3D SYSTEMS

ProX® SLS 6100

3D Printer

User Guide

Original Instructions

3D Systems, Inc.

CONTENTS

1 INTRODUCTION

Thank you for purchasing the 3D Systems ProX® SLS 6100 (Selective Laser Sintering) 3D Printer, auxiliary SLS equipment, and 3D Systems materials! Before you start printing parts with your process facility, please read this guide carefully to enjoy optimum process performance and longer equipment service life.

ABOUT THIS GUIDE

This guide describes how to operate and maintain your ProX® SLS 6100 3D Printer, and auxiliary equipment used for the SLS process. For part printing instructions, refer to the Material Guide for your specific material. The SLS Single MQC System Use Guide can be found here.

What's Inside?

This guide includes the sections summarized below:

Introduction to the ProX® SLS 6100

This section describes basic components and concepts of your SLS system.

Safety Guidelines and Instructions

The Safety section tells you what you need to know to avoid injury or equipment damage. Read this section before you switch on power to any SLS equipment or handle any material.

Printing Parts with the ProX® SLS 6100

This section gives you an outline of the entire part printing process.

ProX® SLS SLS 6100 System Operations

This section describes the printer and provides operating instructions for manual control of the machine.

Machine Operations

This section provides an overview of Material Quality Center (MQC) operation, refer to SLS Single Use MQC System operations or SLS Dual Use MQC System operations for your specific MQC.

OTHER DOCUMENTS

Refer to the following manuals for additional information:

3D Sprint Quick Start Guide

This guide takes you through the 3D Sprint SLS workflow for setting up your first print with the new ProX SLS 6100

Material Guides

Each material used with the ProX® SLS 6100 system has its own manual which details the part printing and processing procedures specific to that material.

ProX® SLS 6100 Facility Guide

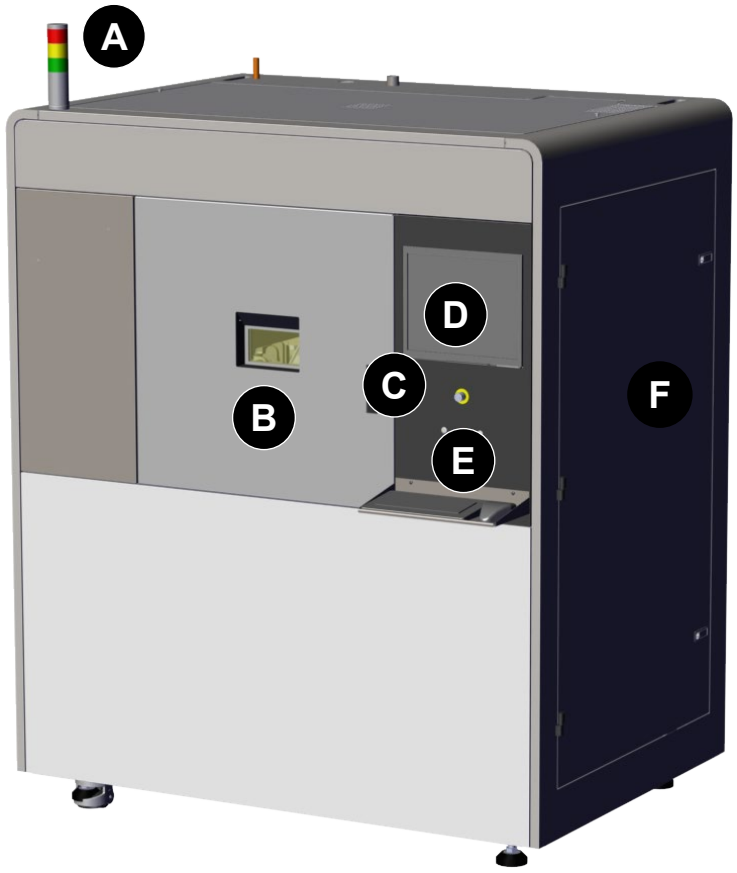
Details the necessary requirements to install your ProX® SLS 6100 3D Printer, SLS Single Use MQC System, and auxiliary equipment can be found here.

2 INTRODUCTION TO THE PROX® SLS 6100

The ProX® SLS 6100, the new cutting-edge Selective Laser Sintering (SLS) production 3D printer from 3D Systems, takes SLS toughness, part quality and manufacturing economics to the next level. Designed for smooth integration with your manufacturing workflow, the ProX® SLS 6100 produces parts for a variety of end-use and functional prototyping applications in aerospace, medical, industrial design and more. Use the ProX® SLS 6100 and DuraForm® plastic materials to produce parts with superior mechanical properties, resolution, surface finish and edge definition compared to other processes.

Ensure repeatable, consistent, tool-free manufacturing and produce durable functional parts faster with this mid-size production 3D printer. Additionally, the ProX® SLS 6100 is equipped with mature production automation, mobile production control and material recycling functions, so it pays you back faster.

ProX SLS 6100 AT A GLANCE



A **Stacklight:** Indicates the state of the system.

B **Print Chamber Area:** There are two doors in front of the Print Chamber—the outer locking door, and the inner print chamber door. The parts are printed inside the Print Chamber.

C **E-Stop:** The Emergency Stop button is a safety mechanism used to shut off the machine in an emergency situation in which it cannot be shut down in the usual manner.

D **User Interface (UI):** The user controls the system using a monitor, keyboard and pointing device.

E **LED Interface Lights and Controls:** There are three LED lights which give the user visual feedback regarding the system. The two buttons allow the user to control the chamber lights and enable the system. There is one standard USB port beneath them.

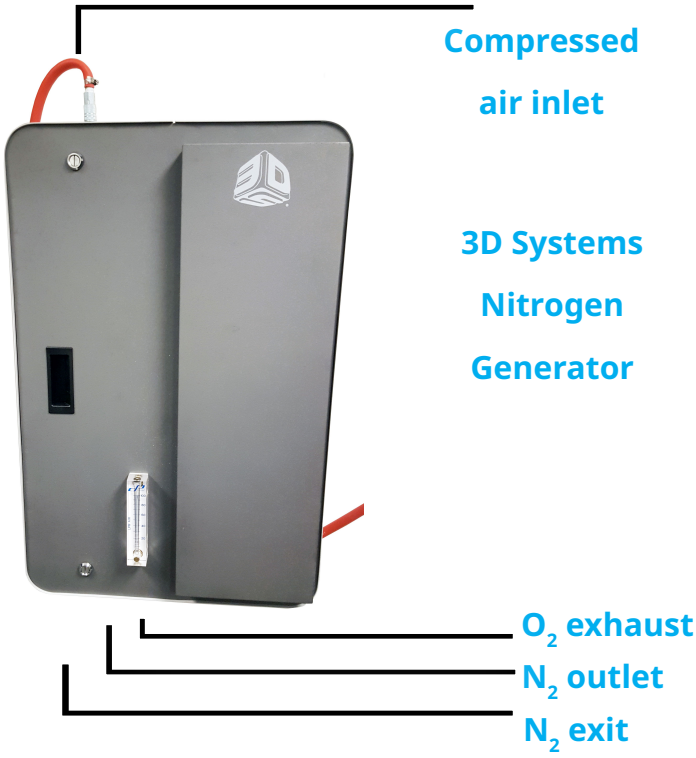
F **User and Service Access Panels:** There are two types of panels on the sides and back of the machine—user access and service access. The user access panels are hinged doors. The service access panels are lift-off panels.

AUXILIARY SLS EQUIPMENT

There are several auxiliary components which can accompany the ProX® SLS 6100 system. The Nitrogen Generator and Bead Blaster (optional) are shown below.

Nitrogen Generator

3D Systems manufactures a High-Performance Nitrogen Generator — Part Number 104011-02. The generator is ideal for SLS applications.



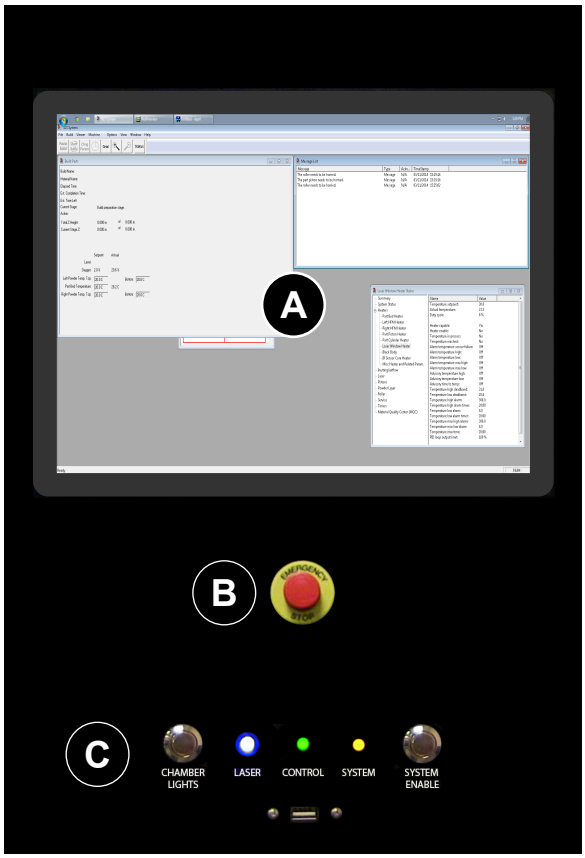
Bead Blaster (Optional)

If you plan to use DuraForm SLS material, 3D Systems recommends you install a pneumatic abrasive blast cabinet (“bead blaster”) in the part finishing area separate from the ProX® 6100 SLS 3D Printer process station room.

ProX® SLS 6100 SYSTEM COMPONENTS

ProX® SLS 6100 User Interface

The User Interface, located on the front panel of the printer, consists of a monitor and the system status LED indicators. An E-Stop is located above the touchscreen.



A **User Interface:** The user controls the system using a keyboard and pointing device located below the monitor.

B **Emergency Stop:** This switch, located above the monitor, immediately disables all hazardous machine functions or renders them safe. However, some surfaces may remain hot and care should be taken when handling them. After being pressed, it remains in the closed state until it is manually returned to the open state

C **Buttons, Indicators, USB Ports:**

Chamber Lights: This button turns the chamber lighting on or off

LED Indicators: The LED indicators under the monitor indicate the system's power and safety status. Each indicator operates as follows:

- **"Laser" Blue LED**
  - ON, Solid
    - » Laser is enabled.
  - OFF
    - » Laser is not enabled.
- "Control" **Green LED**
  - ON, Solid
    - » System is on and its controller has initialized.
    - » The system is in RUN mode.
  - OFF
    - » System is OFF or its controller is still initializing.
- "System" **Amber LED**
  - ON, Solid
    - » All E-stop buttons are reset, and system power is enabled.
  - OFF
    - » An E-stop button is pressed or system power is not enabled.

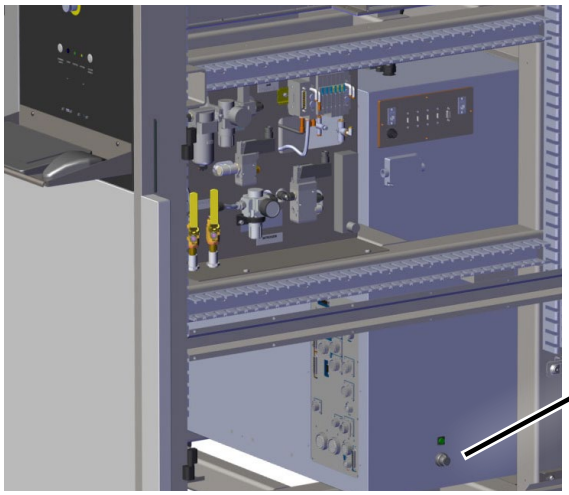
System Enable: This button re-enables the system following an emergency stop, which occurs after the emergency stop switch returns to the open state.

USB: There is one standard auxiliary USB port connected to the control PC. It is located under the LED Indicators.

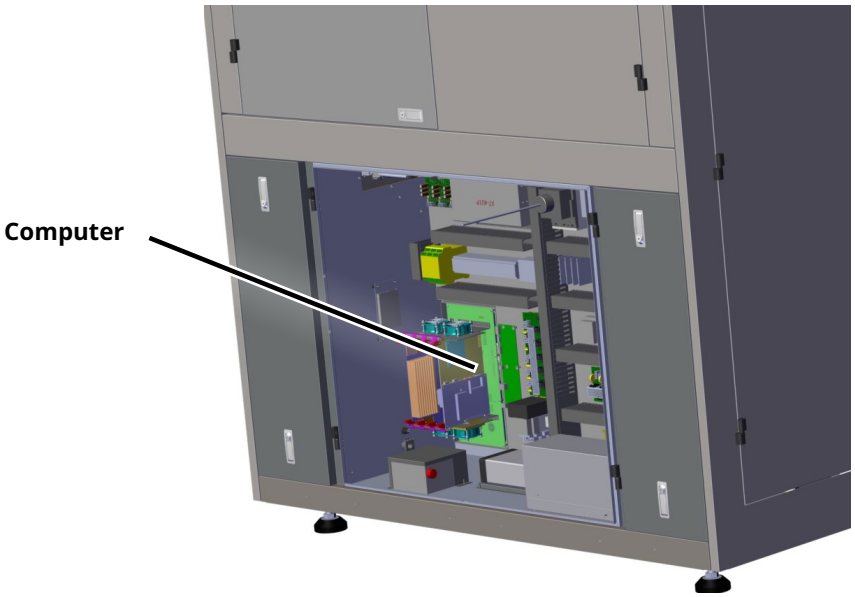
Electrical Cabinet

Power Supply: This module distributes all the AC power that the system needs. Circuits for the various subsystems are located in this module.

Main Power Disconnect: The main power disconnect, located on the rear side of the system on the right panel door, enables you to turn on and off all power to the system. Do NOT position the equipment so that it is difficult to operate this device. There is a **computer reset button** on the right side of the machine, that the user may need to access in order to reboot the software if it should become inoperable.



