

Smoke Generator

(Part #: 601-2050-002)

USER MANUAL

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Essential Safety Notes

This section describes potential hazards which may exist in the operation of these units. A number of warning labels and symbols are affixed to your instrument. These symbols are used to inform you of potential dangers which may exist or where caution is required. Before installing your new unit, please take time to familiarize yourself with these warnings and symbols.

THE PROTECTION GIVEN BY THE EQUIPMENT MAY BE IMPAIRMENT IF USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER.

Hazards and Warnings

This instrument is subject to the following identified hazards:



Do not locate the smoke generator near flammable or heat-sensitive materials.



Never operate the smoke generator with the glass door open. THE IGNITER GETS EXTREMELY HOT

Welcome

Congratulations on joining the community of users worldwide who rely on DSI products to perform preclinical physiologic research. Thank you for your interest in DSI products. We are committed to providing you with quality products and services.

The smoke generator smokes cigarettes and delivers the smoke to most any exposure apparatus (chamber, tower, etc.). The smoke generator accommodates up to eighty cigarettes and allows separate or combined exposures to direct and/or indirect smoke.

Menu options include:

- Adjustable draw period
- Adjustable draw frequency
- Adjustable draw volume
- Adjustable cigarette smoke duration
- Adjustable pause between cigarettes
- Service mode activation
- Total cigarettes smoked counter/reset
- Adjustable lighter position

The cigarettes are smoked in sequence; as one cigarette is completed, the next one is automatically loaded and ignited. This sequence continues until all eighty cigarettes are smoked.



Note: The number of cigarettes to be smoked is configurable by the user and can be extended beyond eighty using the Hopper Extender (601-2113-001)

Application Overview

For respiratory or other physiological investigations related to cigarette smoke, a cigarette smoke generator is needed. One or more test subjects may be placed in a mass dosing chamber for a general exposure, or an inhalation tower may be used for individual exposures. A burning cigarette generates two sources of smoke: (1) environmental smoke wafting from the burning end of the cigarette - we refer to this as indirect smoke, and (2) smoke drawn through the cigarette and filter (if provided) - we refer to this as direct smoke.

System Components

The Buxco smoke generator is an integrated self-contained unit. All components are housed in a single cabinet. The major components include:

- The sealed firebox containing (Figure 1)
 - An orifice where cigarettes are inserted for puffing
 - A lighter assembly
 - A cigarette waste collection tray
- A pressure sensor used for detecting the presence of each cigarette
- A glass door with latches for access to the firebox (Figure 3)
- The pump for clearing and delivering indirect smoke
- The pump assembly for drawing and delivering direct smoke
- A display for viewing settings and messages during operation (Figure 1)
- Menu pad for adjusting operational settings (Figure 1)
- Power cord
- Tubing for the delivery of direct and indirect smoke
- Exterior filter to protect the internal components

The top view of the unit can be seen in Figure 1. The top of the unit includes the following components:

- Menu Pad
- Hopper Access Panel
- Firebox Viewport

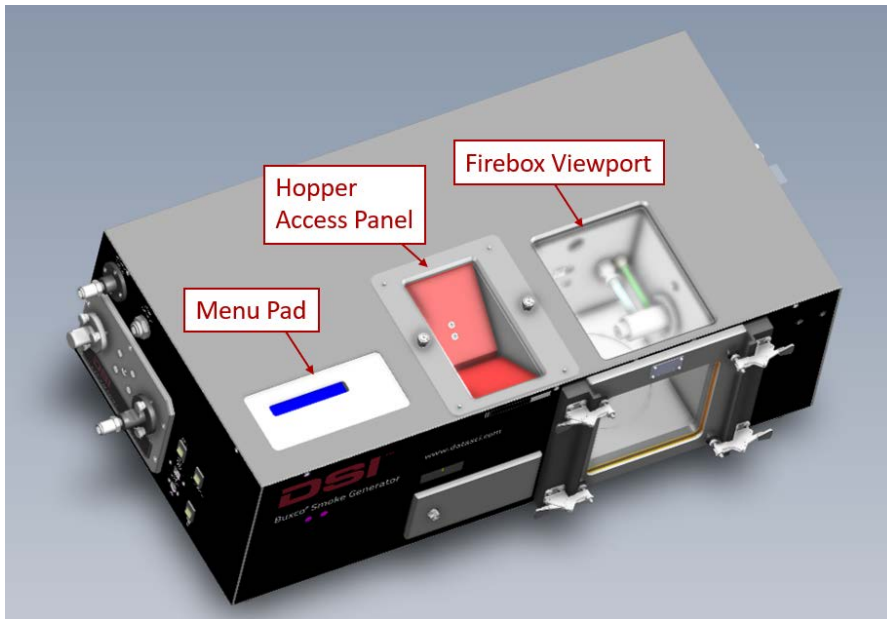


Figure 1 Top View

The left side of the unit can be seen in Figure 2. This side of the unit hosts several items of interest including:

- The Indirect Smoke port
- The Direct Smoke port
- Power switch
- USB port (for service by Buxco technicians)
- Power connection
- Light switch



Figure 2 Left Side View

Additional Components

The Hopper Extension (601-2113-001) can be added to the smoke generator to support additional cigarettes being loaded into the Hopper. The Hopper Extension (see Figure 3) is placed above the hopper to load and hold cigarettes and should be used when the user would like to load up to 300 cigarettes.

