits. Although all live circuits of the ODS are covered or isolated, you must adhere to all Electrical Hazard cautionary messages. The Equipment is of “Type 2” according 11.1, SEMI S2-93. Refer to SEMI updates as issued.

5.10 NORMAL SYSTEM SHUTDOWN AND PURGE

This procedure should be followed to perform a normal system shutdown, for either extended idle periods or to perform system maintenance.

1. Follow your facility’s procedures to notify appropriate personnel that you will perform a system shutdown, and to ensure that you are authorized to re-start the system at this time.
2. Turn off the Ozone Generator.

Control Interface	Setting Method
Ozone Generator	Turn the concentration knob fully counter-clockwise (CCW) then turn off the ozone generator power breaker.
SCI	refer to SCI manual

RS-232 Interface	refer to RS-232 commands

3. Manually direct residual gas through the internal ozone destruct by turning the front panel gas valve to EXHAUST.
4. Allow oxygen to continue to flow for 1 hour to purge/flush any residual Ozone from the system. This eliminates Ozone from the system. No further decontamination is required.
5. Set the oxygen MFC to 0 flow, then close the EV valve.
6. Turn off the main power breaker on the Power Distribution Panel.

6 MAINTENANCE

QUALIFIED TECHNICIAN

You MUST be trained on the use the system to prior to attempting to install, operate or perform maintenance on the system. (See training requirements outlined in Section 2.1.2**).**

Performance of periodic maintenance requires advanced knowledge, understanding, and training with the Ozone Generator System. NEVER perform a maintenance task unless you are trained and certified to perform the task.

6.1 PREVENTATIVE MAINTENANCE SCHEDULE

Item	Action	Interval			
		As Needed	Monthly	6 Months	12 Months
Regulators/Filters	Evaluate external fluid regulators and filters as required by manufacturers, if installed.	YES	YES	YES	YES
EMO Circuit	Verify operation of EMO Circuit	-	YES	YES	YES
Customer Interlock Circuits	Verify the proper operation of the remote shutdown circuit and any customer-	-	YES	YES	YES
Replace UV Lamps	UV lamp for the Ozone Sensor UV lamp for the Ozone Safety Monitor (optional item)	-	-	-	YES

6.2 SOLID WASTE DISPOSAL

The system requires very little maintenance and produces little waste. In addition to cleanroom wipes, which can be used to clean the external surfaces of the control cabinet, you will need to properly dispose of the system's UV lamps.

No other system components need to be discarded at any time unless they fail. Failure of an Ozone Generator would require repair or replacement. Contact TAPI for proper return of the system as the ozone safety monitor contains an integral catalyst, which must not be serviced by non-factory personnel.

6.3 MONTHLY PREVENTATIVE MAINTENANCE

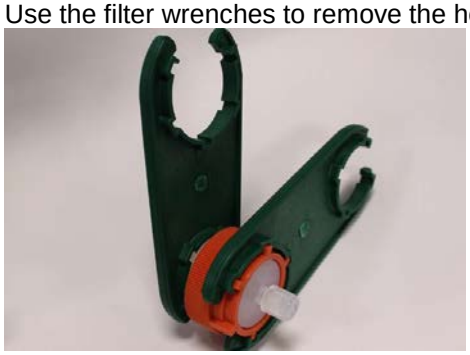
Replacement parts: None.

1. Verify the proper operation of the EMO circuit.
2. Verify the proper operation of the remote shutdown circuit and any customer-supplied system interlocks.