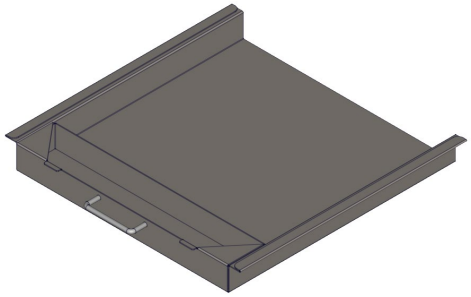
Computer: A computer which handles much of the functionality of the user interface and printer is located inside the electrical cabinet. It is part of a wider system of electronic components (Field-Programmable Gate Arrays, Digital Signal Processors, etc.) which control the hardware of the system.



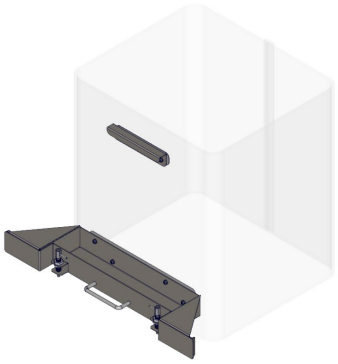
ProX® SLS 6100 Rear View

Part Transfer Cart Assembly

The print cake Extraction Cylinder, Part Transfer Tray and Part Transfer Cart, are used to remove the print cake from the ProX® SLS 6100 print chamber and transport it to the MQC System. The system ships with the cylinder and tray. The transfer cart is optional.



Part Transfer Tray



Extraction Cylinder

Part Transfer Cart

ProX® SLS 6100 Stack Lights

The stack lights let the user know from a distance what state the system is in. There is a stack light for both the main system and the ProX® MQC System.

ProX® SLS 6100 System Stack Light Conditions

Light Color	Solid	Flashing	Off
Red	E-Stop condition	System fault active	Normal
Yellow	System is in service mode	System warning active and/or message present on touchscreen	E-Stop condition or normal
Green	Print job active	System Active, not printing, manual operations possible	E-Stop condition or normal

3 SAFETY GUIDELINES & INSTRUCTIONS

GENERAL GUIDELINES

Before using your SLS equipment, your company should have a safety program in place. The safety program should:

- Point out hazardous equipment, materials, and procedures.
- Explain what to do in case of an emergency.
- Provide information about the hazards of the equipment and materials in the form of Safety Data Sheets (SDS). The Safety Data Sheets are provided with all materials supplied by 3D Systems.

All SLS equipment is designed with safety in mind. However, improper use, malfunctions, and excessive exposure could cause injury.

TRAINING AND INSTRUCTIONS

Follow these general safety guidelines when operating any SLS equipment:

- Do not operate any SLS equipment before receiving proper training.
- Read and follow all operating instructions.
- Follow all safety rules in this section and heed all hazard warnings in this guide.
- Do not try to perform any equipment maintenance procedures you were not trained to do.
    - **Operators** are trained to operate the system and perform all the necessary tasks to print a part.
    - **Certified service personnel** are those who have completed the 3D Systems service training package and are certified to perform service tasks. Certification may occur at various levels, and servicers should only perform tasks they are authorized and certified to complete.

MACHINE HANDLING

- Do not try to access, service, or adjust any components inside any SLS equipment enclosure.
- Do not try to open any panel or door while a machine is running.
- Do not access any area of the machine near the print chamber during printing.
- Use special caution when handling a heated print cake and when dealing with the heated, inert environment inside the SLS system's print chamber. Take note of all thermal hazard warning labels on the machines.
- Secure electrical cables and coolant hoses to prevent tripping.

MATERIAL HANDLING

- Do not use any material without first reviewing its Safety Data Sheet (SDS).
- To prevent injury and equipment damage, be sure to follow all handling guidelines detailed in the appropriate **Material Guide**.

LASER

- **Do not** try to access, service, or adjust the laser system in any way.
- **Do not** enter any area displaying posted warning signs during open beam operations. Open beam operations refer to the laser, and they **only** occur during service procedures.

ALARMS AND WARNINGS

- If you see an error, alarm, or warning message on any SLS equipment display, note the state of that machine's stack light. Clear the alarm, error, or warning message before resuming operation.
- Displayed error, alarm, or warning messages can result from unsafe practices, such as opening an enclosure door or panel when equipment is powered up and running.

SAFETY SYMBOLS AND DEFINITIONS

The following safety labels are posted at various points on the machine to indicate potentially hazardous conditions:

HOT SURFACES HAZARD: There are surfaces and materials in the vicinity that may be hot and could cause severe burns.

LASER RADIATION HAZARD: Invisible laser radiation is accessible in the vicinity of this sign or behind the access panel. Direct and scattered radiation can cause severe burns and blindness. Access panels are for service only and should be opened only by certified service personnel.

ELECTRIC SHOCK HAZARD: High voltage electricity is accessible in the vicinity of this sign or behind the access panel. High voltage can cause severe burns or death. Access panels are for service only and should be opened only by certified service personnel or trained maintenance personnel.

CAUTION: Indicates something may happen that could cause loss of data, damage to equipment, or personal injury.

CRUSH HAZARD: Injury or death from crushing weight.

NOTCHED BELT ENTANGLEMENT: Injury or death from entanglement in notched pulley drive belt.

FIRST AID SECTION – WHAT TO DO

In the case of an accident while using any SLS equipment, seek medical attention immediately. Use the following guidelines for specific safety instances.

Burns

This equipment contains high temperatures and burning laser radiation which could cause 2nd degree burns. Do not attempt to remove any protective panels. There are no user serviceable parts inside.

If a burn occurs, seek first aid and immediate medical attention. Pushing the E-stop button will de-energize the equipment and diffuse the hazardous situation.

Reporting Laser Radiation Exposure

If the injury was determined to be the result of laser radiation overexposure, please send a report to:

Attention: Laser Safety Officer
3D Systems, Inc.
333 Three D Systems Circle
Rock Hill, South Carolina, 29730
USA

Include the following information in your report:

- Nature of the accident and circumstances surrounding it
- Where the accident occurred
- Model and serial number of the machine
- Number of people involved
- Any other pertinent information

Please send this information to 3D Systems within a day of the accident.

Electrocution

The SLS system contains equipment energized at 208 volts, 3-phase delta. Do not attempt to remove protective panels. There are no user serviceable parts inside.

If electrocution occurs, seek first aid and medical attention immediately. Pushing the E-stop button will de-energize the equipment and diffuse the hazardous situation.

Material Inhalation

The part cleaning process may create a choking or air restriction hazard. If someone has difficulty breathing or a “loss of breath” sensation, transport the person to a well-ventilated room or outside of the facility. If the condition persists, seek immediate medical attention.

SLS EQUIPMENT SAFETY FEATURES

A major design goal for all SLS equipment is to provide a safe operating environment. The frame and enclosure designs passively limit hazardous access while the electronics and software actively and automatically sense and react to unsafe conditions when they arise. For example, if the SLS system detects unsafe operating conditions, it will immediately stop operating and, in some cases, shut down completely.

CAUTION: If any SLS equipment safety features fail, your actions may be all that will prevent potentially hazardous operating conditions.

Safety Interlocks

Safety interlock devices on the SLS equipment help prevent accidental laser exposure, electrical shocks, crush injuries, burns, and fires. SLS equipment will not operate unless all safety interlocks are satisfied.

CAUTION: Never try to disable or override any safety interlock device on any SLS equipment. Operating equipment without all safety interlocks enabled can cause equipment damage, injury, or death. If you suspect a safety interlock device is not working properly, do not operate your SLS equipment. Rather, disconnect power from the equipment and contact 3D Systems Customer Support for assistance.

SLS System Response if an Interlock Fails

Safety interlock devices mounted on the SLS system sense the hazardous operating conditions below. The SLS system takes the actions listed when an interlock fails.

SAFETY INTERLOCKED CONDITION	IF THIS INTERLOCK FAILS...
• One or more internal print chamber panels are open[a] • E-stop button pressed on user interface console • External oxygen monitor connected to SLS system detects too little oxygen in room	• Print will not start • Warning message appears on SLS system display • Red Stacklight illuminates • Nitrogen generator (if in use) shuts down • Warning message appears on SLS system display • Red Stacklight illuminates • Laser, motors, and valves disabled • Nitrogen supply shuts off **E-Stop Only:** • CDA supply shut off • System power disabled

a. Internal panels are for service access only. Several interlocked panels are for customer maintenance: overflow cleanout, blackbody cleaning port, and the filter box located on back of machine.

Limited Access and Barrier Shielding

SLS equipment frame and enclosure designs limit access to the following:

- **Service areas**, such as cabinets and enclosures for electrical power and automation controls. This prevents accidental exposure to electrical shock hazards.
- **Material areas**, such as material feed hoppers, storage bins, and transport tubes. This prevents:
  - burn hazards by minimizing exposure to heated material
  - slip hazards by keeping material from dropping on the floor
  - fire hazards by minimizing airborne dust cloud formation and potential ignition. See SDS for complete material hazard details.
- **Laser beam optics and scanning areas,** including the fully-enclosed **Laser Enclosure**—where the laser beam originates—and the interior of the print chamber, into which the beam projects. The Laser Enclosure and print chamber are designed to minimize hazards such as burns, eye injury, and fire in the following ways:
  - The Laser Enclosure optics and laser beam duct (at the top of the print chamber, below the removable Laser Window) prevents the laser beam from being aimed outside the print chamber.
  - The fully enclosed print chamber blocks laser radiation from escaping to the outside.
  - The material of the print chamber window also blocks laser radiation so you can safely observe the part bed during a print.

Other Active Safety Features

- The ProX® MQC System, coupled with the **Dust Collector**, removes airborne material during part breakout in accordance with standard industrial ventilation practices.
- An optional room oxygen monitor automatically initiates SLS system shutdown when it detects too little oxygen in the room.
- Software in the SLS system automatically initiates immediate equipment shutdown if certain unsafe conditions are detected during operation.

ELECTRICAL SAFETY

To prevent electrical shock, SLS equipment will not operate unless all external panels are installed and all electrical safety interlock circuits are closed.

ELECTRICAL HAZARD: Hazardous voltage exists inside the enclosures of all SLS equipment. Injury or death from electrical shock can result if you remove external panels or try to defeat safety interlocks. Panels should only be removed, and interlocks should only be defeated, by trained and certified 3D Systems Customer Support personnel.

ELECTRICAL HAZARD: Verify your facility's electrical service ratings before connecting power to any SLS equipment. Power must only be connected by a certified electrician.

ELECTRICAL HAZARD: Do not open the panel behind disconnect switch! Live voltage present. This should only be opened by qualified personnel after power is disconnected from the facility's power circuit/breaker panel.

All SLS equipment was designed to minimize operator exposure to electrical hazards during normal operations. All exposed electrical circuits are inside limited-access cabinets. This is to separate the operator from service and maintenance areas.

When operating any SLS equipment, keep the following electrical safety points in mind:

- Only 3D Systems certified service personnel should operate SLS equipment with access panels or service doors open.
- Heed high voltage warning signs and labels.
- Take common-sense safety precautions when operating any electrical equipment.
- After any change to the electrical wiring, make sure the equipment is properly grounded.

ENVIRONMENTAL ISSUES

The SLS system emits no toxic substances when using materials approved by 3D Systems.

Emissions

Material heating – Analytical testing on 3D Systems materials indicates no detectable emissions outside acceptable limits from the SLS system. (See the materials' SDS.)

Nitrogen – The SLS system uses nitrogen, which is passively vented in the print chamber.

NOTE: <u>Do not install a fan in the exhaust port</u>. The exhaust port in the print chamber must not be blocked. The nitrogen-inert atmosphere in the SLS system print chamber is at higher pressure than the outside atmosphere. The chamber will vent without a fan. Installing a fan in the exhaust port will draw nitrogen-rich air out of the print chamber too fast, raising the oxygen concentration in the chamber. This can keep the SLS system from reaching inert status, or cause an in-process print to abort.

Material Disposal

Refer to the DuraForm ProX® material SDS for disposal information. Follow any applicable local regulations.

LASER SAFETY

The SLS system contains a 100-watt continuous-wave CO_2 laser. The laser itself is designated Class IV. Very brief exposure to a direct—or specularly or diffusely reflected—laser beam can cause significant burns or eye damage. It can also be a fire hazard.

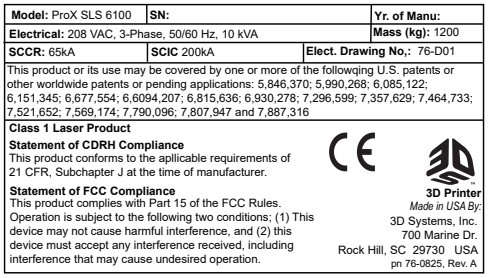
During normal operations of the SLS system, the laser beam path is wholly contained within the machine. This makes the entire machine a Class I Laser System. That means the SLS system does not produce damaging emissions under normal operations.

Laser Safety Classifications

Class I and Class IV are designations established by the U. S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Center for Devices and Radiological Health (CDRH), and by IEC 60825 (the International Electrotechnical Commission's *Radiation Safety of Laser Products, Equipment Classification Requirements, and User's Guide*). The Class I and Class IV laser designations also comply with DIN VDE 0837/02.86+A1/07.90. You can read more about laser safety and classifications in ANSI Z136.1-1993 (the American National Standards Institute standard for the safe use of lasers).

Laser Safety Labels on the SLS system

The SLS system has the two types of laser safety labels below. Laser safety label locations on the SLS system are shown in the figures that follow the table:

LASER SAFETY LABEL	WHAT IT MEANS
	**LASER RADIATION HAZARD** Invisible laser radiation is accessible in the vicinity of this sign or behind the access panel. Direct and scattered radiation can cause severe burns and eye injury, or start a fire. Access panels are for service only and should only be opened by certified service personnel.
	**DEFEATABLY INTERLOCKED PROTECTIVE HOUSING** If you defeat the SLS system laser safety interlocks, then open this housing (panel or door), you can be exposed to hazardous direct and scattered Class 4 invisible laser radiation which can cause severe burns and eye injury, or start a fire.
	**LASER CERTIFICATION/IDENTIFICATION** Identifies laser system Class and shows CDRH Statement of Compliance.