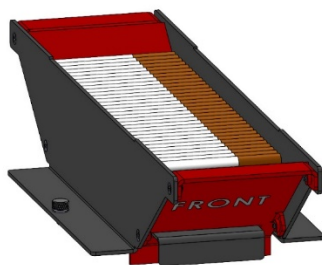


Figure 3 Hopper Extension

The Smoke Generator Pool (601-2114-001) can be used to easily wash out discarded cigarettes butts from the cigarette waste collection tray. To connect the pool to the smoke generator,

1. Remove the cigarette waste collection tray from the firebox.
2. Remove the bottom plug in the smoke chamber.
3. Insert the joint tube with the O-rings into the smoke chamber from underneath the controller.
4. Set the controller on the pool and being careful to align the joining tube with the pool.

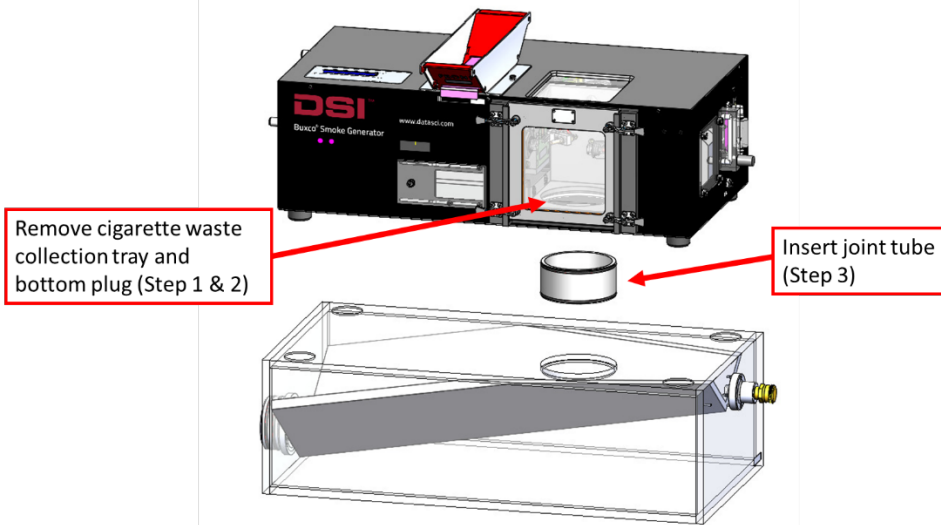


Figure 4 Connecting the Smoke Generator with the Pool.

The pool is filled with water by filling water on the right side of the pool prior to utilizing the smoke generator. The Pool should be drained by utilizing the drain port on the right side of the pool.

	Note: The Smoke Generator Pool, 601-2114-001, shown in Figure 4 is intended to be filled with water to extinguish cigarettes upon ejection. Operation of the unit without adding water will damage the box.
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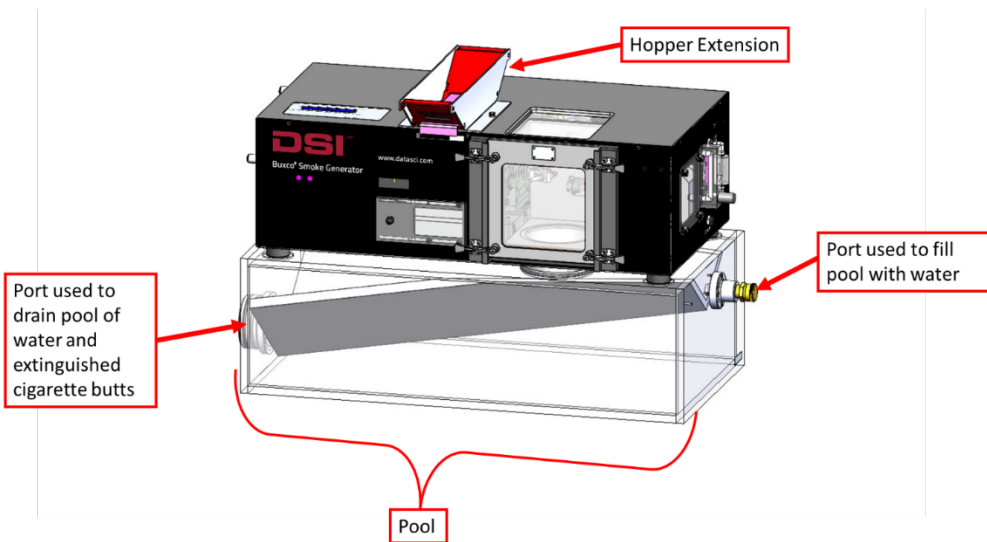


Figure 5 Smoke Generator with Hopper extension and Pool.

