



Novasafe Dry Bed Abatement System
Installation, Operation and Maintenance Manual

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About this Manual

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1 Introduction

This manual provides essential information to those who will receive the Novasafe® Dry Bed Abatement System, unpack and store it, transport it to its location within the facility, mount it and connect it to the facility's services.

This section introduces you to the *Novasafe Installation, Operation and Maintenance Manual*, the equipment about which this manual is written and the ways to contact CS CLEAN SYSTEMS to get assistance or to provide feedback. This chapter and the next, Chapter 2, form the foundation upon which the rest of this manual is built. You are encouraged to read these two chapters before proceeding.

1.1 Purpose

This manual describes the installation, operation and maintenance of the Novasafe Dry Bed Abatement System. The system uses a disposable resin canister to remove a specific process chemical or by-product from the effluent of semiconductor process tools.

Read this entire manual before installing the system. It contains important safety information and provides information that familiarizes you with the system.

1.2 Manual Use and Layout

1.2.1 Intended Audience

The intended audience for this manual includes:

- On-site personnel responsible for the installation of the system
- CS CLEAN SYSTEMS field service engineers responsible for supporting the customer in installing and maintaining the system

1.2.2 Scope

The information in this manual is for facility technicians, facility managers, the facility's environmental health and safety department and others involved in the installation and maintenance of the Novasafe Dry Bed Abatement System.

This manual does not apply to CS CLEAN SYSTEMS employees during the design, manufacturing, or testing of CS CLEAN SYSTEMS products.

1.2.3 Organization of this Manual

This manual is organized as a comprehensive reference and is arranged into logical sections, with each section covering a specific function or need. It includes information for users who have limited experience with the Novasafe Dry Bed Abatement System as well as for more experienced users. Refer to the Table of Contents for a complete listing of all topics.

The *Novasafe Installation, Operation and Maintenance Manual* is divided into the following sections:

Chapter 1, Introduction This chapter provides an equipment description as well as a general introduction to the structure and purpose of this manual. This chapter specifies the intended audience, briefly describes the manual's organization, explains special text format conventions, lists the customer's responsibility related to planning and installation of the Novasafe Dry Bed Abatement System and provides emergency contact information.

Chapter 2, Safety This chapter covers the safety considerations and safety precautions that must be addressed when working with the Novasafe Dry Bed Abatement System. This chapter describes the types of hazards associated with the Novasafe Dry Bed Abatement System and includes procedures to lockout/tagout the system.

Chapter 3, Theory of Operation This chapter describes the basic theory of operation of the system, safety features and process reliability of the Novasafe.

Chapter 4, Facilities Requirements This chapter describes the proper location, site preparation, environment, clearances and facilities requirements and connections for the Novasafe.

Chapter 5, Installation This chapter provides instructions on how to properly unpack the system, inspect for damage and inventory the shipment. This chapter provides procedures for installing the canister.

Chapter 6, Startup This chapter provides the initial startup procedure for the Novasafe Dry Bed Abatement System.

Chapter 7, Canister Replacement This chapter provides the procedure for removing and replacing the canister.

Chapter 8, Preventive Maintenance This chapter provides routine preventive maintenance procedures to ensure continuous trouble-free performance of the Novasafe Dry Bed Abatement System. Annual and quarterly preventive maintenance procedures are described.

Chapter 9, Troubleshooting This chapter provides a summary of possible problems and their respective solutions.

Appendix A, Parts List This appendix provides a list of parts for the Novasafe Dry Bed Abatement System.

1.3 Customer's Responsibility

The following are some of the customer's responsibilities related to the planning, purchase, receipt and installation of the system. These responsibilities are not part of the purchase agreement with CS CLEAN SYSTEMS unless specifically identified in the purchase contract.

The customer is responsible for:

- ensuring that the requirements of all authorities having jurisdiction are met
- completing the proper planning, scheduling and preparation of the location of the equipment
- providing adequate transportation and storage of the system before it is installed
- inspecting the system upon receipt and immediately notifying the carrier and CS CLEAN SYSTEMS of any apparent damage that occurred in shipping
- providing adequate scrubbed exhaust that meets the system's exhaust requirements
- complying with all local codes and ordinances for the mechanical, structural and piping aspects of the installation

1.4 Applicable Products

This manual is used with Novasafe Dry Bed Abatement System. See Figure 1-1.



Figure 1-1. Novasafe Dry Bed Abatement System

1.5 Available Configurations and Options

The Novasafe Dry Bed Abatement System is designed to abate the effluent from semiconductor processes. Specifically, the system is targeted to abate effluent from ion implant processes. The System can be customized to treat effluent from other applications as well. Effluent from other processes can be abated by configuring the dry system media inside the Novasafe. For more information, please contact your local CS CLEAN SYSTEMS representative.

Options for the Novasafe System include:

- Paper Detection Option
- Inlet Pressure Gauge

1.6 Contact Information

1.6.1 Emergency Contact Information

For inquiries about CS CLEAN SYSTEMS equipment, call +1(203) 797-8155

1.6.2 Obtaining Technical Support



INFORMATION: Contact the CS CLEAN SYSTEMS Customer Support Center at +1 (203) 797-8155 for help with the Novasafe Dry Bed Abatement System.

1.7 Drawings and Dimensions

Drawings in this manual are not drawn to scale. The tolerance of dimensions is $\pm 1/16$ inch (± 1.5 mm), unless otherwise noted.

Dimensions are provided in English units followed by International System (SI) units in parenthesis, as shown in Figure 1-2.

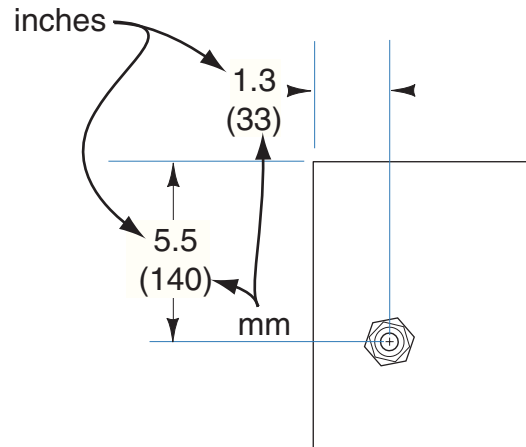


Figure 1-2. Dimensions Shown in English and SI Units

2 Safety

2.1 Introduction

This safety section is designed to notify the end user of the Novasafe equipment that some physical or chemical hazards could exist in the operation and maintenance of the Novasafe. Physical hazards are related to the servicing of the Novasafe, while chemical hazards are related to the process gases and their by-products which are abated by the Novasafe.

Air pollution regulations, employee health concerns, and growing awareness of toxic agents from manufacturing demand increased improvements in process exhaust gas conditioning. The Novasafe Dry Bed Abatement System reduces hazards associated with effluent from semiconductor processes as well as other process effluents.