MATERIAL SAFETY

All materials certified by 3D Systems are safe during normal operation. However, you should be aware of the following issues:

- Any material, material-like substance, or airborne cloud of material has a remote chance of rapid combustion.
- Breathing some materials may cause certain people to experience respiratory irritation.
- Material safety hazards are minimized by good industrial housekeeping and ventilation practices.
- Spilled material can cause the floor to become very slippery.
- Material should be sifted in a well-ventilated room.

Refer to the SDS's and to 3D Systems material guides for information on specific materials.

CAUTION: Using materials that have not been certified for use in the SLS equipment may cause health or safety hazards and may damage the equipment and void the warranty.

Material Ignition Information

Powdered materials can be flammable and can be ignited by static electricity in a non-inert environment. Refer to each material's SDS for specific information.

CAUTION: The operator must use an approved vacuum cleaner to clean up excess material. 3D Systems recommends an ESD or explosion-proof model. Contact 3D Systems Customer Service for purchasing options.

Finding Material Safety Information

Use the Material Safety Information table to locate references and contacts for information on important material safety topics. Also check the SDS of the material used for the specific precautions to be observed.

Material Safety Information

TOPIC	REFERENCE / CONTACT		
Standard industrial ventilation practices	**US**: American Conference of Governmental Hygienists, Committee on Industrial Ventilation **Europe**: Maximale Arbeitsplatz Konzentration, January 1990		
Housecleaning and prevention of accumulation of explosive dust concentrations	**US**: NFPA 654: Standard for the Prevention of Dust Explosions in the Plastics Industry; National Fire Protection Association, Volume 5 of the National Fire Codes **Europe**: Maximale Arbeitsplatz Konzentration, January 1990		
Material exposure	**US**: Code of Federal Regulations, 29 CFR, section 1900.1000, available from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 **Europe**: DIN EN 26184 Teil 1 /06.91		
Specific materials	Material Safety Data Sheets (MSDS) from 3D Systems, Inc.		
	US/Canada:		Europe:
	Mfgr. Contact:	3D Systems Corporation 333 Three D Systems Circle Rock Hill, SC 29730 USA	3D Systems GmbH Guerickeweg 9 D-64291 Darmstadt, Germany
	Information	Phone: 803.326.3900 or Toll-free: 800.739.3669	Phone: (+49) 6151 357-0
	Emergency	1.800.262.8200 - Chemtrec	1.703.741.56100 - Chemtrec (U.S.)

Material Handling Precautions

During normal operation of the SLS system using 3D Systems' materials, you are not required to wear a dust mask or special personal protection equipment unless specifically designated. Check the SDS of the material used for the specific precautions you should observe. Use the following table of precautions as a general guide:

Safe Material Handling Guidelines

CATEGORY	PRECAUTION
FIRE/HEAT	• Never smoke or ignite anything around powdered materials. • Maintain proper clearance from materials when using portable heating devices. • Store flammable liquids away from materials. • After removing a part from the print chamber, allow it to cool to room temperature in a well-ventilated area. • Use anti-static mats in front of SLS equipment.
INHALATION	• Avoid breathing powdered materials; when exposure to dust or fumes is likely, wear a NIOSH-approved respirator appropriate to the airborne concentration. • Always provide adequate ventilation.
SHOP SAFETY	• Train operators in SLS system procedures. • Wear safety glasses. • Use extreme care with all heated materials. • Make sure that the room is well ventilated.
AVOIDING SPILLS	• Keep containers closed when not in use. • Have a fully-grounded internal non-ignition vacuum cleaner ready to use. • Have any equipment specified in the SDS ready to use.
SDS	• Give operators access to the SDS's that apply to materials they will be handling and ensure that they read them. If necessary, translate them. • File SDS's in an easily accessible location for immediate reference. • Strictly follow all the conditions in each SDS.

NITROGEN/OXYGEN SAFETY

The SLS system uses nitrogen to create an inert atmosphere in the print chamber. The nitrogen inhibits any potential rapid combustion of particulate matter during the SLS process.

The oxygen content of air is approximately 21 percent. Displacement of the normal atmosphere with an inert gas, such as nitrogen, can reduce the oxygen content in a room. In the remote chance that nitrogen leaks into the room during the sintering process, the situation can be hazardous.

Your site must have an oxygen alarm monitor installed in the room containing the SLS system. This monitor will alert you if the oxygen level drops below a designated point. It must be wired to trigger an immediate shutdown of the SLS system and nitrogen generator (if in use).

CAUTION: Exposure to an atmosphere containing 12 percent or less oxygen causes unconsciousness without any warning symptoms. This happens so quickly that you cannot help or protect yourself.

The table of **Oxygen Deprivation Effects and Symptoms** explains the potential effects and symptoms that can occur at different concentrations of oxygen in the atmosphere.

When you work in an environment that may become oxygen-deficient, make sure you comply with the following items:

- If, at any time, you feel you are experiencing symptoms of oxygen deprivation, leave the area immediately.
- You have received oxygen/nitrogen safety training.
- The room is well-ventilated; at least 4 air exchanges per hour.
- Self-contained breathing apparatus is available and easily accessible.
- The room oxygen alarm monitor is functioning and audible.
- Leave the SLS system room/area immediately when you hear the oxygen alarm.

Oxygen Deprivation Effects and Symptoms

OXYGEN CONTENT (% BY VOLUME)	EFFECTS AND SYMPTOMS AT ATMOSPHERIC PRESSURE[a]
15 – 19 %	Decreased ability to work strenuously. May impair your coordination or may induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12 – 14 %	Increases respiration during exertion. Pulse rate goes up. May experience impaired coordination, perception, and judgment.
10 – 12 %	Respiration continues to increase in rate and depth. Lips become blue. May lose consciousness at this point.
8 – 10 %	Mental failure. Fainting and unconsciousness. Face becomes ashen, lips become blue. Nausea and vomiting may occur.
6 – 8 %	100% fatal after 8 minutes of exposure. 50% fatal within 6 minutes. Recovery with treatment within 4 to 5 minutes.
4 – 6 %	Coma within 40 seconds; convulsions, respiration ceases, death occurs.

a. From Safety Bulletin SB-2 - 1983—”1983 by the Compressed Gas Association, Inc. 1235 Jefferson Davis Highway, Arlington, VA 22202

4 PRINTING PARTS WITH THE PROX® SLS 6100

This section gives an overview of the part printing process.

The software used to print parts on the ProX® SLS 6100 printer consists of the 3D Sprint and Sinter applications. 3D Sprint is used to prepare models for printing. The models are then processed and transferred to the Sinter application which controls the printing of the parts.

Before printing, several components of the SLS equipment should be cleaned and the ProX® MQC System must have transferred material to the printer.

PROX® MQC SYSTEM PREPARATION

The ProX® MQC System should be started and filled with material before proceeding. After it has been loaded with material, it will need to transfer the material to the printer.

The ProX® MQC System must be in Full cycle mode for material to be sent from the blended bin to the ProX SLS 6100. Before selecting **Full** or **Local** cycle mode, the user should verify that the desired blend ratio is selected. (See Material Guide for recommended ratio.)

PROX® SLS 6100 START-UP SEQUENCE

If you're starting the printer from it's powered-off state, you must first perform the following machine start-up sequence before you start a print:

- Verify the system's clean, dry, compressed air supply
- Verify the system's nitrogen supply
- Verify the system's material supply
- Put Sinter in Manual Operations (Man Ops) mode
- Move the part piston to its Home position
- Move the roller to its Home position
- Move the piston back to its Start position

Instructions for each step in this sequence are described next.

If you're starting the printer from its powered-off state, do not attempt to start a print before you perform the startup sequence. Also, never attempt to start a print if the dsp button is not shown in the taskbar. (Putting Sinter in Build mode then opening a build packet starts a build.)

1. Verify the printer's compressed air supply.
    a. Verify that facility compressed air is on and connected to the gauge panel **AIR INLET**.
    b. The air pressure gauge label indicates the correct reading. This should be: 350 KPa (50psi).
2. Verify that the system has an adequate supply of nitrogen.

NOTE: Skip Step (a) if you have a nitrogen dewar or bulk tank connected to your SLS system instead of a nitrogen generator.

    a. Open the compressed air supply valve at the bottom of the N_2 generator.
    b. Make sure the **NITROGEN INLET** ball valve on printer's gauge panel is open. It needs to be turned at a 90° angle so that it is aligned with the direction that the nitrogen is flowing.
    c. Verify that the regulated **N_2 PRESSURE** gauge on gauge panel reads 140 KPa (20psi).
3. Verify the material supply using either of the following two ways.
    - In Sinter, check the ProX MQC System's window in the Man Ops screen. This displays the ProX MQC System's status, including the amount of available powder.

    or...

    - Check the ProX MQC System's status in the Sinter Status window which also displays the amount of available powder.

PREPARING A PRINT JOB USING 3D SPRINT

3D Sprint is 3D Systems' exclusive software for importing CAD data and preparing it for printing. 3D Sprint can be used either on the ProX 6100 or remotely connected from your workstation or off-line at a stand-alone workstation (Virtual Printer). The 3D Sprint application contains extensive help with further details pertaining to the operation of the software.

To prepare a print job on the ProX 6100, you will need to do the following:

- Run Sinter
- Launch 3D Sprint
- Import files ("parts") to your print job. 3D Sprint supports most standard file formats including .3dsprint, STL, OBJ, CTL, PLY, BPZ and IGES
- Repair files, if needed (automated)
- Orient and position parts in build volume
- Set specific "build" and "part" parameters for your site.
- Quality check (optional)
- Run Build Time and Material required estimate.(optional)
- Save the 3D Sprint file or output the print job for processing

Each procedure is summarized below

RUN SINTER APPLICATION

1. Start the Sinter application: from the Windows task bar; choose Start > Programs > SLS System > Sinter, then . . .

- The Sinter application window opens .
- The RealMonitor utility starts, appearing as a RealMonitor button in the Windows taskbar . Sinter icons will remain grayed-out until the DSP is initialized . (Sinter uses DSP to control SLS system heaters and motion, and to communicate with the laser scanning system .)

2. When you see the DSP button in the taskbar, the Sinter application is ready to start a print . However, you must prepare the chamber before printing the parts .

Preparing the Print Chamber

The following steps are a suggested guideline for preparing the system to print parts .

1. Check to see if the MQC is in Full Cycle mode and that there is enough powder in the blended bin for the print .
2. Close and latch the inner print chamber door and close the outer door . All interlocks must be engaged to move the piston or roller .
3. If the piston is not homed, go to Sinter > ManOps > Piston Control and select Home Piston .
4. If the roller has not been homed, press the Roller button on the toolbar, then press the Home Limit button in the dialog box to home the roller .
5. Press the Inert button on the toolbar and select the Enable toggle option to activate the inerting process .
6. Press the Add Powder button on the toolbar to create level print bed:

While the machine is inerting, begin leveling powder. Set the **Layer Thickness** to 0.0. Specify the number of cycles, normally 2 at a minimum, in the **Layer Cycle Count** field press the **Add Layer** button to begin leveling.

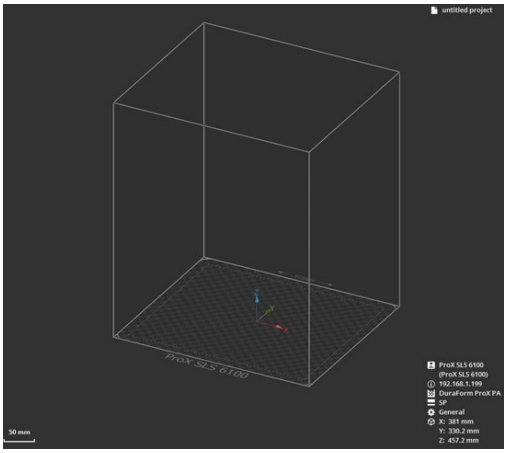
7. Once the powder has been leveled, and if the next build has not yet been set-up, open 3D Sprint, complete the build preparation process, and close 3D Sprint.

Launch 3D Sprint:

1. Choose **Start > Programs > SLS System > 3D Sprint**

   Or launch from Sinter main menu

2. 3D Sprint starts with a display of empty virtual build volume.



Position Parts in the virtual build volume

While 3D Sprint can orient, place and nest your parts, using the Auto Place command on the Print tab to place part files automatically on the printing platform in and optimize print time and area for the current printer.

You can also:

- Drag parts
- Position parts numerically
- Rotate parts

In time, you'll learn optimal placement and orientation strategies for the types of parts you build most often. Since this optimal placement and orientation is material dependent you should refer to your **Material Guide** for more specific information.

"Parameters" are settings in a build packet that you can change. Parameter settings apply to parts or the entire build. You set parameters in 3D Sprint's **Part Profile Editor** and **Build Profile Editor** dialog boxes. Parameters control most aspects of how a part is built.

Modify Build and Part Parameter Values for the Print Job (optional)

3D Sprint and the ProX6100 are installed with configuration files containing default values for processing a variety of materials. You may need to adjust these default parameter values slightly based on your application or desire to customize results..

Build parameters control values that apply to the entire build, such as temperature setpoints and feed amounts.

Part parameters control values that apply to individual parts, such as Laser Power and can be set differently for each part.

