ZPRINTER® 310 PLUS
HARDWARE MANUAL

Part Number 09548
Rev C, August 2007

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60/741,573	60/808,721	09/706,350	09/835,292	11/453,695	60/472,221
10/848,831	6,416,850	6,610,429	6,403,002	**6,989,115**	**7,037,382**
7,087,109	**11/335,282**	**10/817,159**	**10/650,086**		

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ZPrinter 310 Plus Hardware Manual

Table of Contents

1 Overview

This chapter gives you a description of the principles behind the ZPrinter 310 Plus 3D Printer, will familiarize you with the terminology we will use to describe the System, and will introduce you to some of the features of your printer.

This manual will speed you along the path towards quickly and inexpensively building parts. We recommend that you use this manual together with service training for best results. See service@zcorp.com for more information. The manual contains the following chapters:

Overview. This chapter provides an overview of the principles behind the System, familiarizes you with the terminology we will use to describe the System, and describes the printer components.

Quick Start Guide. Get printing quicky by following the steps in this chapter.

EZ Print Mode. Describes how to setup a print using EZ Print mode.

Prepare The 3D Printer. This chapter guides you through putting powder and binder in the printer, and cleaning the Service Station.

Setup The Build In ZPrint. This chapter takes you through preparing the build and checking parameters in the ZPrint Software before printing.

Post Processing. This chapter explains how to remove printed parts from the build envelope, how to remove excess powder from the part, and how to infiltrate the parts to improve strength and surface finish.

Material Systems. This chapter instructs you on how to use the ZCast® and the Snap-Fit materials with instructions on how to prepare your printer, printing, and post-processing the part.

Maintenance And The Service Menu. Here we review a few preventative maintenance steps, offer some tips for troubleshooting and inform you about where to go if you experience any problems printing.

System Details. Describes the System Specifications for the ZPrinter 310 Plus 3D Printer.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT THE Z CORPORATION SERVICE DEPARTMENT AT (781) 852-5050, TOLL-FREE AT (877) 88-ZCORP OR VIA EMAIL AT SERVICE@ZCORP.COM. YOU MAY ALSO VISIT THE USER GROUP WEBSITE AT WWW.3DPUSER.COM.

1.1 How It Works

Z Corporation 3D Printer processes are based on the Massachusetts Institute of Technology's patented 3DP™ (Three-Dimensional Printing) technology.

The proprietary ZPrint Software first converts a three-dimensional design file (built using 3D CAD) into cross-sections or slices that are between 0.003" – 009" (0.0762 - 0.2286 mm) thick. The printer then prints these cross-sections, one after another, from the bottom of the design to the top.

Inside the printer there are two pistons. The *feed piston* is represented in the diagrams below on the left and is shown in the 'down' position filled with powder. The *build piston* is the piston on the right, shown below in the 'up' position. Also represented in the diagrams is the *roller* (drawn as a circle) and the *print*

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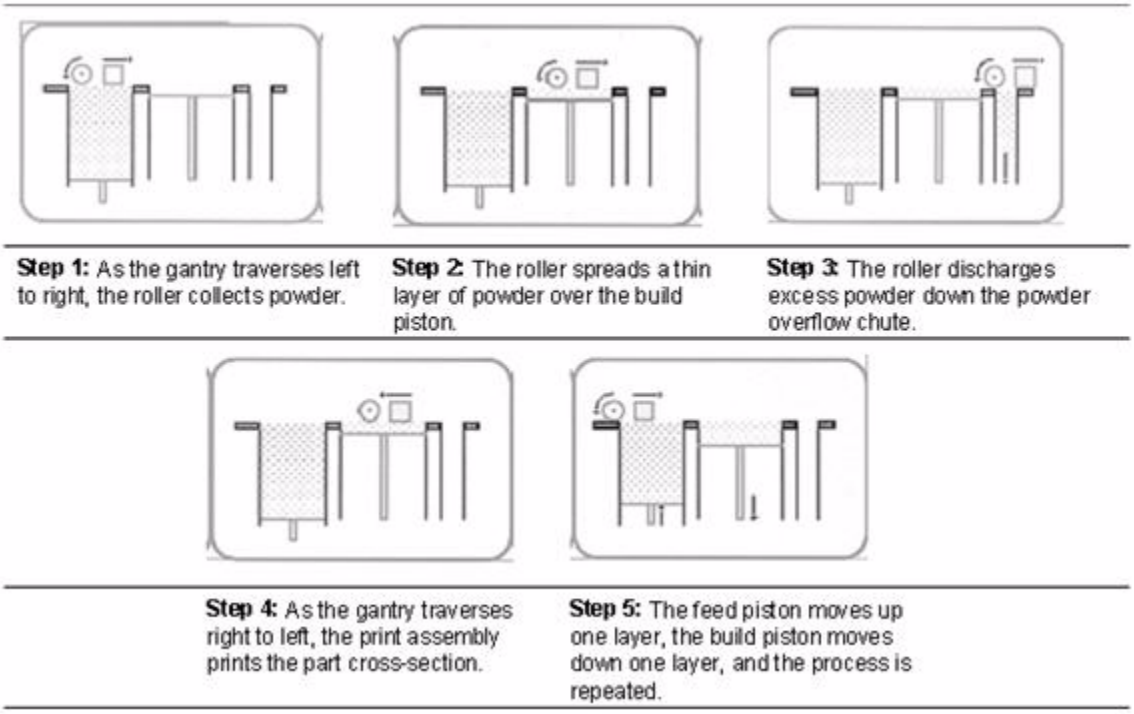
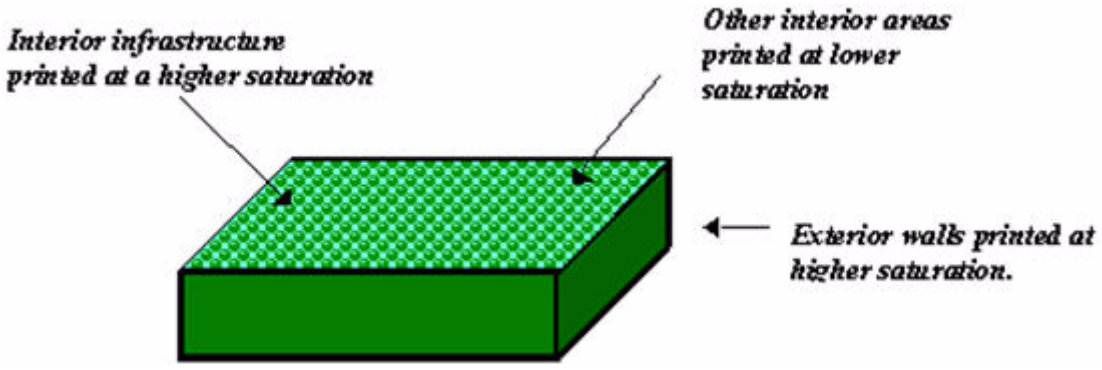
assembly (drawn as a square.) On the printer, the roller and the print assembly are mounted together on the *gantry* which moves horizontally across the build area.

To begin the 3D printing process, the printer first spreads a layer of zp® series powder in the same thickness as the cross section to be printed. The HP print head then applies a binder solution to the powder, causing the powder particles to bind to one another and to the printed cross-section one level below. The feed piston comes up and the build piston drops one layer of the thickness. The printer then spreads a new layer of powder and repeats the process, and in a short time the entire part is printed.



The printer employs several techniques to quickly build great parts. First, binder solution is applied in a higher concentration around the edges of the part, creating a strong shell around the exterior of the part. The printer builds an infrastructure within the part by printing with a higher concentration of binder solution. The remaining interior areas are printed with a lower saturation, which gives them stability, but prevents over saturation, which can lead to part distortion.



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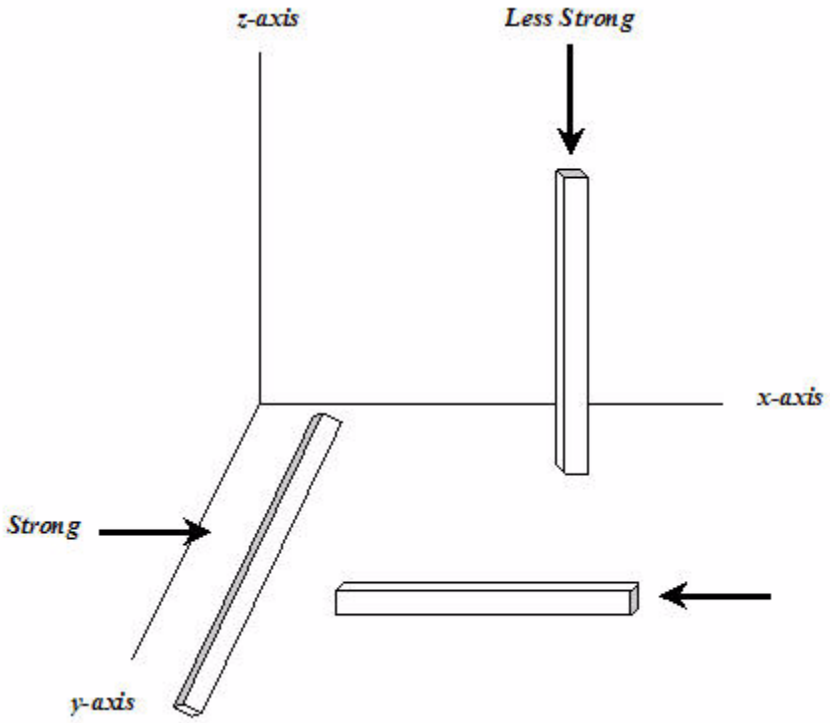
After printing, the part is removed from the powder, depowdered, and dried. The part can then be infiltrated with wax, or other performance resins, to increase strength and durability. For more information regarding infiltrants, see Post-Processing.

There are several important characteristics of the printer that will help you print the best parts for your intended purpose.

Part Placement. ZPrint will place the parts within the build box to maximize build speed, the most important criteria for the majority of our users. The software positions the parts with the smallest dimension in the Z (vertical) Axis. In addition to part placement, however, the following other characteristics should be considered.

Strength. This discussion only applies to untreated parts; once parts are infiltrated, they uniformly take on the strength characteristics of the infiltrating material. The ultimate strength of the part will be affected by its orientation within the build envelope. The part will be strongest along the Y-Axis and the X-Axis and less strong along the Z-Axis. This is because the cross sections are printed in continuous strips along the Y-Axis (the binder cartridge direction of travel), prints in bands across the X-Axis (the gantry direction of travel) and prints in laminated layers along the Z-Axis.



Accuracy. The accuracy of the part depends on the materials you choose. You can use features in ZPrint like Anisotropic Scaling to adjust for expected shrinkage and bring your parts into true scale. More information is found in Chapter 3, Prepare the 3D Printer.

