



# sPro 60 SLS<sup>®</sup> Center User's Guide

## Contents

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|                                |           |
|--------------------------------|-----------|
| <b>What's New?</b> .....       | <b>2</b>  |
| <b>Overview</b> .....          | <b>10</b> |
| <b>Safety</b> .....            | <b>23</b> |
| <b>SLS System Basics</b> ..... | <b>44</b> |
| <b>Building Parts</b> .....    | <b>52</b> |
| <b>Legal Notices</b> .....     | <b>82</b> |
| <b>Index</b> .....             | <b>85</b> |



# What's New?

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This section describes new and changed functions in LS Software version 4.4 (v4.4) for both the **Build Setup** and **Sinter** applications. Unless noted otherwise, you can use these new software functions with all SLS center materials on any SLS center running v4.4.

Operating instructions, safety guidelines, and maintenance procedures for sPro 60 SLS centers are also covered later in this guide along with instructions and procedures for the older models.

- [OptiScan™ Build Parameter](#)
- [LogManager](#)
- [Session Log Files](#)
- [Other Enhancements in v4.4](#)



## OptiScan™ Build Parameter

OptiScan is a new licensed build parameter available in Build Setup 4.4. When enabled, it causes the SLS center to scan all cross sections on a layer as if they were a single cross section. The more cross sections a layer has, the more layer scan time OptiScan saves. The amount of time saved depends on the cross sections' shape and complexity.

## Session Log Files

While Sinter v4.4 is running, it automatically generates consolidated “**session log**” files with a **.3DL** extension. These files contain all the individual error and parameter log files Sinter creates. Session log files are stored in a new **..\dtm\3DLog** folder on your installation drive.

### Individual Log Files and Session Log Files


The Sinter application generates many separate log files such as, Slicer.tlog, States.blog, and RealMonitor .rmt files. These log files tell you, moment-by-moment, what data values a Sinter module was using or producing during a specific time period. They can very useful for SLS process diagnostics and quality control, however, accessing many separate log files can be cumbersome.

To make it easier to analyze all these separate log files, Sinter v4.4 aggregates them into the two types of **session log files** called **Build session log files** and **Manual Ops session log files**. Both are described below:

- **Build session log files** – contain a copy of the data in stored in every individual log file generated *during a build*. Sinter automatically creates a Build session log file when a build ends, then stores it in the **..\dtm\3DLog\Build** folder.
- **Manual Ops session log files** – contain a copy of the data in stored in every individual log file generated *between builds*. Sinter automatically creates a Manual Ops session log file when a build starts (even if it's the first build after you start Sinter). Manual Ops session log files are stored in **..\dtm\3DL\Manual Ops**.



In addition to aggregating log file data, session logs also contain copies of configuration control files (such as .ini files) which record machine status. For further information on session log file structure and contents, see the “Session Log Files” section of your [Software Utilities Guide](#). Also see [“LogManager” on page 6](#) for a description of the new **LogManager** utility in v4.4; a standalone program that enables you to view, create, and manage session log files—and the individual log files they contain.

 For complete instructions on using LogManager, see the "LogManager" section of the [Software Utilities Guide](#).

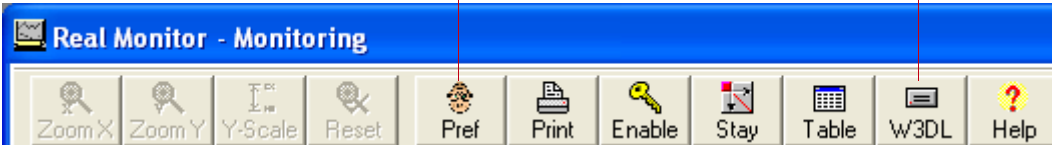
## RealMonitor™ and Session Log Files in v4.4

The RealMonitor utility was upgraded to work with the new .3DL session log files in v4.4. You can control the number, size, and age of both Manual Ops session log files and Build session log files using the **DiskSpace Manage** tab of the RealMonitor **Preferences** window (shown below).

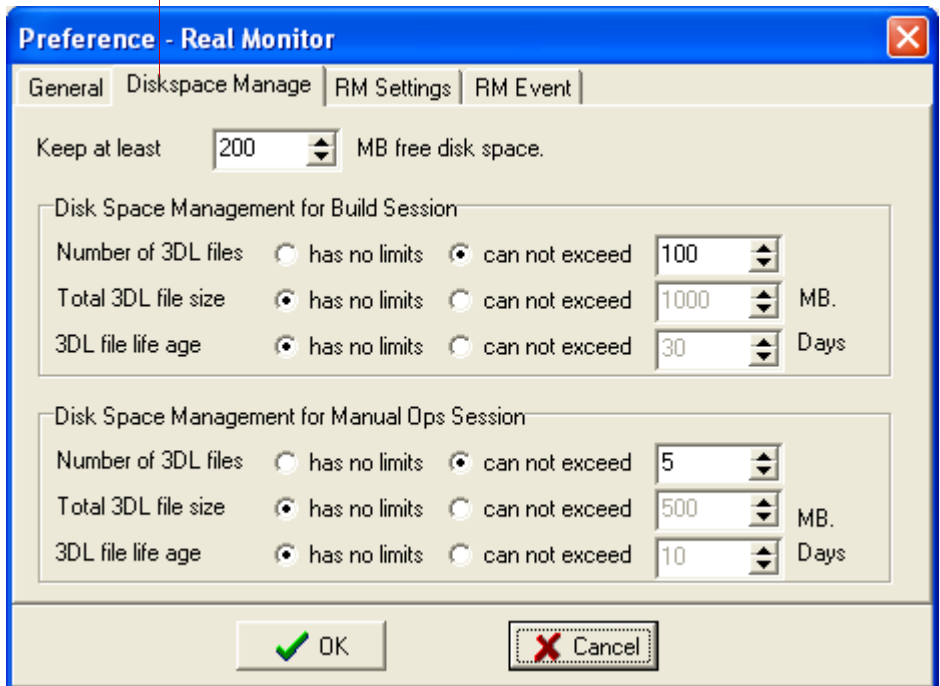


Click to set RealMonitor Preferences

Click to datestamp 3DL log file



Manage 3DL log file number, size, and age on the RealMonitor **Diskspace Manage** tab





## LogManager

**LogManager** is a new standalone program in v4.4 that enables you to view, search, print, and export 3DL [Session Log Files](#)—and the many individual log files they contain—all in one easy-to-use tabbed window. LogManager replaces the older **RealMonitor Viewer** and **BrowseLog** utilities with a more capable and comprehensive program for studying historical log files.

(Examples of LogManager log file tab views are shown on [page 7](#).)

Parameter and build event graphing functions in LogManager (similar to RealMonitor Viewer) require a RealMonitor software license. Log file text data browsing (similar to BrowseLog) does not. Specifically:

- **Without a RealMonitor license** – you can browse and search text data 3DL session log files and all individual Sinter log files (as in BrowseLog, but with additional search and filtering capabilities).
- **With a RealMonitor license** – you can view enhanced “RealMonitor Viewer-style” parameter graphs with build events, export log files, and browse/search log file text data. LogManager also lets you display a “moving average” trend line on historical parameter plots. Each point plotted is an average of the last 120 data values.

After you run Sinter at least once, one or more 3DL session log files will be available for you to view in LogManager. You can launch LogManager by double-clicking any Build Session Log file in the `..\dtm\3DLog\Build` folder, or any Manual Ops session log file in the `..\dtm\3DLog\ManualOps` folder.



You need to run a build to get a Build session 3DL file in the `..\3DLog\Build` folder.

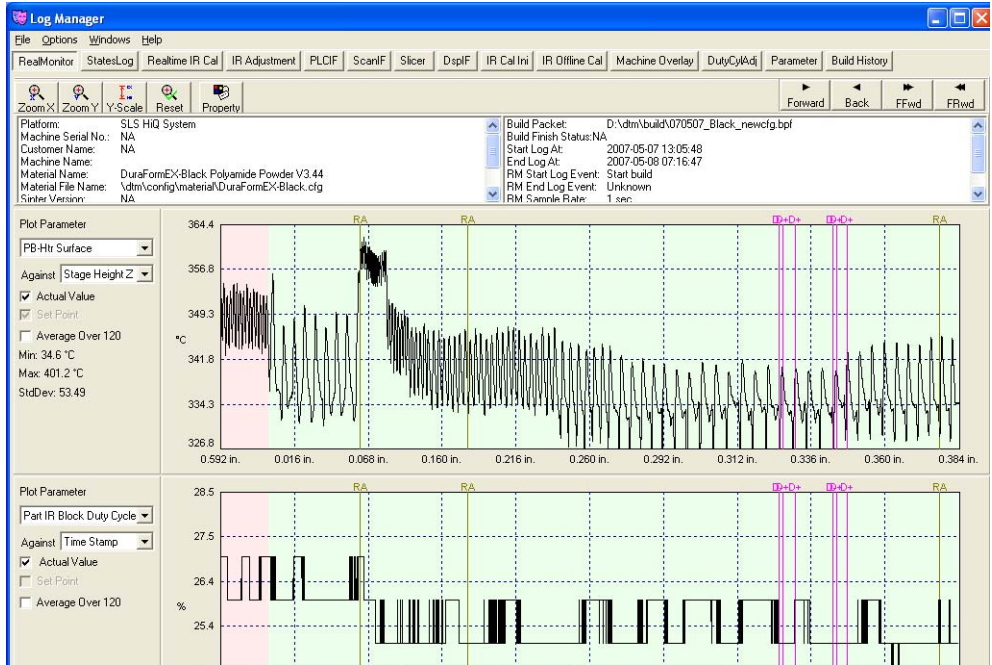


See the “RealMonitor” and “LogManager” sections of your [Software Utilities Guide](#) for further information including changes to RealMonitor with the introduction of Session Log Files.



## LogManager – example tab views for individual log files

RealMonitor tab view showing parameter graphs, events, and summary text data stored in RealMonitor log (.rmt) file



StatesLog tab view showing data in States.blog file

The figure displays the StatesLog tab view in the Log Manager software. It shows a list of log items with columns for Item #, Time Stamp, and details. Item 7087 is highlighted.

| Item # | Time Stamp          | Details   |
|--------|---------------------|---|
| 7081   | 2007-05-07 15:20:09 | Inbound-> ADD_POWDER_LAYER_NOT_REACHED_P                  |
| 7082   | 2007-05-07 15:20:10 | Inbound-> ALP_TO_PST_STATE_I_Status = 0000 0000 0000 0010 |
| 7083   | 2007-05-07 15:20:11 | Inbound-> CHAMBER_TEMP_P, 3552                            |
| 7084   | 2007-05-07 15:20:12 | Inbound-> PART_BED_TEMP_P, 1852                           |
| 7085   | 2007-05-07 15:20:13 | Inbound-> CHAMBER_TEMP_P, 3558                            |
| 7086   | 2007-05-07 15:20:14 | Inbound-> PART_BED_TEMP_P, 1860                           |
| 7087   | 2007-05-07 15:20:15 |   |
| 7088   | 2007-05-07 15:20:16 |   |
| 7089   | 2007-05-07 15:20:17 |   |



## Other Enhancements in v4.4

Minor enhancements included in Build Setup 4.4 and Sinter 4.4 are described below.

### Build Setup Enhancements

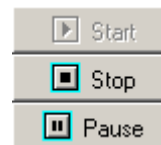
The Build Packet Browser in Build Setup 4.4 now allows you to **Remove** build packets that have not been backed up in the `..\dtm\backup` folder without displaying an error message.

### RealMonitor Enhancements

In addition to its new ability to generate 3DL session log files, the RealMonitor utility in v4.4 also lets you limit the size of RealMonitor log (.rmt) files by giving you the option to control when logging occurs. You can start and stop logging in RealMonitor on demand, or, when an event occurs.

- **On-demand logging control:** Stop, pause, and restart logging data to RealMonitor (.rmt) log files at any time using the **Start**, **Stop**, and **Pause** buttons below the RealMonitor toolbar.

Click these buttons to start, stop, or pause data logging to .rmt log files at any time.