The safe operation of the Novasafe Dry Bed Abatement System is the responsibility of the user. CS CLEAN SYSTEMS provides safety information regarding the system and its proper use. CS CLEAN SYSTEMS assumes no responsibility or liability for procedures adopted by the user while operating the Novasafe Dry Bed Abatement System.

Novasafe systems provide controlled conditioning of process exhaust gases. As with any processing system, malfunction and failure can occur due to unforeseen and or uncontrollable circumstances. CS CLEAN SYSTEMS, its officers, managers, engineers representatives cannot be held responsible for such failure nor for the customer's negligence or misuse of this equipment. At the very least, follow procedures and recommendations outlined in this document for proper system functioning.



INFORMATION: Contact the CS CLEAN SYSTEMS Customer Support Center at +1 (203) 797-8155 for help with the Novasafe Dry Bed Abatement System.

2.2 Safety Notices and Terms



Review this manual carefully. There are safety advisories throughout this manual. It is the user's responsibility to become familiar with the contents of this manual to understand the hazards and how to avoid them. Always follow approved safety procedures, including the use of lockout/tagout devices, proper clothing, and eye and face protection. Pay particular attention to warnings and precautions in this manual.

A description of the hazards and a discussion of general safe practices are included in this manual so that precautions can be taken to protect against injury or death to personnel and damage to the Novasafe Dry Bed Abatement System. This chapter includes general warnings and cautions that apply during the operation and servicing of the Novasafe Dry Bed Abatement System.



The following are examples of safety notices used in this manual. Read the instructions carefully anywhere a Warning, Caution, or Note is used in the manual.

Warnings



Electrical Hazard: Warns of high voltage and other electrical hazards.

	 WARNING
	<p style="text-align: center;">Hazardous Voltage</p> <p>Potentially lethal electrical voltages are present which could cause shocks, burns or death. Turn off, lockout and tagout.</p>



Respiratory Hazard: Warns of respiratory hazards associated with dust or other toxic materials in the air.

	 WARNING
	<p style="text-align: center;">Respiratory Hazard</p> <p>Due to the potentially hazardous and/or toxic nature of the dust and particulate by-products that accumulate in the system, protective clothing and breathing apparatus should be worn.</p>



Flammable Materials: Warns of flammable gases or materials that could be present.

	 WARNING
	<p style="text-align: center;">Flammable Materials</p> <p>Flammable materials may be present. Some of these may ignite spontaneously when exposed to air. See specifics in the warning.</p>



Hazardous Fumes: Warns of hazardous gases or fumes that could be present in the air.

	 WARNING
	<p style="text-align: center;">Hazardous Fumes</p> <p>Hazardous gases or fumes may be present. Contact your safety department for appropriate personal protective equipment and ventilation requirements.</p>



Hazardous Materials: Warns of hazardous materials that could be present in the equipment or by-products that can damage the skin and eyes.

	 WARNING
	<p style="text-align: center;">Hazardous Materials</p> <p>Materials are present that may be hazardous upon contact with skin and eyes. Contact your safety department for appropriate personal protective equipment.</p>



Hot Surfaces: Warns of hot surfaces in the equipment that can cause severe burns.

	 WARNING
	Hot Surface Hot surfaces are present which could cause severe skin burns upon contact.

Heavy Object: Warns that an object is heavy or must be lifted from an awkward position which could cause injury to personnel. It is usually recommended to use two people or a mechanical lifting device to lift the object.

	 WARNING
	Heavy Object Lifting a heavy part and/or being in a awkward position can result in muscle strain or permanent back injury. Use two-person lifting techniques or mechanical lifting aids when removing or installing these assemblies.

General Warning: Warns of potentially dangerous situations for which can cause death or serious injury and for which there is no other warning alert defined.

	 WARNING
	Warning This warning notice identifies potentially dangerous situations, where improper actions could cause death or serious injury to personnel, or major property damage.

Cautions



Caution: The caution notice is a general hazard indicator that identifies situations where improper actions could cause damage to the equipment or product.



Data Loss: This icon warns against data loss due to improper or careless operation or by utilizing media (storage devices) in an improper manner.



Tip Hazard: This icon is placed before an operation involving moving of equipment, or opening or removing heavy panels or lids on the equipment that could result in instability or tipping of the machine.



Environmental Hazard: This icon is used to alert users to environmental concerns (contamination of air, water, etc.), such as improper disposal of cleaning materials, solvents, or by-products, or discarding certain types of components or subassemblies.

General Icons



INFORMATION: This icon indicates special instructions or information that is important but is not related to hazards.





Lockout/Tagout Required: This icon and message indicate that lockout/tagout is required. It might be placed at the beginning of a procedure or it might be placed as a step in a procedure.

2.3 End User Responsibilities

The information published by CS CLEAN SYSTEMS in engineering specifications, manuals and guides are correct as of publication date. CS CLEAN SYSTEMS is not responsible for product application, including, but not limited to, compatibility with other equipment.

The end users and their subcontractors must be responsible to ensure that their employees receive hazardous communication training which meets or exceeds OSHA Standards (“Hazardous Waste Operations and Emergency Response”). They must also ensure that their employees are provided with material safety data sheets (MSDSs), available from their Environmental Health and Safety Department, for all gases and chemicals which pass through or are treated by the system.

	 WARNING
	<p style="text-align: center;">Hazardous Materials</p> <p>During installation of the Novasafe Dry Bed Abatement System, exposure to, corrosive, flammable, combustible, or toxic substances could occur.</p> <p>Personal protective equipment in the form of impervious clothing, gloves, and face shields (eight-inch minimum), should be worn to prevent any possibility of skin contact.</p>

Proper ventilation for the system and the work area must be maintained to reduce health or fire hazards.

If exposure to clothing occurs, remove the contaminated clothing immediately and place it in closed containers pending disposal or cleaning. Splash-proof safety goggles are required if there is any possibility of eye contact with any of the substances described above. Emergency eyewash fountains should be provided in the immediate work place. It is imperative that each end user follows the policies and procedures required by their Environmental Health and Safety Department.

During preventive maintenance or service of the Novasafe canister, personnel must be aware of the potential hazards associated with it. Labels throughout the manual include, but are not limited to, hazardous chemicals.

An additional potential hazard exists in the cleaning of the lines connected to the Novasafe. In many cases, the particulate by-products formed contain hazardous substances that must be considered and treated as hazardous wastes. When cleaning the lines to and from the system, the proper equipment for vacuuming such materials must be used. Service technicians must adhere to the proper handling procedures defined by the facility's Environmental Health and Safety Department.

It is important that the system is installed according to this manual, the recommendations of CS CLEAN SYSTEMS and the process tool manufacturer, and all federal, state and local codes and regulations. Placement of any additional labels required by local or state agencies must be done during installation.