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1.2 System Components

ZPrinter 310 Plus

ZD5 Powder Recycling Station

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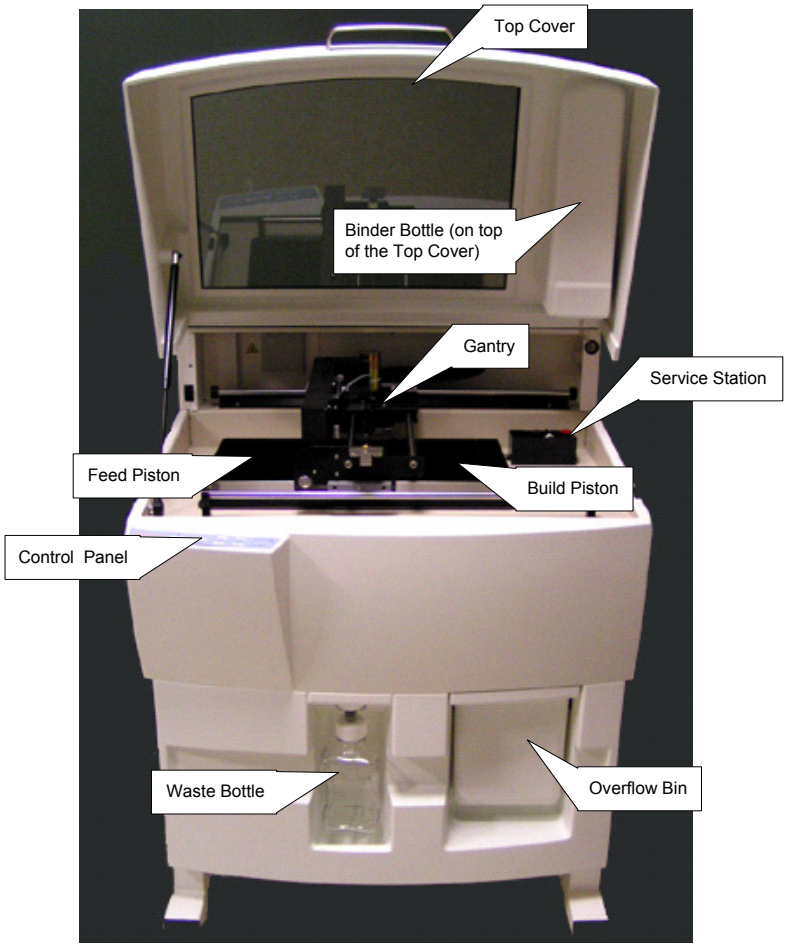
1.3 ZPrinter 310 Plus Subcomponents



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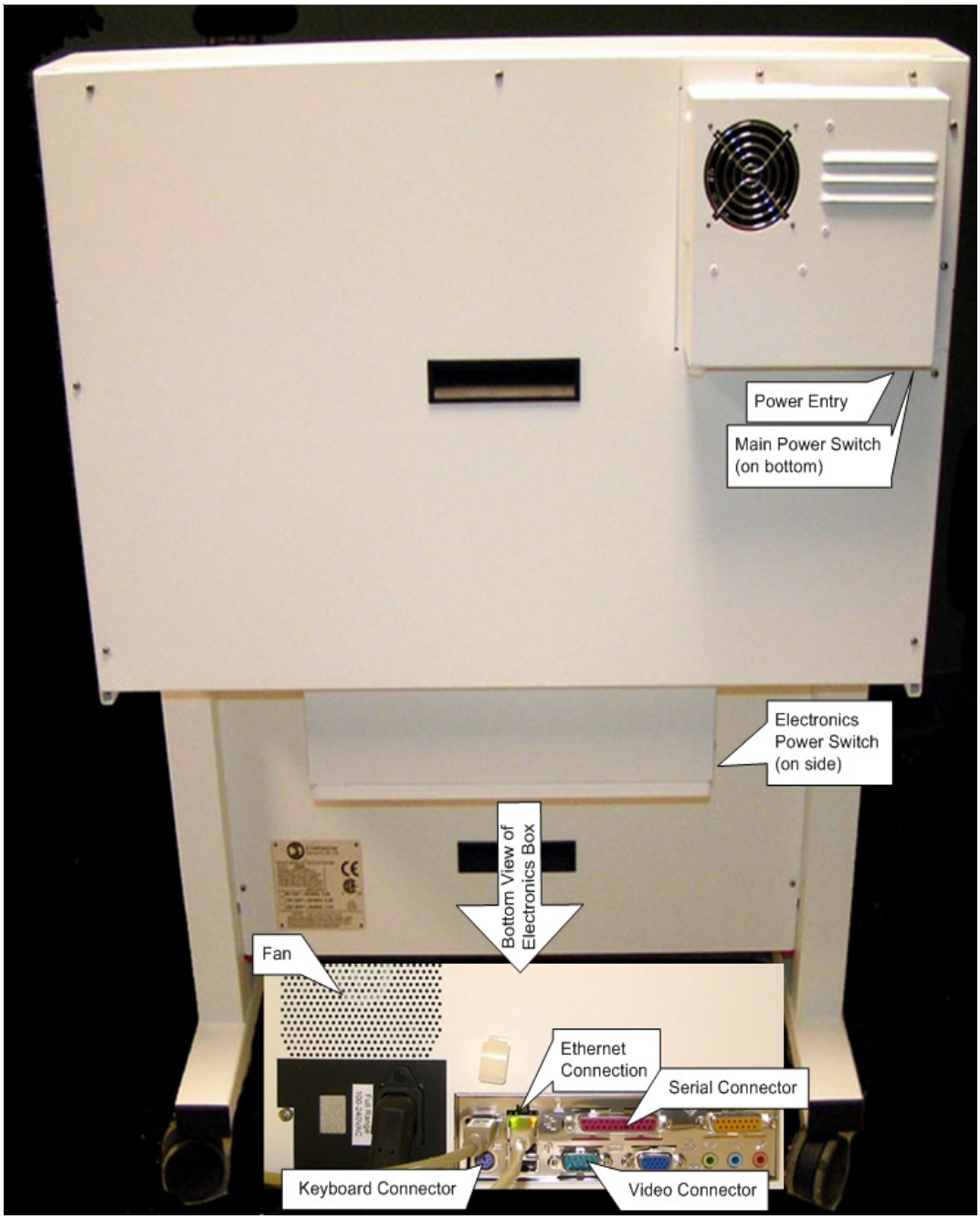

Back Panel View

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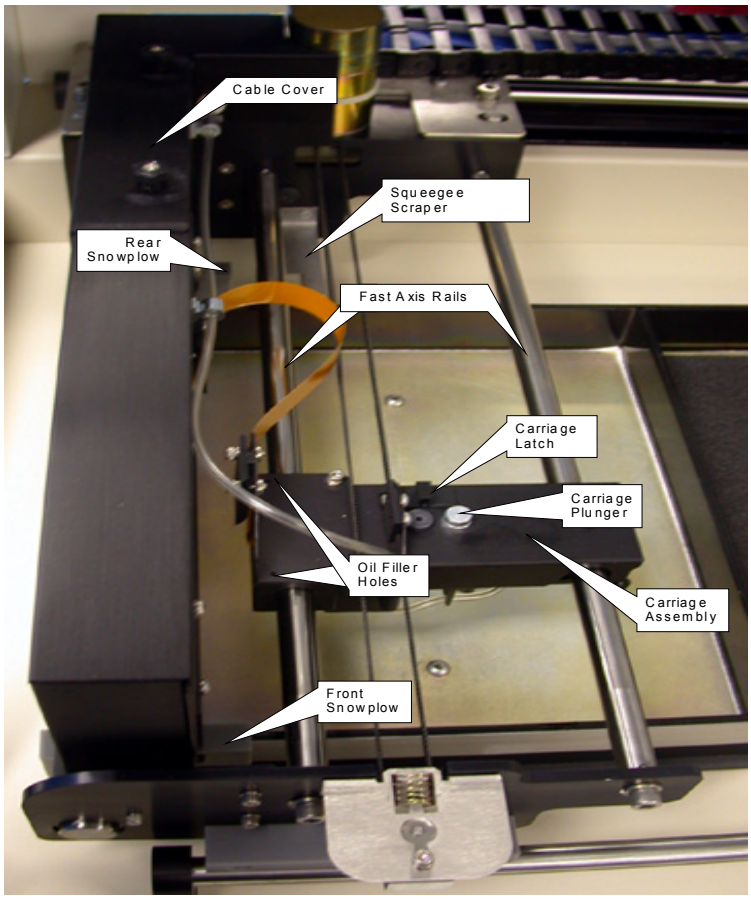
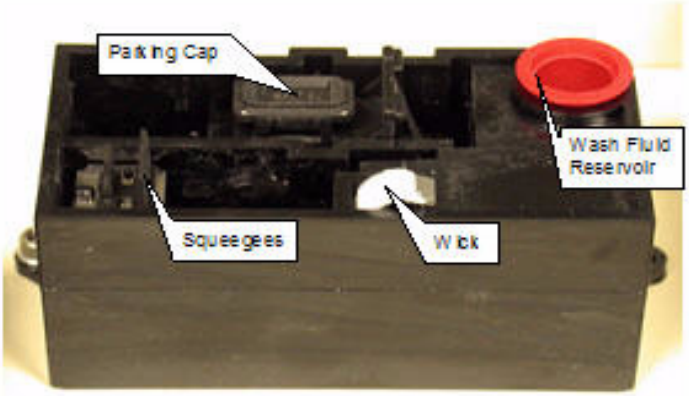
1.4 Gantry (Top View)



Gantry (Top View)



Service Station (Top View)

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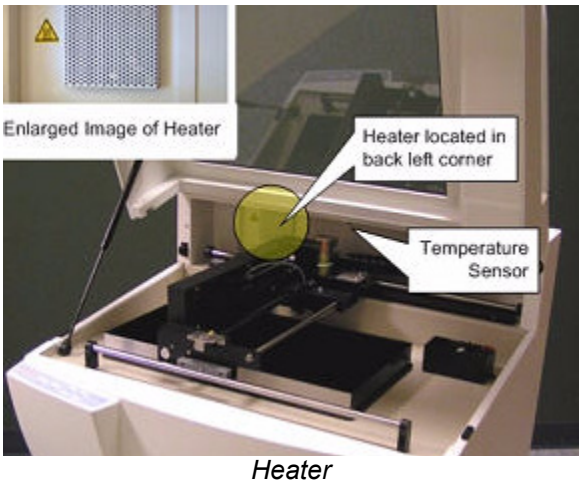
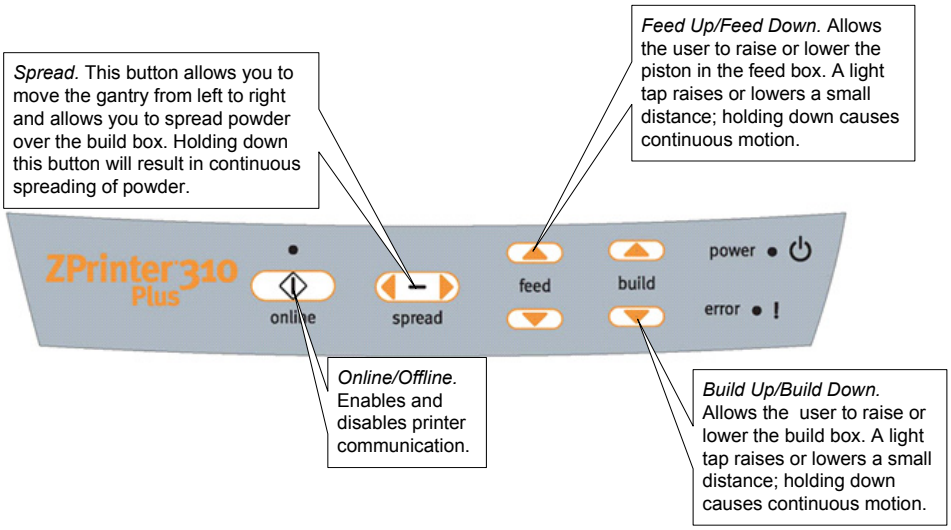


Heater

1.5 Control Panel



ZPrinter 310 Control Panel Detail

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ZD5 Powder Recycling Station

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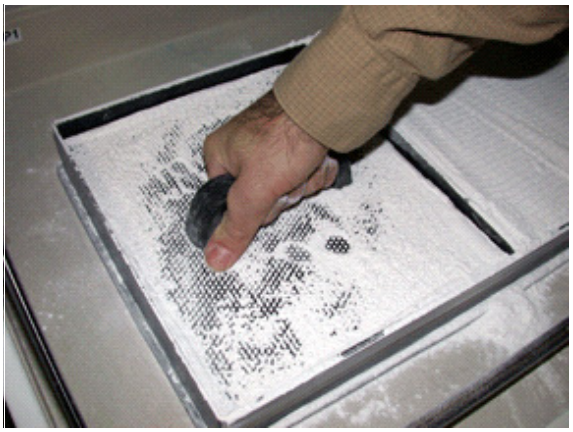
2 Quick Start Guide

This chapter provides an overview of the setup, part removal, and post-processing steps required to complete a print. For a detailed step-by-step guide to printer setup, please refer to the Setup The Build With ZPrint, Prepare the 3D Printer, and Post-Processing chapters.