- **On-event logging control:** Start or stop logging to the current .rmt file when a specific event occurs; choose from a variety of events listed under **Start Monitor At** and **End Monitor At** below the RealMonitor toolbar. After you select a Start or End event, specify the build height at which you want RealMonitor to begin watching for the event to occur.

Choose an event to Start Monitoring At or End Monitoring At from these drop-down lists.

| Start Monitor At      | End Monitor At    |
|-----------------------|-------------------|
| Start Build           | End Build         |
| Start Height: 0.5 in. | End Height: 1 in. |

Enter the build height at which you want RealMonitor to start watching for the selected Start or End event to occur.

- See the “RealMonitor” section of your [Software Utilities Guide](#) for further detailed descriptions of the new functions available in RealMonitor.



# Overview

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This guide describes how to use the 3D Systems sPro 60 SLS center:


This section introduces the *User's Guide*, the selective laser sintering (SLS™) process, the sPro 60, the facility requirements, and the software that manages it. It includes the following topics:

- [How to Use this Guide](#)
- [Other Documents](#)
- [Overview of the SLS Process](#)
- [Major Components of the SLS System](#)
- [Internal Components](#)
- [Back View of the SLS Systems](#)
- [Computers and Controls](#)
- [User Interface Controls and Indicators](#)
- [3D Systems Software Provided with the SLS System](#)
- [Third-party Software Provided with the SLS System](#)
- [Installation and Facilities Requirements](#)
- [About the sPro 60 Center](#)



## How to Use this Guide

This guide provides the procedures and guidelines necessary to operate an SLS center. This guide uses the following conventions:

**Items of Special Interest** If an item is of special interest, the guide uses the *note* format to call attention to it. A note is preceded by the symbol .

**Cautions and Warnings** The guide uses two ways to warn of dangerous or hazardous situations:

### Caution

A *caution* indicates something may happen that will cause loss of data or some other undesirable effect.

### Warning

A *warning* indicates you could be in physical danger or that you are about to do something that will damage the machinery.

**Menus** When you need to choose an option from a menu, the word “select” is used, followed by the menu name, an arrow, and the option. For example, to tell you to choose the Exit option from the File menu, the text would read “select File→ Exit.”

**Keys** The names of keys on the keyboard, such as Enter, Shift, or Ctrl, appear in their own distinctive font.



## Other Documents

There are other documents you can go to for information on the system and the SLS process:

- **Build Setup Help:** Launch the Build Setup Help while you are using the Build Setup application, by selecting Help→ Help on Build Setup. The Build Setup Help system provides information on all aspects of setting up a build.
- **Other on-line documents:** To get to an index of on-line documents, click the Home button at the top of any page of this document.



Click here  
to return to  
the main  
index

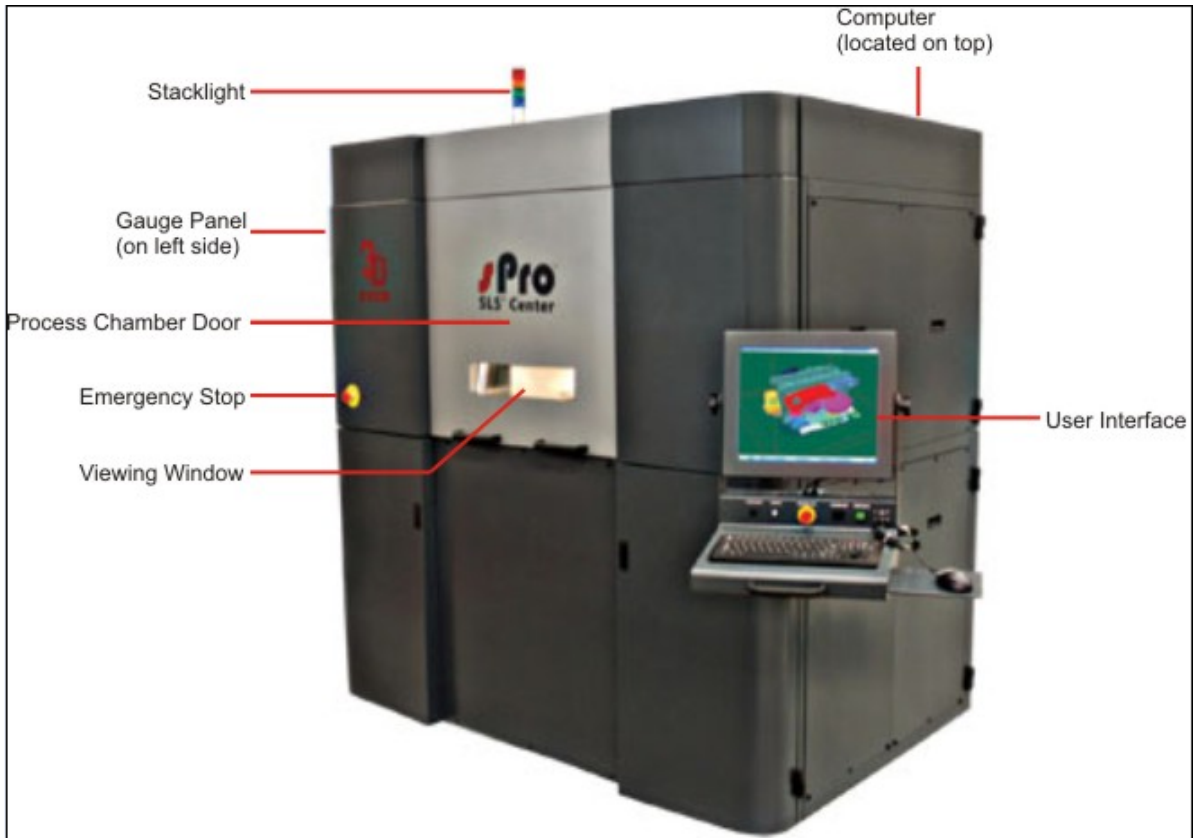


## Overview of the SLS Process

1. Design the model on a CAD system, create the STL file, and transfer it to the SLS center computer.
2. Set up the build packet. See the Help for Build Setup and the material-specific *Material Guide*.
3. Clean the machine if required, and load powder. See [“Preparing the Machine for a Build” on page 54](#).
4. Build parts in the SLS center process chamber, where:
  - A roller delivers powdered material in very thin layers across a flat platform.
  - A laser beam traces across each layer, fusing the powders in specific areas to create a cross-section of the current part.See [“Running a Build” on page 58](#), as well as the *Material Guide* for the material you are using.
5. Break the part out of the powder cake. See [“Breaking Out Parts: Overview” on page 71](#) as well as the appropriate *Material Guide*.



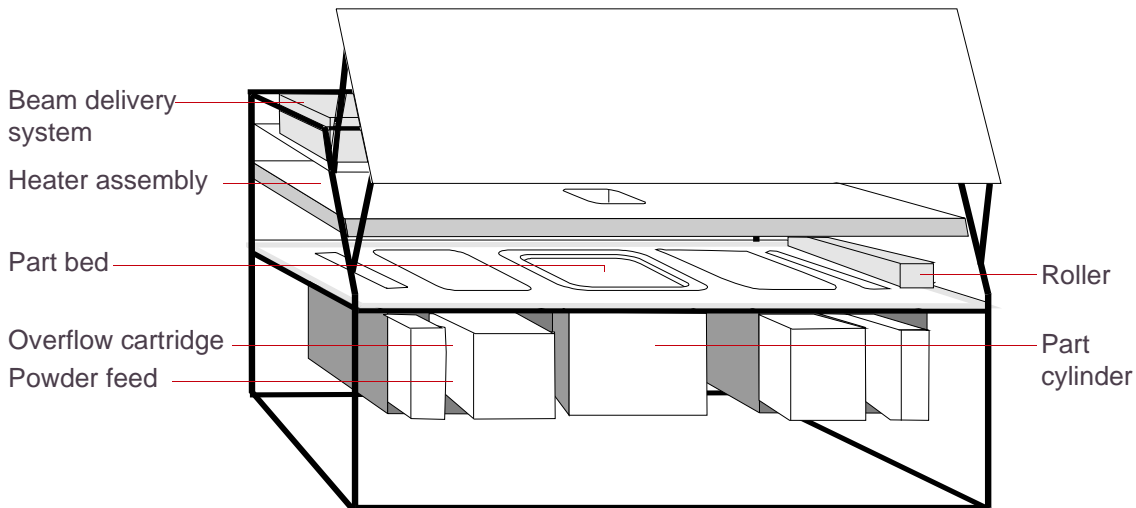
# Major Components of the SLS Center





# Internal Components

## Generic internal view of the sPro 60





# Back View



Service panels for  
access to Main  
Power Disconnect  
Switch

**sPro 60 Center**





## Computers and Controls

You control the sPro 60 with the application computer and a set of [controls and indicators](#). The application computer runs the SLS center software, which runs builds, build setup, and manual operations.

### Computer

The sPro 60 computer is housed on top of the system.





## User Interface Controls and Indicators



| <b>Control/Indicator</b>            | <b>Purpose</b>  |
|-------------------------------------|---|
| <b>sPro 60 SLS center</b>           |   |
| System Secure<br>(Indicator)        | Indicates when all the monitored system safeguards are in place. All E-Stop buttons must be reset, system power must be enabled, and the process chamber must be closed and latched.  |
| Laser On<br>(Indicator)             | Indicates when the laser power has been enabled. It does not mean that the laser is firing, but the potential is there for it to fire   |
| Emergency Stop<br>(E-Stop Switch)   | Pressing any E-stop button shuts down sPro 60 immediately. For safety, all energized components are deenergized when E-stop is pressed.   |
| Chamber Light<br>(Switch)           | Switches the chamber light on and off   |
| System Enable<br>(Switch/Indicator) | The light indicates when system power has been enabled. Pressing the switch will enable system power, which is required after a system power-up or E-Stop event. All E-Stop buttons need to be reset in order for system power to be enabled. |



## 3D Systems Software Provided with the SLS System

### SLS Center Software

The SLS center software controls the SLS center.

With it, you can:

- Set up *build packets*, which store instructions for a build, and preview them. See the Build Setup Help for more information.
- Run builds. See [“Running a Build” on page 58](#) for more information.
- Manually control the SLS center. See Chapter 1, “Manual Operations” in your [Reference Guide](#) for more information on manually controlling the system.

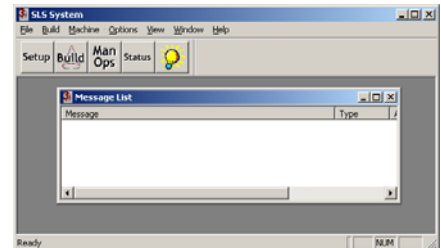
To start the software, see [“Starting and Using the SLS System Software” on page 47](#).

### 3D Systems Utilities

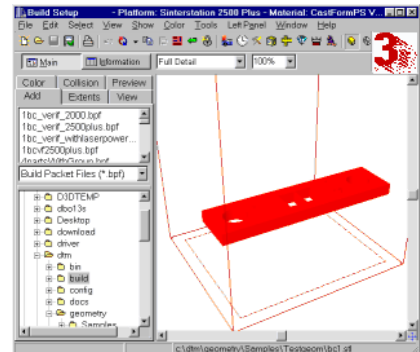
In addition to the software that controls the SLS center, 3D Systems provides utility applications with additional functions, such as reducing log files or checking the status of the system from a remote computer. For more information, see your [Software Utilities Guide](#).

### Major software components

Main application (Sinter.exe)



Build Setup application





## Third-party Software Provided with the SLS System

An STL file editor software package called *Materialise Magics RP* is included with your SLS center shipment. See the *Magics RP* software documentation for instructions. To start the *Magics RP* software, double-click the *Magics RP* icon on your Windows desktop.

Basic functions of the software are free. The software's advanced functions are free for 60 days, and then must be purchased. The 60-day evaluation period is activated by the 3D Systems representative who installs your system. If you do not purchase the activation password, advanced functions are disabled.