Basic Setup

1. To set up the Buxco smoke generator, first place the unit on a secure stable bench, stand, cart, or rack capable of supporting at least 100 pounds (45 kg) and away from any flammable or heat-sensitive materials.



Important: It is recommended that the smoke generator be located in a dedicated room, if possible, with good ventilation.

2. Attach the power cord and plug it into a power outlet.
3. Connect tubing provided (cut to desired length depending on set up) to the Direct and Indirect Smoke ports (see picture). The tubing is connected by pushing the end firmly into the respective ports.
4. Decide which type(s) of smoke will be used for your study and connect one or both of the tubes to the exposure chamber. If one of the smoke sources will not be used, place the open end of that tube in a ventilation hood or other exhaust handling system.

Note: For safe operation, and to prevent premature wear on internal components, do not block either the direct or indirect exhaust ports.

5. Ensure the collection tray or pool and the glass firebox door are securely in place.

The smoke generator is now set up and ready to use.

Loading cigarettes

The ember smoke generator utilizes a hopper loading assembly that makes loading the cigarettes quick and easy. First, remove the hopper cover from the top of the machine.

Next, paying attention to the image printed on the surfaces inside the hopper (see Figure 4), place up to eighty cigarettes in the hopper with the butts toward the firebox. Finally, reinstall the hopper cover



Figure 6

Depending on the length of the cigarettes being used, it may be necessary to calibrate the positioning of the lighter assembly inside the firebox. When the lighter assembly is extended, the cigarette tips should just touch the igniter or at least fall within 1/8-inch (32mm) of the igniter.

During operation, once the igniter has lit the cigarette, the lighter assembly will retract for unobstructed airflow. Calibration of the positioning of the lighter assembly will be covered in the [Calibrate Lighter](#) section.

Operation

To operate the ember Smoke Generator, first turn on the power. When on, the display will show how many cigarettes the user has chosen to smoke during a single run. Pressing the up/down buttons on this screen will cause the number to increase/decrease, respectively. To reduce unnecessary wear on the internal components, the number of cigarettes to smoke should be less than or equal to the number of cigarettes loaded. If the number selected is greater than the number of cigarettes loaded the ember unit will detect after a few failed attempts that no more cigarettes are available and will automatically abort.

Cigarettes loaded: 80
Press Start to begin

Next, use the menu pad to select the desired settings. Pressing the "Menu" button repeatedly cycles through the settings options. Note: A timeout of five seconds exists on all manual input menu screens. If no activity occurs within that timeout the menu will return to the default "Cigarettes loaded" screen in preparation to run.

Period

The Period is the length of the draw part of the cycle in seconds. The cycle is split 2/3 draw (analogous to inhalation), 1/3 return (analogous to exhalation). The Period can be set from 1 to 3 seconds in 0.5 second increments. Example: A Period setting of 2.0 will draw on the cigarette for 2.0 seconds and return over 1.0 seconds.

```
Period: 1.0 sec
Set draw (puff) duration
```

Use the Up/Down arrows to choose the desired setting and press OK.

Puffs/min

The Puffs/min setting determines the frequency of draw cycles. This can be set from 1 to 5 puffs/minute in 1 puff/minute increments. Example: A Puffs/min setting of 3 will result in puffs that begin every 20 seconds.

```
Puffs/min: 5
Set # of puffs per min
```

Use the Up/Down arrows to choose the desired setting and press OK.

Volume

The Volume setting determines how much air will be drawn during a puff. This can be set from 35 to 55 ml in 5 ml increments. Example: A Volume setting of 45 means 45 ml of smoke-containing air will be drawn through the cigarette and delivered as direct smoke.

```
Volume: 55 ml
Set the draw volume
```

Use the Up/Down arrows to choose the desired setting and press OK.

Recommended ranges

While each of the settings above can be set as described, some combinations are not recommended. If an improper combination has been selected the following error screen will be displayed.



Parameters Are Invalid
Refer to User Manual (OK)

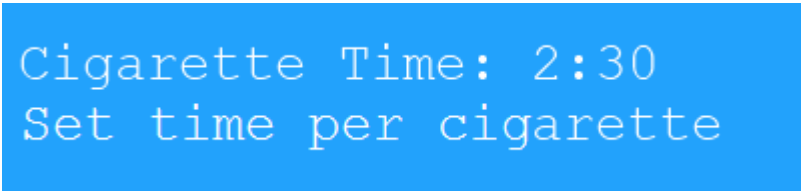
Press OK and adjust one or more settings to build a recommended combination. **WARNING: Operating outside the recommended range of combinations can shorten the smoke generator's life.**

The chart below shows recommended settings combinations.