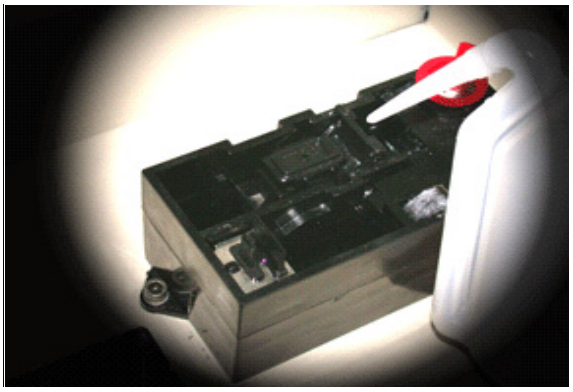
For additional information on post-processing techniques visit the Z Corp. 3DP User website at www.3dpuser.com.

2.1 Printer Preparation



1. Fill the feed box with powder. Recycle any powder in the overflow bin or add fresh powder as needed. (*See Section 4.2.*)

2. Spread powder over the build area and use the tamper to gently compress the powder. (*See Section 4.2.2.*) Vacuum any excess powder from the top deck.



3. Clean and wipe the squeegees and parking cap on the Service Station with distilled water. (*See Section 4.2.6.*)

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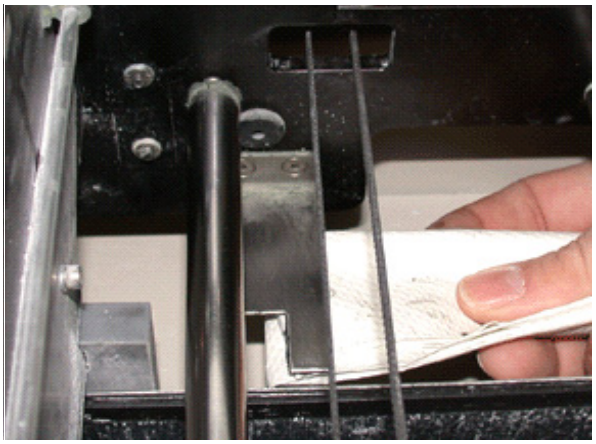
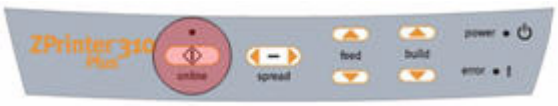


4. Clean the squeegee scraper with a damp paper towel. (*See Section 4.2.6 - Steps 9 and 10.*)

5. Check the binder level and fill if necessary. Fill the binder fluid to the neck of the binder bottle. (*See Section 4.2.7.*)

6. Check the waste bottle. Remove and dispose of liquid in accordance with local disposal regulations. (*See Section 4.2.9.*)



7. Place the printer Online.

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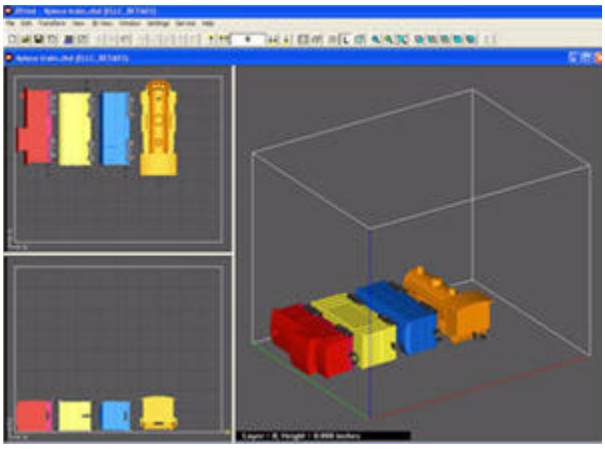
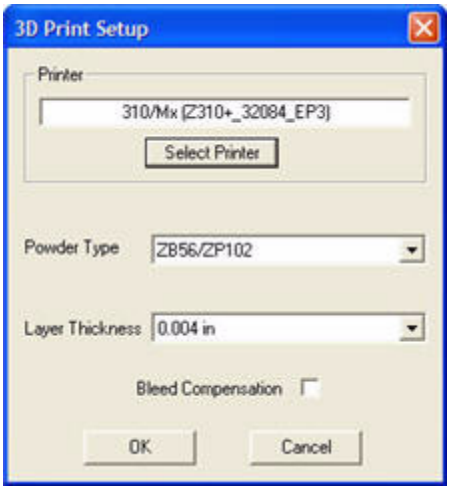
2.2 Print A Part



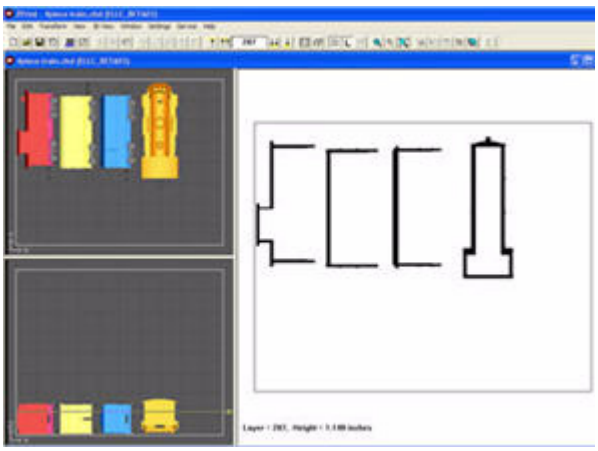
1. Launch the ZPrint Software. Open or import the file for the build. (*See Section 5.1*.)



2. Select **File > 3D Print Setup** or click the **3D Print Setup** icon on the ZPrint Toolbar.

3. In the **3D Print Setup** dialog, click **Select Printer** to check that the software is communicating with the printer. Confirm whether the printer is connected through either a **Serial Port** or **Network** connection. The printer will show up as an option in the text field if the software is properly communicating with the printer.

4. Check your powder settings to ensure the selected **Powder Type** is the powder you are currently using in the printer.



5. Click the **2D** icon on the Toolbar to view the build in 2D View and examine the cross-sections of the part before printing.

IMPORTANT: Before starting the build, run **Collision Detection**, (found on the ZPrint **View** menu), when the build contains multiple parts, or when you are printing a part with a Fixture.

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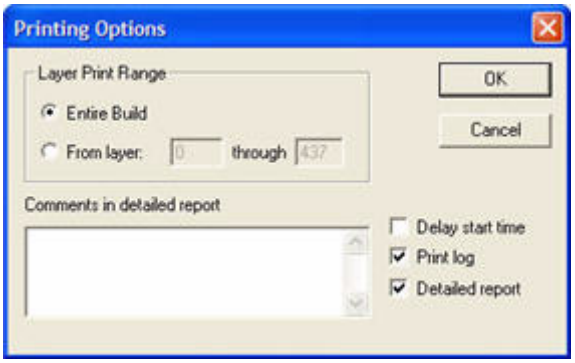
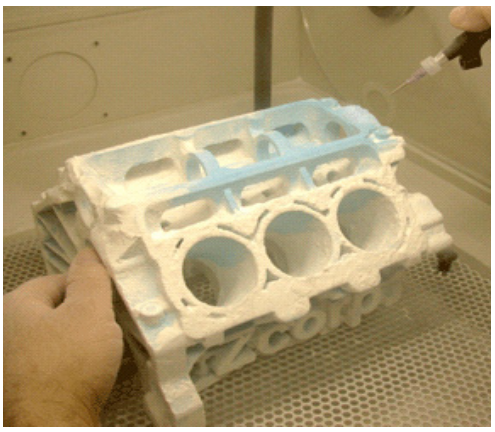


6. Select **File > 3D Print,** or click the **3D** icon on the Toolbar, to initiate the build. The printer will display the **Printing** dialog where the status of the build is reported for the duration of the print. Click **OK** to start the build.

2.3 Post-Processing

1. Get a tray for transporting the part and place it beside the build box. Use the tools that ship with your printer to remove excess powder from the part. *Gently* remove the part from the build box.



2. Place the part in the depowdering station and turn the compressor on. Test the air pressure from the air wand against your hand and adjust as necessary. Use low pressure for fine, delicate part features so they do not break when air is applied.

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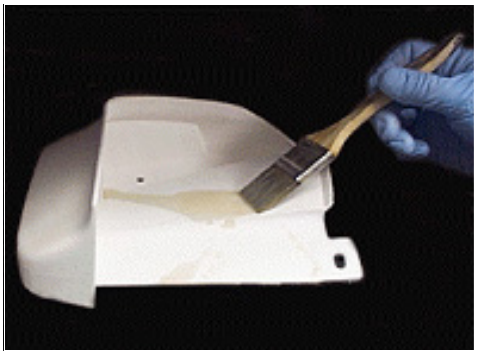

3. After the part is depowdered, you can allow it dry longer or you can infiltrate the part with the material of your choice. See *Post-Processing* for complete information regarding different options for infiltration.

2.4 Useful Tips

2.4.1 Part Setup, Orientation and Print Settings

- Do not tightly pack parts into the build. Keep in mind that you will need to depowder and remove them from the build box. Allow a little room around the part so you can vacuum the powder away and get your fingers around or under the part.
- Orient parts so delicate features are supported in the Z-Axis. If a delicate feature is only supported by unprinted powder the chances of breaking that small feature during depowdering is greatly increased.
- When building delicate parts always use a Fixture (see the *ZPrint Software Manual*). Raise the part 0.25" (6.4 mm) from the bottom of the build and generate a Fixture under the part. With a Fixture, the part can easily be handled, or transported to an oven or a depowder station.
- Do not enable the **Bleed Compensation** if you are building a part with features under 0.050" (1.27 mm). Go to www.3dpuser.com, or see the ZPrint Software Manual for additional information regarding this important feature.
- Parts printed with the High Performance Composite powders can be reliability printed to be within +/- 1.0% or +/- 0.005” dimensional tolerance.
- To increase the strength of thin parts, you can decrease the layer thickness to 0.0035" (0.089 mm) if you are using one of the High Performance Composite materials. As you increase the strength of the part in this manner you are also increasing the amount of time to dry the part. Use of the removable build plate (see *Section 2.4.3*) and oven drying the part are recommended. Remove the part from the removable build plate before placing in the oven.

2.4.2 Gross and Fine Depowdering

- Use ZPrint to check where printed parts are located and oriented in the build box so you do not accidentally bump or brush against a fragile part when removing parts from the printer.
- When removing powder from around the part, do not plunge the vacuum nozzle into the powder bed. Begin at the outer perimeter of the build box, slowly work your way into the build. Hold the tip

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of vacuum nozzle approximately 0.25" (6.4 mm) to .375" (9.5 mm) away from the powder and allow the vacuum to pull the powder up. Slanting the vacuum nozzle will enable you to control the suction. This will decrease the chance of breaking a part during removal.