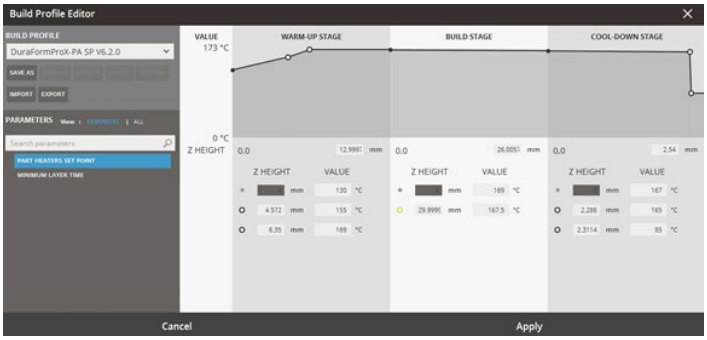
You modify parameters values in the **Part Profile Editor** and **Build Profile Editor** dialogs

Modify Scale and Offset Values

Scale compensates for material shrinkage that occurs during processing . Offsets compensates for width of laser beam

You modify scale and offset values in the **Scale & Offset Editor** dialog

As with part placement, see **Material Guides** for more information about specifics for build, part and scale values. 3D Systems supplies sample build packets which can be used for reference when getting started



Quality Check (optional)

Checks for:

- Collisions
- Wall Thickness
- Other part quality issues

Build Time & Material Estimate

Estimates the time and material required to complete the print job

The last step is save or output:

- You can save:
- Save in 3D Sprint format (.3dsprint) for further editing or
- You can output print job:
- Add to Queue – creates build packet file (.bpf) and associated files that will be used by Sinter to process the print job.
- Alternately, Print to File which creates an compressed zip file (.bpz) that contains the bpf and associated files. This file may be added to the Queue at a later date or transferred to another SLS machine for processing

If 3D Sprint is run on a standalone computer, use Print to File to create the bpz file to be added later to the Print Queue.

NOTE: You cannot run a print job until it is added to the queue.

Running the Build

After the preceding steps have been completed, the printer is ready to print parts .

1. Verify that the IR Core temperature value is 77 °C .
2. If necessary, perform an Offline-IR Calibration .
3. Press the **Exit** button on the toolbar to exit Manual Ops and return to the main Sinter screen.
4. Select **Build > Start Build**, select the build packet name (.bdf), and select **Start** .

NOTE: This BPF for this job will be located in a folder whose name ends with the job name under the C:\dtm\ build\jobs folder.

You can find this location under **File Directory** in the **Job Properties**.

BREAKING OUT PARTS

Once the print job has finished, the part cake will need to be cooled and transported to the SLS Single Use MQC System for breakout you should refer to your **Material Guide** for more specific information about cooling times and breakout..

PRE/POST BUILD CHECKLIST

Print Job Prep

Perform Daily User maintenance tasks, see User Maintenance checklist for weekly, monthly checklist

Daily/Every Print

- Laser Window, inspect and clean if needed
  - Laser Window Assembly O-Rings
    - Consumable replace as needed
    - PM replace (1yr)
- Black body, inspect and clean if needed
- Inner Chamber door, clean seal and window
- Chamber interior including heater trays should be wiped down.

NOTE: Both inner and outer door must be closed (interlocks made) in order to move the part piston or roller. Opening a door or an interlocked cover such as the overflow cover or blackbody cover will cause the contactor to drop out. If the piston or roller is moving when this happens you will need to re-home each of them.

NOTE: When ProX SLS 6100 is idle, keep inner and outer doors closed, and all interlocked covers on so that the IR core heater remains on and the IR core is at a stable temperature.

3D Sprint build packet preparation

Follow normal best practices for part placement and orientation. See Material Guide for specific instructions.

Additional Hints:

- Large cross-sections should be placed at higher z-heights to reduce occurrence of post-build curl.
- If cross-section is large (12,500mm2) it should be rotated to enough so that the area being scanned on each layer is reduced. This helps prevent short feeds and reduce layer time.
- Keep scan time per layer as even as possible. If possible keep scan time under 30-35 seconds.
  - Use Build Time estimate and View Layer time to see scan time per layer
- Geometry's that are closed on all sides except one should be built with the open side up if possible to prevent trapped heat, making breakout easier and extending the life of the powder.

Build Parameters: Print bed heaters

- 6 heaters (Q1,Q2,Q3,Q4, Right Inner, Left Inner)
- One calculated Master Duty Cycle
- Each of the 6 heaters uses a ratio of the Master Duty Cycle. The default ratio values should give a uniform part cake hardness
  - If part cake at breakout is too soft overall, then increase the part heater setpoints by small increments (0.5 to 1.0 degrees)
  - If part cake at breakout is too hard overall, then decrease the part heater setpoint by small increments (0.5 to 1.0 degrees)
  - *Be aware that changing the ratio for one heater may require changes to the ratios of other heaters in order to maintain the balance of the heaters.*
  - *IF making adjustments make small incremental changes of 2%. Increasing/decreasing the ratios by larger amounts will require a change in part heater setpoint.*
- Feed Powder amount
  - This value is the rotation of the Feed Roller (located just under the feed hopper)
  - This should be adjusted so that the traverse roller moves enough powder across the part bed to cover all the scanned area and deposit a small amount in the return piston. If scanned area is very similar on each layer, one feed amount for entire build stage will be good. If scanned area varies a lot from layer to layer then use an amount that will work for the layers with the larger area.

Note: If ProX SLS 6100 is not run for several days, it may take several layers while leveling powder for feed powder to dispense properly.

Note2: If Feed Hopper is emptied completely and then re-filled, allow several hours before starting a build so that powder "settles" and feeds correctly.

Before Starting the build:

- Verify Compressed air on
- Verify MQC in Full Cycle mode
- Verify adequate powder in MQC (in blended bin) or that MQC will be able to blend more if needed.
    - As a normal practice you should keep hopper full by allowing MQC to send powder to hopper as powder level drops below upper prox.
- Verify Heater Trays are in correct position

Build Removal

- Part Bed Surface should be at or below 85C to open Print Chamber door
- Then move piston to approx. 20 mm below current location
- Open doors
- Raise Heaters
- Remove Laser window and Replace with red insert
- Brush loose powder from liner plate onto part bed
- Pull roller forward and brush powder from roller bar into part bed, return roller to left position
- Place extraction cylinder in chamber & close doors
- Move piston to Start position
- Open doors and slide extraction tray under extraction cylinder and lock tray into place
- Use extraction Tray (and cart for heavy builds) to move part cake to MQC
- Complete cooldown in MQC, using Cooling lid (if desired)
- Part Breakout
    - Currently the MQC is set for Cooling by temperature (setpoint is 40C)
    - Discard powder next to parts and any hard clumps that do not break apart easily in hand.
- Material sifting
    - Separate reusable powder to sift and discard remainder

5 PROX® SLS 6100 SYSTEM OPERATIONS

Many of the basic operations and components of the ProX® SLS 6100 have been covered in the previous sections of this manual. These will be referenced under the appropriate headings below. Remaining details will be described here.

ProX® SLS 6100 START-UP SEQUENCE

To start up the ProX® SLS 6100 printer to prepare for a print job, follow the steps described in the section, ***"ProX ® SLS 6100 Start-Up Sequence."***

3D SPRINT AND SINTER APPLICATIONS

To print parts with your printer, you must prepare the models in **3D Sprint** and run the BPF in the **Sinter** application. Follow the procedures listed in section 4, ***"Printing Parts with the ProX® SLS 6100."***

Messages in the Sinter Application

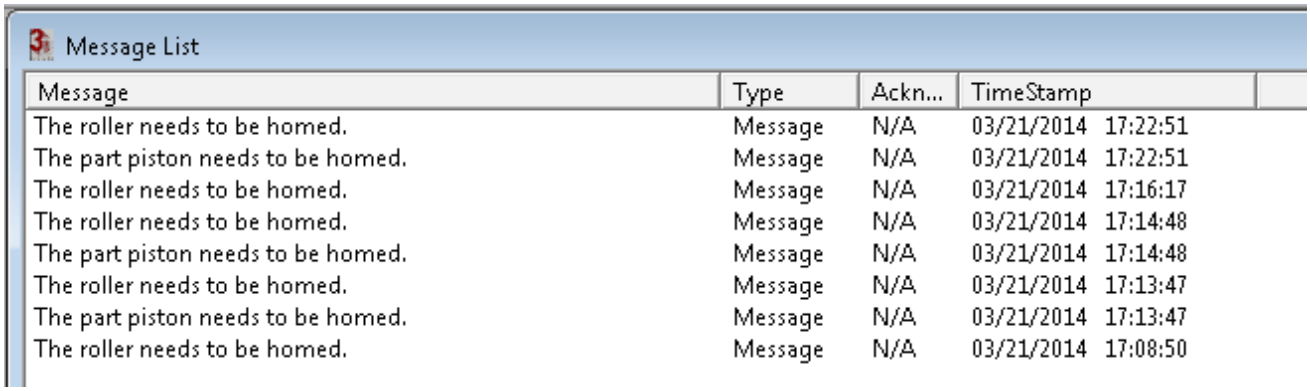
When Sinter is running various types of messages appear in the Message List window (described below). Alarm and warning messages also appear in pop-up windows you must acknowledge.

Message Types in Sinter

TYPE	COLOR	DEFINITION
Message	Black	Informational only or tells of a minor error. These generally occur when you enter different data than the system expects or when a dependency is not met.
Advisory	Yellow	Something occurred that can turn into an alarm condition if not corrected in a specified time.
Warning	Yellow	Something serious may occur that you should attempt to correct; does not terminate the print.
Alarm	Red	Indicates something occurred that will halt the current operation and return the SLS system to a safe state.

About the Message List Window

The Sinter application displays messages in a **Message List** window. New messages appear at the top of the window; old messages scroll down as new ones appear. Messages are color coded to indicate their type. You can select a message and then right-click to acknowledge it; after you do so, it turns black, whatever its initial color was. See **Responding to Messages** in Sinter Help for more information on acknowledging messages.



Restarting a Terminated Build

If you terminate a build before completion, you may be able to restart it. This depends on the material in use and the temperature at which you were running the build.

NOTE: When you restart a build, it resumes building at the layer it was on when the build was terminated. Therefore, if the part piston was moved after you terminated the build, some parts in the build might be ruined.

Keep the following in mind:

- After restarting the build, you may need to increase the laser power for the first few layers to make sure the layers bond properly.
- Make sure the powder is feeding properly

Viewing a Build In Progress

During a build, the **Build Viewer** window displays the slice that the system is currently scanning. Click on a part to display its name at the bottom of the main window.

NOTE: If you close the Build Viewer window when a build is not running, you exit Build mode. You cannot close this window while a build is running, but you can minimize it.

Viewing Options on the Toolbar

While the system is in **Build** mode, the **Build** toolbar appears at the top of the main window as shown:

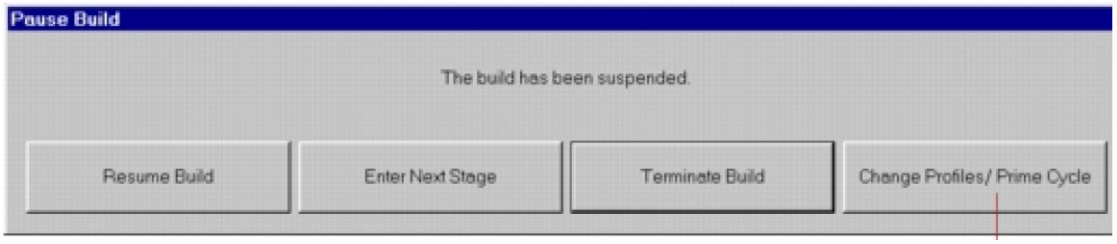
Click the **Grid** button to turn the display of grid marks on or off. Click the zoom buttons to expand or contract the scale of the **Build Viewer** window.

Options on the Viewer Menu

While the system is in Build mode, you can set the following options for the Build Viewer. These options appear on the Viewer menu in the main window:

VIEW OPTION	DESCRIPTION
Set grid size	This option displays a dialog box that lets you control the size of the grid drawn on the **Build Viewer** window.
Grid marks	This option is the same as the Grid button on the toolbar.
Clear after every slice	When this option is checked, the system erases the display before drawing a new slice. Otherwise, the system draws new slices on top of old ones.
Dark background	You can toggle this option on or off by selecting it. When checked, the system displays a dark background in the **Build Viewer** window.

Pausing a Build



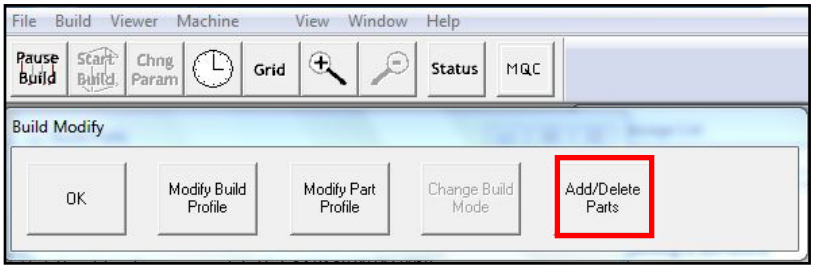
When the Pause Build button is active, click on it to pause the build and display options.

Resume the build as soon as possible after you pause it.

CLICK THIS PAUSE BUILD BUTTON...	TO DO THIS...
Resume Build	Continue the build.
Enter Next Stage	Move from Warmup stage to Build stage, or Build stage to Cooldown.
Terminate Build	Stop the build. If you terminate a build when the system is in the Build stage, and you do not want to restart the build from the termination point, remove any parts from the print bed and review the build packet in 3D Sprint. Make any changes that can improve the build.
Change Profiles/Prime Cycle	Modify a profile, add/delete parts, or run a prime cycle.

Modifying a Build in Progress

Make changes during a build with the **Build Modify** dialog box.



To display it, click the **Change Parameter** button; if the build is paused, click the **Change Profiles/Prime Cycle** button in the **Pause Build** dialog box.

Modifying Part and Build Profiles

Click the **Modify Build Profile** or **Modify Part Profile** button to display a profile editor dialog box. Modify parameters as described in the 3D Sprint Help.