Period	Puffs/min				
	1	2	3	4	5
1.0					
1.5					
2.0					Caution
2.5				Caution	Caution
3.0			Caution	Caution	Caution

Cigarette Time

The Cigarette Time setting specifies how long the smoke machine should smoke each cigarette. By default, the smoke generator is set to smoke cigarettes for two minutes and thirty seconds. Depending on the length of the cigarettes being used and other atmospheric factors this time may need to be adjusted. This setting can range from one to ten minutes in fifteen second increments. The ideal smoke time should be set so that approximately ¼" or 6mm of tobacco is left on the cigarette. This allows for deviations in manufacture of cigarettes and prevents the burning of the filter elements.



Cigarette Time: 2:30
Set time per cigarette

Use the Up/Down arrows to choose the desired setting and press OK. Note: This setting can be changed "on the fly". While the ember unit is smoking cigarettes the time remaining will periodically be displayed on the screen. Pressing up/down will add/subtract 15 seconds to the time remaining. It is useful to watch the first cigarette and make the necessary adjustments to the smoke time in order to produce the best results for the remaining, unsupervised cigarettes.

Pause between cigarettes

By default, when one cigarette is fully smoked, the next one is ignited after a two minute delay. For some studies a greater delay between cigarettes is desired. This setting can be changed from 0 to 60 minutes. Note: Selecting a pause period less than two minutes will cause premature contamination, and require more frequent replacement, of the filter on the side of the ember unit (see Figure 5).

Pause Period: 2 mins
Time Between Cigarettes

Note: When installing new filters, make sure the arrow on the filter points in the same direction as the arrows printed on the side of the ember unit (Figure 6).

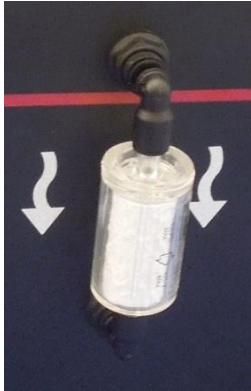


Figure 7

Service Mode

This menu option is set only before you plan to clean the unit (see Maintenance section below).

Service Mode
Press OK to begin

Total Smoked Counter/Reset

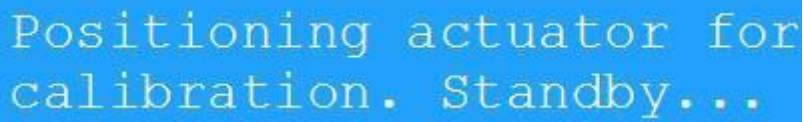
The ember smoke generator keeps track of the number of cigarettes it has smoked. A user may prefer to reset this counter when you replace filters so you can keep track of a filter's remaining life expectancy. If so, the counter should be reset when the filter is replaced.

Some users may want to keep track of the total number of cigarettes smoked since the unit was put into service. In this case the user should never reset the counter. Note: These users may find it helpful to record the number of cigarettes smoked when filters are replaced so that they can calculate the remaining life expectancy of the filter.

Total Smoked: 0
Press OK to Reset

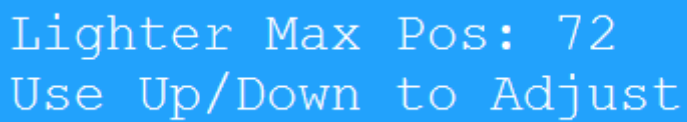
Calibrate Lighter

As mentioned earlier, the positioning of the lighter assembly may need to be adjusted depending on the length of cigarettes being used. To perform this task the user must first remove the door to the firebox. Then, with the unit powered on press the menu button until the following screen appears.



Positioning actuator for
calibration. Standby...

This screen indicates that the ember unit is clearing the cigarette orifice so a new cigarette may be inserted. It is also positioning the lighter to its extended (Max) position. The following screen will display when the unit is ready for calibration.



Lighter Max Pos: 72
Use Up/Down to Adjust

At this point, the user should quickly insert a cigarette into the orifice and begin moving the lighter assembly with the up/down buttons on the menu pad to the desired location. If the lighter is extended so much that inserting a cigarette would damage the cigarette, first retract the lighter assembly then insert the cigarette. When the lighter just touches a fully inserted cigarette and causes a slight bend the calibration is complete. Either press Menu to return to the start screen or wait five seconds for the automatic menu reset mentioned earlier.

When all settings are selected, press the "Start" button to begin. Once started, the first cigarette will be loaded and lit.

The cigarette will be smoked according to the settings chosen. When the time remaining countdown reaches zero the cigarette waste will be ejected and the next cigarette will be loaded. This will continue until all of the cigarettes have been smoked.

After the cycle has been completed a screen will indicate that the cigarette waste should be removed for the unit. Turn off the power, open the glass door to the firebox, and empty the cigarette waste collection tray. Reinsert the tray and reinstall the glass door before restoring power to the ember unit.

Maintenance

Overview

This section explains how to properly maintain your DSI smoke generator and keep it working in top condition. If you regularly perform the required routine maintenance on your generator (shown in the table below), you will increase its working life and minimize the chance that a failure will occur right in the middle of one of your critical smoke experiments.