When working on any piece of equipment, the service technician must follow all policies, practices and procedures established by the facility's Environmental Health and Safety Department.

2.4 Hazard Alert Label

A single hazard alert label is placed on the front of the Novasafe to bring attention to potential safety hazards. Figure 2-1 shows the warning label. This warning label provides information regarding medical treatment if the user is exposed to the resin and how fire response personnel should be protected as well as how to put out fires involving the Novasafe. Emergency contact phone numbers are also listed on the warning label.



Figure 2-1. Hazard Alert Label

2.5 Personal Protective Equipment

Personal protective equipment (PPE) is worn to protect workers and other people near hazardous chemical operations when administrative or engineering controls are not enough to ensure their safety. Users should refer to their facility procedures for information about what PPE to wear for specific applications. Material safety data sheets (MSDSs) provide information about the hazards associated with each chemical processed or used by the system.

Table 2-1 describes the extent of covering for the four levels of PPE protection. The material from which the protective clothing must be constructed depends on the process chemical. More information can be found in MSDSs or a guide such as the *Quick Selection Guide To Chemical Protective Clothing*. Other considerations for personal protective equipment include the type of expected exposure (gas, accidental spray, immersion, etc.), potential length of exposure, age and service history of the clothing and other factors.

Table 2-1. Personal Protective Equipment Requirements

PPE Level	Respirator	Face Protection	Clothing	Gloves	Boots
A	SCBA	Totally encapsulating suit		Double layer	Chemically resistant
B	SCBA	Hooded chemical suit		Double layer	Chemically resistant
C	Air purifying respirator	Hooded chemical suit		Double layer	Chemically resistant
D	None	Optional shield	Coveralls	Optional	Optional

Users must avoid wearing improper PPE because it provides a false sense of security and as a result actually increases the danger to their health. Refer to the facility PPE matrix or health and safety department for specific information regarding the type of material and extent of covering required for the chemicals in use and the process being performed.

2.6 Energy Isolation Procedures

2.6.1 Purpose

The purpose of energy isolation procedures is for personnel protection during maintenance or service operations on machinery. It ensures that the machinery is stopped and isolated from all potentially dangerous energy sources. OSHA regulations require that a method, device, or technique be established to accomplish this.

2.6.2 Lockout/Tagout Procedure

For facilities without an established lockout/tagout procedure, a model procedure, which may be adopted, is provided below:

1. Establish and maintain a lockout/tagout log, which lists the date, time, purpose and the authorized person (originator) performing the lockout.
2. Notify affected personnel of shutdown of the equipment for maintenance or service.
3. On the tag, identify the originator of the tagout and the purpose of the lockout.
4. Shut off all energy sources at the lockout location.
5. Securely attach a lockout isolating device or lock which cannot be readily removed.
6. Attach a tagout tag on the lockout device or in an easily observed location.

In the Novasafe, the primary sources to lockout/tagout are the incoming process gases to the canister. It is also recommended that the exhaust be locked out and tagged out in case of exhaust backstreaming from the exhaust lines.

2.6.3 Lockout Devices

The available types of lockout devices include:

- locks especially assigned for lockout use
- grounding rods with electrically insulated handles to discharge capacitors
- clamps or holding devices designed for compressed springs
- support devices for elevated machines or elevated machine components
- rotational blocking devices for rotating parts

- stopping devices for hydraulic systems
- shutoff valves for compressed gases

2.6.4 Removing the Lockout/Tagout

To return the locked-out equipment to service, use the following procedure:

1. Remove all tools and other items which were brought in for the maintenance or service work.
2. Verify that the equipment is ready to be operated.
3. Notify affected personnel that the equipment is to be restored to operation.
4. Verify that all personnel in the equipment area are in a safe location.
5. Remove all lockout devices and restore all energy sources to the equipment.
6. Notify affected personnel that maintenance or service work is completed and the equipment is ready for use.
7. Record the time the equipment was returned to operating status in the lockout log.

3 Theory of Operation

3.1 Introduction

Air pollution regulations, employee health concerns, and growing awareness of toxic agents from manufacturing demand increased improvements in process exhaust gas conditioning. The Novasafe Dry Bed Abatement System reduces the hazards associated with flammable, toxic or corrosive gases and vapors.

Novasafe effluent gas systems offer an extremely safe and efficient way to treat toxic and corrosive gases resulting from semiconductor processes. This system is a technologically advanced dry chemical system containing approximately 2.5 gallons (9.5 liters) of scrubbing media. The system is suitable for use in production and general laboratory environments. Operating passively at ambient temperature, chemical resins in the canister react on contact with process gases and by-products, converting them to non-volatile inorganic solids.

Gas flows through the Novasafe Dry Bed Abatement System from bottom to top. See Figure 3-1. The canister contains two layers of resin. The two layers of resin can be configured to abate various target gases. For example, the two-layer design is especially suited to target the effluent from ion implant processes which typically contains both hydride and acid gases.

The two layer design can be configured with a variety of different resins to abate effluent from other semiconductor process, as well. Contact your local CS CLEAN SYSTEMS representative to discuss the types of resin for a particular process effluent.