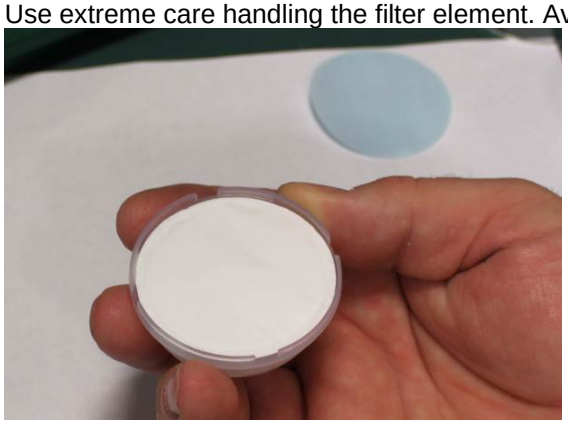
6.4 AEROSOL FILTER ELEMENT REPLACEMENT

1. Disconnect the filter from the gas line. Fittings are standard compression seals.

2. Use the filter wrenches to remove the housing retaining ring.



3. Separate the housing and insert a new filter element into the house as shown. Use extreme care handling the filter element. Avoid any contact, twisting or folds.



4. Place the housing cover over the filter element. Keep the assembly vertical to prevent damage, folding, or twisting of the element.

5. Slide the retaining ring over the housing assembly and hand-tighten.

6. Continue to hold the assembly vertical, then hold the base of the housing with one wrench and turn the retaining ring with the other wrench. Fully tighten.

7. Visually verify the filter integrity (no folds, twists) by looking through the inlet hole.

6.5 EMO CIRCUIT PREVENTATIVE MAINTENANCE

Replacement parts: None.

1. Verify that the system is in a safe state to disable power.
2. Notify users facility safety representatives, as necessary.
3. Actate each EMO device to verify proper operation.
4. Reset all EMO devices as necessary to restore the system to proper operation condition.

6.6 VERIFY THE PROPER OPERATION OF CUSTOMER INTERLOCK CIRCUITS

Replacement parts: None.

1. Verify that the system is in a safe state to disable power.
2. Notify users facility safety representatives, as necessary.
3. Actuate each customer interlock device to verify proper operation.
4. Reset all interlocks as necessary to restore the system to proper operation condition.

6.7 UV LAMP(S) REPLACEMENT

CAUTION - UV HAZARD

Carefully follow bulb replacement and adjustment procedures, as directed by the bulb maintenance instructions. DO NOT look directly at a UV lamp as irreversible, disabling eye damage can occur. Always wear proper eye protection equipment (safety glasses specified for UV light protection) when calibrating UV lamps to prevent accidental exposure.in.

CAUTION - TOXIC HAZARD

Carefully follow bulb replacement and adjustment procedures, as directed by the bulb maintenance instructions. DO NOT look directly at a UV lamp as irreversible, disabling eye damage can occur. Always wear proper eye protection equipment (safety glasses specified for UV light protection) when calibrating UV lamps to prevent accidental exposure.in.

Required Safety Equipment:

- Safety Glasses specified for UV lamp protection (consult your safety engineer)

Optional Equipment:

- Powder-free latex gloves (for handling optics elements)

Before replacing the bulb(s):

1. Verify that the Ozone Delivery System has been properly shutdown and all energies have been properly locked-out/tagged-out.
2. Remove panels, as necessary to access the applicable component. Verify and/or label each wire and tubing connection to the ozone safety monitor then disconnect the wiring and tubings. Cut any tie-wraps as necessary to free the component from the system. .

Refer to the respective component manual (either the ozone sensor or the ozone safety monitor) and follow the UV lamp replacement instructions.