If your company purchased the password at the same time that it purchased the SLS center, the software will be fully activated by the field service representative who installs your system. If you did not order a permanent activation password for Magics RP software when you purchased your SLS center, you can order one by contacting Materialise. See your Magics RP software documentation for information.

| Basic Functions   | Advanced Functions   |
|---|--|
| <ul style="list-style-type: none"><li>■ View STL files</li><li>■ Rotate STL files</li><li>■ Translate STL files (offset parts from their base location)</li><li>■ Scale STL files (increase or decrease the size of a part proportionately)</li></ul> | <ul style="list-style-type: none"><li>■ Hollowing parts</li><li>■ Changing wall thicknesses</li><li>■ Repairing STL files<sup>a</sup></li><li>■ Mold creation</li><li>■ Collision detection</li><li>■ Cutting parts<sup>a</sup></li><li>■ Punching holes in parts<sup>a</sup></li><li>■ Triangle reduction</li></ul> |

a. You can also repair, cut, and punch holes in STL files within Build Setup v3.44. See your Build Setup Help for details.



## Installation and Facilities Requirements

3D Systems personnel install the SLS system. Prior to installation, your company receives specific facilities requirements and a pre-installation facility checklist from 3D Systems. For complete information, refer to the [Site Preparation Guide](#).

 The pre-installation facility checklist must be completed and returned to 3D Systems Customer Support before you can schedule installation.

The SLS center computer can be on a TCP/IP network.



## About the sPro 60 Center

The sPro 60 center provides unparalleled temperature accuracy through automatic temperature sensor calibration. The features supporting this enhanced thermal control include:

- Clean Sweep IR sensors (standard)
- Accutemp (optional)
- Software management of the calibration process
- Automatic, real-time (in-build) calibration for DuraForm [PA, GF, EX, AF, and Flex], and LaserForm A6 Steel materials, (available with Accutemp only).
- Offline calibration (in Manual Operations) for all other materials, (available with Accutemp only).
- Over-temperature protection

The sPro 60 superior thermal management enables you to run the same build packet on multiple sPro 60 machines. It also increases the recyclability of unused material by drastically reducing the incidence of powder overheating, especially at the end of the build.

Temperature management in the Sinterstation sPro 60 enhances safety as well as thermal accuracy. For example, if the sPro 60 senses a feed heater or part bed heater over-temperature condition; i.e., above 350° C for the left or right feed heater and above 425° C for the part bed heater, the system automatically shuts down the build and disables the laser and all heaters.



# Safety

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

- Label and point out hazardous equipment, materials, and procedures.
- Explain what to do in an emergency situation.
- Provide information about the hazards of equipment and materials in the form of Material Safety Data Sheets (MSDS's). The MSDS's are provided with all materials supplied by 3D Systems.

This section points out some safety considerations that specifically concern the SLS system. It includes the following topics:

- [Safety Design Features in the SLS system](#)
- [Safety Hazards and General Guidelines](#)
- [Safety Labels](#)
- [Environmental Issues](#)
- [Laser Safety](#)
- [Powder Safety](#)
- [Nitrogen/Oxygen Safety](#)
- [Pinch Points](#)
- [Hot Surfaces and Powders](#)
- [Lifting Safety](#)
- [Electrical Safety](#)



## Safety Design Features in the SLS system

One of the design goals of the SLS system was to provide a safe operating environment.

### **Warning**

**If any of the following safety features fail, your actions may be all that will prevent potentially hazardous operating conditions.**

- Safety interlocks at the SLS system process chamber doors and limited access to electrical cabinets are intended to prevent accidental exposure of the user to the laser beam, thermal hazards, or electrical shock.
- The design of the beam delivery system and the laser window is intended to prevent the laser from being aimed outside the area of the process chamber.
- Limited access to service areas prevents accidental exposure to electrical shock hazards.
- The viewing window to the process chamber prevents user exposure to laser emission while observing operations.
- Limited access to powder areas during builds prevents accidental exposure to thermal hazards.
- The design of the Breakout Station (BOS) and Rough Breakout Station (RBO), in accordance with standard industrial ventilation practices, is intended to remove airborne powder during breakout procedures.
- The use of a room oxygen monitor is intended to automatically implement a shutdown when it detects too little oxygen in a room.
- If the SLS system detects certain unsafe conditions during operation, it is designed to shut down immediately.





## Safety Hazards and General Guidelines

The SLS system was designed with safety in mind. However, as with all equipment, improper use, malfunctions, and excessive exposure could cause injury.

When operating the SLS system, always keep the following points in mind:

- Do not operate the SLS system before receiving proper training.
- Follow the procedures in this guide.
- Conform to all the safety rules in this section and the remainder of this guide.
- Use common sense in dealing with the heated, inert environment of the process chamber.
- Do not access any area of the machine near the powder engine and overflow cartridges during high-temperature-material builds.
- Do not use any material without first reviewing its Material Safety Data Sheet (MSDS).
- Do not attempt to access, service, or adjust the laser system in any way.
- Do not attempt to perform any service or maintenance procedures unless you have been specifically trained to do so:
  - *Operators* are trained to operate the system and perform all the necessary tasks to build a part.
  - *Certified service personnel* are 3D Systems, customer, or contract personnel who have completed the 3D Systems service training package and are certified to perform corrective service tasks. Certification may occur at various levels, and the servicer should only be authorized to perform tasks he/she is certified to complete.
- Do not enter any area displaying posted warning signs during open beam operations. *Open beam operations* refer to the laser, and they occur *only* during service procedures.


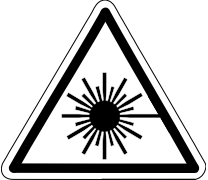
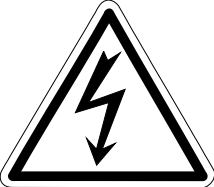


- If you hear an audible alarm, look at the message displayed on the computer screen and refer to Chapter 7, “Messages” in your [Reference Guide](#).



## Safety Labels

Safety labels are posted on the SLS system machine. The following table contains an illustration and description of each of these labels.

| Safety Label   | What it Means   |
|--|---|
|   | <p><b>Hot Surfaces Hazard</b></p> <p>There are surfaces and powders in the vicinity that may be hot and could cause severe burns.</p>   |
|   | <p><b>Laser Radiation Hazard</b></p> <p>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. See <a href="#">“Laser Safety” on page 29</a>.</p> |
|  | <p><b>Electric Shock Hazard</b></p> <p>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.</p>  |



## Environmental Issues

The SLS system emits no toxic substances when using materials approved by 3D Systems. This subsection describes environmental issues to be aware of. For more information, see your *Site Preparation Guide*.

### Emissions

Analytical testing on 3D Systems powders indicates no detectable emissions outside acceptable limits from the SLS system. (See the MSDS's.) The SLS system uses nitrogen, which must be vented to the outside.

### Waste Heat

The SLS system produces waste heat, which must be considered when attempting to maintain the temperature specifications in the installation room.

### Powder Disposal

When you dispose of powder, refer to the MSDS for that material and follow any applicable local regulations.

### Noise Levels

The following table quantifies the noise levels for various components of the SLS system.

| Component                                      | Noise Level                  |
|--|------------------------------|
| SLS System (not including the BOS/RBO station) | 60 dBA                       |
| RBO station composite (sifter and air handler) | 84 dBA @ operator standpoint |
| RBO sifter only                                | 82 dBA @ operator standpoint |
| BOS composite (station and air handler)        | 79 dBA @ operator standpoint |
| Air handler only (BOS and RBO)                 | 79 dBA @ operator standpoint |
| Air handler self-cleaning cycle                | 83 dBA @ operator standpoint |



## Laser Safety

The SLS system contains a 30 or 75-watt CO<sub>2</sub> continuous-wave laser that operates at a 10.6 micrometer wavelength. The laser itself is a Class IV laser. A very brief exposure to a direct—or specularly or diffusely reflected—laser beam can cause significant injury or blindness. It also can 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.

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 825 (the International Electrotechnical Commission's *Radiation Safety of Laser Products, Equipment Classification Requirements, and User's Guide*). You can also read about these designations in *ANSI Z136.1-1993* (the American National Standards Institute standard for the safe use of lasers). This laser classification also complies with DIN VDE 0837/02.86+A1/07.90.

### Reporting Laser Radiation Exposure

If anyone at your site is exposed to laser radiation from the SLS system, report the following information to 3D Systems Corporation:

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

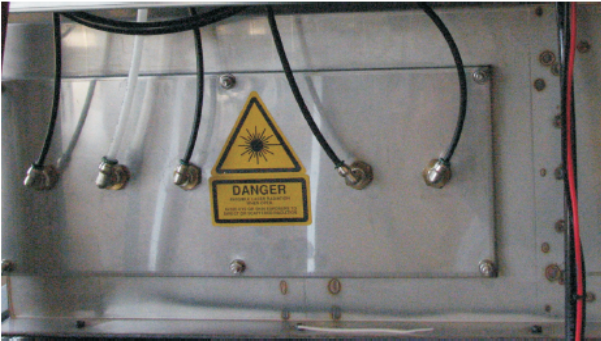
Please send this information to 3D Systems within a day of the accident. The information can be



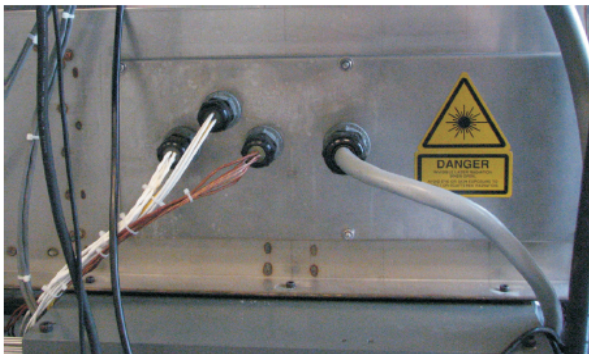
sent by regular mail to 3D Systems marked “Attention: Laser Safety Officer” or by e-mail to [LaserSafetyOfficer@3DSystems.com](mailto:LaserSafetyOfficer@3DSystems.com).

## Laser Safety Label Locations

Left Side of  
Build Chamber



Right Side of  
Build Chamber



Access Cover for  
the Laser





## Laser Safety Label Locations



Rear of Build Chamber



Front of Build Chamber



## General Laser Safety Rules

### Warning

**Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.**

**Failure to follow laser safety rules can result in exposure to hazardous radiation. Radiation can cause burns on the skin and cornea, which can temporarily or permanently damage your vision.**

You should always comply with the following rules when working with laser equipment.

- Operators must attend a training class for SLS system procedures.
- Operate the SLS system *only* with the process chamber door latched and all covers in place. The SLS system laser is enclosed in a protective housing to prevent exposure to radiation. *The protective housing has tool-access locks to prevent access to the laser during normal SLS system operation.* However, if someone tampers with or defeats the interlocks and opens the protective housing, the potential for exposure exists.
- Do not look directly into a laser beam or even at diffuse reflections of a beam.
- Do not operate the SLS system with a broken or missing window.
- Operate the SLS system in accordance with all local regulations. If your state or national government does not provide guidelines for operation of Class I laser systems, refer to *ANSI Z136.1-1993* (American National Standards Institute standard for the safe use of lasers).
- Only certified service personnel specifically trained in laser safety should perform laser service procedures.
- Do not enter any area displaying posted warning signs during *open beam operations*. Open beam operations occur only during service procedures and with a warning sign posted.