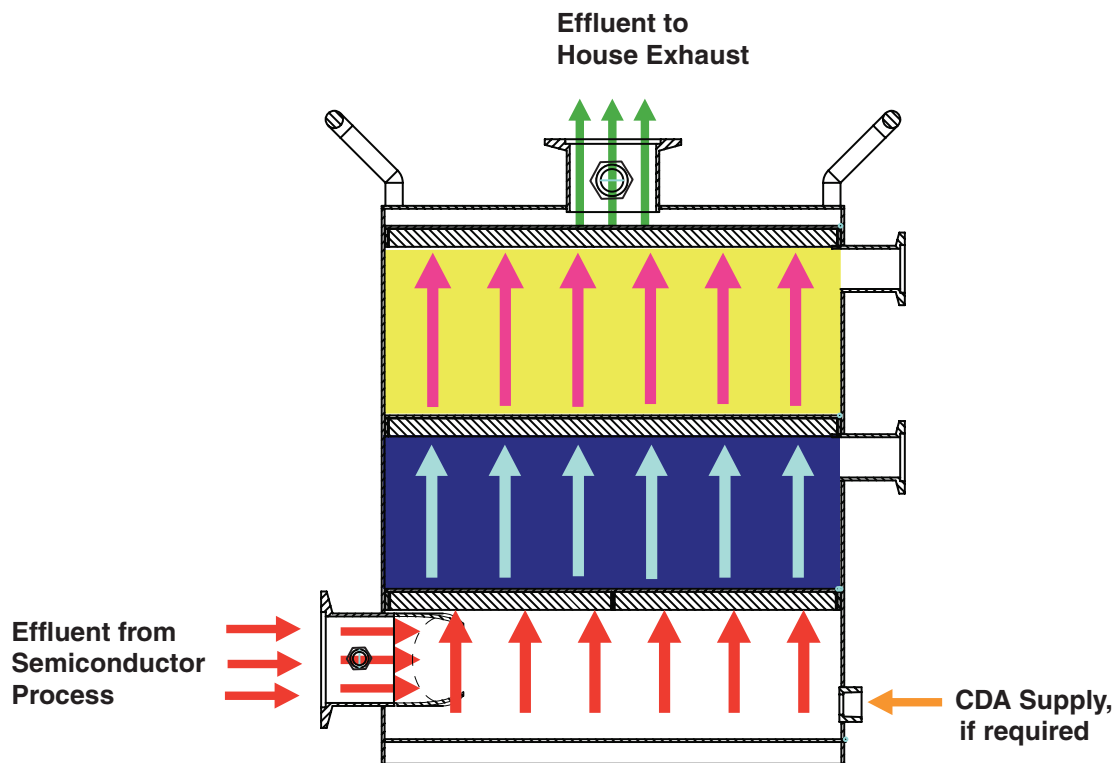


Figure 3-1. Gas Flow through the Canister



INFORMATION: The Novasafe Dry Bed Abatement System is designed to target the effluent from semiconductor processes. It can be customized to treat variety of applications. For more information regarding customization of the Novasafe for a specific effluent, please contact your local CS CLEAN SYSTEMS representative.

3.2 Novasafe Dry Bed Abatement System

The gas to be treated enters the plenum at the bottom of the unit through a KF-50 connection and flows upward through the two resin beds. The gas exits through the KF-50 outlet connection at the top of the canister. See Figure 3-1.

A toxic gas sensor to monitor the Novasafe Dry Bed Abatement System outlet for breakthrough can be installed by the customer. A port is provided in the KF-50 outlet stuff for this purpose. The sensor must have a means, such as a pump, for removing the gas sample from the Novasafe sampling port. Select a sensor that is sensitive to the gas being treated. See Figure 3-2. Both the toxic gas monitor port and the inlet pressure port consist of a 1/4-inch stainless steel tube fitted with a compression fitting nut, ferrules and a cap. These parts are Swagelok® tube fittings or equivalent.



Figure 3-2. Various Port Locations

If the Novasafe System is being used to abate ion implant effluent, CS CLEAN SYSTEMS recommends using an arsine sensor rather than a sensor for boron trifluoride or phosphine because hydride gas is expected to break through first. Arsine has a lower TLV than other hydride gases.

If the Novasafe is being used to abate process effluent from other semiconductor processes, contact your local CS CLEAN SYSTEMS representative for a recommendation on which species of gas to monitor for.

3.2.1 Paper Detect Option

CS CLEAN SYSTEMS offers a paper detect option for the Novasafe Dry Bed Abatement System. The paper detect option provides a visual indication that the resin has been consumed. The paper detect option can be used in conjunction with, or as an alternate to, a toxic gas monitor. The paper detection is located on the side of the canister just below the top of the canister. See Figure 3-2 and Figure 3-3. As the resin bed is consumed, the paper detection will come into contact with the unabated effluent gases. When the paper contacts the unabated gases, the paper will change color. The paper is visible through a viewport on the side of the canister. There are two types of paper detect options available. The first type is designed to detect the presence of acid and/or caustic gases. The second type is designed to detect the presence of hydride gases. A color indicator chart is provided with each paper detect option for visual comparison. See Figure 3-4 for examples of color indicator charts.



INFORMATION: The paper detect option may not be applicable for all process effluents. Please contact your local CS CLEAN SYSTEMS representative to determine if the paper detect option can be used for your application.



Figure 3-3. Paper Detect Option



Figure 3-4. Color Indicator Charts

3.2.2 Pressure Gauge Option

A port for connecting a customer-supplied pressure sensing device to monitor the pressure at the canister inlet is also available. See Figure 3-2.

Alternately, CS CLEAN SYSTEMS can provide a pressure gauge already connected to the pressure sensing port. If this option is selected, the pressure gauge that will be provided is a 0.5" w.c. gauge.

3.2.3 Air Oxidation Port

Clean dry air (CDA) is introduced through a 1/4-inch female NPT port on the lower part of the canister. See Figure 3-2. Novasafe System media has been designed to provide very high hydride (arsine, phosphine, silane, tert-butylarsine, etc.) scrubbing capacity. In the process of treating hydride gases, Novasafe media becomes chemically reduced. Typically, the spent media in this family of resins reacts exothermically with air. Air oxidation ensures that the spent resin is rendered non-air-reactive and that any residual adsorbed hydrides on the spent portion of the media are fully oxidized. Destruction of adsorbed species is especially important in applications involving phosphine, tert-butylarsine and tert-butylphosphine, which have a greater tendency to adsorb on the spent media. After air oxidation, the spent media will contain no residual hydride gases.

Air oxidation is a relatively simple process. Air oxidation consists of delivering a controlled flow of air into the canister.

When air oxidation is initiated, the oxygen in the air reacts with the spent media and any residual reactive hydride gases. Initially, the canister may become warm to touch as the spent media is oxidized. As the oxidation progresses, a "band" of heat will gradually progress through the entire bed. When the addition of air generates no additional heat, the contents of the canister are no longer reactive and will contain no residual hydride gases. Because the Novasafe canister is small, the generated heat may not be apparent outside the canister.

There are two means of performing air oxidation:

- Air oxidation may be performed in situ, that is, concurrently while the process gases are flowing. In situ air oxidation is not recommended for processes which contain silane or hydrogen. The recommended flow rate for in situ air oxidation is 50 scfm.
- The second means of performing air oxidation is after the resin has been fully consumed. To perform air oxidation, the canister must be purged of residual process gases. In particular, silane and hydrogen must be purged to ensure that flammable or pyrophoric mixtures cannot exist when air is introduced into the canister.





The time required to conduct air oxidation of a fully spent canister is a function of several variables.

- How heavily the system has been used
- The air flow rate

Even if in situ air oxidation is used, a final air oxidation is recommended. In situ air oxidation reduces the time required for a final deactivation step once a canister is spent. It is convenient to conduct air oxidation overnight or during weekend shutdowns. If a canister is to be reused following the air deactivation, it must be thoroughly purged with nitrogen to ensure that flammable mixtures do not occur once the process gases are introduced into the canister.



INFORMATION: CDA should not be connected for some applications such as when the Novasafe is used for vent gas (SiH_4) applications or when abating acid gases. Contact CS CLEAN SYSTEMS INC. if you are unsure about connecting CDA to the Novasafe.