NOTE: You can find definitions of the parameters in the 3D Sprint Help.

In most respects these dialog boxes work just as they do in the 3D Sprint software, with the following differences:

- Settings for Z levels below the current are yellow and cannot be changed.
- The current Z level is displayed as a green vertical line in the parameter chart.
- In the Build Profile Editor, a new button appears. Use this button to make a profile change at the current Z level. Click the button and a new row appears in the current build stage. Click in the **Value** column and enter a value, then click **Apply**. When the system applies the value, it updates the row to the current Z level.
- If you make changes near the current Z, the system may not be able to apply them. If you do not get the message **The parameter change has been applied** after clicking **Apply**, try again at a higher Z. (There is no message when the attempt fails.)

Adding and Deleting Parts and Other Changes

Click the **Add/Delete Parts** button in the Build Modify dialog to launch the 3D Sprint application. From here you can modify most aspects of your build packet during the build.

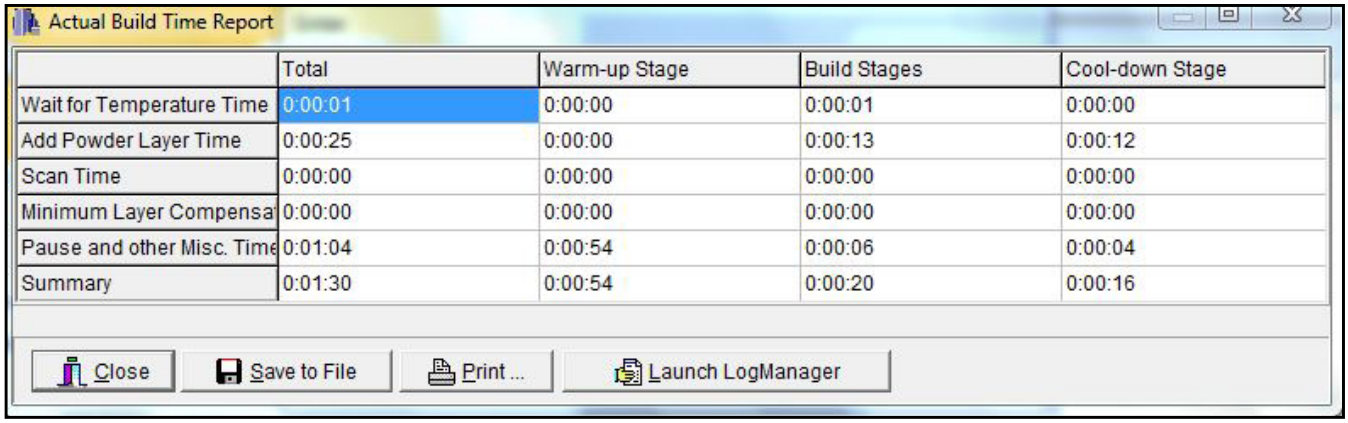
The application works just as described in the 3D Sprint Help, except that it also displays a plane marking the current Z level. Changes you make below the plane, such as adding or moving parts, will not affect the current build, although they will be saved and will affect future runs of this build packet.

Running a Prime Cycle

The Prime Cycle can only be run if the user has paused the build. Click the **Prime Cycle** button in the **Build Modify** dialog to spread powder across the print bed without moving the part piston, which can compensate for a short feed.

When a Build Ends

At the end of a build, the Sinter application displays a summary of the actual build times such as the example below:



MANUAL OPERATIONS

The **Manual Operations (Man Ops)** section of the Sinter application provides access to several components of the printer which need to be controlled manually while operating the system.

Homing the Part Piston and Roller

It may be necessary to "home" (reset the reference limit position) the piston and the roller. This needs to be done before a print job is begun and may need to be performed during maintenance procedures.

Before you can do either, these dependencies must be met:

- SLS system start-up is complete and Sinter is running.
- The **Add Powder Layer** window is closed.

To Home the Part Piston

Before you can move the part piston to any position other than the home limit, the piston must be successfully homed. All the buttons except for **Home Limit** are dimmed for a piston that needs to be homed.

1. To home the piston, click the **Home Limit** button in the **Piston Control** window.
2. After the piston is homed, click the **Start Position** button

To Home the Roller

- To home the roller, click the **Home Limit** button in the **Roller Control** window.

Adding and Leveling Powder

Just before you run your print, use the **Add Powder** dialog box in **Man Ops** mode to add and level powder in the print chamber.

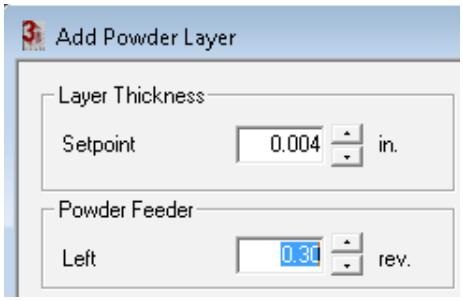
Adding powder creates a smooth powder bed on the floor of the print chamber.

To Add and Level Powder

Use the **Add Powder** button to manually add a layer of powder to the print bed. Before you can add a powder layer, all these dependencies must be met:

- The roller must be stopped at the left limit.
- The piston must be homed and if empty, moved to the **Start** position.
- The **Roller Control** and **Piston Control** dialog boxes must not be open.

When you click **Add Powder**, the **Add Powder Layer** dialog box appears:



To Use the Add Powder Layer Dialog Box

Change the settings for each parameter in the Add Powder Layer dialog box to the settings you want, then click the Add Layer button.

NOTE: Click the Stop button if you need to stop the roller while it is adding a layer. If you do this, you must move the roller back to a limit before continuing. Click the Move To Limit button to move the roller back to a limit.

NOTE: Under some circumstances, the system may not correctly update the Move to Limit, Stop, or Add Layer buttons; they may remain dim when they should be enabled. If a button you need to use is dim when it should be enabled, close and reopen the Add Powder Layer dialog box to enable the button.

The following parameters are available to set in the Add Powder Layer dialog:

NOTE: You cannot close the Add Powder Layer dialog box while the printer is adding layers.

Add Powder Layer Parameters

PARAMETER	RANGE	DEFAULT	DEFINITION
Powder Feed amount	0 to 10 rev.	0.2 rev.	The number of revolutions the powder dispenser makes when dispensing powder on top of the roller. (The powder dispenser is at the bottom of the feed hopper.) Typical setting is 0.2 rev.
Layer Thickness	0.1 mm (0mm available for Add Powder Layer)	0.1 mm	The distance that the part piston lowers each layer.
Layer Cycle Count	1 and 32,000	1	The number of consecutive powder layers to be added.
Roller: Rotation Ratio	0 to 15	11	The ratio of the roller's counter-rotation angular velocity to its (linear traverse) speed. The larger the ratio, the faster the counter-rotations.
Roller Traverse Speed	76 and 305 mm per second (3 and 12 inches per second)	203	Specifies the speed at which you want the roller to travel.

Calibrating the IR Sensor

The printer will recalibrate the IR sensor dynamically during a build. This calibration is a quick process which occurs multiple times during a print to compensate for sensor drift and changing environmental conditions within the machine.

NOTE: You must perform an initial offline IR calibration to enable automatic, real-time recalibration during the print. If recalibration requires too great an adjustment, a message pops up advising you to perform offline calibration again when the print completes.

NOTE: Once you perform an Offline-IR calibration, the settings are saved in the system. An Offline-IR calibration does not need to be performed before each print.

If you want the printer to do real-time IR sensor recalibration during the print, perform a manual IR calibration before you start the print as described below.

NOTE: You can opt to have the printer simply verify IR sensor readings rather than recalibrate. Click the Verification Only checkbox in the IR Cal window to choose this option.

To Perform Manual IR Calibration

1. Put the system in **Manual Operations** mode.
2. Click the **IR Cal** button.
3. The **Manual IR Sensor Calibration** dialog box appears.
4. Click the **Start** button on the dialog box. The calibration will last approximately 10 minutes.

NOTE: During the calibration, an Abort button appears; click it if you need to stop the calibration process for any reason.

NOTE: If the part bed or the blackbody is above 60 °C, the software waits until they cool to actually start the offline calibration.

NOTE: If the IR sensor core temperature is below 77 °C, the offline IR Calibration will wait until 77 °C has been reached, and then an additional 5 minutes for the core to stabilize.

REMOVING THE PRINT CAKE FROM THE PRINT CHAMBER

The print cake can be removed from the print chamber either before or after it has finished cooling.

CAUTION: Do not begin breakout of the parts from the print cake until the cooldown stage is complete. The temperature must be no higher than 85 °C. The print cake can remain extremely hot for hours after a build. To prevent burns, allow sufficient time for cool down (up to 24 hours without the nitrogen lid) before removing parts from the print cake. The temperature of the print cake can be tested using the thermocouples in the breakout area of the MQC system.

Where to Cool Down the Print Cake

If you cool down the print cake inside the print chamber, wait until the print cake reaches its final cooldown temperature of no more than 85 °C. If you choose to let the print cake cool down outside the print chamber, you can take it to the ProX® MQC System and either let it cool down normally or use the nitrogen cooling lid on the side of the ProX® MQC System.

To use the nitrogen cooling lid, do the following:

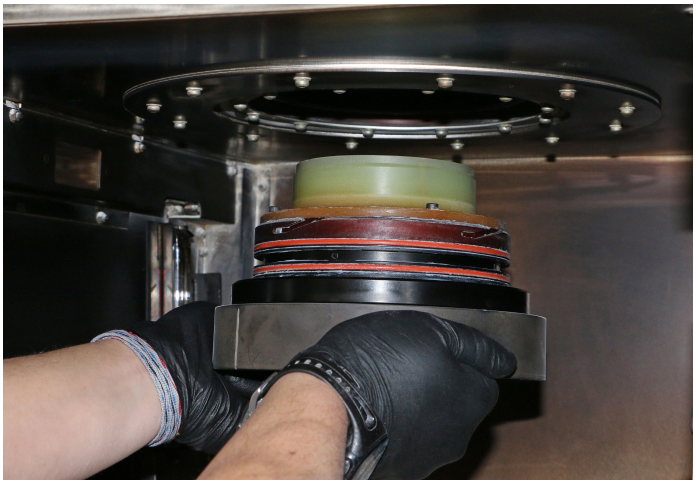
- Immediately after placing the hot print cake in the breakout area of the ProX® MQC Single Use System, place the nitrogen cooling lid onto the print cake cylinder. Then...
  - use the cooling lid to do a controlled cooldown for a programmed amount of time (the default is 3 hours), or until a programmed temperature is reached.
  - let the print cake cool down without the nitrogen flow.

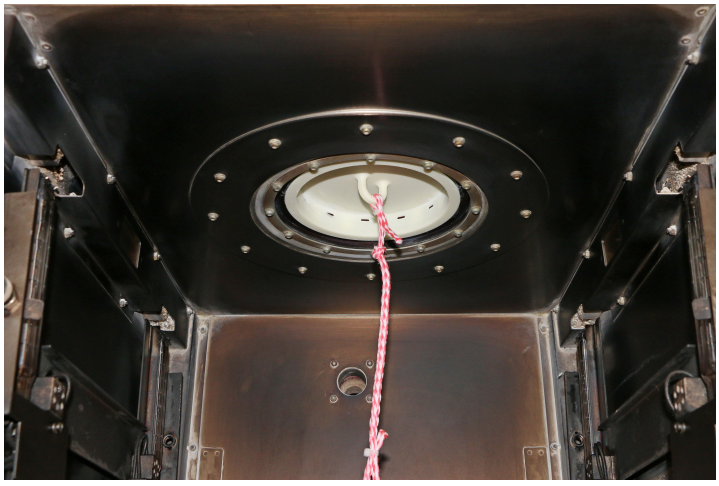
Unloading the Print Cake After a Print

After a print and before part breakout, you must remove the print cake from the print chamber and transport it to the ProX® MQC System.

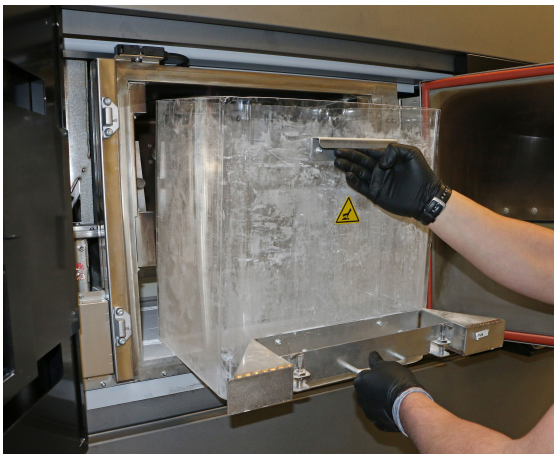
To remove the print cake:

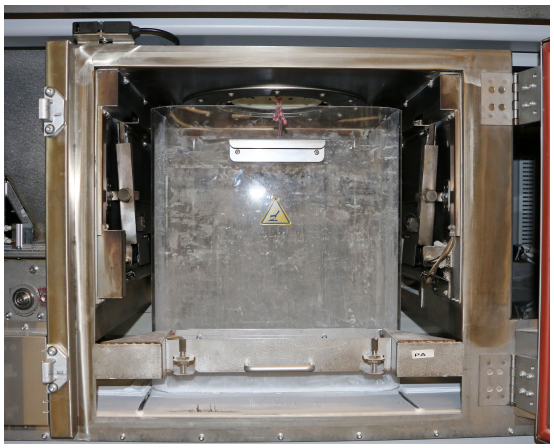
1. Turn off the chamber lights.
2. Open the outer door of the print chamber.
3. Unlatch and open the inner print chamber door.
4. Raise heaters.
5. Remove the Laser Window by turning it counterclockwise ¼-turn and pulling it out of the top of the chamber. Put it in a safe, clean location and clean it before reinstalling it into the print chamber.
6. Press the red Laser Window Baffle Plug into the top of the chamber (see photo).