## Laser Service Guidelines

On occasion, certified service personnel must perform alignment or focus adjustments on the SLS laser or beam delivery system. When this occurs, certified service personnel at your site should follow the special laser safety precautions described in the following list:

- *Certified service personnel should secure the room containing the SLS system; it is called the Nominal Hazard Zone (NHZ). The room must have locks on the door(s) that limit entry but do not restrict exit. If the SLS system is in an area that cannot be secured by door locks, your company must provide laser safety curtains or alternative safety precautions.*
- *Certified service personnel should post **Exposed Non-Visible Laser in Operation** signs at each entrance to the room containing the SLS system.*
- *Certified service personnel should notify and instruct everyone in the area to wear safety glasses (ANSI Z136.1-1993 section 4.6.2 and ANSI Z87.1; DIN 58215/01.86 and DIN 58219/02.86). The CO<sub>2</sub> laser wavelength cannot travel through glass. It will create a visible indication on polycarbonate. *Your company* must provide industrial safety glasses of either glass or polycarbonate for adequate eye protection.*
- *If your company requires any precautions beyond these, such as a flashing red light to be in operation during the process, *your company* must provide the equipment. Certified service personnel should comply with all of your safety requirements.*



## Powder Safety

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

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

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

---

**Warning**

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**Using materials that have not been certified for use in the SLS system may cause health or safety hazards and may cause damage to the SLS system and void the warranty.**

## Powder Ignition Information

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



## Finding Powder Safety Information

Use the following table to as a general guide to help you find powder safety information. Check the MSDS of the material used for the specific precautions to be observed.

| Powder Safety Information   | Refer to:   |   |  |
|---|---|---|--|
| Standard industrial ventilation practices                                     | <b>US:</b> American Conference of Governmental Hygienists, Committee on Industrial Ventilation<br><b>Europe:</b> <i>Maximale Arbeitsplatz Konzentration</i> , January 1990  |   |  |
| Housecleaning and prevention of accumulation of explosive dust concentrations | <b>US:</b> NFPA 654: Standard for the Prevention of Dust Explosions in the Plastics Industry; National Fire Protection Association, Volume 5 of the National Fire Codes<br><b>Europe:</b> <i>Maximale Arbeitsplatz Konzentration</i> , January 1990 |   |  |
| Powder exposure   | <b>US:</b> <i>Code of Federal Regulations, 29 CFR</i> , section 1900.1000, available from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402<br><b>Europe:</b> DIN EN 26184 Teil 1 /06.91                              |   |  |
| Specific powdered materials   | Material Safety Data Sheets (MSDS) from 3D Systems Corporation:   |   |  |
|   | <b>US/Canada:</b>   |   | <b>Europe</b>  |
|   | <b>Mfgr. Contact:</b>   | 3D Systems Corp.<br>333 Three D Systems Circle<br>Rock Hill, SC 27930 | 3D Systems GmbH<br>Guerickeweg 9<br>D-64291 Darmstadt, Germany |
|   | <b>Information</b>  | Phone: 803-326-4080   | Phone: +49 (0) 6151 357-357<br>Fax: +49 (0) 6151 357-111       |
| <b>Emergency</b>  | 800-424-9300 - Chemtrec   | 703-527-3887 - Chemtrec (U.S.)  |  |



## Powder 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 MSDS of the material used for the specific precautions you should observe. Use the following table of precautions as a general guide:

| Category           | Precaution  |
|--------------------|---|
| <b>Fire/Heat</b>   | <ul style="list-style-type: none"><li>■ Never smoke or ignite any materials around powder.</li><li>■ Maintain proper clearance from powders when using portable heating devices.</li><li>■ Store flammable liquids away from powder.</li><li>■ After removing a part from the process chamber, allow it to cool to room temperature in a well-ventilated area.</li><li>■ Use an anti-static mat in front of the SLS system machine.</li></ul> |
| <b>Inhalation</b>  | <ul style="list-style-type: none"><li>■ Avoid breathing powdered materials; when exposure to dust or fumes is likely, wear a NIOSH approved respirator appropriate to the airborne concentration.</li><li>■ Always provide adequate ventilation.</li></ul>  |
| <b>Shop Safety</b> | <ul style="list-style-type: none"><li>■ Train operators in SLS system procedures.</li><li>■ Wear safety glasses.</li><li>■ Use extreme care with all heated powders.</li><li>■ Make sure that the room is well ventilated.</li></ul>  |



| <b>Category</b>        | <b>Precaution</b>  |
|------------------------|--|
| <b>Avoiding Spills</b> | <ul style="list-style-type: none"><li>■ Keep containers closed when not in use.</li><li>■ Have a fully-grounded internal non-ignition vacuum cleaner ready to use.</li><li>■ Have any equipment specified in the MSDS ready to use.</li></ul>  |
| <b>MSDS</b>            | <ul style="list-style-type: none"><li>■ Give operators access to the MSDS's that apply to materials they will be handling and ensure that they read them. If necessary, translate them.</li><li>■ File MSDS's in an easily accessible location for immediate reference.</li><li>■ Strictly follow all the conditions in each MSDS.</li></ul> |



## Nitrogen/Oxygen Safety

The SLS system uses nitrogen to create an inert atmosphere in the process chamber. The nitrogen inhibits any potential rapid combustion of particulate matter during the selective laser sintering 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 monitor installed in the room containing the SLS system. This monitor will alert you if the oxygen level drops below a designated point. It can be wired to trigger an immediate shutdown of the SLS process.

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**Warning**

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**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 on the next page 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:

- You have received oxygen/nitrogen safety training.
- The room is well-ventilated.
- Self-contained breathing apparatus is available and easily accessible.
- The room oxygen monitor is functioning.
- The room oxygen monitor alarm is audible.



- Listen for the monitor alarm while working at the SLS system.

| Oxygen Content<br>(% by volume)  | Effects and Symptoms at Atmospheric Pressure   |
|--|--|
| 15 - 19 percent  | Decreased ability to work strenuously. May impair your coordination or may induce early symptoms in persons with coronary, pulmonary, or circulatory problems. |
| 12 - 14 percent  | Increases respiration during exertion. Pulse rate goes up. May experience impaired coordination, perception, and judgment.                                     |
| 10 - 12 percent  | Respiration continues to increase in rate and depth. Lips become blue. <i>May</i> lose consciousness at this point.  |
| 8-10 percent   | Mental failure. Fainting and unconsciousness. Face becomes ashen, lips become blue. Nausea and vomiting may occur.   |
| 6 - 8 percent  | 100% fatal after 8 minutes of exposure.<br>50% fatal within 6 minutes.<br>Recovery with treatment within 4 to 5 minutes.                                       |
| 4 - 6 percent  | Coma within 40 seconds; convulsions, respiration ceases, death occurs.   |
| From Safety Bulletin SB-2 - 1983—©1983 by the Compressed Gas Association, Inc. 1235 Jefferson Davis Highway, Arlington, VA 22202 |  |



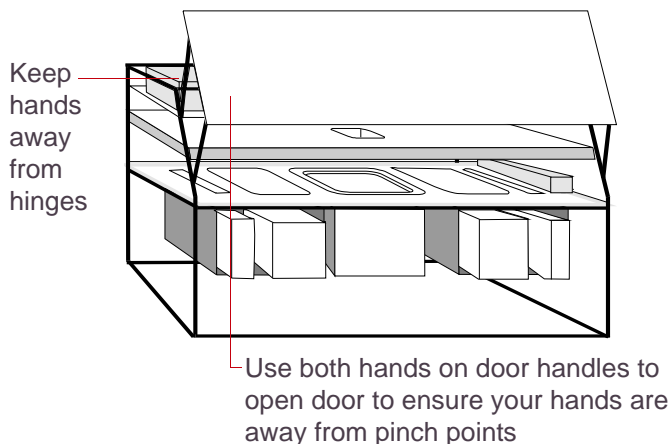
## Pinch Points

You should be aware of the following pinch points in the SLS system:

**Process Chamber Door** The process chamber door is hinged with a linkage that can crush your hand if you place it in the hinge path. To avoid potential injury, follow these safety precautions:

- Always open and close the door completely, using *both hands* on the handles. Do not allow the door to rest partially open.
- Keep your hands away from the hinge area; always check that no one else is in the area.

**Powder Lids** For some powder containers, there is a pinch point on the powder barrel retaining ring when you close it from an open position. The two edges can close to create a severe pinch point if your fingers are between them.



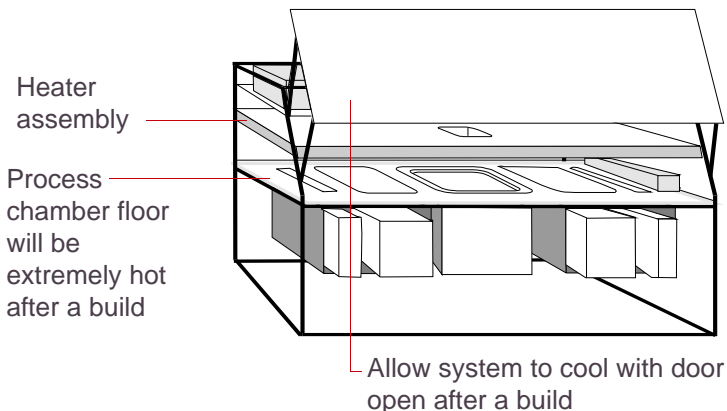




## Hot Surfaces and Powders

The SLS process chamber contains heaters. During and after a build, the process chamber contains hot materials. Avoid burns by taking the following precautions:

- Allow the process chamber to cool after opening the process chamber door.
- Know which surfaces in the process chamber are likely to be hot after a build. These are indicated by warning labels (described in [“Safety Labels” on page 27](#)). Avoid those surfaces when moving the heater assembly and removing parts from the process chamber. In particular, avoid the floor of the process chamber.
- Use appropriate gloves when removing the part cake from the process chamber, or let the part cake cool for several hours before you touch it.





## Lifting Safety

The following table gives weights of items that may need to be lifted while using the SLS system. Use standard lifting practices (one person per 22.7 kg (50 lb)) when loading these items in or out of the SLS system. If you are not accustomed to lifting this much weight, or if you have back problems, do any or all of the following to protect yourself: use additional people to lift the items, scoop out powder to reduce weight, or use an optional material handling lift cart.

| <b>Item</b>                   | <b>Weight</b>                    |
|-------------------------------|----------------------------------|
| Overflow cartridge, empty     | 5 kg (10 lb)                     |
| Overflow cartridge, full      | 25 kg (55 lb) to 134 kg (296 lb) |
| Feed transfer container, full | 20 kg (44 lb) to 129 kg (284 lb) |
| Part transfer container, full | 42 kg (92 lb) to 243 kg (536 lb) |



## Electrical Safety

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

When operating the SLS system, keep the following points in mind:

- Only certified service personnel should operate the SLS system with the access panels and service doors open.
- Heed the warning signs regarding high voltage.
- Use common sense and take the usual safety precautions when operating any electrical equipment.
- After any change to the electrical wiring, make sure the system is properly grounded.



# SLS System Basics

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This section describes basic tasks for using the SLS system. It contains the following topics:

- [Turning on the Equipment](#)
- [Logging In to Windows](#)
- [Starting and Using the SLS System Software](#)
- [Message List Window](#)
- [Selecting a Display Language](#)
- [Shutting Down the Computer Normally](#)
- [Using the Stop Button to Stop Motion, Heating, and Laser Power](#)
- [Shutting Down the Entire SLS System](#)



## Turning on the Equipment

3D Systems designed the SLS system to remain with the power on at all times. You seldom need to power-up the machine or computer. If you ever find the power off, this subsection describes how to turn on the system.

### **Turning on the SLS System Machine**

1. Make sure the facility power to the system is turned on.
2. On the back of the SLS machine, turn the Main Power Disconnect to the On position.



## Logging In to Windows

When you turn on the SLS system computer, the system starts the Windows operating system. You will need to log in before you can run the SLS system software. When prompted by the operating system, press the Ctrl-Alt-Del keys at the same time to display the login panel. Then enter your username and password in the fields provided. Your system administrator may provide you with a username and password; if not, the default username is Administrator, with no password required. For more information, see your Windows documentation.



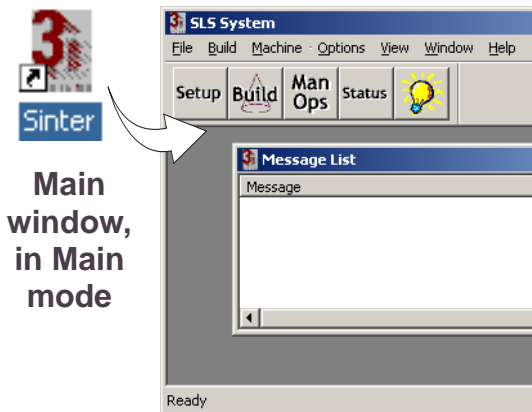
# Starting and Using the SLS System Software

To start the software, double-click the Sinter icon on your Windows desktop, or select Programs→SLS system→Sinter from the Start menu.