- When fine depowdering, always start with low air pressure to minimize the chance of breaking fine details on the part. When the top and sides of the part are completely depowdered, tilt the part onto one of its sides. Handle the part carefully as it may be fragile and brittle before infiltration. If none of the sides of the part can support the weight of the part, you can apply a small amount of resin or epoxy to those areas to strengthen it. When doing this, be careful not to let any of the infiltrant come into contact with any powder that may still be on the part. Let the infiltrant dry before continuing to depowder process.

2.4.3 Use of the Removable Build Plate

The removable build plate is an excellent tool. It allows you to quickly remove the part from the build bed, clean up the printer, and start printing again. The removeable build plate also helps the user easily transport the part to an oven or a depowdering station without ever having to handle the part.

2.4.4 Oven Dry the Part

Although a part printed with one of the High Performance Composite materials can be handled when it is not completely dried, the part reaches full strength when it is completely dried. Placing the part in an oven at temperatures less than 200^{o}F (93^{o}C) for 2-4 hours will greatly increase the strength of the part. This is only recommended for parts printed with the High Performance Composite materials. Remove the part from the removable build plate before placing it in an oven.

2.4.5 Part Infiltration

Go to the 3DP User website for complete information on materials and applications.

When using Z-Bond™:

- Always infiltrate the most delicate features of the part first. Z-Bond immediately strengthens the part areas it is applied to. Let the detailed areas cure for a couple of minutes and then continue applying Z-Bond to the remainder of the part. Do not apply Z-Bond to the same area twice.

- Try to avoid infiltrating the part by applying Z-Bond from spot to spot. When drizzling Z-Bond onto a part, pick a good starting place and hold that area upward relative to the rest of the part. With your free hand, place the tip of the Z-Bond bottle against the part and allow the cyanoacrylate (CA) to flow from the bottle. It is important that the CA flows at a uniform rate and to see how quickly Z-Bond wicks into the part. By seeing how quickly Z-Bond wicks into the part, it will be easier to judge where and how quickly to apply it.

- Keep the part moving in your hand when you apply Z-Bond. Doing this will prevent Z-Bond from sticking to your gloves.

When Using Z-Max™ or Z-Snap™ Epoxy:

- If the part has delicate features, infiltrate them first and allow the epoxy to cure. This will decrease the chance the feature will break from the part if nudged or bumped. Keep in mind that the features

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that are infiltrated with epoxy will be weak until the epoxy has had a chance to cure and gain strength.

- If the part has multiple delicate features, or it is impossible to handle the part without breaking a feature, infiltrate those features first. Allow the Z-Max or Z-Snap epoxy to cure and then infiltrate the rest of the part. This will add time to post-processing the part but it ensures that you have a good strong part without any fractures.

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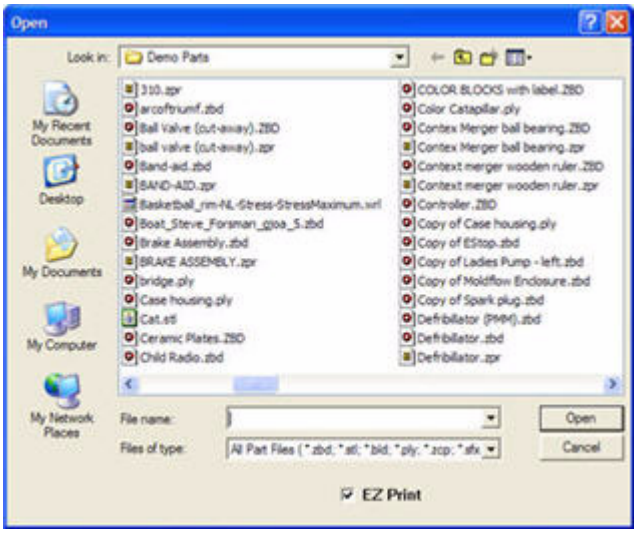
3 EZ Print Mode

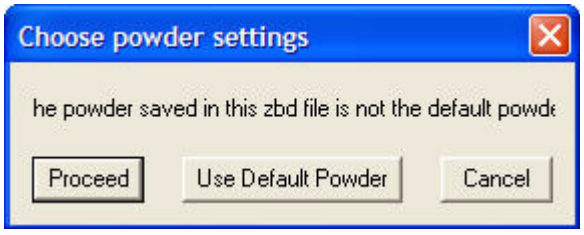
You may choose to print using **EZ Print** mode if you are using ZPrint version 7.2 or higher. **EZ Print** mode is useful for the inexperienced user who may need assistance in building a part. EZ Print automates some functions that eliminates the need for the user to manually setup the part in the build. The **EZ Print** mode settings are on the **Settings > General Preferences > EZ Print Mode** tab in ZPrint. For more information, see the ZPrint Software Manual.

PLEASE NOTE: EZ Print allows you to easily print a SINGLE part and is *ONLY* available to use with the high composite powder series (zp®). EZ Print mode will print the part using the default settings for the selected materials.



1. Launch ZPrint and select **File > Open**. When the **Open** dialog displays, the **EZ Print** checkbox at the bottom of the dialog is checked. Select a file to print and click **Open**.

   If you do not want to print in **EZ Print** mode, uncheck the **EZ Print** checkbox before opening a file to print.



If you are opening a *.zbd* file and the powder associated with the *.zbd* file is not one of the high composite materials, ZPrint will give you the option to proceed with the current powder settings, proceed with the default powder settings, or cancel out of **EZ Print** mode.

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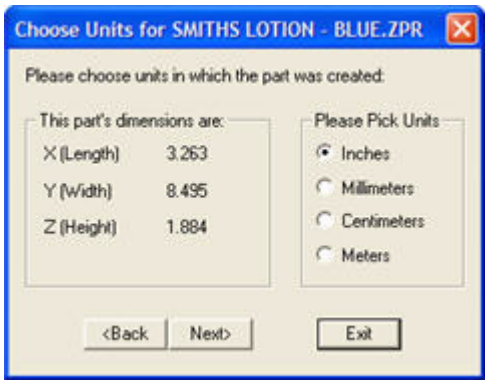
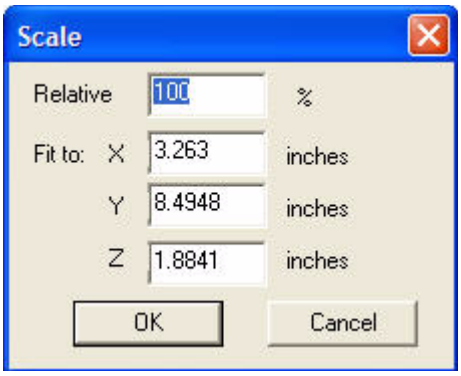


2. Select the display units for the part and click **Next**.



3. If this part does not fit in the build box, ZPrint will prompt you to scale the part using the **Scale** dialog. Adjust the scale and click **OK** to continue.

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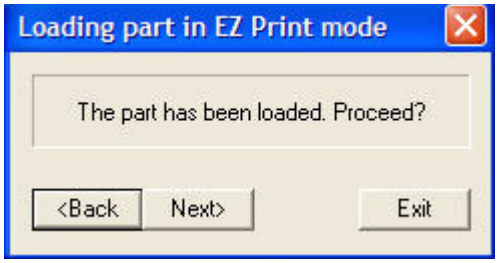
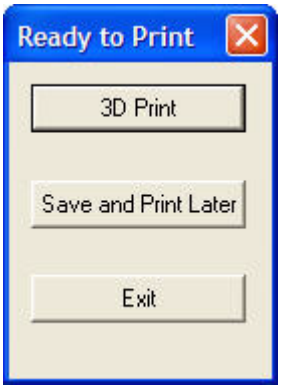


4. After the part is loaded, ZPrint will prompt you to proceed. Select **Next** to proceed with printing or select **Back** to open a different part or to change the scale of the currently loaded part.

   When **Next** is selected, ZPrint creates a Fixture. It automatically runs **Collision Detection** to make sure the Fixture and part are not touching. If there are any collisions detected, ZPrint will regenerate the Fixture with a higher accuracy level.

   PLEASE NOTE: There are several different options for Fixture generation on the **Settings > General Preferences > EZ Print Mode** tab. The default setting is **Auto**. When **Auto** is selected, ZPrint will determine if the part has a non-flat bottom. If it does, ZPrint will automatically create a Fixture for the part.



5. After a Fixture is created, you may choose to print your part, save and print later, or you can exit **EZ Print** mode and cancel the print.

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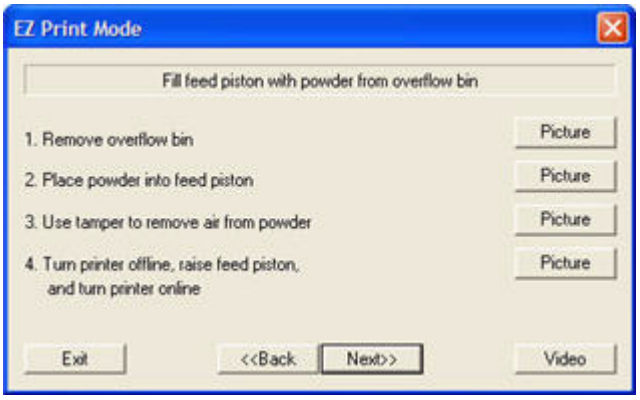
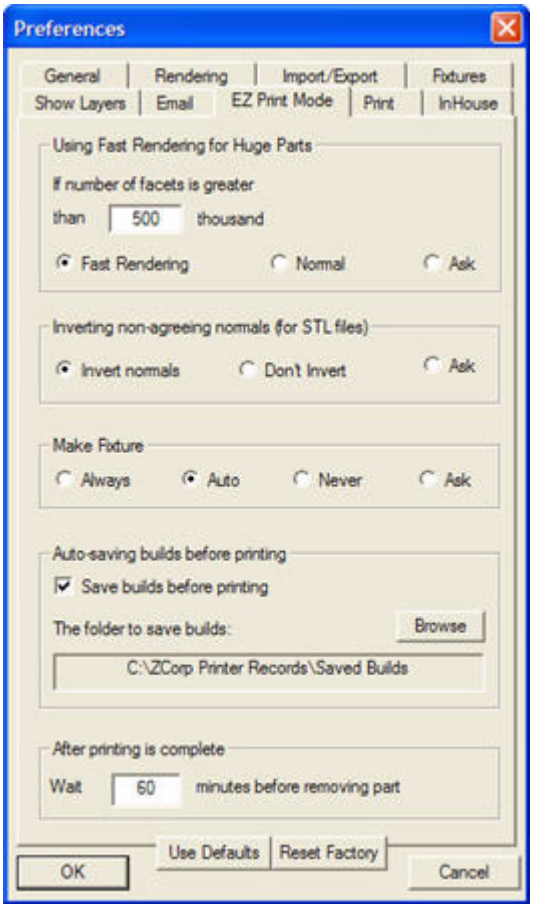


6. ZPrint takes you through four or five dialogs to help you prepare the printer. There are pictures for each step, or you can watch a video of the complete pre-printing preparation.



7. After the steps to setup the printer are completed, ZPrint starts printing the part. If the **Auto-Saving** option is checked on the **EZ Print Mode** tab, ZPrint automatically saves your *.zbd* file to a specified folder. For more information, see the ZPrint Software Manual.