	 WARNING
	<p style="text-align: center;">Hot Surface</p> <p>The Novasafe Dry Bed Abatement System is not designed for treating emergency releases of toxic gases. The treating of hydride gases is exothermic, meaning heat is liberated by the reaction between the gas and the resin. An uncontrolled release of gas into the system may generate an excessively high temperature in the canister.</p>
	 WARNING
	<p style="text-align: center;">Flammable Materials</p> <p>Air is introduced into the canister to perform controlled air oxidation of consumed system media and reduce the possibility of exposure to flammable media. Not all applications require air oxidation. Please contact your local CS CLEAN representative to determine if air oxidation is required for your particular application.</p>

The useful life of the Novasafe canister depends on the particular application for which the Novasafe is being used. For most implanter applications, the scrubber is expected to last one year. The useful life may be shorter in applications that have other gas species, high gas flows or that produce large amounts of solid by-products.



INFORMATION: Contact the CS CLEAN SYSTEMS Customer Support Center at +1 (203) 797-8155 regarding questions about the lifetime of the Novasafe Dry Bed Abatement System.

3.3 Features

3.3.1 Safety

- Totally passive
- Continues scrubbing even if power is lost
- Ambient temperature operation
- Toxic gas sensor port at canister outlet
- Pressure port at canister inlet
- Visual indication of resin consumption

3.3.2 Process Reliability

- Works on demand
- Low maintenance and energy requirements
- Eliminates build-up in ducts
- Minimizes waste
- Reduces concentration of hazardous material
- Small footprint
- Easy to install
- No moving parts

3.3.3 Environmental Control

Accumulation of solids in the ducts downstream of the system is virtually eliminated, increasing reliability.

Dry chemical systems contain and concentrate by-products up to 20,000-fold, dramatically reducing the total volume of waste.

Reclaiming, incinerating or burying (landfill) the used canister or the chemisorption resins by a disposal facility, contracted by the customer, completes the cycle.

The Novasafe Dry Bed Abatement System complies fully with the latest regulatory standards for toxic emissions. It does not create or release any nitrous oxides or acid gases into the environment.

4 Facilities Requirements

This chapter describes the proper location, site preparation, environment, clearances, facilities requirements and connections for the Novasafe.

4.1 Site Location Requirements

Locate the Novasafe Dry Bed Abatement System in an area that is:

- Well-illuminated
- Well-ventilated
- Easily accessible to maintenance personnel
- Situated so that dust or particulate that escapes during maintenance will not contaminate other areas or equipment



INFORMATION: The Novasafe System does not have a ventilated enclosure. The customer must provide a suitable enclosure if state, local or facility regulations require it to be enclosed.

4.1.1 Mounting

Install the Novasafe Dry Bed Abatement System as close as possible to the exhaust of the pump of semiconductor equipment. It may be installed within the semiconductor equipment enclosure if the guidelines described above are met. Install the system in a vertical position.

If necessary, provide support for the Novasafe. Connections to the canister must be easily accessible and there cannot be excess stress on the inlet, outlet or other connections. Any stand or support required for the scrubber must be provided by the customer.

4.1.2 Dimensions

Table 4-1 lists the overall dimensions of the canister. Figure 4-1 shows details of its dimensions.

Table 4-1. Canister Dimensions

Height, overall	14 inches (35.6 cm)
Diameter	10 inches (25.4 cm)
Weight	30 pounds (13.6 kg)

Note: Weight is approximate and will vary according to the type of resin inside the Novasafe.

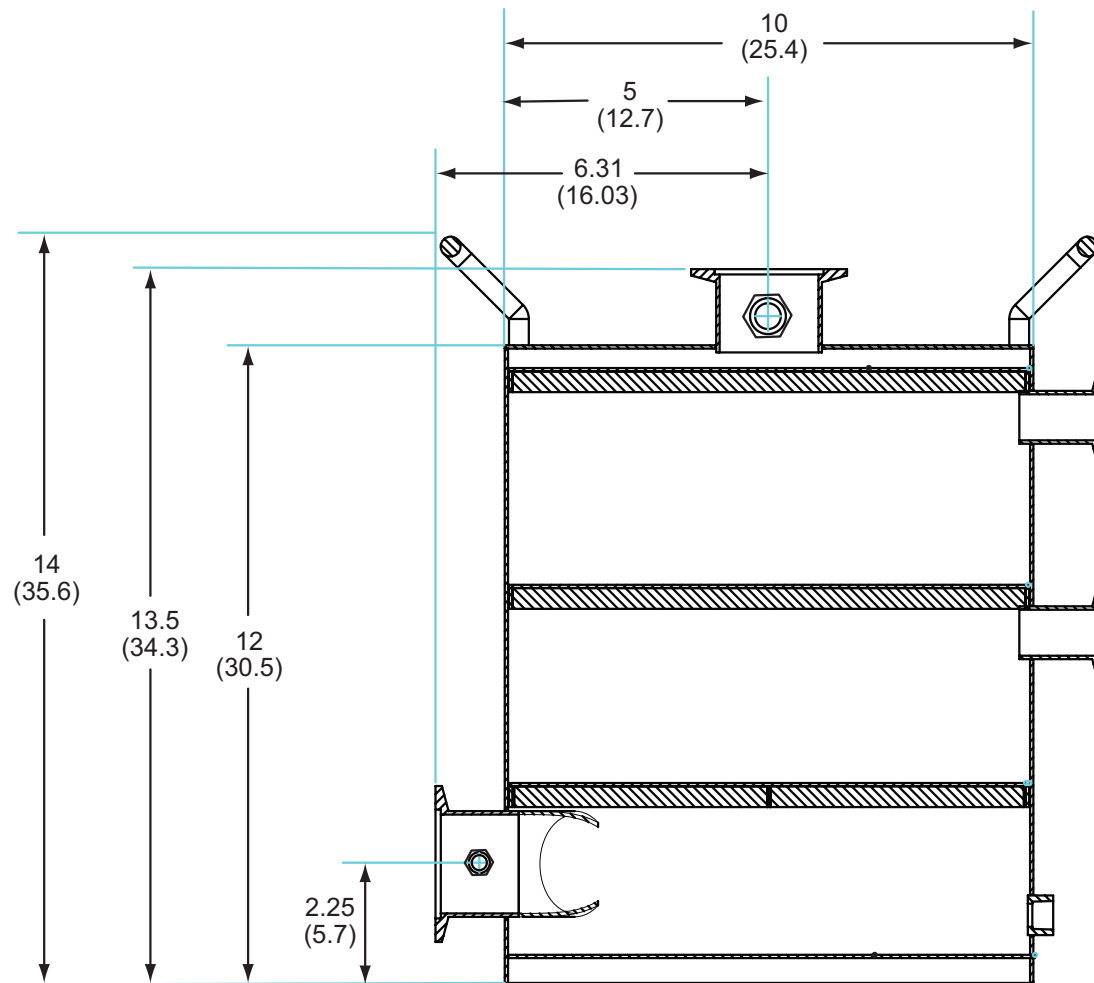


Figure 4-1. Canister Measurements

4.1.3 Clearance

Provide enough clearance around the Novasafe Dry Bed Abatement System to allow adequate access for maintenance. Approximately 6 inches (15 cm) of clearance is required around each fitting that must be accessed.

