

Portable Sanitization Chamber

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Operation Manual

Document

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1.0 INTRODUCTION

W.L. Gore & Associates needs a portable sanitization device that will decrease the bioburden levels of *Bacillus atrophaeus* past a certain threshold. Many devices today are used for sterilization, but that is not always what is needed in the medical field. W.L. Gore is looking for a device that is safe for all users, portable, reduces the level of bioburdens on various instruments and materials, cost efficient, and finishes the process in a certain time limit. This device would mainly be used in the medical field or in certain industries where sanitization is needed on a regular basis. The scope of the project described by W.L. Gore can be found in Appendix A.

The goal of the project is to develop a portable sanitization process that sanitizes bioburden amounts past acceptable levels. The design, testing, and manufacturing must not exceed \$3,000 and the process must be safe to the user and environment under OSHA standards.



Figure 1.1: Initial Prototype



Figure 1.2: Final Prototype

2.0 OPERATIONS

The following section provides detailed steps on the operating procedure.

Safety:

When using the chamber to sanitize objects, be sure to wear safety goggles in case of exposure to hydrogen peroxide. If eyes become itchy and irritated, immediately rinse out with water. Do not touch the fogging machine mounted on top of the chamber. The cover of the fogging machine may be hot. When moving the chamber, utilize handles provided on the sides. If anything goes wrong, the emergency switch will turn off all power for the machine. If this occurs, be sure to

wait at least two hours to open the door to ensure that the user is not affected by hydrogen peroxide that is left in the chamber.

Setup:

In order for the system to begin the process, the door must be closed. Once the door has been closed and latched, the process can be started by pressing the start button. The display prompts the user to choose the type of cycle to run. Press the start button repeatedly until the desired process is display, then wait for 5 seconds to select. The selected process runs autonomously and the display will prompt the user when complete in conjunction to the corresponding LED lights. Table 2.1 shows the LED light codes and their corresponding meanings.

Table 2.1: LED light codes

Before START

Flashing YELLOW	Door is open
Solid RED, Flashing GREEN	Door closed, Waiting for user to press start

After cycle is initiated

NO lights	Default mode, wait 5 seconds to select
Solid RED	Quick cycle (10s soak, 40 sec UVC), wait 5 seconds to select
Solid RED and YELLOW	Long cycle (2mins soak, 5min UVC), wait 5 seconds to select
Solid RED, YELLOW, and GREEN	UVC test (10s uvc), wait 5 seconds to select

During cycle

Flashing GREEN	Waiting for fogger to become ready
Solid GREEN	Fogger is ready, cycle is running
Flashing RED and GREEN	Cycle is done and waiting for user to open door

Do not attempt to unlatch the door during use. Door lock engages when running to prevent users from opening the chamber, preventing exposure to ultraviolet light and hydrogen peroxide.

Test Procedure:

Three sets of tests were performed using BI strips with a certain amount of *Bacillus atrophaeus* spores. Three different objects were tested with a BI strip placed on top of the material. These materials include a metal hemostat, plastic tackle toolbox, and a lab notebook. When placing objects of similar material into the chamber to be sanitized, Table 2.2 can be used as a reference as to how close the object will get to sterilization with the given cycle. A result of >10,000% means that the object was completely sterilized. All of these objects can reach sterilization, the user will need to change the cycle to a longer time in order to achieve this with the tackle toolbox and the notebook.

Table 2.2: Testing and Results

Object	Components	Time	Concentration	Results
Hemostat	H ₂ O ₂	30 seconds	3 mg/L	>10,000%
	UV lights	40 seconds	8 light bulbs	
Tackle Toolbox	H ₂ O ₂	30 seconds	3 mg/L	3000%
	UV lights	40 seconds	8 light bulbs	
Notebook	H ₂ O ₂	30 seconds	3 mg/L	98% of 1 log
	UV lights	40 seconds	8 light bulbs	

3.0 COMPONENTS

This section contains all of the components of the sanitizing chamber. Figure 3.1 shows each component numbered.