## Modes

The SLS system software has three modes. In each mode, a different toolbar appears on the main window.

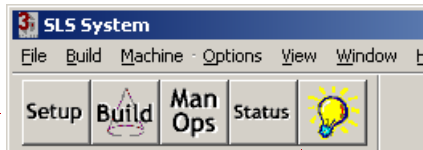
When you start the SLS system software, the software is in *Main mode* and displays the Main toolbar. You use Main mode to get to the other modes and to launch other applications.



Main window, in Main mode

## Main toolbar

Set up a build (launches the Build Setup application)

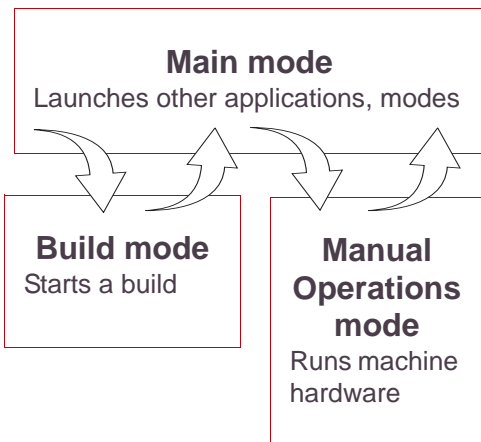


Enter Build mode (see ["Running a Build" on page 58](#))

Enter Manual Operations mode

Display a Status window

Chamber lights on/off (not available on some systems)





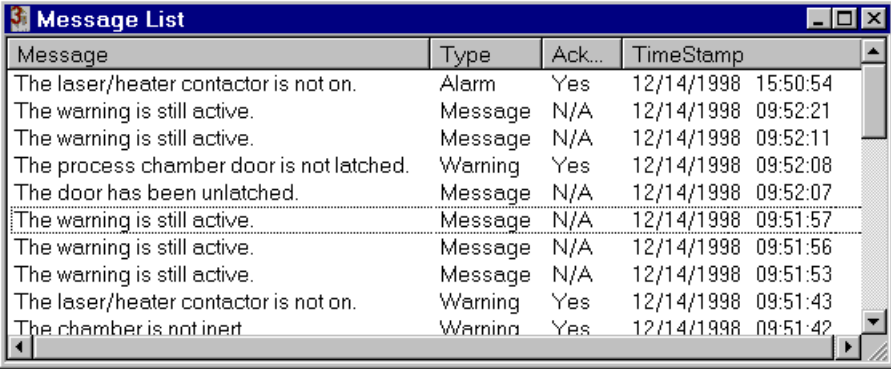
## Message List Window

The Message List window appears within the main SLS System window. It displays messages about the operation of the system. As new events occur, descriptive messages are added to the list. You can minimize this window, but you cannot close it.

The Message List window is available in all three software modes.

There are four types of messages: Messages, Advisories, Alarms, and Warnings. The last three types also display pop-up boxes. Each pop-up box contains a Help button that you can click for more information about the specific Advisory, Alarm, or Warning.

- ✓ For more information on the types of messages that you can receive, see Chapter 7, “Messages” in your [Reference Guide](#).



| Message                                  | Type    | Ack... | TimeStamp           |
|--|---------|--------|---------------------|
| The laser/heater contactor is not on.    | Alarm   | Yes    | 12/14/1998 15:50:54 |
| The warning is still active.             | Message | N/A    | 12/14/1998 09:52:21 |
| The warning is still active.             | Message | N/A    | 12/14/1998 09:52:11 |
| The process chamber door is not latched. | Warning | Yes    | 12/14/1998 09:52:08 |
| The door has been unlatched.             | Message | N/A    | 12/14/1998 09:52:07 |
| The warning is still active.             | Message | N/A    | 12/14/1998 09:51:57 |
| The warning is still active.             | Message | N/A    | 12/14/1998 09:51:56 |
| The warning is still active.             | Message | N/A    | 12/14/1998 09:51:53 |
| The laser/heater contactor is not on.    | Warning | Yes    | 12/14/1998 09:51:43 |
| The chamber is not inert                 | Warning | Yes    | 12/14/1998 09:51:42 |





## Selecting a Display Language

The SLS system software can use languages other than English. To choose one, select **Options**→**Language**. The Change Language dialog box appears. Select a language from the drop-down list and click the OK button. You can also select a language in the Build Setup application through its Preferences dialog box.



## Shutting Down the Computer Normally

3D Systems designed the SLS system to remain with the power on at all times. You seldom need to power-down the computer, unless:

- You are shutting down the entire SLS System.
- The computer requires service.
- The system loses facility power and does not regain it immediately.
- The system will be idle over an extended period of time.

### Caution

**Before you turn off the computer, the Windows operating system must manipulate files and processes to prevent file corruption. The steps in the following procedure describe how to perform an orderly shutdown that prevents file corruption.**

1. Exit the SLS system software.
2. From the Windows Start menu, select Shut Down.

The system displays a dialog box asking you to verify that you want to shut down the computer. Select Shut Down and click the Yes button.



## Shutting Down the Entire SLS System

Power down the entire SLS system when:

- 3D Systems instructs you to do so
- The machine will be idle over an extended period of time
- It is required as part of a company-wide shutdown

To shut down the entire system:

1. Exit the SLS system software and Windows and turn off the computer.

For instructions, see [“Shutting Down the Computer Normally” on page 50](#).

2. Turn the Main Power Disconnect switch on the back of the SLS system to the Off position.

### Turning off the SLS system



# Building Parts

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This section covers the tasks involved in building parts. It contains the following topics:

- [Pre-build System Checklist](#)
- [Preparing the Machine for a Build](#)
- [Verifying Powder Quantity](#)
- [Filling Feeds](#)
- [Pressing Powder](#)
- [Emptying Overflow Cartridges](#)
- [Running a Build](#)
- [Restarting a Terminated Build](#)
- [Viewing a Build While In Progress](#)
- [Changing Critical Parameters During a Build](#)
- [Calibrating IR Sensors](#)
- [Pausing a Build](#)
- [Modifying a Build in Progress](#)
- [When a Build Ends](#)
- [Breaking Out Parts: Overview](#)
- [Preparing to Remove a Part Cake](#)
- [Removing a Part Cake from the Process Chamber](#)
- [Using the BOS](#)
- [Breaking Out Parts at the BOS](#)
- [After Breakout](#)



## Pre-build System Checklist

Check the following items before starting a build:

- At least 50 MB of hard-disk space on the SLS center computer.
- Enough nitrogen available.

The SLS center uses as much as 2800 liters of nitrogen during the initial purge for a build. The sPro 60 SLS center uses up to 7 lpm during the build. If you know how long the build will take, calculate the nitrogen needed; if you are not sure, estimate and make sure you have plenty of extra nitrogen and/or the ability to easily switch nitrogen tanks.

 Some materials require less nitrogen, and some require no nitrogen. Consult the appropriate *Material Guide* for more information.

- Enough powder in the feeds. See [“Verifying Powder Quantity” on page 55](#).
- Verify that the gas flow rates are set properly. See “Monitoring/Adjusting Gauges” in Chapter 2 of your [Reference Guide](#).



## Preparing the Machine for a Build

Clean the blackbody before every build when you clean the process chamber (step 1, below). Lower the blackbody and wipe its surface with a clean dry, lint-free cloth or lens tissue, moistened with ethanol if needed. Do not spray the blackbody with ethanol. After you clean the chamber and level powder as described below, run an offline calibration if one has not been performed recently; see [Calibrating IR Sensors \(with Accutemp Installed\)](#).

1. Clean the process chamber. See “Cleaning the Process Chamber” in Chapter 2 of your [Reference Guide](#).
2. Move the heater assembly into build position. When moving the heater assembly, grasp the heater assembly handles with both hands, then pull it out. After you pull the heater assembly out, raise the blackbody.
3. Put the SLS center software in Manual Operations mode by clicking the Man Ops button on the main toolbar.
4. Close the process chamber door and latch it using the SLS center software (see “Latch” in Chapter 1 of your [Reference Guide](#)).
5. Level powder with the Level Powder dialog box (see “Level Powder” in Chapter 1 of your [Reference Guide](#)).



## Verifying Powder Quantity

Before you start a build, make sure there is enough powder to complete it.

### Determining Available Powder

1. With the SLS center software in Main mode, select Build→ Parts or click the Build button on the toolbar.

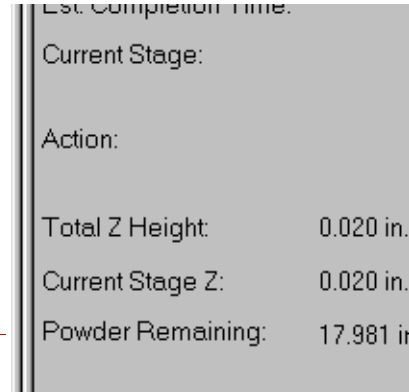
The Build Parts window appears.

2. Check the Powder Remaining value on the Build Parts window.

This value indicates how much powder remains in the powder feed with the *least* powder remaining.

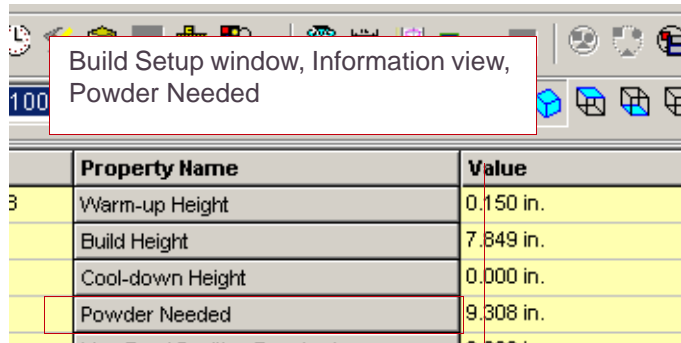
### Build Parts window

Powder Remaining



### Determining Powder Needed

Open the build packet in the Build Setup application. Display the Information view by clicking the Information button on the toolbar. Check the Powder Needed amount in the Build Setup window.






If Powder Needed is in red, the Build Packet has Smart Feed enabled but Powder Needed has not been calculated yet. Run Time and Powder Estimation or a Build Preview to calculate Powder Needed.



## Filling Feeds

This topic describes how to fill feeds with powder. To fill the feeds, you will need to perform manual operations described in Chapter 1, “Manual Operations” of your [Reference Guide](#).

-  See [“Powder Safety” on page 34](#) for appropriate guidelines and precautions.
-  If you have new piston seals, make sure the piston is pushed down as far as it will go in the bottom of the cylinder.
-  For systems with a blackbody on the roller, install the blackbody cover provided before adding powder. Powder residue on the blackbody face can reduce its accuracy as a temperature reference.

## Filling Methods

Use one of the two methods below to fill the SLS center feeds with powder before a build.

**Scoop method** Use a barrel scoop to scoop powder out of the container and directly into the feeds.

**Transfer container method** Place a feed transfer container of powder on a tray over the feed, remove the tray, then lower the feed piston so the powder slides down into the feed.

## Pressing Powder

After you fill the feeds, use a flat plastic or heavy cardboard plate the size and shape of the feed opening to tamp the powder in the feeds. Compressing powder in the feeds provides the maximum amount of powder for the build.





## Emptying Overflow Cartridges

After removing an overflow cartridge, do not discard the powder; most powders can be sifted and reused.