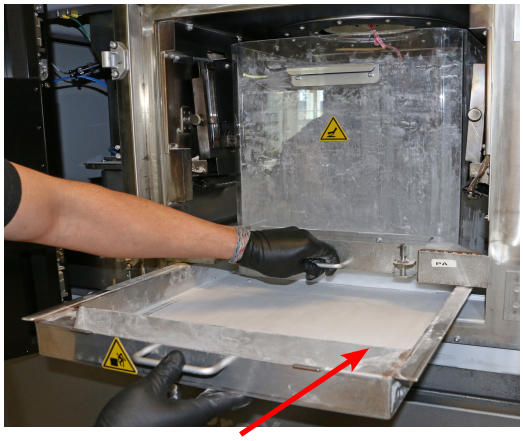
7. With the handle facing towards you, fully insert the extaction cylinder into the print chamber, placing it over the print bed.

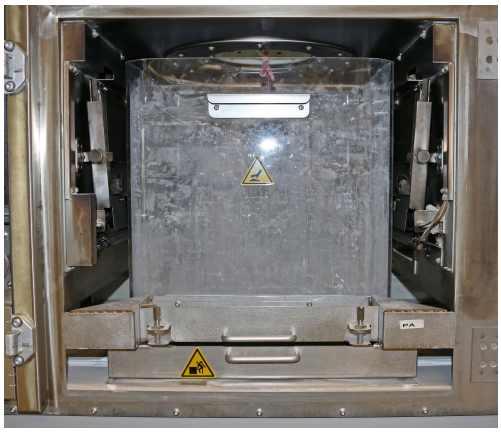




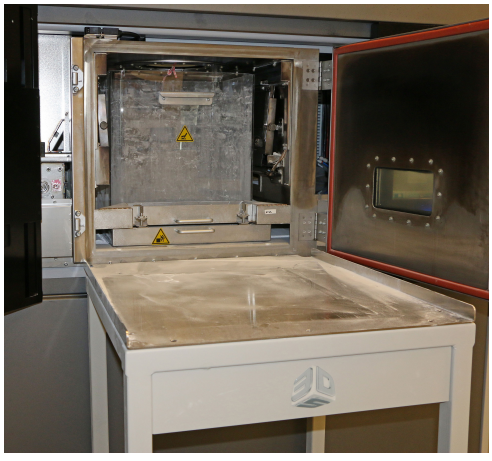
Make sure the outer tabs of the cylinder catch on the rim of the print chamber door.

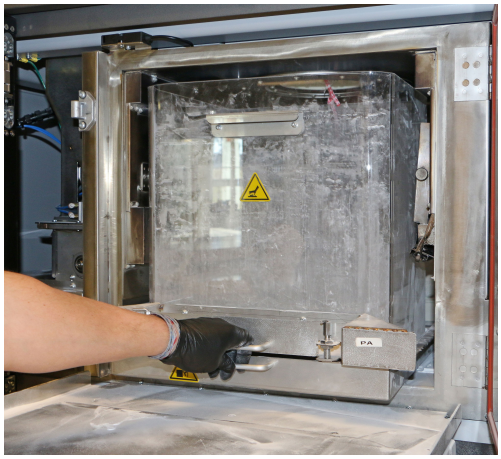
8. Close and latch the inner print chamber door.
9. Close the outer print chamber door.
10. In Sinter, open the **Piston Control** and press the **Start Piston** button to raise the print cake into the cylinder.
11. Once the piston has finished raising the print cake, open the outer and inner print chamber doors.
12. Slide the Print Cake Tray underneath the cylinder, as shown, and latch the tray with the pull pins on the cylinder.





13. If the print cake is light enough, it can be moved manually to the ProX® MQC System. Otherwise, use the Part Transfer Cart.
14. Move and align the cart to the print chamber.

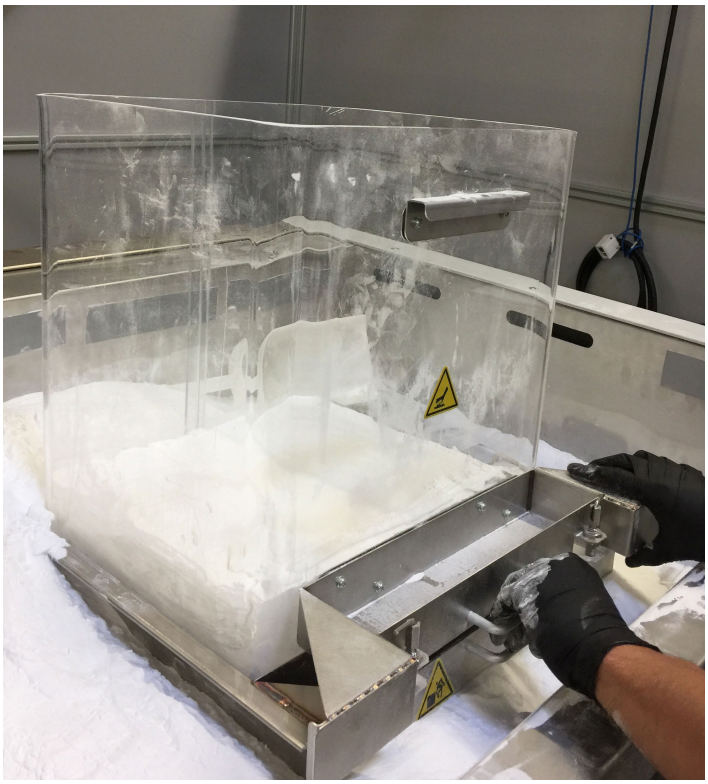


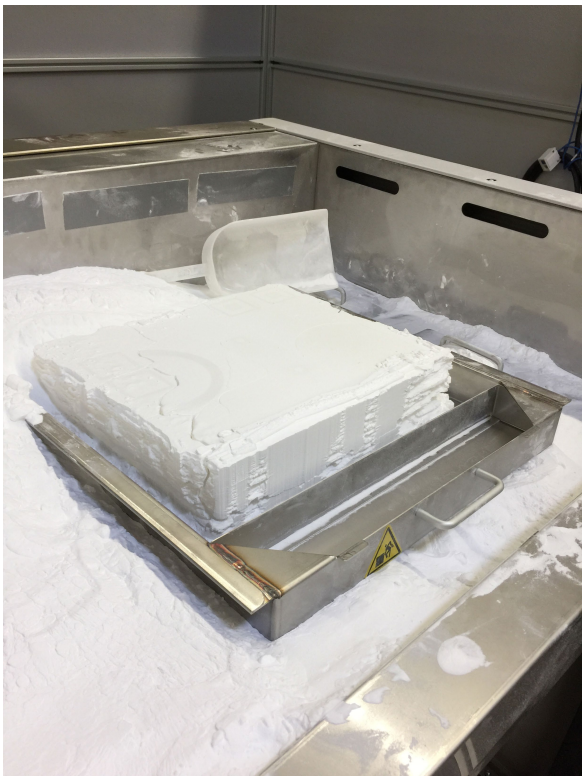


15. Slide the cylinder and tray out of the chamber and onto the cart.
16. Move the transfer cart to the MQC System.

BREAKING OUT PARTS

When a print completes, you need to remove the sintered parts from the print cake and clean them. Removing parts from the print cake is called “breakout.” This section describes the procedures you follow when you break out parts.





NOTE: You can find material-specific information about breaking out and cleaning parts in your Material Guide.

Before breakout, you must:

- Cool down the print cake then remove the part transfer cylinder from the print chamber—or vice-versa.
- Roll the part transfer cart to the ProX MQC Single Use System and unload the print extraction cylinder onto the breakout area.
- Remove the print cylinder.
- Remove the surrounding powder from the outline of the parts with a spatula and brush. Ensure the sifter is running, then brush unsintered print cake powder into the sifter.
- When you can easily grasp a part, carefully lift it. Gently brush off the parts and place them on the breakout area of the ProX MQC Single Use System.

Part Finishing After Breakout

NOTE: Consult your Material Guide for full details on part finishing.

After breakout, remove and dispose of any remaining print cake material from holes and crevices.

Your SLS system ships with a basic set of rough and fine part cleaning tools. You may find it useful to supplement these with other fine tools, picks, and brushes, such as those used for dental and jewelry work.

3D Systems recommends you also purchase a glass bead blaster (pneumatic blast cabinet). A bead blaster makes fine cleaning much easier and faster. See your **Facility Guide** for recommended third party suppliers.

6 MAINTENANCE PROCEDURES

This section covers the following topics:

- Replacing Light Bulbs in the Process Chamber
- Cleaning the Print Chamber
- Cleaning the Roller Assembly
- Cleaning the Laser Window
- Replacing the Laser Window
- Cleaning the IR Sensor
- Cleaning the Black Body
- Cleaning the Exhaust Port
- Cleaning and Replacing Filters
- Chiller Maintenance

MAINTENANCE PROCEDURE PRECAUTIONS

Observe the following precautions during user maintenance procedures:

- Do not perform any procedures without thoroughly reading and understanding the safety information.
- Provide adequate ventilation during any maintenance procedure that might cause material to become airborne.
- Use an ignition-proof vacuum only, do not use compressed air.
- Spilled material can cause the floor to become very slippery; clean up spills promptly.
- Some cleaning solvents are flammable and can cause skin and/or respiratory irritation. For each solvent, refer to its Safety Data Sheet (SDS) for more details.
- Do not perform any procedures that are not covered in this section or that you are not fully trained and qualified to perform.

MAINTENANCE KIT

With each ProX SLS 6100, 3D Systems provides a maintenance kit for routine maintenance procedures. Many of the tools you need for these procedures can be found in this kit.

PRINT CHAMBER MAINTENANCE

Replacing Light Bulbs in the Process Chamber

There are two light bulbs located on the heater assembly of the print chamber. If one or both of them burns out, contact 3D Systems Field Service.

Cleaning the Print Chamber

Before any new print job, clean the print chamber. To print parts with a different material than you used in the previous job, thoroughly clean all parts of the print chamber to prevent mixing or contaminating materials. If a material becomes contaminated by another material or any foreign substance, discard it. Contaminated material can adversely affect part quality.

NOTE: The following procedure contains the steps for a thorough cleaning of the print chamber. If you are not changing materials, you can omit the steps marked by the * *(asterisk) symbol*, to perform a moderate cleaning.

NOTE: Perform a moderate cleaning after every print job. Perform a thorough cleaning whenever you change materials in the SLS system.

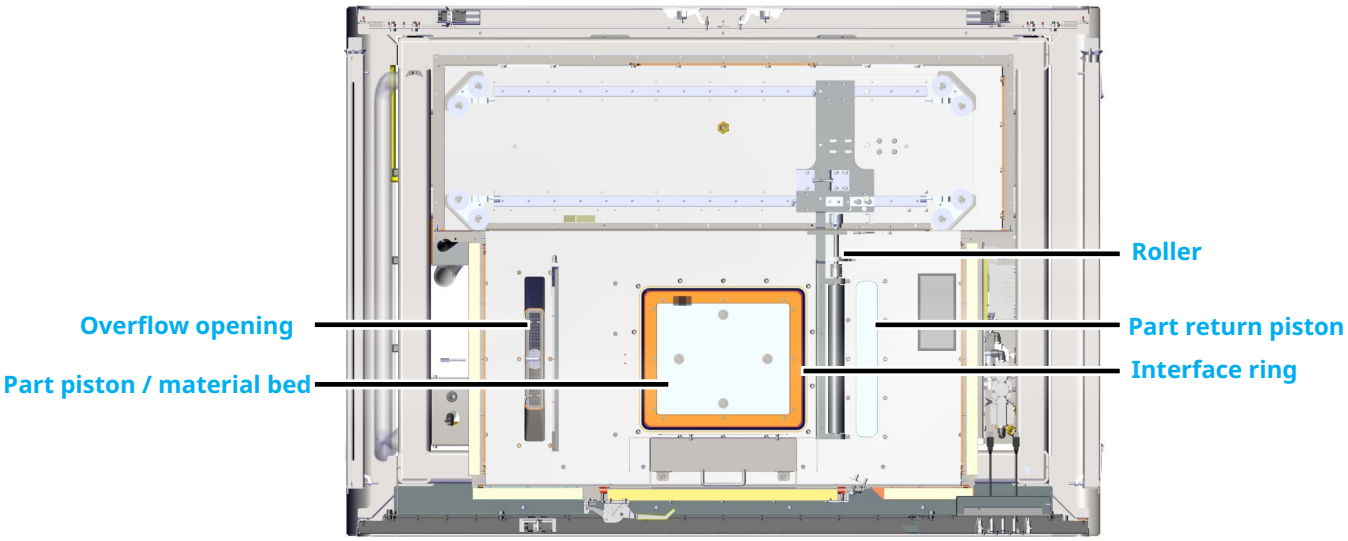
Tools and Supplies Needed

- Scoop for material
- Non-ignition vacuum
- Tack cloth or dust rag
- Container for discarded material
- Lab-grade acetone and lab-grade ethanol
- 2.5 mm Allen wrench
- Soft brush

CAUTION: Before beginning any of the procedures in this section, make sure that the printer has cooled down adequately to prevent burn hazards.

The following figure illustrates the bottom surface of the print chamber, as if you were looking straight down from the ceiling of the print chamber.

NOTE: Refer to the appropriate Material Guide for special cleaning instructions for specific materials.



Overhead Section-View of Print Chamber

To Clean the Print Chamber

1. Close and latch the inner print chamber door. Close outer print chamber door
2. Put the **Sinter** application in **Manual Operations** mode.
3. If necessary, exit **Print** mode. Then select the **Man Ops** button to access the manual operations screen.
4. Using the **Roller** screen, move the roller to the center position.
5. Open the outer print chamber door. Unlatch and open the inner print chamber door.
6. Vacuum and brush the material from the seal around the inside of the print chamber door. Use a non-ignition vacuum cleaner.
7. Clean the door with the tack cloth and vacuum the door and the window. If necessary, clean the window with ethanol or glass cleaner.