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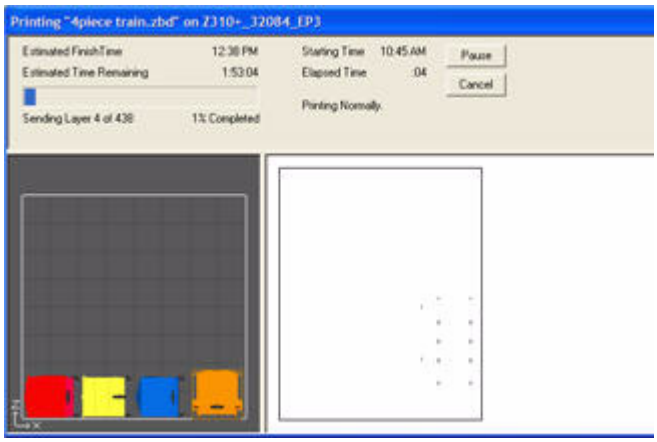
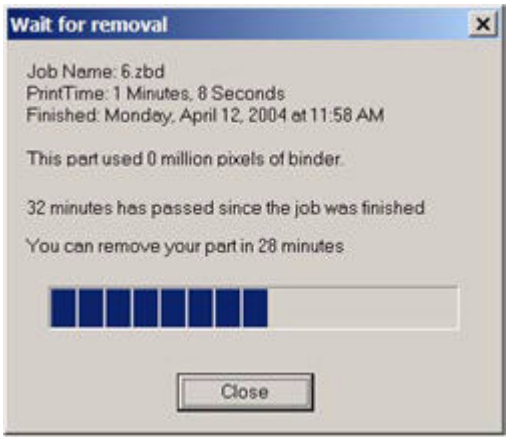


8. The **Printing** dialog appears when the build starts and will remain open for the duration of the build, so you can view the status of the build and see the estimated time remaining before the build is complete.



9. After the print job is completed, the part must dry in the build box before it can be removed. The drying cycle will strengthen the part for easier handling and removal from the powder. ZPrint will countdown the time remaining before you can remove your part from the build box. For more information, consult the ZPrint Software Manual.

10. When the part is finished drying, ZPrint will display a message informing you that the part is ready for removal. This dialog contains several helpful video clips about how to remove, depowder, and infiltrate the part. Remove and post-process the part as instructed in the video, or in the steps below. See the ZPrint Software Manual for complete details.

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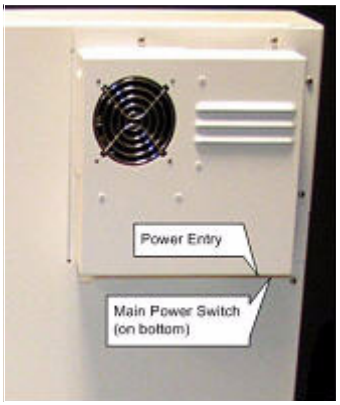
4 Prepare the 3D Printer

This chapter is a step-by-step guide for preparing the printer to print. It covers preparing the build area, cleaning the Service Station, filling the binder bottle, and emptying the waste bottle.

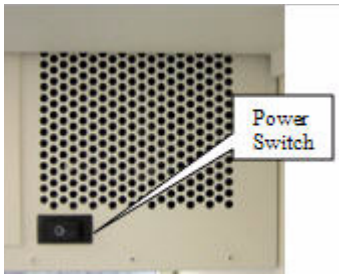
For additional assistance and information, please contact the Z Corporation Service Department at (781) 852-5050, toll-free at (877) 88-ZCORP or via email at service@zcorp.com. You may also visit the 3DP User website at www.3dpuser.com.

4.1 Start the Printer

We recommend that you leave the printer on at all times. The printer periodically exercises a print head routine that services the print heads during down times. If the printer is off, you must turn it on to prepare the printer.



1. Press the main power switch located on the back right side of the printer.



2. Press the power switch located on the electronics box.
3. When the online light, located on the control panel, is on, the printer is ready.

4.2 Prepare the Build

4.2.1 Fill the Feed Box With Powder

Warning: *Use only powder supplied by Z Corporation. Use of any other material may impact the performance and/or safety of your printer and will void warranty and service contracts.*

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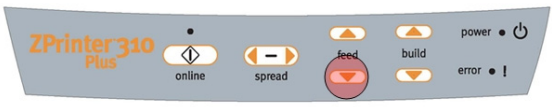

1. Press and hold the **Feed** DOWN button until the online light begins to blink. The feed piston will lower itself until it reaches the bottom.

2. Check the overflow bin to see if there is powder to be recycled. If so, remove the powder from the overflow bin and place it in the Feed box.

3. If you do not have any or enough powder to recycle from the overflow bin, pour fresh powder into the Feed Box.

TECHNICAL TIPS

- Keep powder containers closed when not in use to keep powder dry and free of contaminants.
- Scoop powder carefully to minimize airborne particles.
- Make sure that you carefully vacuum up excess powder. It only takes a minute, and the cleaner the machine is, the less often it will need maintenance!

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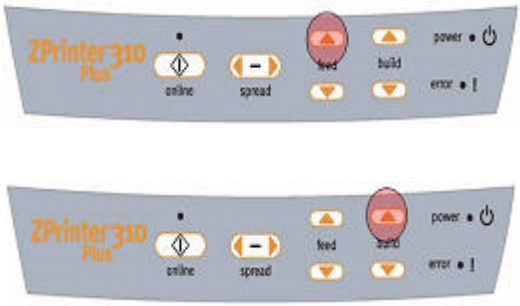
4.2.2 Remove Air from the Powder and Pack the Feed Box

1. Insert the powder scoop repeatedly a few inches into the loose powder to compact it. Continue for about a minute until it feels firm. Repeat for every two scoops of powder.

2. When the feed box is filled to the top, take the tamper and slowly press it into the powder surface. Be careful not to “slap” the tamper into the powder, which will produce airborne particles. About 10-15 pounds of force will give it a smooth, flat, and compact surface. Failure to firmly pack the powder will affect part quality.

4.2.3 Prepare the Build Area



1. Press and hold the **Feed** UP button until the surface of the powder is even with the printer top deck.

2. Press and hold the **Build** UP button until the build piston stops.

3. Make sure the build area is clean.

PLEASE NOTE: If using a build plate see directions below (*Section 4.2.4*), otherwise you may skip these steps and go to the following section Clean Up.

4.2.4 Insert the Removable Build Plate

The removable build plate is a useful tool that helps you get the most out of your printer. It allows you to lift delicate parts from the printer without handling them. It also provides a way for you to safely remove parts from the machine sooner after they are printed, so that you can quickly start another build. You can also use the build plate for transferring parts to an oven to quickly dry them to their full green strength.

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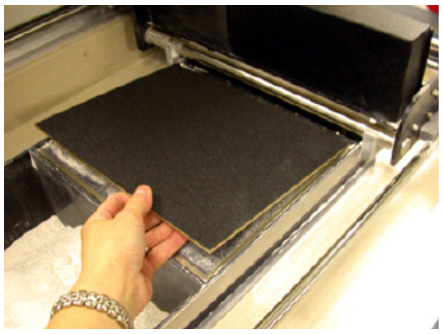
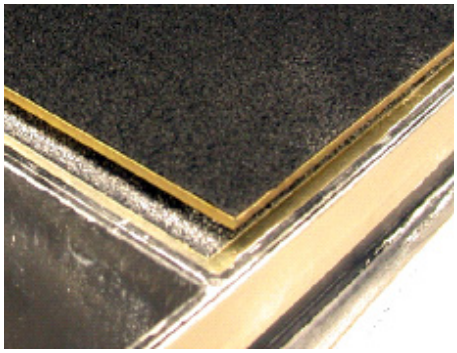
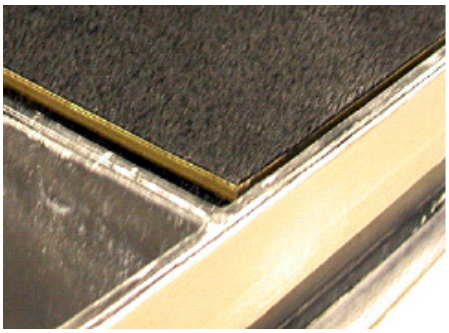


1. Bring the build piston all the way to the top and place the build plate on top of build piston.



2. The build plate will project above the top of the build box. In this position, the gantry would hit the build plate if you tried to spread powder.



3. Lower the build piston so that the top of the build plate is slightly below the top of the build box.

WARNING: *If the gantry or the spread roller hits the build plate, you may damage your printer.*

4. Press and hold the **Spread** button for four spreads, on the fifth spread, the automatic **Fill Bed** routine will take over. The printer will perform 13 more spreads with coordinated piston movements to prepare the build area. (You can also perform this operation by selecting **Service > Fill Bed** in ZPrint.)

   (To cancel the **Fill Bed** operation, press **Online** on the printer control panel, or click **Cancel** in ZPrint.)

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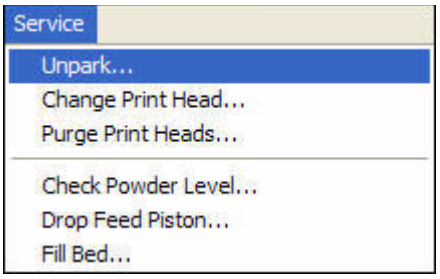
4.2.5 Clean Up

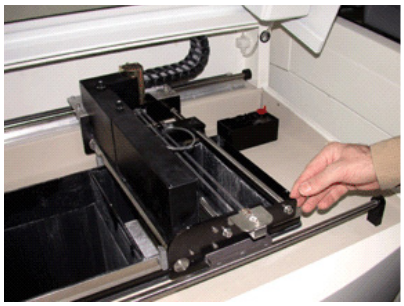
1. Vacuum off any powder that is visible on the printer top deck.

4.2.6 Clean the Service Station

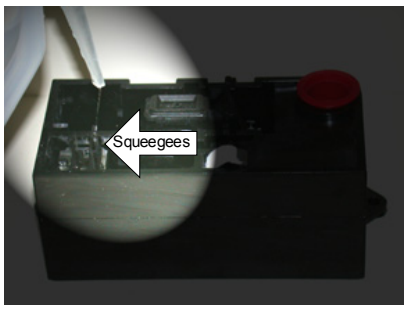


1. With the printer top cover closed, place the printer online.

2. Select **Service > Unpark** in ZPrint. The gantry will move away from the Service Station for easy access to the squeegees and parking cap.