The main enemy of the smoke generator—no surprise here! —is the tar generated by the cigarettes it smokes. As smoke passes through the generator, tar is deposited in the tubes, cartridges, O-rings, and other internal components of the generator. To prevent this liquid tar from slowly turning into a solid/semi-solid sludge that can truly impair the generator’s performance, the liquid tar *must* be removed daily from the two direct smoke cartridges (described below). The cleaning process is quick and easy, and if you do it *every single day*, the process becomes part of your shutdown and start-up routine and takes just minutes to complete.

Thereafter, the required routine maintenance depends on either 1) the number of cigarettes the generator has smoked, or 2) the time that has elapsed since a particular maintenance task was last performed. A schedule of required maintenance tasks for the generator is shown below. An enlarged version of this table is provided at the end of this document. We suggest you print the page and pin it up in the lab next to the generator as a reminder.

Description of Required Routine Maintenance	Daily**	Every week or 200 cigarettes*	Every two weeks or 400 cigarettes*	Every 500 cigarettes*	Every month or 800 cigarettes*
Clean cartridges with isopropyl alcohol (IPA)	X				
Brush the inside of the cartridges. Grease all the O-rings.		X			
Inspect all cartridge O-rings and replace if brittle.			X		
Replace pump filter.				X	
Brush the inside of the transverse lung pipe.					X

* Whichever comes first.

** No matter how many cigarettes have been smoked.

These maintenance tasks are described in more detail in the following sections.

Cigarette Waste Trays

The waste trays provided should be removed and cleaned after every run. Failing to do so can cause the cigarette waste to build up and block the cigarette delivery robotics, causing failures in delivery. **Caution: Hot ashes should be handled carefully and placed in water or a nonflammable container.**

Cleaning Instructions

Within the Firebox, the tray needs to be emptied each time the cigarettes are reloaded. In order to keep the top of the Firebox clear for viewing, the top glass needs to be wiped down when necessary.

In order to increase the longevity of the unit, the areas where most tar accumulates are removable for cleaning purposes. These cartridges, seen in Figure 8 are held down by thumbscrews. We recommend removing them every 500 cigarettes and bath them in alcohol. Use the brush provided to ensure the internal pipes are clean. Note: enter service mode (described earlier) before removing and inserting cartridges.

Cleaning the Cartridges with IPA

This section tells you how to clean the two direct-smoke cartridges with isopropyl alcohol (IPA). The cartridges should be cleaned **every day** (at the end of the working day), no matter how many cigarettes the generator smoked during the day. The purpose of this daily cleaning is to prevent liquid tar from accumulating and drying out over time, creating a semi-solid/solid sludge that can negatively affect the generator's performance.

Do this daily—no matter how many cigarettes have been smoked.

1. Locate the two direct smoke cartridges in the left side panel of the generator.



Figure 8: Smoke Cartridge

2. Remove the three knurled retaining screws (marked with a red arrow in Figure 7) that attach each cartridge to the generator.

3. Pull the cartridges out of the generator and place them in glass container with enough isopropyl alcohol (IPA) to completely submerge the cartridges. Keep the cartridges submerged overnight to soak.
4. Next morning, dry the cartridges (both inside and outside) with a paper towel, reinsert them into the generator, and re-install the three retaining screws, which should be hand tightened. Please note that the position of the screw holes in the left and right cartridge prevents you from inserting a cartridge in the wrong hole. If the holes will not align, the cartridge is in the wrong hole.

Brushing Out the Cartridges and Greasing the o-rings

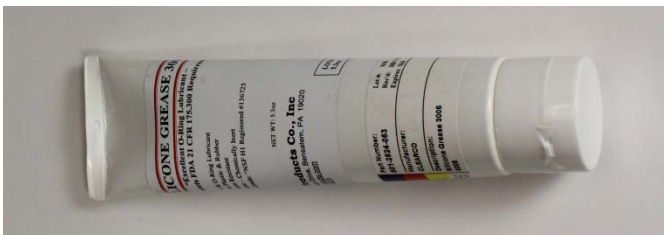
Every week, or after 200 cigarettes have been smoked, the internal surface of the direct smoke cartridges should be brushed out to prevent tar build-up, and all the O-rings should be greased. A special bore brush and necessary grease have been provided in the generator's maintenance kit. This is important! The cartridges must be soaked overnight *before* the cartridges are brushed out and the O-rings are greased.

Do this weekly or after 200 cigarettes have been smoked.

1. Remove the two direct smoke cartridges by unscrewing the three retaining screws and pulling the cartridges out of the generator.
2. Place the cartridges in isopropyl alcohol (IPA) overnight to soak.
3. After the cartridges have been soaked *overnight*, remove the cartridges from the IPA and dry them (both inside and outside) using a paper towel.
4. Locate the bore brush (shown below) in the generator's maintenance kit.