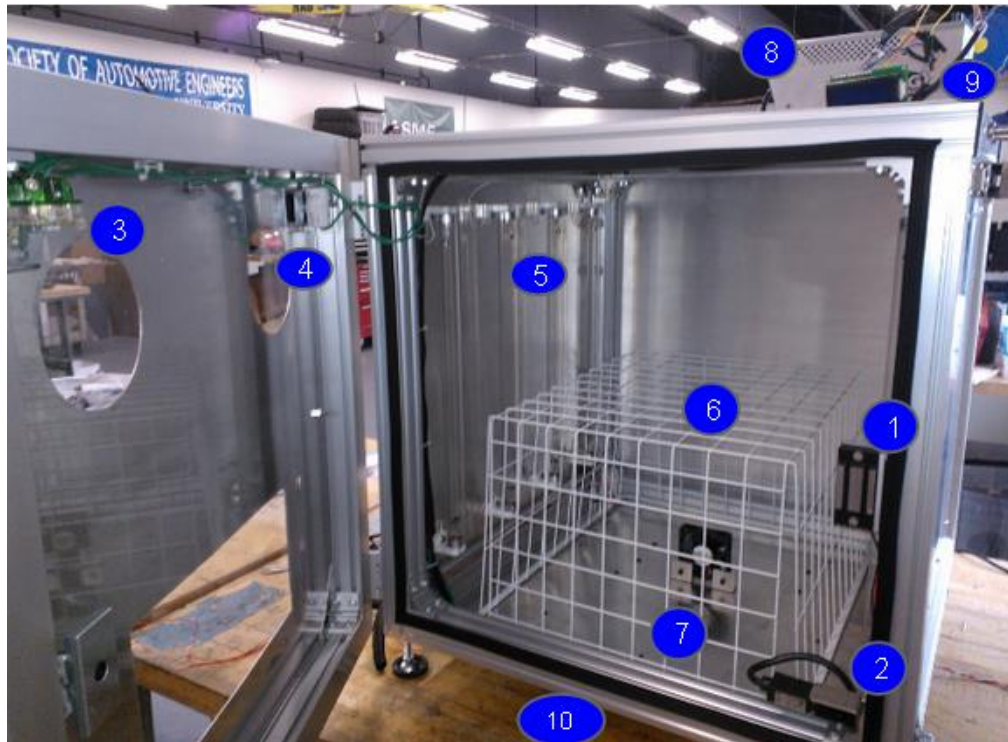


Figure 3.1: Components

- | | |
|-----------------------|---------------------------|
| 1. Magnetic Lock | 6. Rack |
| 2. Safety Switch | 7. Fan |
| 3. Start Button | 8. Fogging Machine |
| 4. Emergency Shut-off | 9. LCD/LED Display |
| 5. UVC Lights | 10. Electrical Components |

Magnetic Lock:

This safety feature works when an electrical signal passes through the device. When activated, the lock prevents the user from opening the chamber while the sanitization process is running. The lock has a 80 pound pull so it is incredibly hard to force open when the operation is in progress.

Safety Switch:

This device detects whether the machine is open or closed. This feature is to prevent users from using the machine while it is open. Take caution to not accidentally bend the pin that connects the door to the safety switch while inserting objects to be sanitized.

Start Button:

Figure 3.2 shows the door of the chamber with the emergency shut off and start buttons. The start button has several settings that allows for different sanitization cycles when pressed. The cycles include default cycle, quick cycle, long cycle and UVC light cycle. These cycles can be determined by the display on the LED/LCD screen.



Figure 3.2: Emergency Shut-off (Left button) and Start Button (Right Button)

Emergency Shut-off:

Figure 3.2 shows what the button looks like from the front. The emergency button acts as a power off device and a kill switch. The primary purpose of this device is to cut off all power to the chamber and stop all process in case of an emergency. The only down side to this is that if pressed while the operation is in progress, the user must wait up to 2 hours before opening the chamber so that the hydrogen peroxide fully dissipates. When pressed in, this switch can also act as an off switch so nothing is on while plugged in. In order to bring power back after pressing the button in, simply pull the button back out to its original position.