3. Lift the printer top cover and manually pull the gantry away from the Service Station.



4. Fill the Wash bottle (supplied in the Toolbox) with distilled water.

5. Rinse the squeegees with water until all debris is removed.

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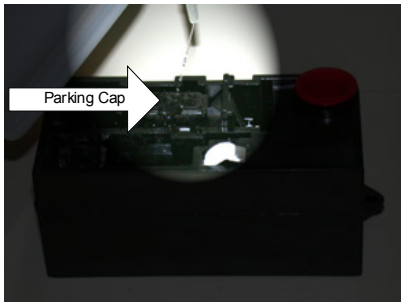
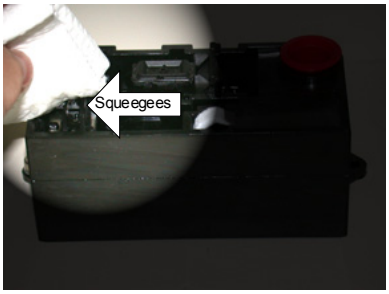
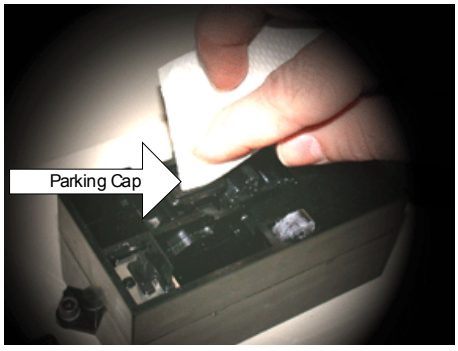


6. Rinse the Parking Cap with distilled water.

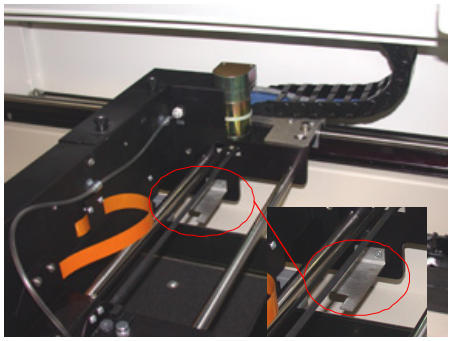


7. With a clean and dry paper towel, wipe residue off the squeegees and thoroughly dry.



8. With a clean and dry paper towel, dry off the Parking Cap.

9. Check the Wash Fluid reservoir and refill if needed. For more information, see the *Maintenance and the Service Menu* chapter.



10. Locate the squeegee scraper on the back of the printer assembly.

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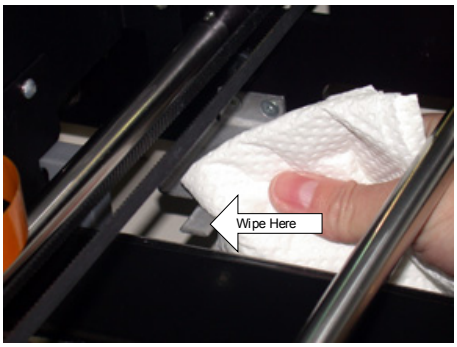


11. Using a damp paper towel, wipe off the top and bottom surfaces of the squeegee scraper.

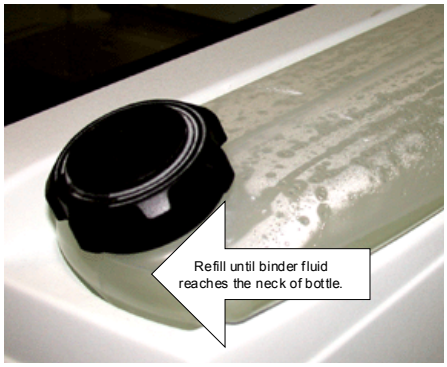
12. Close the printer top cover.

13. Press **OK** in ZPrint to repark the gantry.

4.2.7 Refill the Binder Bottle

Warning: *Use only binder supplied by Z Corporation. Use of any other material will impact the performance and/or safety of the printer and will void warranty and service contracts.*

1. Unscrew the black cap of the binder bottle.



2. Fill with binder fluid until liquid reaches the neck of the bottle. Hold bottle sideways to avoid spilling binder.

3. Replace the binder bottle cap.

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4.2.8 Change the Print Head

The only time you will need to change the print head is if it is expired. ZPrint will alert you if your print head is old and may not complete the build. For more information about changing print heads, please refer to the *Maintenance and the Service Menu* chapter.

Technical Tip

A good practice to get into the habit of performing is to fill the binder bottle everytime you change the print head. This way, there will always be enough binder to last the normal life of the print head.

4.2.9 Empty the Waste Bottle

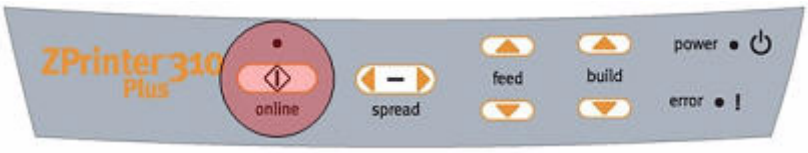
1. Remove the waste bottle by depressing the button on the waste fitting and pulling down on the waste bottle.
2. Dispose of waste liquid. Binder waste should be treated in accordance with local disposal regulations.
3. Replace the waste bottle by inserting the bottle back onto the fitting.

   PLEASE NOTE: Make sure the binder bottle is completely inserted against the fitting. A double clicking sound will confirm that the binder bottle is locked into place.

Warning: *Never recycle waste binder solution. The waste is contaminated with powder and use of this liquid in the printer will clog the internal plumbing system and the print head.*

4.2.10 Place the Printer Online

1. Press the Online button.



2. The green online indicator light illuminates.
3. The printer is ready to print.

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5 Setup The Build In ZPrint®

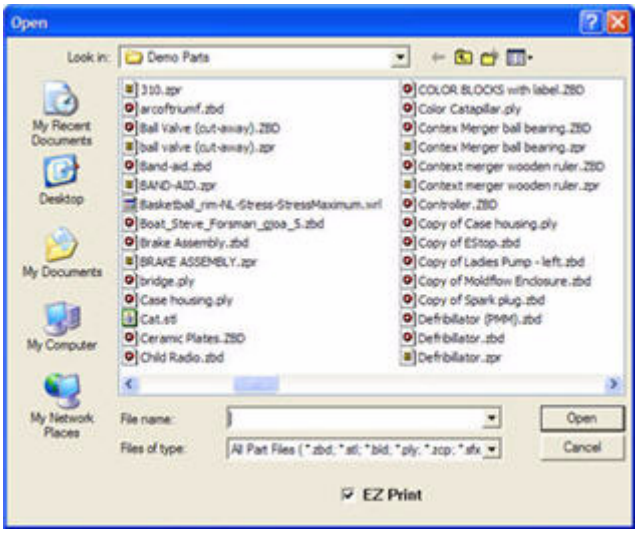
This chapter explains how to setup a build in ZPrint, check the 3D Print Settings, and print. For more information about the features available in ZPrint, please refer to the ZPrint Software Manual.

For information and guidance on software features, please contact the Z Corporation Service Department at (781) 852-5050, toll-free at (877) 88-ZCORP or via email at service@zcorp.com.

> **PLEASE NOTE:** Verify that ZPrint is installed on the computer that is dedicated to the printer. If needed, installation instructions can be found in the ZPrint Software Manual.

5.1 Open or Import a File

1. Launch ZPrint. The **Open** dialog appears. Highlight a file you wish to open and click **Open**, or double-click on the file.



2. Choose the display units for the part and click **Next**.

3. The file will be brought into ZPrint and sliced. To open additional files in the same build, choose **File > Import**.

5.2 Part Orientation

5.2.1 Parts Containing an Opening or Hollow Area

If the part has an opening or is hollow, place the open or hollow side of the part so that it is facing upward. This will allow for easier removal of powder during the depowder process.

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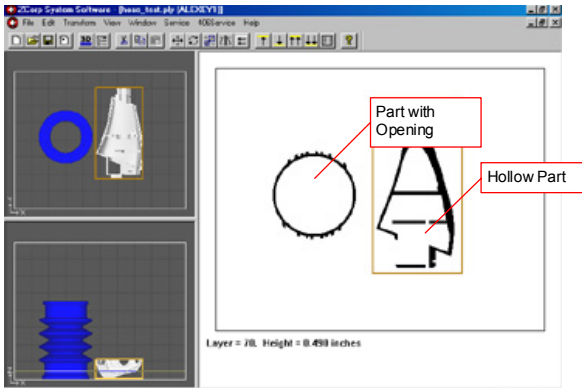
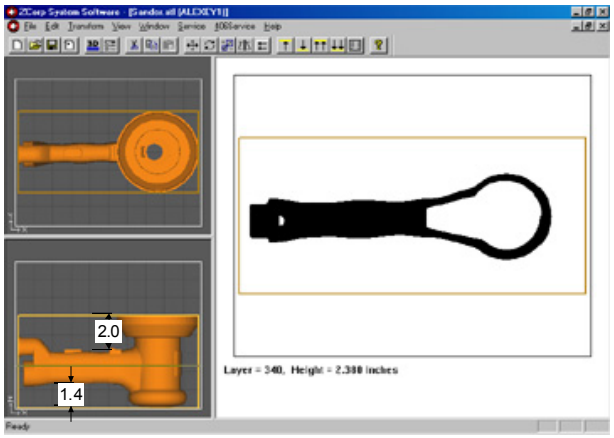


5.2.2 Parts Containing Overhangs

Unsupported overhangs should be placed on the left-hand side of the build box. Generate a Fixture underneath the overhanging surfaces to reduce any movement of the overhang during printing. For information on generating Fixtures, refer to the *ZPrint Software Manual*.

Cylindrical features are most accurate when they are parallel to the Z-Axis. For example, if you were to print a bottle, the bottle should be printed standing up, with the mouth of the bottle facing the top of the printer.



5.3 Check The Build Settings

ALWAYS check build settings before printing.

1. Select **File > 3D Print Setup** (or select  on the Toolbar).

2. Check the **Printer** selection, **Powder Type**, and the **Layer Thickness** for the build are correct in the **3D Print Setup** dialog. Be sure the correct powder type is selected and that it matches the powder type currently being used in the printer.

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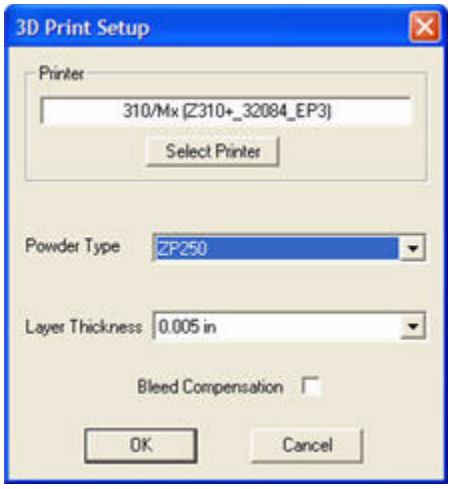
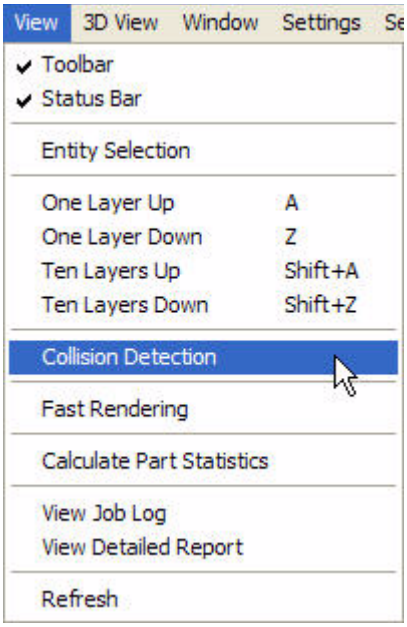


3. It is strongly recommended that you run **Collision Detection** (if more than one part is being printed, or you are printing a part with a Fixture) before starting the build. **Collision Detection** is found on the ZPrint **View** menu.

    - **Collision Detection** will scan through each layer of the build and report those layers in which the part is found to be overlapping or touching another part, or the Fixture. Adjust the build settings if a collision is reported. For parts with Fixtures, this will likely mean adjusting the Fixture **Clearance** value to a higher number. For builds containing multiple parts, use ZPrint to adjust the part positions so they are not overlapping or touching. In both cases, rerun **Collision Detection** until you get the *No Collision Found!* message.



5.3.1 Print the Build

It is strongly recommended that the build settings be confirmed before printing. To check build settings, choose **File > 3D Print Setup**, or click on the **3D Print Setup** icon located on the Toolbar. 