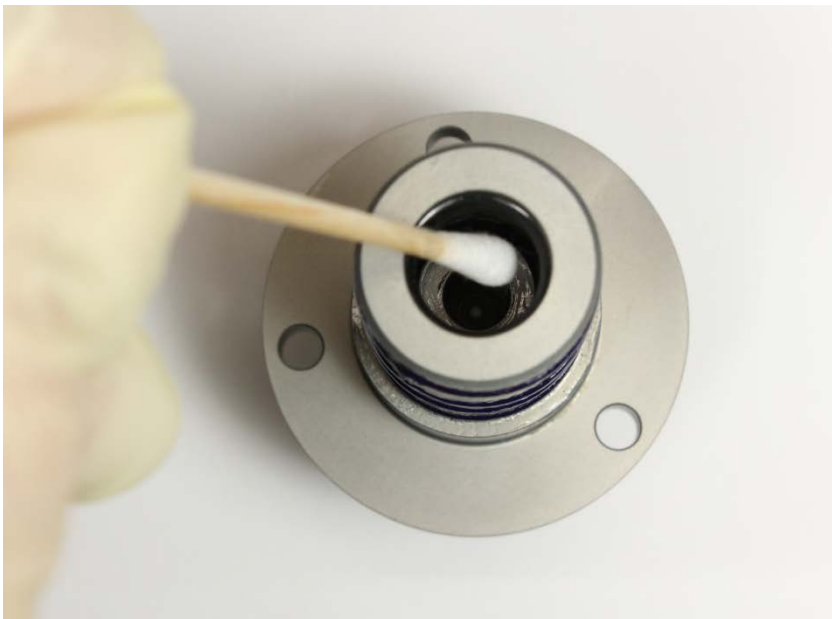
5. Run the bore brush several times in and out of the internal bore of each cartridge.
6. Locate the tube of O-ring grease in the generator's maintenance kit.



7. Using your finger, rub a small amount of grease onto the four external O-rings on the left cartridge and the two external O-rings on the right cartridge.



8. Using a cotton swab, rub a small amount of grease onto the internal O-rings inside the left and right cartridge. Because these can be difficult to see, please note that there are *two* internal O-rings in each cartridge.



9. Reinsert the cartridges into the generator and re-install the three retaining screws, by hand-tightening. If the screw holes will not align, the cartridge is in the wrong hole.
10. Clean the bore brush in IPA after maintenance is complete.

Inspecting all cartridge O-rings—both internal and external

Every two weeks, or after 400 cigarettes have been smoked, the internal and external O-rings on the two direct smoke cartridges should be inspected for the following defects:

- Cracking, distortion, or other obvious visual flaws
- Brittleness or lack of flexibility

Rings with any of the above indications should be replaced using a new ring from the generator's maintenance kit. Rings with no defects may be reused.

Do these every two weeks or after 400 cigarettes have been smoked

1. Remove the two direct-smoke cartridges by unscrewing the three holding screws and pulling the cartridges out of the generator.
2. Locate the "O-ring removal tool" (shown below) in the generator's maintenance kit.



3. Put on rubber gloves (so you do not handle any tar-contaminated components) and remove (using the O-ring removal tool) all the external O-rings from the two cartridges.



4. Feed the removal tool into the internal bore of the cartridge, and pry part of the O-ring out of its seating groove. Grab the O-ring with a pair of tweezers and completely remove it. Please note that there are two internal O-rings in each cartridge.
5. Inspect all O-rings for the following defects:
 - a. Visual defects—such as cracking or distortion.
 - b. Brittleness or lack of flexibility.
 - c. Discard all rings that display any of the above symptoms.
6. Place any rings that pass inspection into a beaker of isopropyl alcohol (IPA), add the two cartridges, and soak these components overnight. This will ensure that the seating grooves on the cartridges as well as the old rings are thoroughly clean, before being re-installed.

7. After soaking overnight, use the brush to clean the inner bore and O-ring grooves and briefly dip them back into the IPA. Remove all components (cartridges, O-rings) from the IPA and dry them with a paper towel.
8. Using your fingers, install (cleaned or new) O-rings in the external seating grooves on the cartridges.
9. Please note that installing (cleaned or new) O-rings in the *internal* seating grooves of the cartridge is a little trickier. The best way to do this is as follows:
 - a. Using your fingers, bend the O-ring into an oval and push it into the bore.
 - b. Take a small screwdriver (after checking to make sure the blade does not have any sharp edges that could damage the O-ring) and push the ring until part of it makes contact and slips into the seating groove.
 - c. Starting from the point where the ring is already seated, carefully work the remainder of the O-ring into the seating groove.
 - d. This is important! *Double-check* that both rings are properly seated (by gently prodding the entire circumference with the screwdriver) before moving on to the next step.
10. Reinsert the cartridges into the generator, and re-install the three retaining screws, which should be hand tightened. If the screw holes will not align, the cartridge is in the wrong hole.

Replacing the pump filter

After 500 cigarettes have been smoked, the pump filter should be replaced.

Do this after 500 cigarettes have been smoked.