4.2 Facilities Connections

Figure 4-2 shows the location of the connections to the canister that are described in this section. Table 4-2 summarizes the facilities requirements for the system.

4.2.1 Inlet

The inlet of the Novasafe Dry Bed Abatement System is a KF-50 flange located on the lower side of the canister. It should be connected to the 2-inch (5 cm) stainless steel line leading from the pump exhaust. If the exhaust line from the pump is a different size, install an adapter between the exhaust of the vacuum pump and the Novasafe System. The customer must provide this adapter.

4.2.2 Outlet

The outlet is also a KF-50 flange, located in the center on the top of the canister. Connect it to the house exhaust system using stainless steel ductwork that is at least 2-inch (5 cm) in diameter. The draw provided by the exhaust system should be at least -2.0 inches wc @ 1.0 scfm (-13 mm wc @ 28 slm). If the ductwork to the exhaust system is larger, use an adapter, which must be provided by the customer.

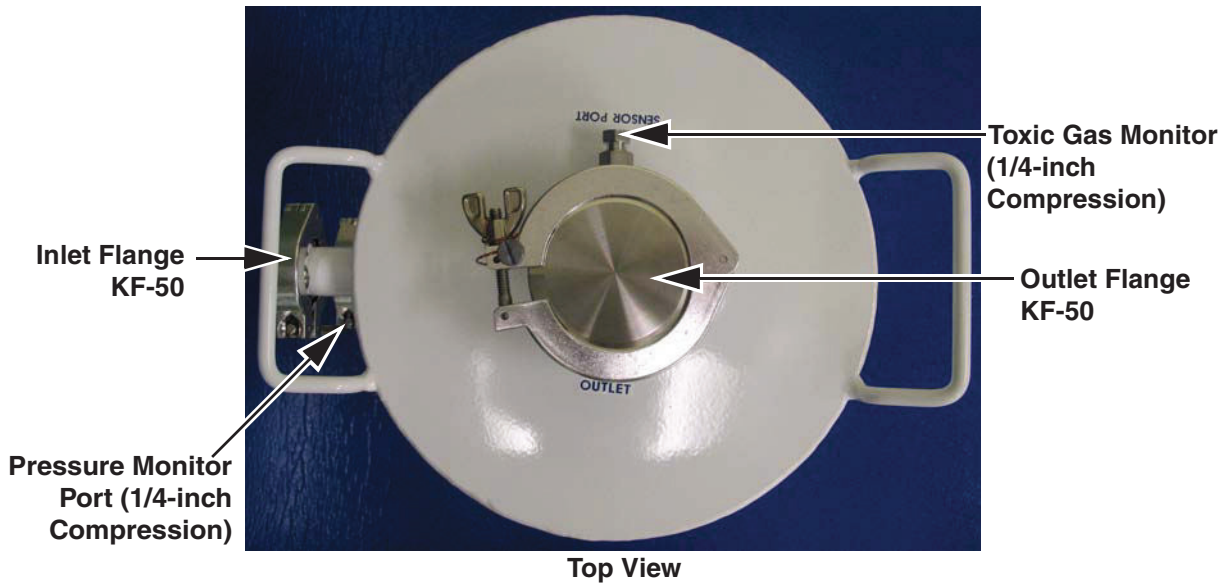


Figure 4-2. Canister Inlet and Outlet Connections

4.2.3 CDA Supply

The use of air deactivates the consumed resin and supports the controlled oxidation of flammable solids, such as phosphorus, that are sometimes produced by semiconductor processes. Connect a clean dry air (CDA) supply to the 1/4-inch female NPT port labelled **CDA**, located opposite the inlet port.

The CDA supply should be provided at a pressure of 80–90 psi (552–621 kPa) and a flow rate of approximately 0.11 scfh (50 sccm). The customer must provide a regulator, a rotameter or other flow control device and a check valve.

4.2.4 Toxic Gas Monitor

The gas sample connection to the system is a 1/4-inch (6 mm) compression tube fitting labelled **SENSOR PORT**. A line must be run from the Novasafe Dry Bed Abatement System to the location of the monitor. CS CLEAN SYSTEMS recommend using a 1/4-inch (6 mm) OD Teflon® tube. See the manual provided with the toxic gas monitor for any restrictions in the length of this tubing. The monitor must pull the sample from the Novasafe sensor port, so the means to do this must also be provided.

4.2.5 Pressure Monitor

There is a small pressure drop, usually less than 0.5 inches wc (13 mm wc), across the Novasafe Dry Bed Abatement System. A 1/4-inch (6 mm) compression tube fitting, labelled **PRESSURE PORT**, is provided at the inlet to the canister for connecting a pressure monitoring device, such as a Dwyer Instruments Photohelic® differential pressure switch or gauge. If a differential pressure device is used, the second port can either be left open to atmosphere (to measure gauge pressure) or connected to the exhaust duct downstream of the Novasafe outlet (to measure the pressure drop across the canister).

Table 4-2 lists the facilities requirements for the canister.

Table 4-2. Facilities Connections

Facility	Material	Fitting Type	Performance Requirements
Inlet	2 inches (50mm) 316 SS	KF-50 flange	1 scfm (28 slm) maximum flow ^{a,b}
Outlet	2 inches (50mm) 316 SS	KF-50 flange	1 scfm @ -2.0 inches wc (28 slm @ -13 mm wc) minimum
CDA	1/4-inch 316 SS ^c	Female NPT	0.11 scfh @ 80–90 psig (50 sccm @ 551–620 kPa) minimum
Pressure monitor	1/4-inch 316 SS	Compression tube	Suggested range: 0–2 inches wc (0–13 mm wc)
Toxic gas monitor	1/4-inch Teflon	Compression tube	Monitor set to the TLV of arsine

a. The maximum flow includes the pump ballast plus the process effluent.

b. Maximum flow is dependent upon the application. Some applications may have higher flow rates.

c. Stainless steel is recommended for the CDA connection.

4.2.6 Electrical

The Novasafe Dry Bed Abatement System does not require any electrical connections. If a toxic gas monitor or other toxic gas monitoring system is used to detect breakthrough, refer to the manual which comes with the monitor for electrical requirements.

5 Installation

This chapter provides instructions on how to properly unpack the Novasafe shipping crates, inspect for damage, inventory the shipment and provides the installation procedure for the canister.

5.1 Unpacking the Canister

The Novasafe canister and its associated parts are shipped in one or more containers; the packing slip indicates the number of crates.

All systems are carefully inspected prior to shipment. Before unpacking the Novasafe Dry Bed Abatement System, inspect the shipping container, looking for external damage or signs of rough handling. After removing the canister from the container, inspect it for damage and ensure that the flanges and fittings are tight.