6.8 SPARE PARTS ORDERING INFORMATION

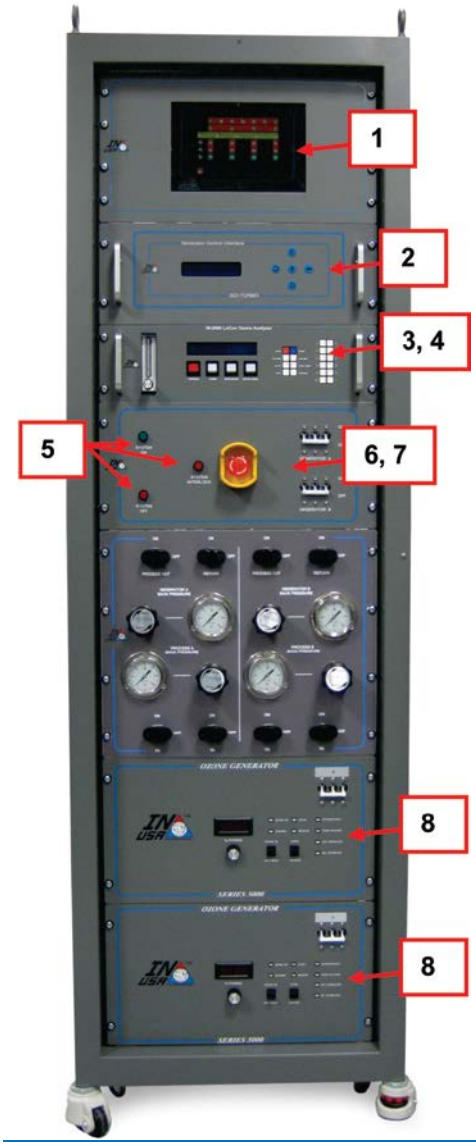
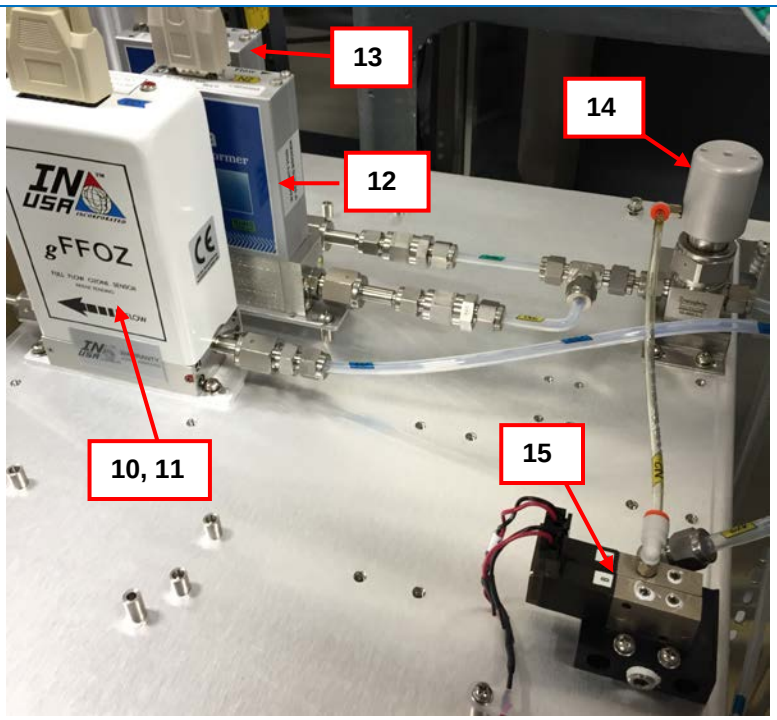
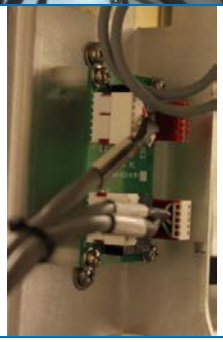
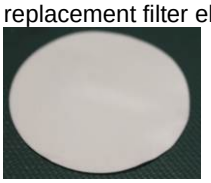
Figure	Description	Part Number	Qty
	1. Mask for Interlock Board	330-0112-01	1
	2. System Controller Interface (SCI)	820-1174-01	1
	3. Ozone Safety Monitor	820-1073-01	1
	4. UV Lamp Replacement	110009	1
	5. Lamp for Round Switch/Indicator	421-0003-01	3
	6. Power Distribution Box	810-0411-01	1
	7. EMO Control Board (not shown, located internal to Power Distribution Box)	840-0110-01	1
	8. Ozone Generator	820-1110-01	1

Figure	Description	Part Number	Qty
	9. Ozone Destruct, Catalyst	085560000	1



Description	Part Number	Qty
10. Ozone Sensor	820-1021-04	1
11. UV Lamp Replacement	421-0002-01	1
12. N_2 Mass Flow Controller	390-0489-01	1
13. O_2 Mass Flow Controller	390-0488-01	1
14. Bellows Valve, SS-BNS4-6 (pneumatically controlled shutoff valve)	310074-IO3	1
15. Solenoid Assembly, MAC	085600100	1