NOTE: Use only soft cloths or paper towels and non-abrasive cleaners on the inside of the print chamber window to avoid damaging the coating that prevents the laser beam from escaping during the print process.

8. There are pull pins on the front of the heaters which will release them.
9. Vacuum and wipe off the entire roller assembly.
10. Clean the roller.
11. * Wipe the print chamber walls with a tack cloth.
12. Clean under the roller. To see the overflow on left, the powder chute must be lifted manually.
    a. Close the inner and outer print chamber doors.
    b. The roller should be in the center. If not, press the green **System On** button to engage the roller contactor.
    c. Use the **Roller** button to move the roller.
    d. Unlatch and open the print chamber doors.
    e. Brush material in the area that had been covered by the roller into the overflow, then clean the area with a non-ignition vacuum cleaner and tack cloth.

13. Clean the belt seals.
14. *Clean or replace the print chamber filters.
15. *Clean the part piston and around the part piston seals.
16. Return the heater assemblies to their print position.
17. Clean the laser window.

*** These items must be performed before each build.**

Cleaning the Roller Assembly

This section describes how to clean the roller assembly. Perform these procedures in conjunction with a thorough cleaning of the print chamber, described previously.

Tools and Supplies

- Tack cloths
- Lab-grade ethanol
- Bottled air

1. Close and latch the print chamber door.
2. Move the roller toward the center of the print chamber.
3. Unlatch and open the print chamber door.
4. Clean around the roller assembly. Use a brush and a non-ignition vacuum cleaner.
5. * Clean the roller using ethanol. Wipe dry with a tack cloth.

Cleaning the Laser Window

The laser beam passes through the laser window into the print chamber. It is very important that all impurities are kept off the laser window. Impurities can be burned onto the laser window, decreasing the laser power available at the print bed.

Cleaning the laser window is a delicate procedure. The laser window can be damaged and may need to be replaced if serious damage occurs. Handle the laser window very carefully and follow the cleaning procedure exactly.

Tools and Supplies

- Lens tissue
- Lab-grade acetone
- Applicator bottle for acetone
- Dawn liquid soap
- 2.5 mm Allen wrench
- Cotton gloves (optional)
- Paper towels

Removing the laser window and inserting the baffle plug as described in the section above.

1. After removing the laser window, bring it to a clean area and set it down on a clean cloth as shown. When not in use or being cleaned, cover it with lens tissue and secure the tissue over of the lens using the tissue box.

Laser window on clean cloth

Cover when not in use

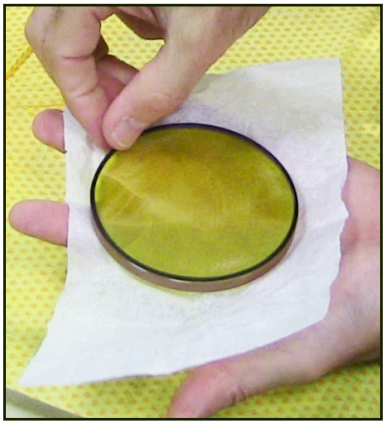
2. The laser window is enclosed in the baffle assembly. Remove the top cover of the assembly using a 2.5mm allen wrench. Be sure to loosen the screws in a cross-pattern so that the tension is relieved evenly.
3. Set the screws and the lid to the side.

Remove lid and set to the side

4. Cover the lens with a lens tissue and turn the assembly over so that the lens comes out.

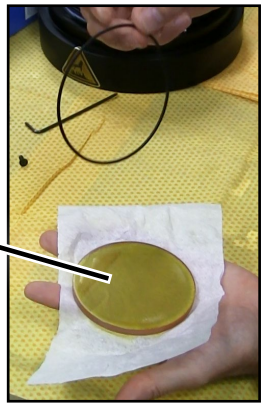
Cover with lens tissue

Turn the assembly over

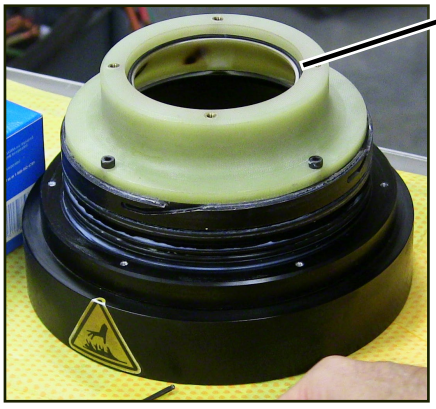


Remove lens and set on work table

5. Set the lens aside on the work table. This will be the side of the O-ring that will need to be cleaned the most. However, both sides will be cleaned in this procedure.
6. Remove the O-ring and wipe it clean.

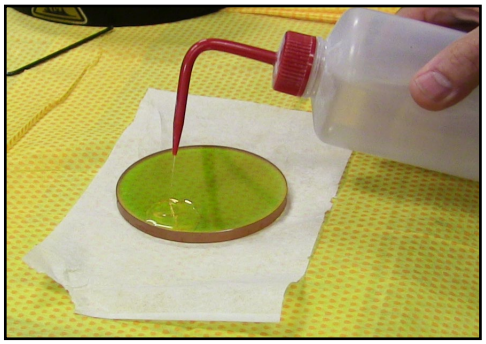


Remove and clean O-Ring

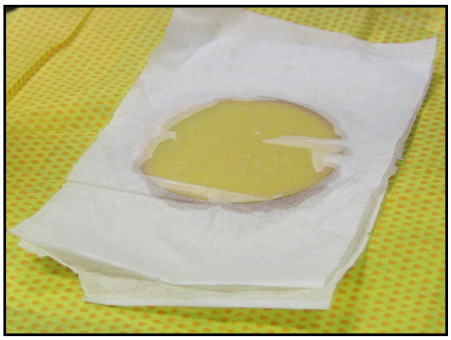


Replace into baffle assembly

7. Replace the O-ring into the laser window baffle assembly.
8. Transport the lens to an area where it can be cleaned with mild soap (Dawn liquid soap is recommended) and warm water. Have lens clothes ready. This is a pre-cleaning that needs to be performed to get the stickier material off before a final cleaning with acetone.
9. First, clean hands and run warm water over the lens.
10. Apply a moderate amount of soap to the lens and spread it across the surface by hand.
11. Rinse the lens in the warm water. Repeat these steps until the lens is thoroughly cleaned.
12. Dry the lens using the lens cloth.
13. Return the lens to the work table to clean with acetone.
14. Set the lens down on a clean tissue in a clean area of the work table. It does not matter which side is facing up.
15. Using the applicator filled with acetone, apply a moderate amount of acetone to the surface of the lens.
16. Set a tissue on top of the lens to soak up the excess acetone.

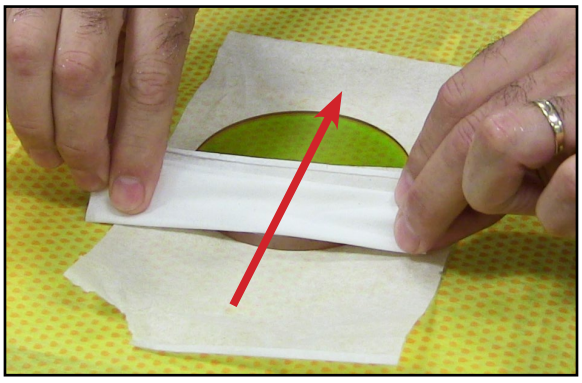


Apply acetone to lens

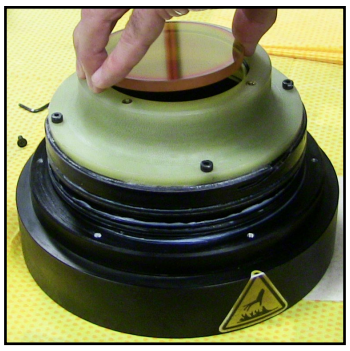


Soak up excess acetone with lens tissue

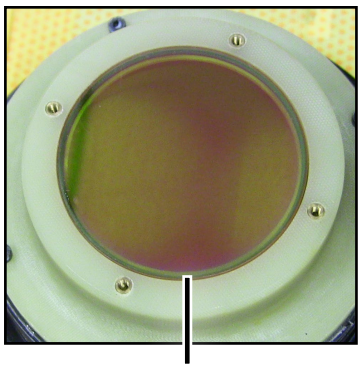
17. After the tissue has soaked up some of the acetone, pull it off gently to avoid streaking. Discard the tissue.
18. Apply a small amount of acetone to the lens again.
19. Fold up a lens tissue lengthwise to wipe the acetone off with.
20. Gently pull the tissue across the lens.
21. Fold the same tissue once again and gently wipe once more. This should completely remove the acetone from this side of the lens.
22. Repeat the process for the other side of the lens.
23. Gently press the lens back into the laser window baffle housing. Ensure that the O-Ring is visible and that the lens is fully seated and flush with the housing.
24. Place the housing ring on top of the assembly.
25. Fasten the ring using the screws that were set aside earlier using a 2.5mm allen wrench. Use the long end of the allen wrench to prevent over-tightening. Tighten in a cross-wise fashion to even out the tension.
26. Cover the lens using a lens tissue and weigh down with the tissue box.



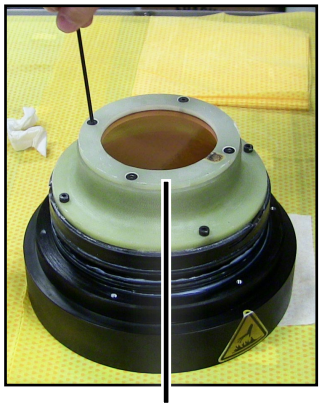
Gently wipe lens dry



Replace lens



Ensure O-Ring is visible and lens is flush with housing



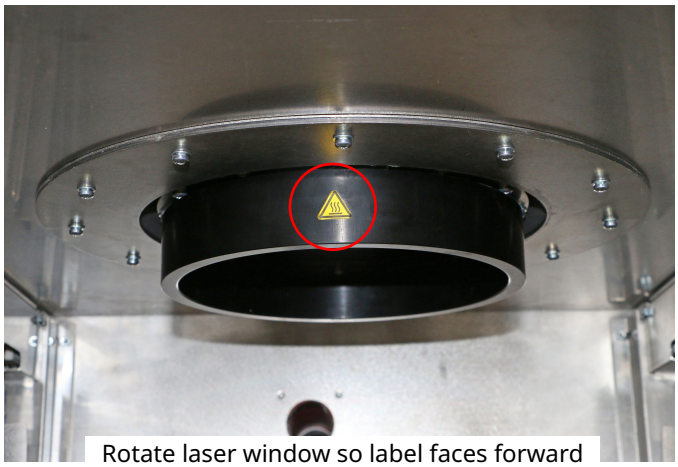
Replace top ring and fasten with 2.5mm allen wrench

Cover when not in use

Replacing the Laser Window

Once the laser window and print chamber have been cleaned, you must reinstall the laser window.

1. Remove the red laser window baffle plug.
2. Insert the laser window into the recess at the top of the print chamber with the warning label facing slightly to the left. This will be so that when you tighten it, the label will be facing forwards.
3. Rotate the laser clockwise ¼-turn to tighten it into the print chamber.



Rotate laser window so label faces forward

Cleaning the IR Sensor (Inspect first and olny clean if necessary)

1. Place a small amount of ethanol on an SLS IR sensor cleaning swab (part #4100-01431).
2. Use the wet swab to clean the head of the IR sensor by gently touching the IR sensor head with the tip of the wet swab and rotating the swab.
3. Use a dry swab to dry the IR sensor head by gently touching the IR sensor head with the tip of the dry swab and rotating the swab.

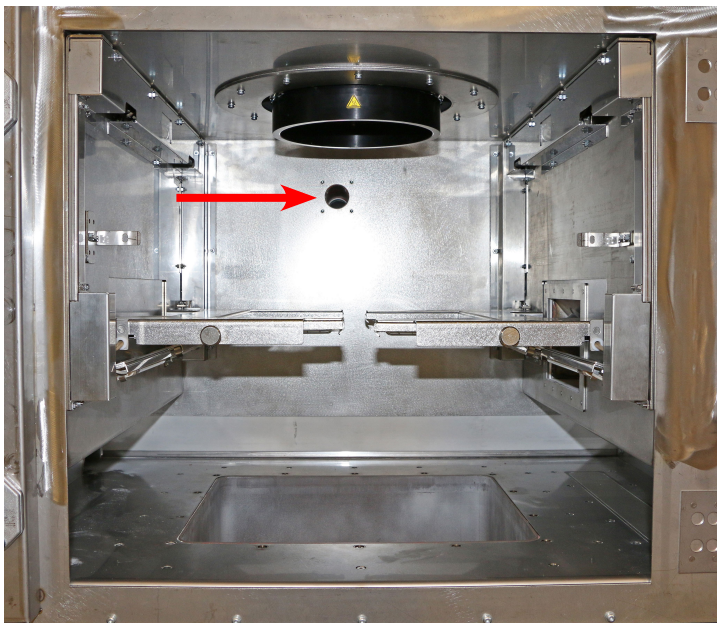
Cleaning the Black Body

A clean black body will have a dark matte finish. It is important to inspect the black body at least 3 times a week or after 40 hours of print time and clean, if needed. Powder deposit on a black body surface can permanently change the surface if the powder sinters on the surface of the black body.

1. Gently vacuum the black body without touching its surface.
2. Place a small amount of ethanol on an SLS IR sensor cleaning swab (part #4100-01431).
3. Gently rub the swab in a back-and-forth motion to clean the black body.
4. Use a dry swab to dry the black body. Repeat until clean.

Cleaning the Exhaust Port

To clean the exhaust port inside the print chamber, use a non-ignition vacuum cleaner to remove any debris that has accumulated.