INFORMATION: Report any broken, damaged, or missing parts immediately to CS CLEAN SYSTEMS Customer Support Center. Please have the serial number of the unit, located on the side of the canister, ready to give to the customer support representative.



5.2 Installing the Canister

This section provides the installation procedure for the canister.



INFORMATION: Make the inlet connection first.

1. Move the Novasafe Dry Bed Abatement System to its operating location.

	 WARNING
	Heavy Object Recommend using proper lifting procedures or two people for moving the Novasafe. Approximate weight of the Novasafe canister is 30 pounds (13.6 kg).



2. Turn off all vacuum pumps and perform a lockout/tagout of the vacuum pumps before installing the Novasafe.
3. Remove the KF-50 clamp, O-ring and the blank-off flange from the inlet connection of the canister.
4. Install an adaptor, if required. See Section 4.2.1.
5. Connect the inlet of the canister to the exhaust line of the vacuum pump using the KF-50 clamp and O-ring.
6. Retain the KF-50 blank-off flange; it will be used when the canister is removed.
7. Remove the KF-50 clamp, O-ring, and blank-off flange from the outlet connection of the canister.
8. Connect the outlet of the canister to the exhaust system duct using the KF-50 clamp and O-ring. Install an adaptor, if required. See Section 4.2.2.
9. Retain the KF-50 blank-off flange; it will be used when the canister is removed.
10. (Optional) Connect the CDA supply to the CDA connection on the canister.
11. (Optional) Connect the pressure monitor to the connection point on the inlet to the canister.
12. (Optional) Connect the toxic gas monitor to the compression tube fitting labelled **SENSOR PORT**.

6 Startup

This chapter describes the initial startup procedure for the Novasafe Dry Bed Abatement System.



6.1 Setting up Controls

The Novasafe Dry Bed Abatement System has no electrical controls or alarms.

If a toxic gas monitor is provided, refer to the manual provided with the monitor for information regarding its controls and alarms.

6.2 Initiating Flow



After completion of the installation procedures, the Novasafe Dry Bed Abatement System is ready for initial startup.

	 WARNING
	Hazardous Fumes No hazardous gases should be allowed to flow to the Novasafe at this time.

1. Perform a leak test on the canister, if possible. Test all ports, whether they are in use or capped.
2. Start the house exhaust system, if not already running.
3. Start the vacuum pump upstream of the system.
4. Start the flow of CDA, if required.
5. Adjust the CDA flow rate to approximately 0.11 scfh (50sccm).
6. Purge the canister for at least one hour using inert gas flowing at least 0.7 scfm (20 slm).

6.3 Conducting the Hazardous Gas Trial

Perform the hazardous gas startup procedure described below be used the first time gas is introduced to the Novasafe Dry Bed Abatement System. This procedure can only be performed if a toxic gas monitor has been installed. If your system is not equipped with a monitor, or when the following procedure is completed, the Novasafe Dry Bed Abatement System is fully operational and ready to handle the gas flows and concentrations listed in the purchase specifications.

	 WARNING
	Hot Surface The treating of hydride gases is exothermic. An uncontrolled gas release into the scrubber may result in an excessively high temperature in the canister.

1. Turn on the hazardous gas at approximately ten percent of the projected normal flow rate.
2. Watch the toxic gas monitor. Be prepared to turn off the gas flow if the monitor indicates a hazardous level is present in the scrubbed exhaust.
3. After 15 minutes, increase the gas flow rate to 25 percent and continue to watch the toxic gas monitor.
4. After 15 minutes, increase the gas flow rate to 50 percent and continue to watch the toxic gas monitor.
5. After 15 minutes, increase the gas flow rate to 100 percent and continue to watch the toxic gas monitor.



Caution: Contact the CS CLEAN SYSTEMS Customer Support Center if anything unusual occurs during this startup procedure or if the toxic gas monitor indicates that there are hazardous gas levels present in the treated exhaust.

6. Repeat this procedure for each hazardous gas to be used.

7 Canister Replacement

7.1 Replacement Schedule

The Novasafe canister must be replaced when any of the following conditions occur during normal operation:

- When granulate has been consumed, as indicated by the toxic gas monitor (if one is installed).
- If the inlet pressure is no longer negative or when the pressure drop across the canister exceeds 2 inches wc (13 mm wc).

7.2 Air Oxidation

Perform air oxidation of the Novasafe, if required. Air oxidation is only required when hydride gases have been passed through the Novasafe. A typical air oxidation rate and time for the Novasafe is to purge the Novasafe at 20 slm for 4 hours. For more information on air oxidation, see Section 3.2.3.



INFORMATION: If you are unsure whether the process requires air oxidation, contact the CS CLEAN SYSTEMS Customer Support Center at +1 (203) 797-8155.

The procedure for air oxidation is:





1. Turn off and perform a lockout/tagout of all hazardous process gases to the Novasafe.
2. Purge the canister with nitrogen at 20 slm for one hour.
3. Connect a CDA supply to the Novasafe CDA port if it is not already connected. The CDA supply must include a flowmeter capable of measuring 20 SLM CDA.
4. Turn on the CDA flow at 5 slm and the N₂ supply flow at 15 slm. Let both CDA and N₂ run for 15 minutes checking periodically for heat on the exterior of the canister and monitoring the outlet for toxic gases. If no excessive heat or toxic gases are generated, go to Step 5. If heat greater than

100 °C occurs, turn off the CDA but continue to flow N₂ to cool the canister. If toxic gases are generated, turn off the CDA but continue to flow N₂ to purge the canister.

5. Increase the CDA flow rate to 10 slm and decrease the N₂ supply flow to 10 slm. Let both CDA and N₂ run for 15 minutes checking periodically for heat on the exterior of the canister and monitoring the outlet for toxic gases. If no excessive heat or toxic gases are generated, go to Step 6. If heat greater than 100 °C occurs, turn off the CDA but continue to flow N₂ to cool the canister. If toxic gases are generated, turn off the CDA but continue to flow N₂ to purge the canister.
6. Increase the CDA flow rate to 15 slm and decrease the N₂ supply flow to 5 slm. Let both CDA and N₂ run for 15 minutes checking periodically for heat on the exterior of the canister and monitoring the outlet for toxic gases. If no excessive heat or toxic gases are generated, go to Step 7. If heat greater than 100 °C occurs, turn off the CDA but continue to flow N₂ to cool the canister. If toxic gases are generated, turn off the CDA but continue to flow N₂ to purge the canister.
7. Increase the CDA flow rate to 20 slm and turn off the N₂ supply flow. Let both CDA run for 3 hours checking periodically for heat on the exterior of the canister and monitoring the outlet for toxic gases. If heat greater than 100 °C occurs, turn off the CDA and turn on N₂ to cool the canister. If toxic gases are generated, turn off the CDA and turn on N₂ to purge the canister.