### Warning

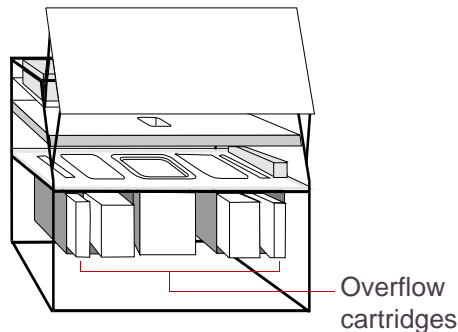
**Full overflow cartridges can weigh more than one person can safely lift; for weight information, see [“Lifting Safety” on page 42](#). If you are running a heavy material, empty the overflow cartridges before they become too full for you to safely lift.**

 Before reusing powder, you must sift it. Refer to the appropriate *Material Guide* for additional information.

## Removing Overflow Cartridges

To remove the (right/left) overflow cartridge:

1. Open the hinged overflow access panel at the front lower (right/left) side of the SLS center
2. Unfasten the two latches on the overflow door.
3. Carefully slide the overflow cartridge out using proper lifting safety techniques.



## Reusing Powder

When you empty an overflow cartridge containing reusable powder, you can do one of the following:

- Pour the powder directly into a storage container.
- Pour the powder into the sifter.

When you empty an overflow cartridge containing a powder that cannot be reused, discard it according to instructions in the MSDS and in compliance with state and local regulations.



## Running a Build


Before you run a build, prepare the SLS center as described in [“Preparing the Machine for a Build” on page 54](#).

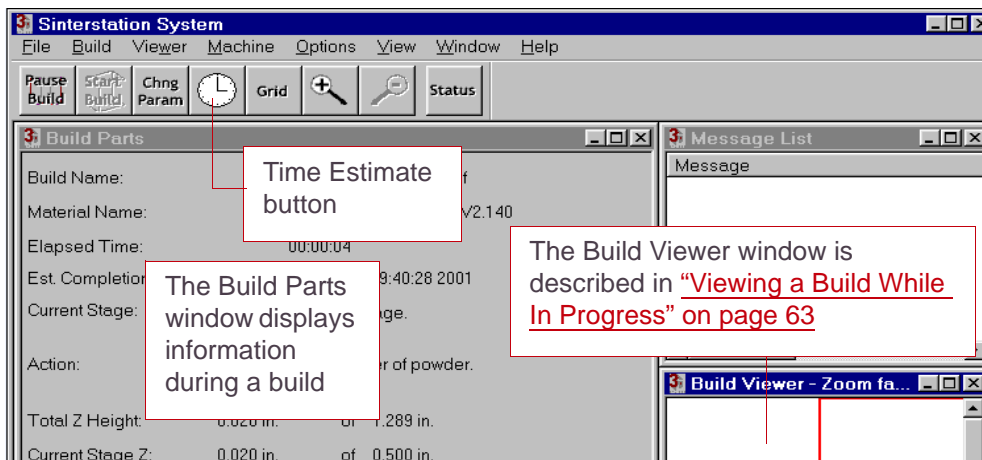
### Build Mode

Before you start a build, put the system in Build mode by clicking the Build button on the toolbar. The Build Parts window and the Build Viewer window appear.

When you open the Build Parts window, the actual values for the oxygen level and

temperatures are displayed immediately. The setpoints display the default or previous values until you press the Start/System On button, at which time the system will supply actual setpoint information.

 If any of the temperature labels are dim, they will not be controlled during the build. Although setpoints will not be updated, you will see actual values.





## Automatically Emptying Feeds

You can click this check box to automatically empty feeds when a build is done if, for example, you want to change materials after a build. (Although the screen text refers to cartridges, the option applies to systems with non-removable feed cylinders as well.)

 When the build completes, wait while the feeds empty automatically.

|  |            |          |               |
|--|------------|----------|---------------|
| Current Stage Z:   | 0.000 in.  | of       | 0.000 in.     |
| Powder Remaining:  | 18.000 in. |          |               |
| <input type="checkbox"/> Automatically empty feed cartridges at end of build |            |          |               |
|  |            | Setpoint | Actual        |
|  |            | Laser:   |               |
|  |            | Oxygen:  | 0.0 % < 0.1 % |
| Left Feed Temperature:   | 0.0 C      |          | 0.0 C         |
| Part Bed Temperature:  | 0.0 C      |          | 0.0 C         |

The SLS center empties the feeds by repeatedly adding powder layers without lowering the part piston. This pushes each new layer of powder into the overflow cartridges until the feeds are empty.

When the feeds are empty, remove the overflow cartridges, clean the machine, and load new or different material.

## Starting a Build

Click the Start Build button. If the last build was not completed, the system asks you if you want to restart it; see [“Restarting a Terminated Build” on page 62](#). Otherwise the system displays an Open dialog box to let you choose a build. If you are not using the default material, the system will ask you to confirm the material choice before beginning to build parts. The system will remind you to make sure that the blackbody is in the up position before proceeding.

After the SLS center reaches inert, you must push the (physical) Start button. A message window pops up to remind you to push Start. This window will not close unless power is reaching the SLS center contactors.



## Build Log File Archiving at Start of Build

When you start a new build, the Sinter application automatically does the following:

- Creates a new Manual Ops Session Log file (even if this is the first build after you start Sinter) and stores it in ...\\dtm\3DL\ManualOps in file named:

*machine-serial-number\_datestamp\_timestamp\_-manual\_ops.3DL*

 See “Session Log Files” in your [Software Utilities Guide](#) for more information on Manual Ops Session Log files.

- Renames States.blog, the most recent build log file, for archiving. The archived build log file name matches the time stamp of its first entry.
- Opens a new States.blog file to log the new build information.

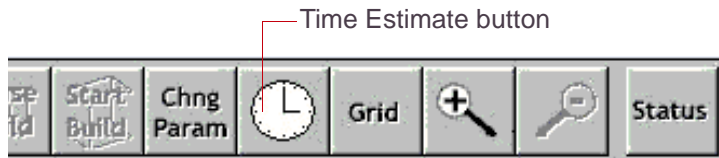
Use Windows Explorer if you want to delete, or, move, copy, rename, etc., any archived build log files.

 See “Session Log Files” in your [Software Utilities Guide](#) for more information on Build Session Log files.




## Time Estimate Button

After you start a build, the Time Estimate button becomes active on the toolbar. Click the Time Estimate button to display a detailed estimate for the build, if an estimate was run earlier from Build Setup. If no estimate exists, the button is disabled, but an estimate will automatically be run when the build starts. The system calculates Smart Feed powder requirements at this time as well, if your system has the Smart Feed feature.



3D Systems expects the estimate to be accurate to  $\pm 10\%$  of actual build times.

 The estimate includes time spent waiting for the machine to achieve desired temperatures (Wait for Temps) during warm-up and cool-down; however, an unusually long or short Wait for Temps period can skew the estimate.



## 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.



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 While 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.

 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.

### Options on the Toolbar

While the system is in Build mode, the Build toolbar appears at the top of the main window. Some of the buttons on the toolbar control options for the Build viewer.



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:

**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.



## Changing Critical Parameters During a Build

During a build, you can change three critical temperature parameters from the Build Parts window.

 If you have Variable Layer Thickness enabled, these heater setpoints change automatically when layer thickness changes.

### Guidelines

- Changes are saved to the build packet, even if you terminate the build.
- Changes apply only to the current stage.
- If you change a setpoint during the Build Preparation stage (during inerting), the system assumes the value is for the Warmup stage.
- A new value clears all higher Z values for that stage. If you had ramped values, you may need to pause and re-profile the build, or continue to monitor the build.

|                       |                          |
|-----------------------|--------------------------|
| Build Name:           | 1bc_verif_2500plus.bpf   |
| Material Name:        | DuraForm Polyamide V     |
| Elapsed Time:         | 00:00:04                 |
| Est. Completion Time: | Fri Feb 02 19:40:28 2001 |
| Current Stage:        | Warmup stage.            |

### Build Parts Window

1. Click the text box for the parameter you want to change.
2. Press Enter.
3. Type the desired new value and press Enter again.

|                         |                                      |
|-------------------------|--------------------------------------|
|                         | Setpoint                             |
| Laser:                  | 0.0                                  |
| Oxygen:                 | 5.5 %                                |
| Left Feed Temperature:  | <input type="text" value="106.0 C"/> |
| Part Bed Temperature:   | <input type="text" value="110.0 C"/> |
| Right Feed Temperature: | <input type="text" value="104.8 C"/> |





## Calibrating IR Sensors (with Accutemp Installed)

For DuraForm [PA, GF, EX, AF, and Flex], and LaserForm A6 Steel materials, Sinterstation sPro 60 systems can recalibrate the IR sensors dynamically during a build. This calibration is a quick process which occurs multiple times during a build to compensate for sensor drift and changing environmental conditions within the machine.

- ☞ You must perform an initial **offline calibration** to enable automatic, real time re-calibration during the build. If re-calibration requires too great an adjustment, a message pops up advising you to perform offline calibration again when the build completes.

### Running an Offline Calibration

To run an offline calibration:

1. Put the system in Manual Operations mode. See Chapter 1, “Manual Operations,” of your [Reference Guide](#).
2. Raise the blackbody to the up position.

- ☞ If you perform a calibration with the blackbody in the down position, your calibration file receives abnormally large values. To recover from this, you must delete the file `ircal.ini` (found in your `\dtm\config\machine` folder), then either run a new offline calibration (which will create a new `ircal.ini` file) or rename `ircal.backup` to `ircal.ini`, then run offline calibration.

3. Latch the chamber door with the Latch button.
4. Click the IR Cal button.

The Offline IR Sensor Calibration dialog box appears. The dialog displays the current roller speed value from the material configuration file for the current material. Change this value only if it is not the value you normally use for this material.

5. Check the roller speed setting, then click the Start button on the dialog box.



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

## Verification Option

If you click the Verification Only check box, the system does not perform a calibration. Instead, it verifies the IR sensors by setting the blackbody to various temperatures and then checking its temperature with all three sensors. The results are plotted and displayed in an IR Verify Result dialog box. The dialog box includes a Save to File option for saving the data to a tab-delimited external file.

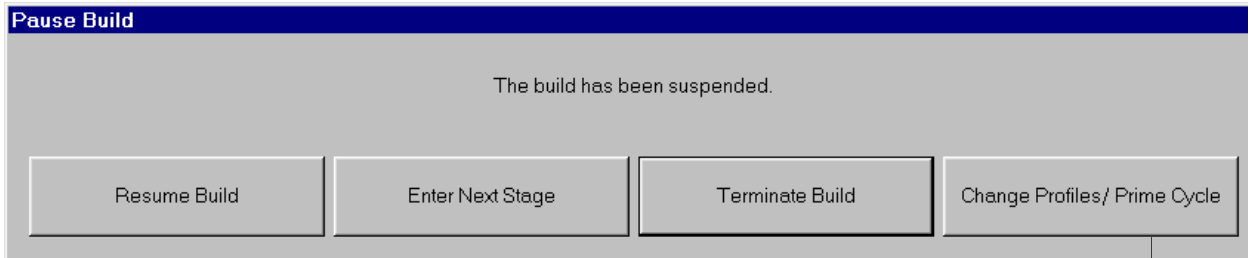


## Pausing a Build

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

**Caution**

If you are running a material that requires heating, resume the build as soon as possible.




Click on the Change Profiles/Prime Cycle button to display additional options

**Resume Build** Click this button to continue the build.

**Enter Next Stage** Use the Enter Next Stage button to move from Warmup to Build, etc.

**Terminate Build** Click this button to stop the build.

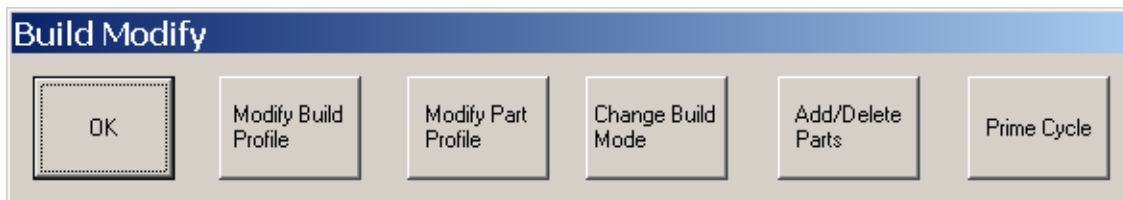
 If you terminate a build when the system is in the Build stage, and you do not want to restart the build from the termination point, remove any parts from the part bed and review the build packet in Build Setup and make any changes that can improve the build.