Print chamber showing exhaust port

CLEANING AND REPLACING FILTERS

There are several filters on the ProX SLS 6100 and MQC System that need to be cleaned or replaced periodically. It is suggested that each of them be checked weekly and replaced as necessary:

ProX SLS 6100 Filters

- Air Processing Module Filter
- Transport Filter (“Sock” Filter)
- Electrical Enclosure Filter

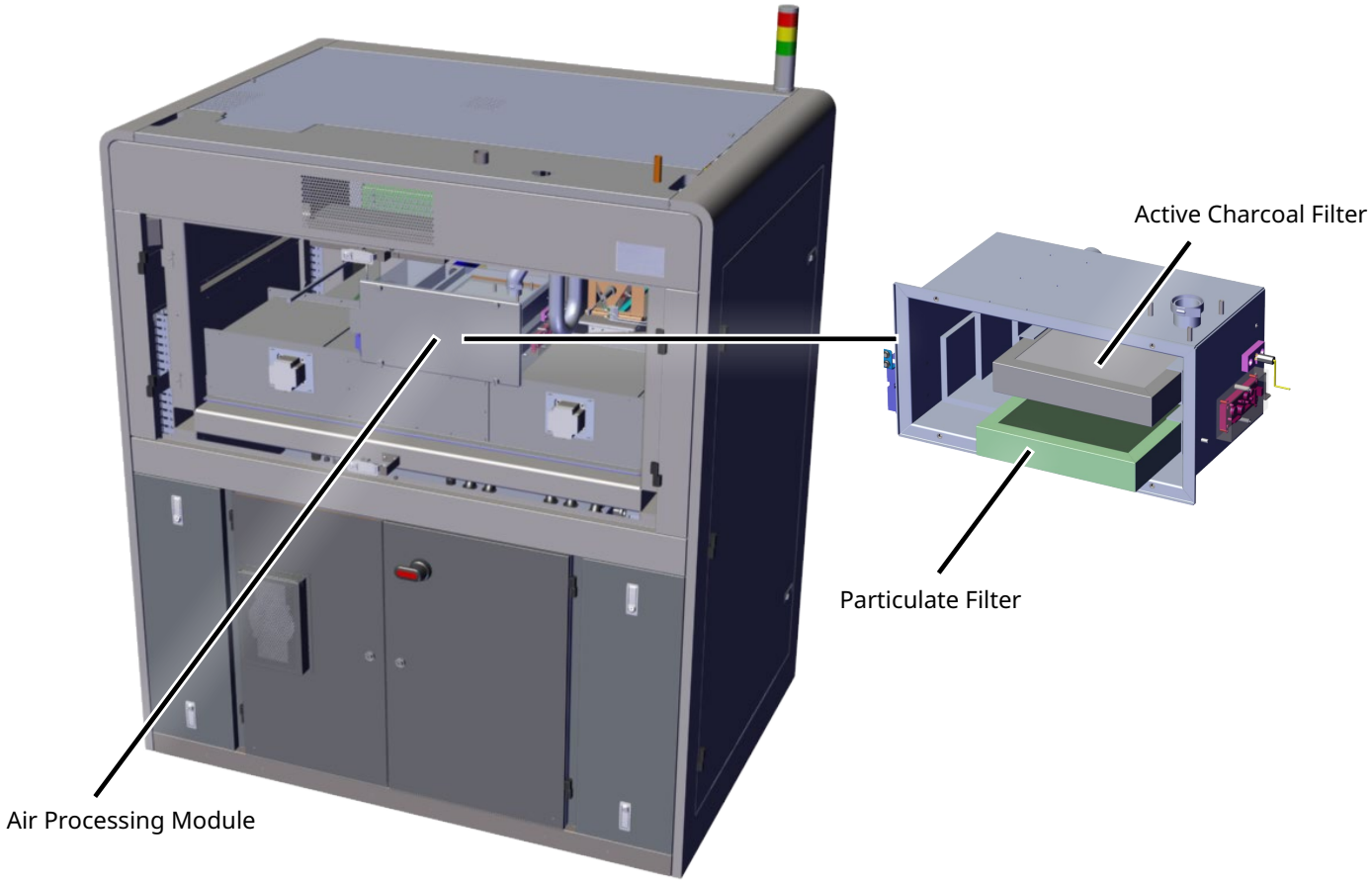
Exhaust Processing Module Filters

Tools and Supplies

- Tack cloth
- New filters
- Non-Ignition vacuum cleaner

The exhaust processing module filters gas moving through the print chamber. You access these filters from the back of the printer by loosening the thumb screws and removing the panel.

To clean or replace the filters:



1. Open the top back doors of the printer.
2. Unscrew the filter cover.
3. Remove the filters and clean them using a vacuum cleaner or cloth, or, replace them with new filters.
4. Replace the filter cover.
5. Close the printer doors.

Electrical Enclosure Filter

Tools and Supplies

- Tack cloth
- New filters
- Non-Ignition vacuum cleaner

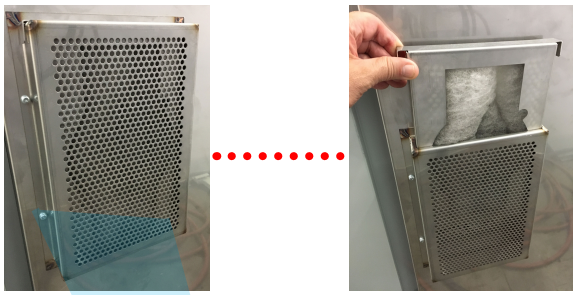
Replacing Electrical Enclosure Filter

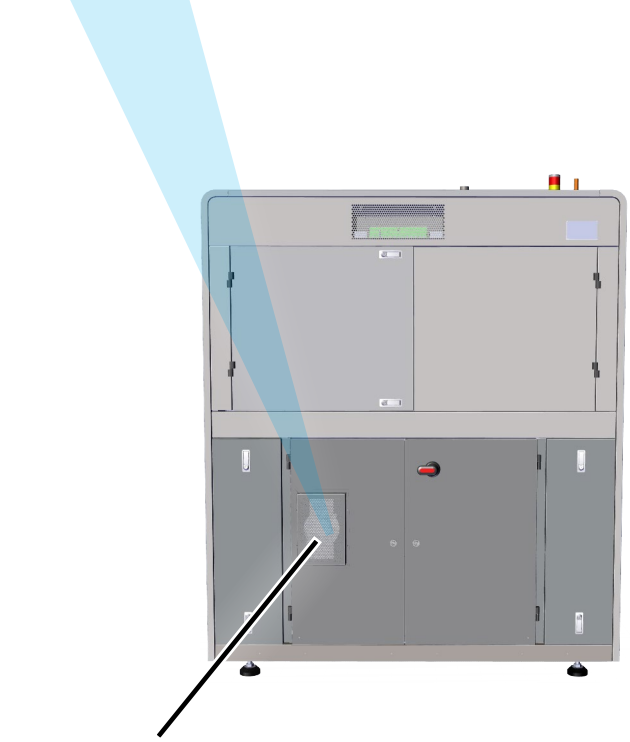
Air moving through the electrical cabinet is filtered from both sides of the cabinet. You access these filters by loosening the thumb screws and removing the covers.

To replace the filter:

1. Open the lower door (left or right) of the printer.
2. Unscrew the filter cover.
3. Remove and replace the filters.
4. Replace the filter cover.
5. Close the printer door.

Electrical Enclosure Filter





Electrical Enclosure Filter

Transporter Filter (“Sock” Filter)

Tools and Supplies

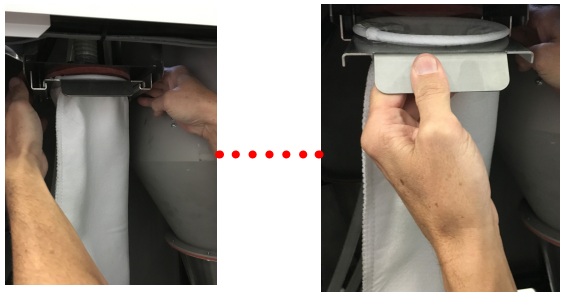
- Tack cloth
- Non-Ignition vacuum cleaner
- New filters

Cleaning or Replacing the Transport Filter

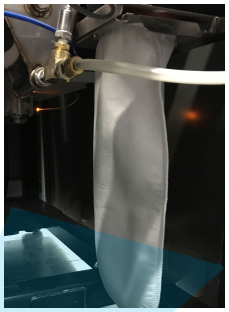
The transport filter filters powder and air moving through the system. There is one located at the rear of the ProX MQC Single Use System and one on the left side of the printer. You access the filter by loosening the thumb screws and removing the cover.

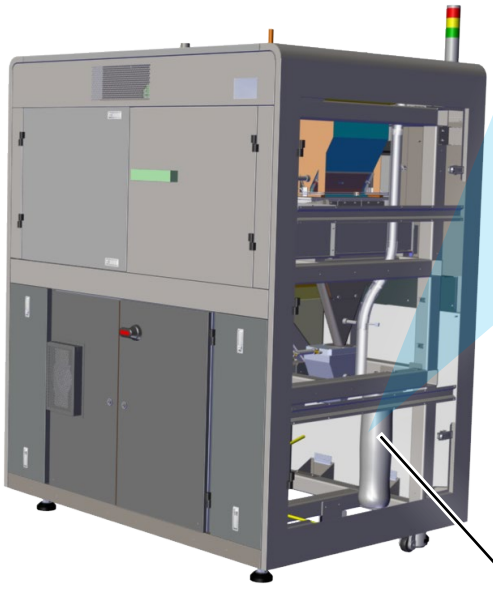
To Clean or Replace the Filter:

1. Open the right-lower door of the printer or rear door of the ProX MQC System.
2. Loosen the top thumb screws to unclamp the sock filter.
3. Remove the sock filter.
4. Turn inside-out, shake off loose powder, and vacuum.
5. If necessary, replace the filter.
6. Replace the filter cover.
7. Close the printer door.



“Sock” Filter





Sock Filter

7 USER MAINTENANCE CHECKLIST

DAILY/EVERY PRINT

- Laser Window, inspect and clean if needed
  - Laser Window Assembly O-Rings
    - Consumable replace as needed
    - PM replace (1yr)
- Black Body, inspect and clean if needed
- Chamber door seal, clean as needed
- Chamber window, clean as needed
- Chamber interior, clean as needed
- Chamber lights, clean as needed
- Check N2 and air regulator settings (note: N2 regulator pressure will drop if purge is on)
  - N2 – used for purge, overflow transfer, laser window flow, Clean Sweep IR
  - Air used for Return Piston motion, Blackbody motion, Feed bar motion

WEEKLY

- Overflow cleanout, inspect and clean as needed
- Blackbody – Inspect, clean as needed
- IR sensor – Inspect, clean as needed
- Roller, clean as needed
- Chamber door seal , inspect and clean as needed
  - Consumable replace as needed
  - PM replace (1yr),
- Sock Filters (ProX 6100 AND MQC), inspect, empty as needed
- Inspect compressed air condensation/oil trap, empty if needed

NOTE: Safety interlocks are located on:

- Overflow cleanout cover
- Blackbody inspections
- Inner Print Chamber door
- Outer Print Chamber door
- Rear Filter box
- (x2 located in the front and back)) Laser/scanner box (should not be accessed by user)

All power is off when all interlocks are not made. If any interlock is broken while moving the piston or roller, then they will need to be homed before continuing.

MONTHLY

- Part Piston Cylinder wall, inspect
- N2 Exhaust Box – Inspect port to chamber, clean if needed
- N2 Exhaust Box – Clean Box interior
- Sock and filters, clean

EVERY 3 MONTHS

- Electrical enclosure filters(2) – replace

EVERY 6 MONTHS

- Part Piston Cylinder wall – lubricate
- Sock and Filters – replace
- N2 Exhaust Filters – replace

AS NEEDED

- Offline IR calibration
- Reboot application computer
- Exit Sinter/Kill Sinter

MQC – USER MAINTENANCE

- Inspect compressed air condensation/oil trap, empty if needed
- Wipe surfaces, sift, discard unusable powder, as needed
- Disposal container
    - Inspect weekly, empty as needed
- Sifter screen
    - Vacuum after every use
- Sock filter
    - Inspect weekly, clean monthy, replace at 6 months

3D PREVENTATIVE MAINTENANCE – ANNUAL

- Replace laser window assembly o-rings
- Replace Chamber door seal
- Replace chamber lights (if needed)
- Replace all filters
- Check and recalibrate laser/scanner
- Clean and lubricate system

3D SYSTEMS

CE 18

EC DECLARATION OF CONFORMITY (DoC)

We

Manufacturer: *3D Systems Corporation*
Address: *333 Three D Systems Circle Rock Hill, SC 29730*

declare under sole responsibility for issuing this declaration of conformity in relation to the following Product(s):

Product Description: *3D Printer*
Model: *ProX SLS 6100*
Serial Number:

For the above given Product(s) is hereby declared that it conforms to the essential requirements set out in community harmonization legislation mentioned below:

Machinery Directive 2006/42/EC of 17 May, 2006
Electromagnetic Compatibility Directive 2014/30/EU of 14 October 2014

Statement about the relevant harmonized standards that have been used, or statement about the specifications in relation to which conformity is declared (Standard: Date of Issue):

EN 61010-1:2010
EN/ISO 13849-1:2015
EN 11553-1:2008
EN 61000-6-2:2005
EN/ISO 12100:2010
EN 60825-1:2014
EN 55011:2009 + A1:2010
EN 61000-3-3:2013

Additional Information: *Reserved*

Name of Person Authorized to compile the technical construction file:

Joel Delanoue
ZA des portes du Maine
72 380 Joué L'Abbé, France

Local contact for regulatory topics only:

North America	Europe
3D Systems Corporation *333 Three D Systems Circle* *Rock Hill, SC 29730, USA*	*3D France ZA* *des portes du Maine* *72 380 Joué L'Abbé, France*

Signed for and on behalf of:

Wilsonville, OR, USA		
Place of issue	*Date of issue*	*David Heath,* *Regulatory Compliance Technical Programs Manager*

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