UVC Lights:

The chamber uses eight TUV T8 bulbs. The specifications for the bulb are listed below:

- Cape Base-G13
- Bulb-T8
- Bulb life- 9000 hr
- Watts- 25W
- Lamp voltage- 48V
- UV-C Radiation- 7 W
- Mercury(Hg)- 2.0 mg
- Diameter- 28 mm
- Overall Length- 451.6 mm
- Product name- TUV 25W 1SL

The UVC lights should have no reaction to the hydrogen peroxide. Lights can easily be replaced when needed, as long as all of the specifications listed above are met. When replacing a light bulb, the user should be careful to not touch the glass and to properly dispose of any broken or non-working light bulbs.

Rack:

The rack is used for the placement of various medical objects that need to be sanitized. It is interchangeable and can be fully removed. This allows for objects of various sizes to be sanitized.

Fan:

A small fan was attached to the middle bottom of inside chamber. It helps in the circulation of the hydrogen peroxide vapor.

Fog Machine:

The fog machine is the component that contains the hydrogen peroxide. Most stores carry the 3% hydrogen peroxide that is used in the machine. On the back of the fog machine is where the user can see how much hydrogen peroxide is left in the machine. Be sure to always have liquid in the machine so that it does not overheat. Hydrogen peroxide can be added by removing the black knob on the top and pouring it in. Be sure to replace the top so that the hydrogen peroxide is not exposed to light for very long. The fog machine heats the hydrogen peroxide enough to vaporize the liquid, so do not touch the fog machine or the tube attached to the nozzle because it will be very hot. Figure 3.3 below, shows the fog machine.



Figure 3.3: The Fog Machine

LCD/LED Display:

The liquid crystal display (LCD) and light-emitting diode (LED) indicate each stage of the process inside the chamber. The LCD screen displays the progress in words, while the LED display describes the same progress but in colored and flashing lights. The meaning of the LED light combinations can be seen in the operation section. Figure 3.4 shows a close up of the display.



Figure 3.4: LED/LCD Display

Electrical Components:

The electrical components are mounted on the bottom of the chamber away from the viewer's eye. Figure 3.4 shows what the bottom of the chamber looks like. This housing contains all of the wiring for the electrical system along with the ballasts for the UV lights and the Arduino Mega that acts as the main control system. The ballasts used are just regular fluorescent light ballasts that hold up to four bulbs, so if there is ever a need to replace one they can be easily found at a hardware store.