7.3 Removing the Canister

1. Turn off the CDA flow (if in situ air oxidation was used during the process).
2. Purge the system with nitrogen flowing at least 0.7 scfm (20 slm) for one hour. If a toxic gas monitor is installed, wait until it indicates less than TLV for the gases being monitored.
3. Turn off the purge flow after the purge is complete.
4. Don the appropriate personal protective equipment (PPE).
5. Disconnect the inlet.

	 WARNING
	<p style="text-align: center;">Flammable Materials</p> <p>Depending on the process, some solid phosphorus may be present within the inlet to the canister and in the plumbing upstream of the canister.</p>

6. Ensure that no toxic gases are present when opening any ports on a consumed canister by using a hand-held gas detector.
7. Attach the KF-50 blank-off flange that came with the canister to the inlet.
8. Disconnect the outlet.
9. Attach the KF-50 blank-off flange that came with the canister to the outlet.
10. Remove the line or pressure monitoring device connected to the pressure port, if one is installed.
11. Cap the pressure port with the 1/4-inch compression fitting cap that came with the canister.
12. Remove the toxic gas sample line connected to the sensor port, if installed.
13. Cap the sensor port with the 1/4-inch compression fitting cap that came with the canister.

7.3.1 Disposing of the Canister



Environmental Hazard: Disposal of the consumed scrubber resin must be in compliance with all local, state, and federal regulations.

Properly dispose of the canister. Some consumed resins are classified as hazardous, while others are not. Contact CS CLEAN SYSTEMS to discuss proper waste disposal. The canister is considered hazardous waste if the Novasafe Dry Bed Abatement System was used to abate arsine and must be enclosed in another container prior to shipping. If you or your disposal facility have questions concerning the classification of consumed resin or shipping requirements, contact your CS CLEAN SYSTEMS representative. CS CLEAN SYSTEMS can also recommend a disposal facility if you do not already have a contract with one.



INFORMATION: If the canister was used to process only phosphine or boron trifluoride, the canister and its contents are not hazardous waste. Contact the CS CLEAN SYSTEMS Customer Support Center if you have any questions or if the canister was used in an application other than ion implant.

8 Preventive Maintenance

This chapter describes the weekly and quarterly maintenance procedures to ensure continuous trouble-free performance of the Novasafe Dry Abatement Bed System.

8.1 Weekly Maintenance



The weekly maintenance procedures consists of two visual procedures to verify that the Novasafe is operating correctly.

1. Perform a visual inspection of the pressure gauge (if installed) to verify the pressure drop across the Novasafe canister is not increasing. These values should be recording on a log each time the pressure is read. Increasing pressure is indicative of solid build-up at the inlet of the canister.
2. Perform a visual inspection of the paper detection option (if installed) to verify that the resin has not all be consumed. See Section 3.2.1 for more information about the paper detection option.

8.2 Quarterly Preventive Maintenance

Shut down the vacuum pump connected to the inlet of the Novasafe Dry Bed Abatement System before performing quarterly preventive maintenance.

If a toxic gas monitor is employed, refer to its operation and maintenance manual for required maintenance intervals and procedures.

	 WARNING
	Hazardous Fumes Always purge the canister as described below before opening any port on the canister.



1. Turn off the CDA flow (if in situ air oxidation was used during processing).
2. Purge the system with nitrogen flowing at least 0.7 scfm (20 slm) for one hour. If a toxic gas monitor is installed, wait until it indicates less than TLV for the gases being monitored.
3. Turn off the purge flow after the purge is complete.
4. Turn off the vacuum pump connected to the inlet of the canister, perform a lockout/tagout of the vacuum pump and ensure purge gas is not flowing.
5. Don the appropriate personal protective equipment (PPE).
6. Disconnect the inlet.
7. Check the inlet to the Novasafe System for the accumulation of solids and remove any that is present.
8. Reconnect the inlet.
9. Remove the line or pressure monitoring device connected to the pressure port, if one is installed.
10. Check the port and inlet of the pressure sensing device or the lines leading to the pressure device for the accumulation of solids and remove any that is present.

9 Troubleshooting

Shut down the vacuum pump connected to the inlet of the Novasafe Dry Bed Abatement System before performing troubleshooting or repair.

9.1 High Pressure at Tool

1. Check for leaks.
2. Check for adequate house exhaust draw.
3. Check for an accumulation of solids in the plumbing between the vacuum pump and the Novasafe canister.



INFORMATION: Measuring the pressure at the inlet of the canister helps to determine the location of the blockage.

- A. If the Novasafe canister is blocked, replace the canister.
- B. If the line upstream of the canister is blocked, either remove the blockage or replace the line.

High pressure can also occur at the tool during startup. When chamber pump-down begins, there is a transient pressure drop across the Novasafe canister due to the large initial flow rate. For a new canister, this value is approximately 5 inches wc (13 cm) for a 35 scfm (990 slm) vacuum pump. The actual value of this pressure spike varies as a function of pump size, chamber volume, foreline size, and other factors. If this pressure is unacceptable, place a flow dampening device, such as an HPS™ Auto-Soft® flow-actuated check valve, in the foreline upstream of the vacuum pump. With a flow dampening device, the momentary maximum pressure drop can be reduced to less than 0.5 inches wc (13 mm wc).

9.2 Toxic Gas Breakthrough

1. Check the process.



INFORMATION: The Novasafe Dry Bed Abatement System is designed to last approximately one year on most ion implant processes, but some processes may decrease the unit's lifetime significantly.

2. Ensure the toxic gas sensor is sampling the outlet (top) of the canister. See Figure 4-2.
3. Refer to the toxic gas monitor operating and maintenance manual.

9.3 Inlet Pressure Increase

Inspect the inlet of the canister particulate accumulation as described in Section 8.2. If accumulation cannot be removed, replace the canister.

A Parts List

Table A-1 lists the recommended spare parts for the Novasafe Dry Bed Abatement System. When ordering parts, provide the Novasafe model and serial number.

Table A-1. Suggested Parts for Preventive Maintenance

Part Number	Description	Purpose	Quantity
1834-04	Clamp, Wing Nut, ISO Flange, Aluminum, NW50	Replacement KF-50 clamp	2
1827-05	Seal Ring, ISO-KF, SST/Viton, NW50	Replacement KF-50 seal ring	2
1838-05	Flange, Blankoff, ISO-KF, SST, NW50	Replacement KF-50 blank	2
1734-04	Cap, Compression, SST, 1/4 OD	1/4-inch compression fitting cap	2
0232-02	Plug, Pipe, Hex Head, SST, 1/4 MNPT	1/4-inch male NPT plug	1
438-10958-00	Gauge, Pressure, 0-5" WC	Measure pressure across canister	1

CS CLEAN SYSTEMS also recommends that the user keep on hand at least one spare flow dampening device (if used) and one spare pressure monitoring device (if used).