1. Locate the white pump filter on the right-side panel of the generator.



These two arrows must point
in the same direction

2. Firmly grasp the two black plastic push-to-connect elbow joints above and below the filter, and pull the top elbow joint first, followed by the bottom joint so that the entire assembly (elbow joints and filter) is out of the generator.
3. Pull the two elbow joints off the filter and discard the filter.
4. Locate a new pump filter in the generator's maintenance kit and push the elbow joints onto the filter's fittings.
5. Carefully note the direction that air must flow through the filter (marked by an arrow on the filter) and align this arrow with the one on the generator's side panel (as shown in the figure above).
6. Firmly grasp the two black plastic elbow joints above and below the filter, then push the elbow joints into the generator's push-to-connect fittings.

Brushing the inside of the transverse lung pipe

Every month or after 800 cigarettes have been smoked, brush out the inside of the transverse lung pipe to remove any accumulated tar. This is important! The generator *must* be powered down before you attempt to access or clean the transverse lung pipe. If the generator is powered up during disassembly or cleaning you risk 1) personal injury, and 2) damaging the generator.

Do this every month or after 800 cigarettes have been smoked.

1. Locate the blue down-arrow on the generator's control panel, and press it eight times to bring up the "Service Mode" menu.



2. Press the **Start** button. (This tells the generator to move the lung's plungers into a safe position for cleaning the transverse lung pipe.)
3. Power down the generator (by turning its main power switch to OFF) and remove the power cord from the power socket (for added safety).

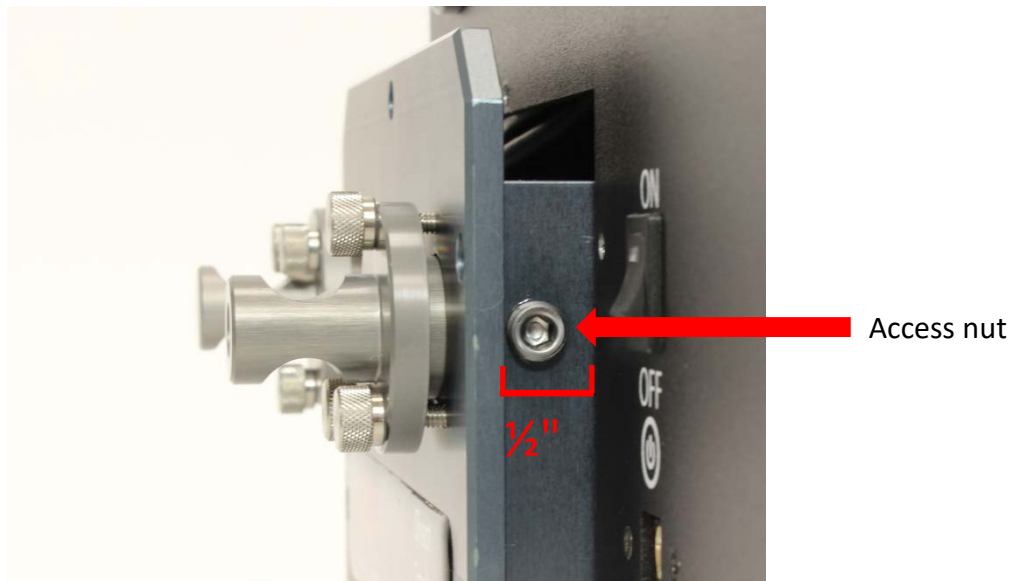


CAUTION: You must power down the smoke generator before accessing or cleaning the transverse lung pipe.

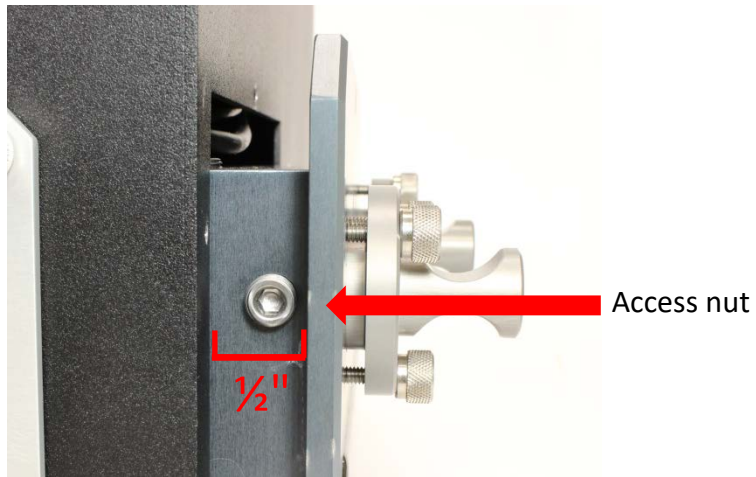
4. Using the hex key provided, unscrew and remove the five hex nuts (below) on the cartridge attachment plate.