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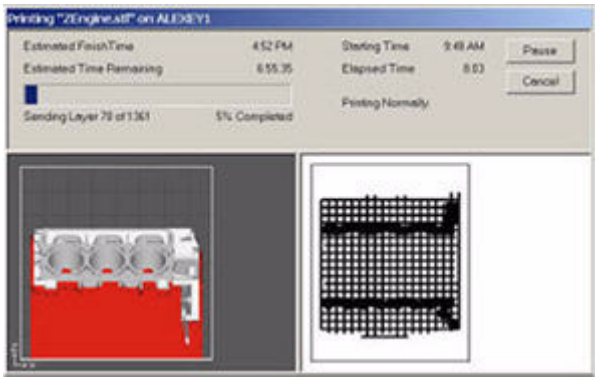
After all of your build settings are confirmed:

1. Choose **File > 3D Print** , or click the **3D Print Setup** icon on the Toolbar. 

2. A dialog appears prompting you to check the powder and fluid levels.

3. Press **OK** to confirm that these have been checked.

4. Once the build has begun, the **Printing** dialog will appear and report the status of the build, from start to completion.



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6 Post-Processing

This chapter explains how to remove a part from the printer, how to remove excess powder by depowdering, and introduces the use of infiltration materials.

For information and guidance on Infiltration materials, please contact the Z Corporation Service Department at (781) 852-5050, toll-free at (877) 88-ZCORP or via email at service@zcorp.com.

1. Allow the part to dry in the machine using one of these recommended times.
   - With specialty material parts (unless otherwise specified), wait approximately ten to fifteen minutes to ensure that the uppermost layers of the part have had a chance to dry.
   - For parts made with High Performance Composite materials, leave the part in the bed for approximately 30-60 minutes. Keep the printer top cover closed with the heater running to help dry the part.
2. Take the machine Offline by pressing the **Online** button.
3. Lift the printer top cover.
4. Press the **Feed** DOWN button to lower the feed piston.

   WARNING: *When performing any vacuuming operation, use the vacuum provided as part of the printer. Vacuuming powder can generate static electricity, and use of a non-grounded vacuum hose will create static charges, which may affect the operation of the printer and harm the operator.*
5. Place a tray on the top of the feed area.
6. Take a moment to look at the computer screen and determine exactly where parts lie in the build box.

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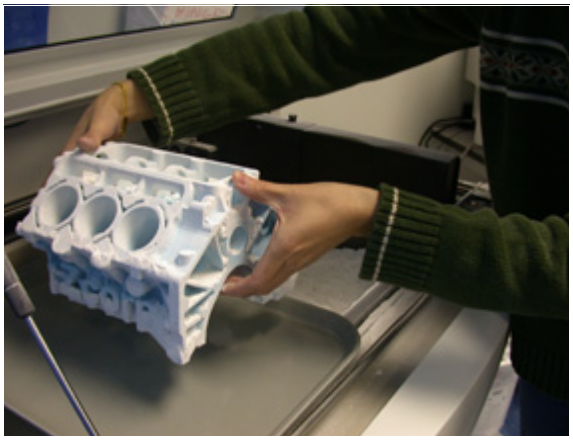
7. At the printer, without raising the build piston, begin vacuuming powder out of the build box. Hold the end of the hose on a 20° to 30° degree angle over the powder so the hose inlet is 1/4" to 3/8" above the surface of the powder. This generates enough of a draft to lift loose powder without damaging the parts.

8. Vacuum powder away from the buried parts, and clean powder out of the margins against the walls of the build box.

9. To gain access to the sides of the parts, raise the build piston by holding the **Build** UP button.



10. Remove the part or build plate and place on the tray. The part is now ready to be fine depowdered.

11. Vacuum off any remaining powder on the printer deck.

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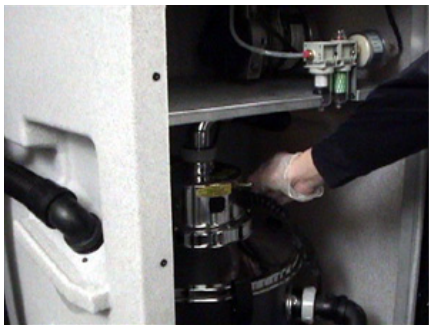
6.1 Depowder the Part

1. Place parts inside the depowder station.

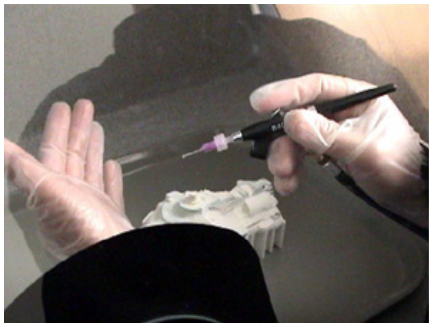


2. Turn on the vacuum cleaner.

3. Turn on the air compressor.

Technical Tip

The air pressure on your depowdering station is adjustable. For bulky parts, turn the air pressure up. For more delicate parts, turn the air pressure down. Always test the air pressure against your hand first before applying to a part.



4. Change the air pressure as needed and check the pressure with your hand before applying air to the part.

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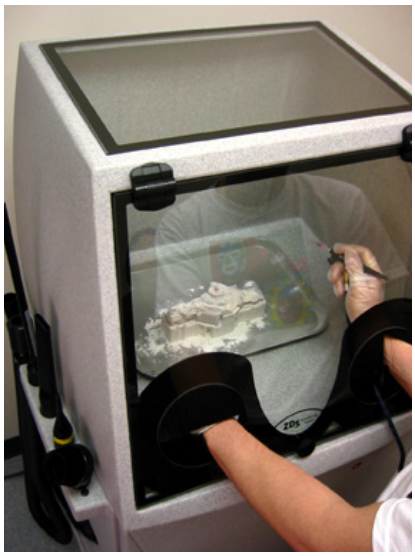

5. Remove the excess powder from the part.

6.2 Using the External Vacuum Bag Liner

Z Corporation has developed an accessory to the vacuum cleaner to assist the user with the removal of the vacuum bag from the canister. The vacuum cleaner liner is easy to use and will prevent ripping and tearing of the blue vacuum bag once it is full of powder. The vacuum cleaner liner is placed in the vacuum canister prior to the bag, and once the bag is full, the liner handles are used to lift the bag out of the canister.

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1. Start with the empty vacuum canister.

2. Place the vacuum cleaner liner into the empty canister, being sure the cutout in the liner goes around the vacuum inlet.

3. Install the vacuum bag inside the vacuum cleaner liner.

4. Fold the handles of the vacuum cleaner liner up onto the top of the empty vacuum bag.

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5. Install the vacuum filter.

6. Install the vacuum motor.

7. Once the vacuum bag is full, remove the motor and filter. Remove the vacuum bag from the canister by lifting the vacuum cleaner liner handles straight up.

8. Rotate the vacuum canister, in the direction of the inlet, from under the vacuum bag.

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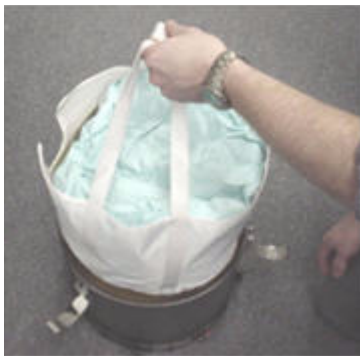


9. Once the vacuum cleaner inlet tube is disengaged from the vacuum bag, you can lift and remove the bag and liner.

6.3 Dry the Part

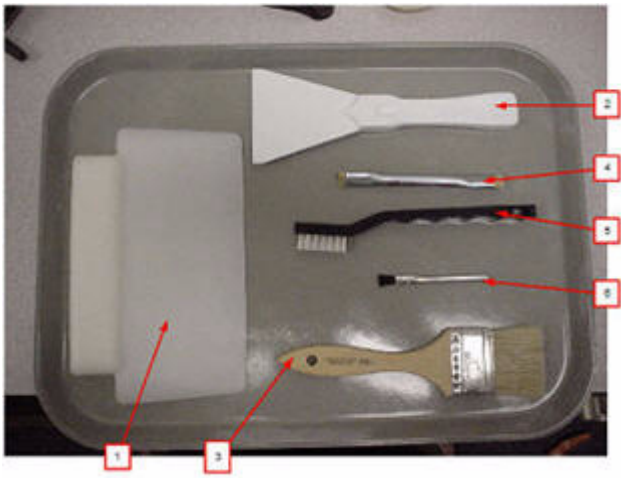
Drying times and part wall thicknesses are directly related. If the average wall thickness is ¼" (6.35 mm), then the part should be in the drying oven for 30 minutes. If average wall thickness is ½" (12.7 mm) inch, the part should be in the drying oven for 45 minutes. Use the chart below as a general guide.

Average Wall Thickness	Drying Time
1/8 inch (3.175 mm)	15 minutes
1/4 inch (6.35 mm)	30 minute
1/2 inch (12.7 mm)	45 minutes
1 inch or greater (25.4 mm)	90 minutes

For instructions on how to use the ZW4 or ZW3 Waxing Systems, please refer to the respective product's user manual.

6.4 Post-Processing Tools

There are six tools included in the Accessories kit that are used for gross depowdering and cleaning powder off of the part.



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Wide Blade Utility Scraper: This part is extremely useful in moving powder from the build chamber or deck surface back into the feed chamber, so it can be reused.

Polypropylene Scraper: When gross depowdering a bulky part, such as the engine block, the user may choose to carve powder away from the part instead of moving it away with either the vacuum or their hands.

Soft Horsehair Brush: This brush has very soft bristles and assists the user with the gross depowdering process. Gently brushing powder away from the part is a useful technique prior to the vacuuming step.

Stiff Detailing Brush: This brush has very stiff bristles, which are useful for scrubbing caked powder out of tight areas of a part. The brush is also very helpful when removing fringing from color part surfaces.

Stiff Handle Brush: This tool serves the same purpose as the Stiff Detailing Brush but is slightly larger and is more useful when working with a larger surface area.

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Soft Acid Brush: This part can also be used to remove caked powder from hard to reach areas and the soft bristles make this brush perfect for delicate features.



6.5 Infiltrate the Part

All parts can be infiltrated with a variety of Z Corp. materials to produce a range of material properties. As an early stage design tool, it may not be necessary to infiltrate printed parts at all. However, the true versatility of 3D Printing is derived from the wide spectrum of material properties that are achieved by applying an infiltrant to a printed part. For additional information on how Z Corp. customers are utilizing our full line of infiltration products, call us at Z Corporation, or visit our 3DP User Group website at www.3dpuser.com. The website has a variety of application and technical tips that describe the many ways that our infiltration products can benefit your 3D Printing operation.

6.6 Using Z-Max™ Epoxy

Z-Max epoxy is a high-strength epoxy infiltration system specifically formulated for Z Corporation. Z-Max epoxy is a low viscosity, high strength, infiltration system designed to work on all of Z Corporation's printers. Printed parts infiltrated with Z-Max epoxy are easily sanded and are surface machinable. For best results always oven dry parts made with High Performance Composite materials at temperatures no greater than 65°C (170°F). Oven drying will yield consistently stronger parts and deeper surface penetration when the epoxy is applied.

6.6.1 Safety Precautions

- Read the Material Safety Data Sheet for Z-Max epoxy prior to using.