Description	Part Number	Qty	Qty
	Interlock Board	840-0145-06	1
	Generator Handshake Board EV Control Board	840-0172-01 840-0172-07	1 1

Description	Part Number	Qty	Qty
	Pressure Switches, Gas	235-0081-01	2
	¼" VCR Gaskets, Stainless Steel, non-plated with retaining clips	310118-IO3	6
	Filter, Gas, with ¼" VCR Male Fittings, Model WG2FT1RR2	390-0230-01	2
	Aerosol Filter and Housing Kit (including wrenches) Contact TAPI for replacement filter elements: 	810-0013-02	1

6.9 CALIBRATION AND ACCURACY

TAPI offers calibration services, and calibrates all units against in-house standards. For analyzers with range 0-10 ppmv, the calibration is traceable to NIST. A certificate of calibration is issued for every unit. Many end users opt to send instruments to our facility on a yearly schedule for re-certification. Please consult with TAPI to determine the most appropriate calibration schedule for your application.

7 TROUBLESHOOTING

This section describes symptoms and solutions for common troubleshooting tasks.

7.1 OZONE GENERATOR

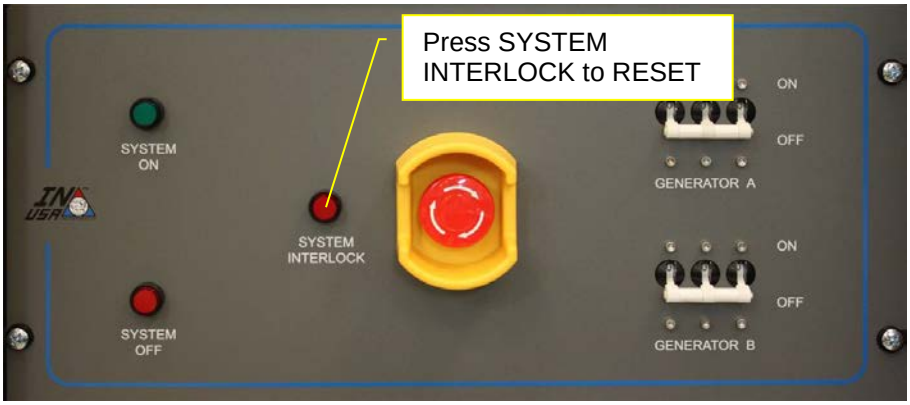
Ozone Generator: Performance Fault Troubleshooting

Symptom	Possible Causes	Corrective Action
Low ozone concentration relative to operating specifications	• Gas flow too high • Cell pressure too high or too low • Cooling Water Temperature too high • Gas feed purity problem • Status fault • Ozone analyzer error • Low cooling water flow • Ozone generator open to air	• Verify flow-metering device setpoint and calibration • Confirm outlet pressure conforms to specifications • Decrease temperature of water • Purge for nine hours with grade 6 O_2 • Refer to generator manual • Refer to ozone analyzer manual • Increase flow of water • Check integrity of seals, fittings, lines, and cabinet. Generate ozone for seven hours
Unstable Concentration	• Unstable gas flow • Unstable pressure • Ozone analyzer error • Unstable temperature of cooling water • Unstable cooling water flow • Unstable power	• Verify flow-metering setpoint and calibration • Confirm outlet pressure conforms to specifications • Refer to ozone analyzer manual • Verify water temperature • Verify integrity of water system and water flow • Verify line voltage within specifications
High Concentration	• Gas flow too low • Cell pressure problem • Water temperature too low • Ozone analyzer error • Power control is not operational	• Verify flow-metering device calibration • Confirm outlet pressure conforms to specifications • Increase temperature of water • Refer to ozone analyzer manual • Reduce power level and verify reduction of ozone concentration. • Call Technical Support

7.2 INTERLOCK SYSTEM

Refer to the description of the Interlock System in 610-0149-01 for details of its operation.