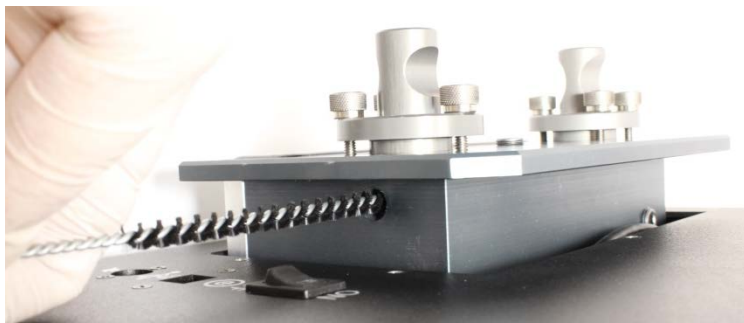
5. Grasp the attachment plate firmly and *gently* pull it out of the generator housing to a distance of *no more* than half-an-inch (shown in the figure below).
- Pull slowly and firmly. Do not tug on the attachment plate; if you do, you risk damaging the wiring.
 - Do not remove the attachment plate more than *one-half inch* from the generator!



6. Unscrew (using the hex key) and remove the transverse lung-pipe access nut (shown in the figure above).



7. Remove the access nut on the opposite side of the assembly (shown in the figure in Step 6 above).



8. Locate the bore brush in the generator's maintenance kit. Run it several times through the transverse lung pipe to remove any accumulated tar (shown above).
9. Re-assemble the unit by doing the following.
 - a. Install and tighten the two lung-pipe access nuts.
 - b. Gently push the attachment plate back into the generator.
 - c. Install and tighten the five hex nuts to secure the attachment plate to the generator.
10. Plug the power cord into the mains socket and, if needed, power up the generator.

Parts List

The table below lists the spare parts you may need to keep your smoke generator running properly. We suggest you keep all these parts in stock, so none of your critical experiments is compromised for lack of a needed part.

Description of Part	Part Number
Inner O-rings	009450-001
Outer O-rings	009460-001
Tube of O-ring grease	601-2524-001
O-ring removal tool	007579-001
Bore brush	008850-001
Pump filter	601-2522-004
Lung assembly—complete	601-2112-001

Kit Contents

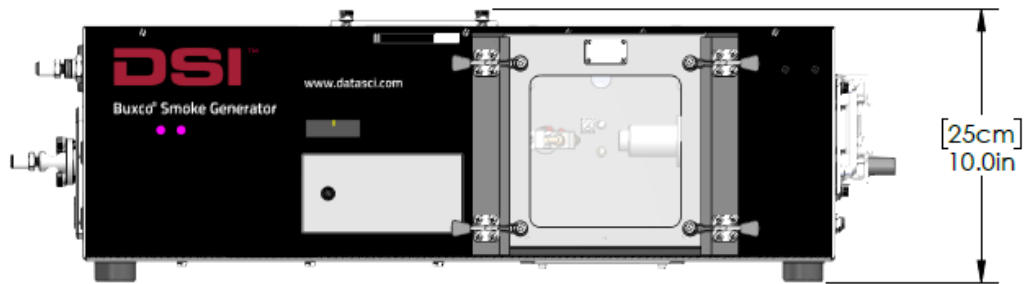


A) Hex keys, B) O-ring grease, C) Bore brush, D) O-ring removal tool, E) O-rings (inner & outer), F) Pump filters

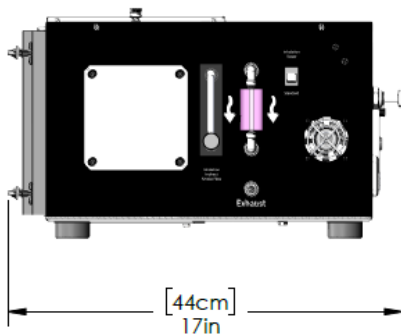
Specifications

Part Number	601-2050-002
Dimensions:	Length: 27.5", working space 33" Width: 14.5", working space 17" Height: 8.5", working space 10"
Weight:	70 lbs (32 Kg)
Power:	120 / 240 VAC 60 / 50 Hz 15 Amps
Capacity:	1 to 80 reference cigarettes, each 75 – 85 mm long Up to 300 with Extended Hopper, each 75 – 85 mm long

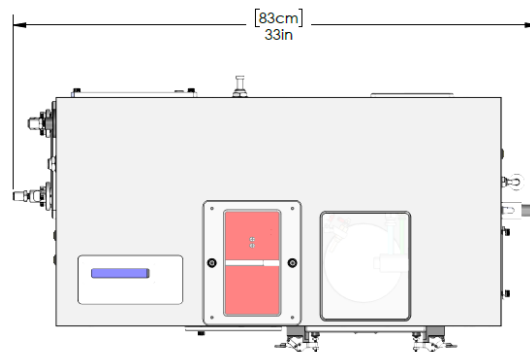
Front View



Side View



Top View



Contact Information

We are available to help you with your questions and concerns. Should you hit a roadblock or need some additional training, please feel free to visit the DSI Support Center at <https://support.datasci.com> to find articles and helpful information in our knowledge base, Chat with an agent, or setup time to receive one-on-one consultation. We are happy to help!

DSI Technical Support—North America

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DSI Technical Support—Europe

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