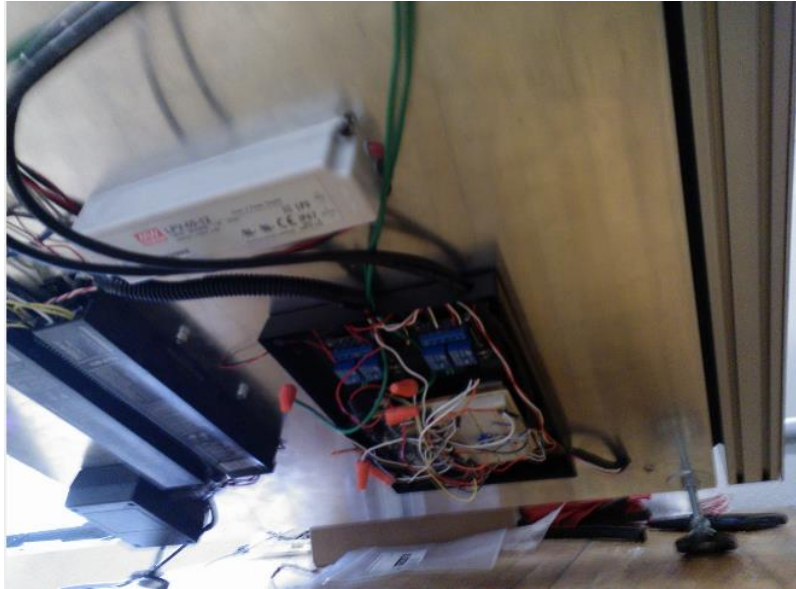


Figure 3.5: Electrical Components

Figure 3.5 below shows the Arduino Mega Microcontroller that controls the entire system. It is an open source microcontroller used for prototyping. The Arduino comes in many different shapes and sizes, all able to accommodate different applications. The MEGA has far more digital pins for interacting with different components than other iterations of the Arduino. It has a USB port for easy programming and is powered by 12 Volt DC power.

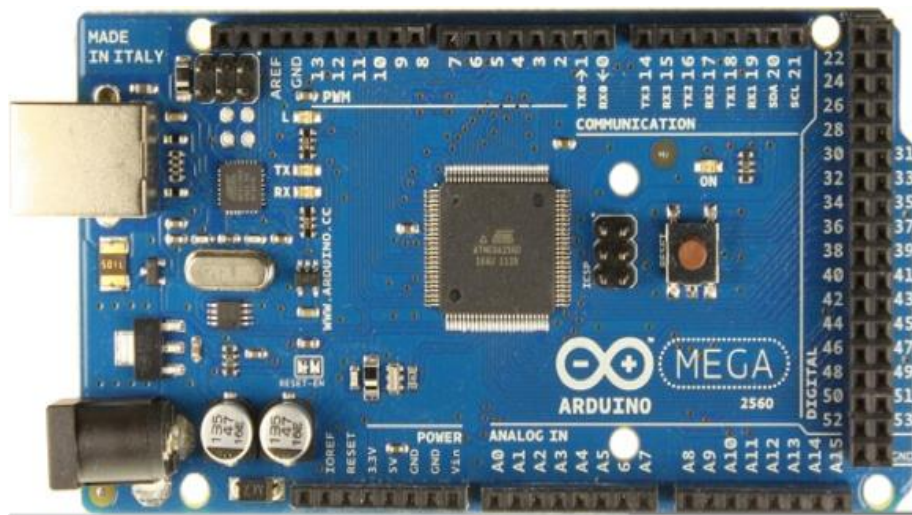


Figure 3.6: Arduino Mega Microcontroller

4.0 ASSEMBLY

The chamber with all electrical components and fogger will be fully assembled upon purchase.

Light Bulbs:

The light bulbs must be inserted into the light bulb ballast. To attach the bulb, insert the bulb into the ballast and gently turning the bulb until it slips and locks in place. To remove light bulbs, gently turn and pull the bulb out of the ballast. When changing light bulbs, make sure to touch the glass as little as possible. Oil from the skin can harm the UV lights.

Fog Machine Fuse:

In the case of a blown fogger fuse, the fuse can be replaced. If the fuse is blown, the red light on the back of the fog machine will be off when the power is on. To replace the fuse, unscrew the fuse cover on the back on the fog machine and pull out the burnt fuse. Replace fuse with a new 5mW fuse and replace the fuse cover, ensuring that the fuse cover is on tightly.

5.0 MAINTENANCE

Regular maintenance of the machine is essential to ensure that the chamber will work at optimum performance throughout the life of the product. The following consists of what needs to be done to keep the chamber running at full potential.

- If the process is being used multiple times throughout the day, allow the door to be open in between runs so that the humidity from the hydrogen peroxide doesn't build up.
- Check that the fog machine is filled with enough hydrogen peroxide on a daily basis. The fogging machine should not be running without liquid.
- If used multiple times a day, wipe down the inside of the chamber so that there is no buildup of hydrogen peroxide or any other chemicals.
- Test the emergency off button once a week to ensure that it still functions properly. If all of the power is turned off after pushing the button, then it is still working.
- Ensure that the electromagnetic lock is clean and free from debris before shutting the chamber door.