**Change Profiles/Prime Cycle** Click this button to modify a profile, add/delete parts, or run a prime cycle. See [“Modifying a Build in Progress” on page 68.](#)



## 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.



This subsection contains three topics:

- [Modifying Part and Build Profiles](#)
- [Adding and Deleting Parts and Other Changes](#)
- [Running a Prime Cycle](#)


### Modifying Part and Build Profiles

Click the Modify Build Profile or Modify Part Profile button to display a profile editor dialog box from the Build Setup application. Use the Change Build Mode button to access the Change Build Mode dialog box. Modify parameters as described in the Build Setup Help.

In most respects these dialog boxes work just as they do in the Build Setup 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, the  button. 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 to launch the Build Setup application, where you can modify most aspects of your build packet during the build. The application works just as described in the Build Setup 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. Parts are initially displayed in Box view.

**Rotating and Zooming the Workspace:** You can rotate and zoom the Workspace in Build Setup with your pointing device as follows:

- Hold down the right mouse/trackball button and drag the pointer to *rotate* the Workspace.
- If your pointing device has a wheel control, use it to zoom in on or out from the Workspace.

## Running a Prime Cycle

Click the Prime Cycle button to spread powder across the part 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.

The screenshot shows a window titled "Time Estimate" with a table of build times and a summary of actual time used. The table has five columns: Total, Warm-up Stage, Build Stages, and Cool-down Stage. The rows are: Pause Time, Wait for Temperature Time, Add Powder Layer Time, Scan Time, and Summary. Below the table, there is a text box containing the summary of actual time used. At the bottom of the window, there are four buttons: Close, Save to File, Print ..., and Launch Build Report. Two callout boxes are present: one pointing to the "Save to File" button and another pointing to the "Launch Build Report" button.

|                           | Total   | Warm-up Stage | Build Stages | Cool-down Stage |
|---------------------------|---------|---------------|--------------|-----------------|
| Pause Time                | 0:00:00 | 0:00:00       | 0:00:00      | 0:00:00         |
| Wait for Temperature Time | 0:00:15 | 0:00:15       | 0:00:00      | 0:00:00         |
| Add Powder Layer Time     | 0:38:02 | 0:04:53       | 0:33:09      | 0:00:00         |
| Scan Time                 | 0:01:05 | NA            | 0:01:05      | NA              |
| Summary                   | 0:39:22 | 0:05:08       | 0:34:14      | 0:00:00         |

Above is the summary of the actual time used by this build. For more detailed information

Save the build time summary to a tab-delimited text file

See Chapter 5, "Build Report," in your [Software Utilities Guide](#) for more information on the Build Report utility

Close Save to File Print ... Launch Build Report



## Breaking Out Parts: Overview

When a build is complete, you need to remove the sintered parts from the process chamber and clean them. The parts and the surrounding powder are called a *part cake*. Removing parts from the part cake is called *breakout*. Once you remove a part cake from the SLS center, you move it to a *breakout station* (BOS)—a stand-alone work area for cleaning off unmelted powder.



You can find material-specific information about breaking out and cleaning parts in each *Material Guide*.

### Breakout Details

For more information, see:

- [Preparing to Remove a Part Cake](#)
- [Removing a Part Cake from the Process Chamber](#)
- [Using the BOS](#)
- [Breaking Out Parts at the BOS](#)
- [After Breakout](#)



## Preparing to Remove a Part Cake

### Before You Begin

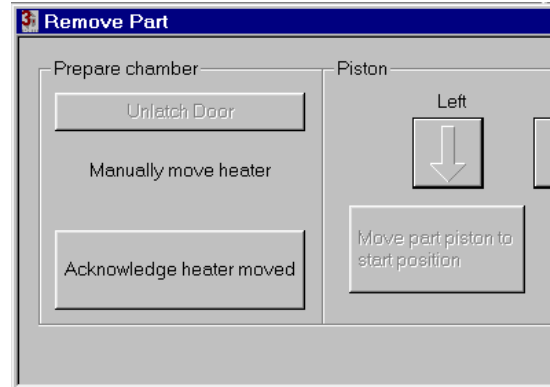
- Know the size, shape, and placement of the parts in the cylinder.
- Make sure there is adequate ventilation in the SLS center area.
- Make sure the parts are cool enough to prevent permanent deformation.

If the core temperature of the part cake is greater than 60 °C (140 °F), do not continue.



If you do not have a thermometer, insert a metal probe or breakout tool into the part cake for 15 seconds; if it is too hot to hold, do not continue. Also refer to the appropriate *Material Guide*.

- Make sure the roller is at a limit.
- Put the SLS center software into Man Ops mode.







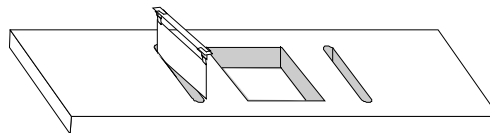
## Preparation

### Warning

**When you open the process chamber door, do not touch any parts or machine surfaces that are still hot, such as the heater assembly. When moving the heater tray and removing the part, wear gloves and touch only the handles of the heater assembly.**

1. Click the Remove Part button on the toolbar to display the Remove Part dialog box.
- ✓ See also “Remove Part” in Chapter 1 of your [Reference Guide](#) for instructions on using the dialog box.
2. Click the Unlatch Door button in the Remove Part dialog box.
3. Open the process chamber door.
4. Remove the swing gates.
5. Move the heater assembly out of the way.
6. Push the heater assembly back.
7. Click Acknowledge heater moved.

When you are done, go to the next topic, [“Removing a Part Cake from the Process Chamber”](#) on page 74.



Removing swing gates



## Removing a Part Cake from the Process Chamber

There are two methods for removing a part cake. Before using either method, complete the steps in the preceding topic, [“Preparing to Remove a Part Cake” on page 72](#).

The two methods are:

- [Removing a Part Cake Using the Part Transfer Tray](#)
- [Removing a Part Cake Without Using the Part Transfer Tray](#)

### Caution

If you are removing a part cake that is 15.5 in (393 mm) tall or more, *do not* use the part transfer tray method.

### Warning

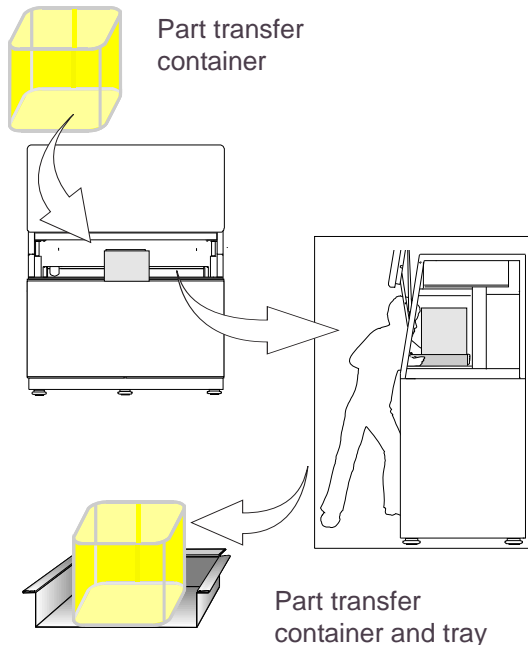
**Builds of high temperature materials can create burn hazards from hot powder and hot machine surfaces once you unlatch the process chamber doors.**



## Removing a Part Cake Using the Part Transfer Tray

When you use the part transfer tray to remove a part cake, you place a bottomless container over the part piston and raise the part cake up into the container with the piston. You then slide a tray under the container and use it to slide the part cake out of the process chamber.



1. Place the part transfer container on top of the part cylinder
2. Hold the part transfer container down and click the Move part piston to start position button in the Remove Part dialog box.
3. Continue to hold the part transfer container down as the system pushes powder up into the part transfer container.
4. Insert the part transfer tray under the part cake: Point the edge of the tray *without the lip* toward the part transfer container, hold the back of the container with one hand, and slide the tray under the container.
5. Slide the tray forward, lift it out, and move to the breakout area.





## Removing a Part Cake Without Using the Part Transfer Tray

This method involves raising the part piston and allowing powder to fall away from the part as the part cake rises.

-  If you use this method with a part cake that is 394 mm (15.5 in) or taller, first cover the feed openings with cardboard to prevent any part cake powder from falling into the feeds. Protect the blackbody with the provided cover.
-  If you are removing a part cake taller than 432 mm (17 in), use the red laser window plug. Remove the laser window baffle and insert the plug before breakout. Push the plug up into the laser window opening and let the rope handle hang down. Use the rope handle to remove the plug after breakout, and remember to reinstall the laser window.

### Caution

**If your build used high cylinder heat, the part cake will be extremely hot. 3D Systems does not recommend removing such a part cake without the part transfer tray, unless it is too tall (more than 394 mm (15.5 in)). In that case, allow for a prolonged cool down (up to 24 hours) before removing the part cake.**

Use the Remove Part dialog box to raise the part piston incrementally. As you raise the piston, remove surrounding powder from the outline of the parts with a spatula and brush. When you can easily grasp a part, carefully lift it. In the case of a tall single part, you may need to tilt it to clear the top of the process chamber. Gently brush off the parts and place them on the part transfer tray.

-  If a part is not completely cool, wait until it has cooled to brush off any powder clinging to it.




## Using the BOS

The breakout station (BOS) provides a work area for removing powder from parts. It includes a work table with an area for you to clean parts, and an air handler unit. The air handler removes airborne dust particles from the work area during part cleaning.

 If you are sifting powder, refer to the appropriate *Material Guide* and the documentation that came with your sifter. Also see “Using the Sifter Connection” in Chapter 4 of your [Reference Guide](#).

You can use various hand tools, such as scrapers, knives, and brushes, at the BOS as you perform part breakout.

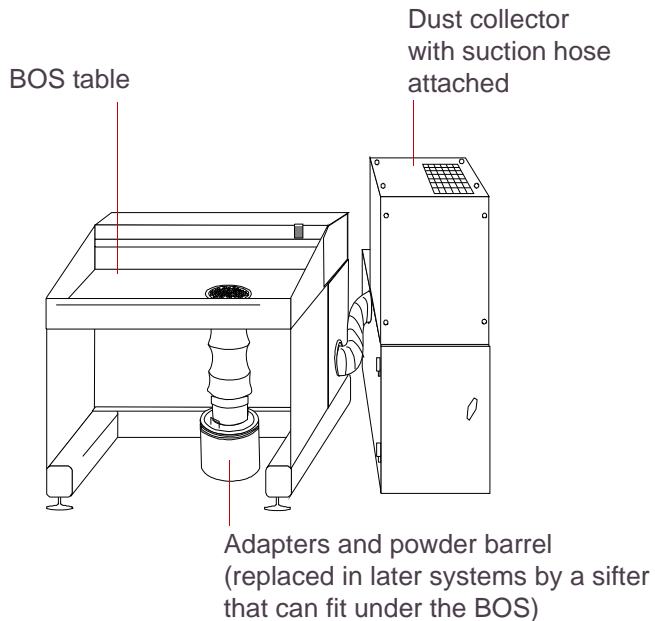
 3D Systems recommends placing an anti-static mat in front of the BOS, as suggested in the [Facility Guide](#).

The illustration on the [next page](#) shows the BOS.

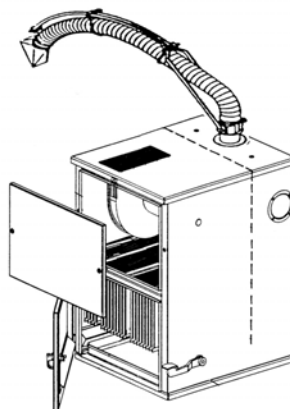
 The BOS dust collector suction hose can be attached to the BOS or mounted on an adjustable support arm so the detached hose hangs over the BOS table. A standard-volume sifter can also be installed under the BOS table as shown.