Note that all alarms are latched – the cause of each fault must be cleared before restoring power to the system.



Any of the listed Interlocks can turn off the power to the generator. To restore power, clear the fault first and reset the interlocks by pressing the SYSTEM INTERLOCK button on the Power Distribution Panel.

Note that the Yellow LEDs on the Interlock Display (shown in Section 3.3) are for the low alarms in the ozone safety monitor – they are warnings only and do not affect the power to the generators.

System Interlocks (Power)

Interlock	Cause(s)	How to Clear
Cabinet Exhaust	Loss of partial vacuum in the exhaust port at the top of the rack	Restore the operation of the exhaust system
Panels	Since the side panels lift off, there is a sensor that detects the presence of each panel. If either panel is removed, this causes an Interlock	Put the panel(s) back on the rack.
Water Leak  **WARNING – Electrical Hazard Do not stand in water when ODS has power connection. Turn off ODS mains power and ODS power.**	Water in the bottom pan	Fix cause of leak; wipe up all water in and around the pan, as well as inside ODS cabinet, including the contacts of the detector itself, and any water that may be on the floor. Once all water is removed from the ODS, turn on mains power and the ODS power.

System Interlocks (Power)		
Interlock	**Cause(s)**	**How to Clear**
ozone safety monitor Instrument Error	The ozone safety monitor detects an internal fault which renders its operation in default.	Repair or replace the ozone safety monitor.
ozone safety monitor Channel 1 Hi Alarm	The ozone safety monitor detects a level of Ozone inside the rack that exceeds the high limit.	Find the Ozone leak and repair it.
ozone safety monitor Channels 2 to 5 Hi Alarm	The ozone safety monitor detects a level of Ozone that exceeds the high limit, where the tubing is located for that alarm.	Find the Ozone leak and repair it.
Oxygen Pressure	The inlet pressure for O2 falls below the preset limit	Restore the inlet pressure
Nitrogen Pressure	The inlet pressure for N2 falls below the preset limit	Restore the inlet pressure

7.3 NO OXYGEN OR NITROGEN FLOW

1. Verify the oxygen supply is turned on.
2. Verify the oxygen supply pressure is within specifications described in the Facilities Interface and Requirements document.
3. Verify nitrogen supply is turned on.
4. Verify nitrogen supply pressure is within specifications described in the Facilities Interface and Requirements document.

   NOTE: this supplies the solenoid assembly that controls the system gas flow into the generator(s). Refer to the pneumatic diagram and electrical schematics included in system binder for more information.
5. Verify ozone process valve (if present) is open
6. Verify valve on flow meter is open. If MFC's are being used, make sure setpoint for oxygen is greater than zero.
7. Verify no external interlock conditions are present.

7.4 NO SYSTEM POWER

1. Check the Emergency Off (EMO) button located on the System Power Module. Twist to reset.
2. Verify the Main Disconnect switch is in the ON position.
3. Verify that the shutdown jumper on the rear of the system is either properly connected to an external circuit, or is jumpered-out.
4. Check the Main Supply circuit breakers.
5. Verify the host interface cable(s) (P400) are properly connected to the Ozone Delivery System.
6. If a negative pressure switch is being used, verify that pressure inside cabinet is lower than ambient pressure.

7.5 TECHNICAL ASSISTANCE

If you encounter a problem that you can't seem to solve, follow the basic steps outlined below.

1. Review all of the information contained in this manual.
2. Consult the appropriate guides listed in *Related Documents* found earlier in this chapter of the guide.
3. Consult your own internal people about the issue.
4. Contact your local field service office about the issue.
5. Contact TAPI Technical Support about the issue:

Teledyne API

ATTN Technical Support

9970 Carroll Canyon Road

San Diego, CA 92131-1106

U.S.A.

Telephone: (toll free) 800-324-5190

+1 858-657-9800

Fax: +1 858-657-9816

Email: api-techsupport@teledyne.com

TAPI Technical Support can also be contacted for parts, technical publications, and training.