## Breakout Station (BOS)



Detached dust collector with adjustable suction hose trunk





## Breaking Out Parts at the BOS

After you remove the part cake, clean (break out) the part to remove excess powder.

✓ You can find additional breakout information in the appropriate *Material Guide*.

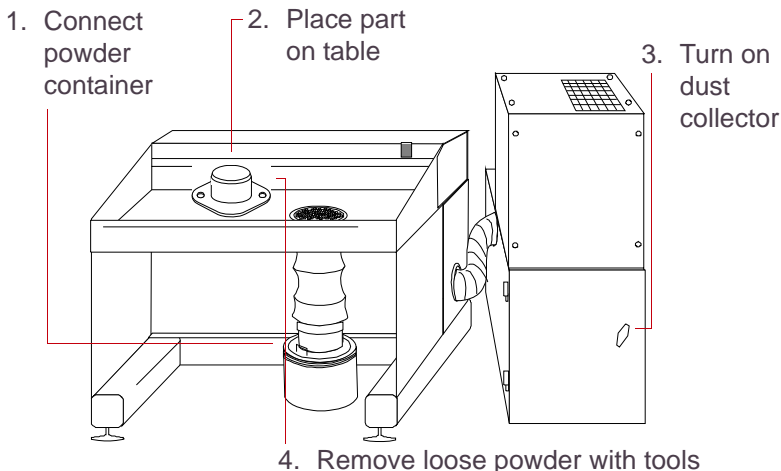
### Warning

**Make sure that the part cake is adequately cooled before you touch it. Hot powder is a burn hazard.**

🔧 If the current part is a different material than the last one broken out at this station, clean the breakout area first to prevent contamination of reusable materials. See “BOS Maintenance” in Chapter 2 of your [Reference Guide](#).

🔧 Make sure the sifter assembly attached to the hopper is for the correct material.

1. Connect a powder container to the tube extension for the sifter assembly. Use a clean container or one that previously held the same material.
2. Place the part on the Breakout Station table.



### Warning

**The Breakout Station is designed to support no more than 34.0 kg (75 lb). Some materials may produce parts heavier than this.**

3. Turn on the dust collector with the switch on the back right side.



4. Turn on the sifter.
5. Using tools and brushes, remove the loose powder and debris from the part, taking care not to damage fragile areas of a part. While cleaning the part:
  - Check the container periodically to prevent overflows. When the container becomes almost full, turn off the sifter and replace the full container with an empty one.
  - Brush any loose powder into and through the grate.
  - Brush chunks and debris onto either side of the table. Dispose of chunks and debris in accordance with the MSDS and local regulations.





## After Breakout

This topic covers tasks you may want to perform after you break out parts. These include sifting powder, cleaning the part transfer container, and post-processing.

### Sifting Powder

After breakout, powder to be reused is sifted in a sifter. For information on how to use the sifter, refer to the documentation that came with it. For information on connecting the sifter, see “Using the Sifter Connection” in Chapter 4 of your [Reference Guide](#). For guidelines on sifting, refer to the appropriate *Material Guide*.

### Cleaning the Part Transfer Container

Follow these guidelines when cleaning the part transfer container:

- Clean the container thoroughly prior to switching materials to avoid powder contamination.
- Clean the container with a non-ignition vacuum cleaner or a dry rag to remove accumulations of powder.

### Post-Processing Options

You can use several post-processing procedures to further refine the surface finish of a part. The procedure you choose depends on the material used, the part design, and the projected use of the part. For more information about post-processing options, refer to the appropriate *Material Guide*.



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# Index

---

#  
A  
B  
C  
D  
E  
F  
G  
H  
I  
L  
M  
N  
O  
P  
R  
S  
T  
U  
V  
W

## Symbols

- 3.44 software features [2](#)
- 3D Systems SLS utilities [19](#)
- 3DL files [3](#)

## A

- aborting IR sensor calibration [66](#)
- adding parts during a build [69](#)

## B

- blackbody [56](#), [65](#), [76](#)
  - cleaning [54](#)
  - protective cover [56](#)
  - raising [54](#), [59](#)
- BOS
  - illustration [77](#)
  - noise levels [28](#)
  - using [77](#)
- breaking out parts [71](#)
  - at the BOS [79](#)
  - preparation [72](#)

- removing the part cake [74](#)
- breakout station. **See** BOS
- breakout, definition [71](#)
- build
  - adding parts during [69](#)
  - calibrating IR sensors [65](#)
  - nitrogen needed for [53](#)
  - powder needed for [55](#)
  - preparing for [54](#)
  - running [58](#)
  - terminating [67](#)
  - viewing [63](#)
- build log file
  - archiving [60](#)
  - automatic delete on exit [60](#)
  - renamed [60](#)
- Build Modify dialog box [65](#), [68](#)
- build packets
  - removing [8](#)
- Build Parts window [55](#), [58](#), [64](#)
- Build session log files [3](#)
- Build Viewer window [58](#), [63](#), [64](#), [65](#)

**C**

calculate

nitrogen needed for build [53](#)

powder needed for build [55](#)

calibrating IR sensors [65](#)

calibration

aborting [66](#)

IR sensor [22](#), [65](#)

ircal.ini [65](#)

offline [22](#), [54](#), [65](#)

real-time [22](#), [65](#)

certified service personnel [25](#)

Change Language dialog box [49](#)

changing a build in progress [68](#)

cleaning blackbody, Sinterstation HiQ [54](#)

components, of SLS systems [14](#)

computer

shutting down [50](#)

computer cabinet [17](#)

conventions, document [11](#)

critical parameters [64](#), [65](#)

**D**

dialog boxes

Build Modify [68](#)

Change Language [49](#)

IR Verify Result [66](#)

Level Powder [54](#)

Offline IR Sensor Calibration [65](#)

Pause Build [67](#)

Remove Part [73](#)

display language, changing [49](#)

document conventions [11](#)

**E**

electrical safety [24](#), [43](#)

emissions

laser [29](#)

powder [28](#)

environmental safety [28](#)

**F**

features, new v3.44 software [2](#)

feeds, filling [56](#)

**H**

hazards [25](#)

HiQ SLS system, Sinterstation [22](#)

hot surfaces, safety [41](#)

**I**

improvements

material recyclability, HiQ [22](#)

SLS system [2](#)

installation, general information [21](#)

interlocks, safety [24](#)

IP addresses to avoid [21](#)

IR Cal button [65](#)

#

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

T

U

V

W



IR sensor calibration [22](#), [65](#)  
IR Verify Result dialog box [66](#)  
ircal.ini [65](#)

## L

language setting, changing [49](#)

laser

- classification [29](#)
- emissions [29](#)
- exposure [29](#)
- general safety rules [32](#)
- open beam operations [25](#)
- safety [24](#), [29](#)
- safety label locations [30](#), [31](#)
- service [33](#)

layer

- thickness, variable [64](#)

Level Powder dialog box [54](#)

lifting safety [42](#)

log files

- Build session [3](#)
- individual [3](#)
- Manual Ops session [3](#)
- session (3DL) [3](#)

logging control (start/stop)

- on-demand [8](#)
- on-event [9](#)

logging in to Windows [46](#)

LogManager [6](#)

- tab views [7](#)

## M

Magics RP [20](#)

Main window [47](#)

Manual Ops session log files [3](#)

mechanical components, safety [40](#)

menus, text conventions for [11](#)

Message List window [48](#)

MSDS [23](#)

## N

network, connecting system to [21](#)

new v3.44 software features [2](#)

nitrogen

- quantity needed for build [53](#)

- safety [38](#)

noise levels [28](#)

non-ignition vacuum cleaner [37](#)

## O

offline calibration [22](#), [54](#), [65](#)

Offline IR Sensor Calibration dialog box [65](#)

open beam operations [25](#)

operators, definition [25](#)

OptiScan [3](#)

overflow cartridges

- emptying [57](#)

- weights [42](#)

over-temperature protection [22](#)

oxygen



depletion effects [39](#)  
monitor for room [24](#)  
safety [38](#)

## P

parameters, changing in build [64](#), [65](#)  
part cake  
  definition [71](#)  
  preparing to remove [72](#)  
  removing from the process chamber [74](#)  
part transfer container  
  cleaning [81](#)  
  using [74](#)  
part transfer tray [74](#)  
parts  
  breaking out  
    Process Chamber [72](#)  
  building [52](#)  
  post-processing options [81](#)  
  tall, removing [74](#)  
Pause Build dialog box [67](#)  
pinch points [40](#)  
post-processing options [81](#)  
powder  
  disposal [28](#)  
  environmental safety [28](#)  
  feeds, filling [56](#)  
  hot surfaces [41](#)  
  ignition information [34](#), [41](#)  
  needed for build [55](#)

  quantity, verifying [55](#)  
  recycling [77](#)  
  reusing [57](#)  
  safety [34](#), [35](#), [36](#), [41](#)  
  sifting [77](#), [81](#)

pre-build checklist [53](#)  
profiles, changing during build [68](#)

## R

RBO  
  noise levels [28](#)  
RealMonitor [4](#)  
  license (for LogManager) [6](#)  
  tab (in LogManager) [7](#)  
real-time calibration [22](#), [65](#)  
Remove Part dialog box [73](#)  
reporting laser radiation exposure [29](#)

## S

safety  
  during high temperature builds [74](#)  
  electrical [24](#), [43](#)  
  environmental [28](#)  
  general hazards [25](#)  
  glasses [36](#)  
  guidelines for operation [25](#)  
  hot surfaces [41](#)  
  interlocks [24](#)  
  labels [27](#)  
  laser [24](#), [29](#)





lifting [42](#)  
mechanical components [40](#)  
nitrogen [38](#)  
noise levels [28](#)  
oxygen [24](#), [38](#)  
pinch points [40](#)  
powder [34](#), [35](#), [36](#), [41](#)  
safety design features [24](#)  
standard shop practices [36](#)  
thermal hazards [24](#)  
safety program [23](#)  
session log files [3](#)  
shutting down  
    computer [50](#)  
    entire system [51](#)  
sifting powder [81](#)  
Sinterstation HiQ SLS system [22](#), [65](#)  
    components [14](#)  
SLS system  
    buttons [18](#)  
    components [14](#)  
    connecting to a network [21](#)  
    controls [17](#)  
    indicators [18](#)  
    installation [21](#)  
    noise levels [28](#)  
    operating safely [25](#)  
    pre-build checklist [53](#)  
    process overview [13](#)  
    running a build [58](#)  
    safety design features [24](#)

shutting down [50](#)  
Sinterstation HiQ [22](#), [65](#)  
software [19](#), [47](#)  
system basics [44](#)  
turning on [45](#)  
software  
    3D Systems utilities [19](#)  
    features, new v3.44 [2](#)  
    Magics RP [20](#)  
    SLS system software [19](#)  
    starting [47](#)  
Start button [18](#), [58](#)  
StatesLog  
    tab (in LogManager) [7](#)  
Stop button [18](#)  
system basics [44](#)  
System Enabled status indicator [18](#)  
System On button [58](#)

## T

terminating a build [67](#)  
thermal management [22](#)  
turning on  
    computer [45](#)  
    SLS system machine [45](#)

## U

User's Guide, how to use [11](#)  
utilities [19](#)

#  
A  
B  
C  
D  
E  
F  
G  
H  
I  
L  
M  
N  
O  
P  
R  
S  
T  
U  
V  
W

**V**

v3.44 software features, new [2](#)  
vacuum cleaner, non-ignition [37](#)  
Vanguard SLS system  
    components [14](#)  
variable layer thickness (VLT) [64](#)  
verify  
    powder quantity [55](#)  
viewing a build [63](#)  
VLT [64](#)

**W**

weight guidelines for lifting [42](#)  
weights, of cartridges [42](#)  
what's new [2](#)  
windows  
    Build Parts [55](#), [58](#), [64](#)  
    Build Viewer [58](#), [63](#), [64](#), [65](#)  
    Main [47](#)  
    Message List [48](#)  
Windows, logging in [46](#)

#  
A  
B  
C  
D  
E  
F  
G  
H  
I  
L  
M  
N  
O  
P  
R  
S  
T  
U  
V  
W