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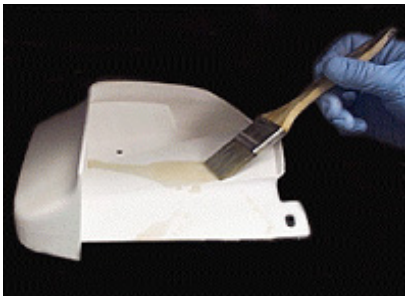
- Wear a lab coat, gloves (we recommend PVC Examination Gloves), face shield, or goggles. A face shield is required when spraying Z-Max. Always apply in a ventilated hood.
- Use specialized containers recommended for dispensing and application. Use a system for catching spills: catch pan, waxed paper, or plastic drop cloth.
- Label disposal materials.
- Wear a dust mask when sanding finished parts.

6.6.2 Mixing Instructions

It is recommended that you mix only what you need. Mix 100 parts Z-Max Resin to 37 parts Z-Max Hardener by weight or 100 parts Z-Max Resin to 41 parts Z-Max Hardener by volume. Mix the two parts thoroughly for two minutes before application. The material has a working time of 35 minutes in a 425 gram mass. Please be aware of the gel time while preparing quantities of material. The gel time decreases as the quantity of material increases.

6.6.3 General Application

- Material can be brushed or sprayed.
- Material will penetrate the surface between 0.079- 0.28 (2 - 7 mm).
- Do not over apply the material, as it will pool off the part during curing.
- Better surface penetration depth is achieved by applying several light coats of material.
- Allow all mixed materials to cure prior to disposal.



6.6.4 Spraying Instructions

Use a Gravity Feed High Volume/Low Pressure (HVLP) Sprayer. We recommend a DeVilbiss Sprayer with 14 - 18 mm tip. The DeVilbiss Sprayer is available from Z Corp. with disposable canister liners and will minimize the amount of cleanup.

1. Have the sprayer, parts and materials ready before mixing Z-Max.
2. Mix Z-Max and pour into the disposable liner in the sprayer canister.
3. **Always spray in a vented hood.** Spray Z-Max between 15 - 20 psi (1 - 1.4 bar).

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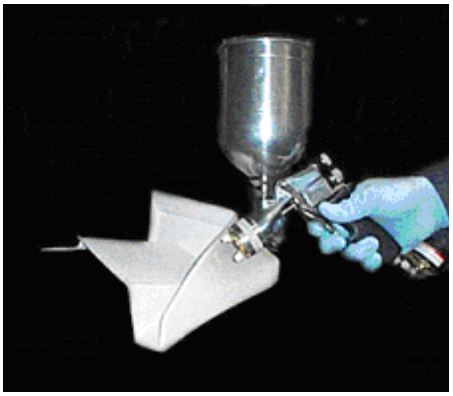
4. When finished, remove the disposable liner and clean the sprayer with a mild solvent, such as isopropyl alcohol or acetone.

5. Remove the tip and thoroughly clean by hand to avoid build up. (Cleanup takes approximately 15 minutes).



6.6.5 Curing Information

- Allow the part to cure for 1 hour at room temperature prior to placing in the oven for accelerated cure to avoid discoloration due to exothermic reaction.

- Z-Max will cure at an accelerated rate in a ventilated oven. **The oven must be vented.** At 160°F (71°C), a part will reach full strength in 2 hours. (Ventilation designs need to meet each customer's respective governmental health and safety requirements. A reference frequently used by U.S. firms to comply with OSHA regulations is the *American Conference of Governmental Industrial Hygienists Industrial Ventilation Manual*.)

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- Wear gloves when handling the parts when they are still at an elevated temperature. Parts will attain full strength and be safe to handle once they cool to room temperature.
- The part should be placed on a non-stick, (wax paper, Teflon®, etc.) material or it will adhere to the surface it is sitting on while curing.
- Z-Max will cure at room temperature after 24 hours.

6.6.6 Painting Parts

Parts can be painted to enhance surface finish and appearance. Z Corp recommends coating all surfaces with Dupont Fill 'N Sand Acrylic Primer-Surfacer #131S, a lacquer-based primer ideal for improving the adhesion of most paints. This material can be purchased at most autobody supply stores.

6.7 Using Z-Bond™ Cyanoacrylate

Z-Bond cyanoacrylate is an extremely fast setting, low viscosity, general-purpose infiltrant. This product is designed to rapidly strengthen parts. Z-Bond is a one part, user-friendly, no-odor, non-blooming product that eliminates the need for special ventilation. It is easily sanded and enhances the vibrancy of color parts. Z-Bond 11 (which can be used with the specialty materials) is available in 0.5 lb bottles and Z-Bond 101 (which can be used with our High Performance Composite materials) is available in 3.5 ounce bottles and 24 ounce spray bottles. Read the Z-Bond User Guide to learn more.

6.7.1 Safety Precautions

- Do not use or handle this product until the Material Safety Data Sheet has been read and understood.
- Wear a lab coat, gloves (we recommend Nitrile Examination Gloves), face shield, or goggles. Always apply in a ventilated hood.
- Use specialized containers recommended for dispensing and application. Use a system for catching spills: Catch pan, waxed paper, or plastic drop cloth.
- Label disposal materials.
- Wear a dust mask when sanding finished parts.

6.7.2 General Application

- Part should be fully dried before applying Z-Bond. Resin reacts with water and produces heat. If the part is not dried, it will heat up the part and produce a gas that may be irritating to the mucous membranes.
- Z-Bond can be dipped or drizzled.
- Z-Bond will penetrate between 0.08 - 0.12 inches (2–3 mm).
- Do not over apply Z-Bond, as it will pool off the part during the cure cycle.

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6.7.3 Curing Information

- The part should be placed on a non-stick material (wax paper, Teflon®, etc.) or it will adhere to the surface it is sitting on while curing.
- Wear gloves when handling the parts to avoid contact with uncured Z-Bond.
- Parts will attain full strength in two to fifteen minutes.

6.7.4 Tips

- Always infiltrate the most delicate features of the part first. Z-Bond gives almost immediate strength to the area of the part that has been infiltrated. When you handle the areas of the part that have been infiltrated, they will be less likely to break.
- Try to avoid infiltrating the part by applying Z-Bond from spot to spot. Pick a good starting place hold that area upward relative to the rest of the part. With your free hand, place the tip of the Z-Bond bottle against the part and allow the cyanoacrylate (CA) to flow from the bottle. It is important that the CA flows at a uniform rate to see how quickly it wicks into the part. By seeing how quickly it wicks into the part, you will be able to judge where and how quickly to move the tip of the bottle when applying, being sure not to apply the CA to the same place more than once.

6.8 Using Paraplast® X-TRA Wax

Paraplast X-TRA is a low viscosity, general purpose, infiltration wax formulated to melt at very low temperatures (122°F or 50°C) and to strengthen both starch and plaster powder parts. Wax cures rapidly and enhances the vibrancy of color parts. Paraplast is available in a case of eight 2.2 lb. (1 kilogram) chips.

6.8.1 Safety Precautions

- Liquid wax is hot and can cause burns. Follow all recommended safety precautions for your Z Corp. Wax Unit.
- Wear appropriate gloves when handling hot parts.

6.8.2 General Application

- Parts should be dried in an oven at 100°F (38°C) prior to infiltrating with wax for deeper surface penetration.
- If the part is bulky, you may preheat it at 150°F (66°C) for up to 30 minutes.
- Soak part in liquid wax tank (follow all tank manufacturer's instructions).
- Remove infiltrated part from waxer.

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- Place part in an oven at 150°F (66°C) until the wax has penetrated or melted off your part (usually around 15 minutes).
- Be aware that these are simple guidelines. Your specific applications may require additional steps.

6.8.3 Curing Information

Allow the part to cool after removal from the oven until it is no longer warm to the touch.

Click the following links to learn about:

Casting Methods
Electroplating
Finite Element Analysis
Functional Testing of Molded Plastic Parts
Creating High Finsh Color Parts
Painting
RTV Molding
Thermoforming
Tough Durable Parts
Water Transfer
Water Resistant High-Strength Parts

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7 Material Systems

This chapter provides material storage information, and instructions on how to use the ZCast® and Z-Snap™ materials. It describes temporary changes to the printer and the ZPrint software settings required to build parts successfully with ZCast or Z-Snap Epoxy.

IMPORTANT - NEW MATERIALS ARE AVAILABLE!

NEW High Performance Composite materials are now available for the ZPrinter 310 Plus. These include the zp130, zp131, and zp140 powders and their respective binders. Check the 3DP User Website for new powder/binder releases. The User Website also has free User Guides for zp131 and zp140 available for dowload, as well as other application and technical tips available for using all Z Corporation products.

For information and guidance or additional questions, please contact the Z Corporation Service Department at (781) 852-5050, toll-free at (877) 88-ZCORP or via email at service@zcorp.com.

7.1 Material Storage Precautions

Carefully read the Material Safety Data Sheets (MSDS) before using any Z Corporation materials.

Material	Storage	Usage
Powder	Store powder on pallets in a cool, dry, ventilated area away from sources of heat, moisture, and incompatible materials. Keep containers tightly closed.	Use of powder in environments with more than 30% relative humidity will affect powder performance.
Binder and Wash Fluid	Store in cool, dry place, away from sun. Keep tightly capped.	Binder is **NOT** recyclable.
Printhead	Store in cool, dry place, unopened, away from sun.	
Infiltrants	Store in cool, dry place, away from sun. Keep tightly capped.	For more information, visit the 3DP User website at: www.3dpuser.com.

7.2 Using ZCast Powder

7.2.1 General Information

ZCast powder is a plaster-ceramic composition that allows you to print sand casting-like molds and/or cores with your Z Corp. printer. Once printed, depowdered and baked, you have the ability to immediately pour molten metal, yielding a cast metal part. Arguably, the ZCast process is the fastest and most direct way to obtain a metal part from digital data. ZCast has been optimized for non-ferrous materials ranging from zinc to brass, including aluminum and magnesium.

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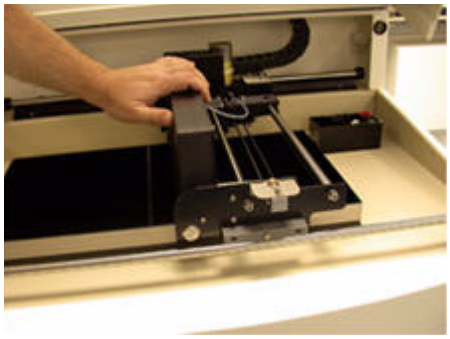
WARNING: **NEVER POUR MAGNESIUM** without first contacting a Z Corporation technical representative. **NEVER ATTEMPT TO POUR FERROUS METALS IN ZCAST MOLDS**.

On the User Website, you will find a detailed document entitled *ZCast Direct Metal Casting - Design Guide* for additional information. Please review the guide along with safety issues before using this product. Upon review, contact the Z Corporation Applications Team for information about a **free online training session** by sending an email entitled *ZCast Online Training Seminar* to applications@zcorp.com. Be sure to include preferred meeting times. The session is approximately one hour.

7.3 Using ZCast With Your ZPrinter 310 Plus

7.3.1 Temporarily Remove the Scraper Blade When Using ZCast

When using ZCast powder on the printer, the scraper blade must be removed. Failure to remove the scraper blade while using ZCast will result in excessive wear on the scraper blade and will require replacement. The entire activity should take less than ten minutes and requires two hex wrenches. Remember to reinstall the scraper blade when printing with ZCast is complete. Follow the instructions below to remove the scraper blade.



1. Turn off the power and unplug the printer.
2. Slide the gantry to the middle of the print area.

3. Remove the cable enclosure cover by unscrewing the two screws on the top of the enclosure.

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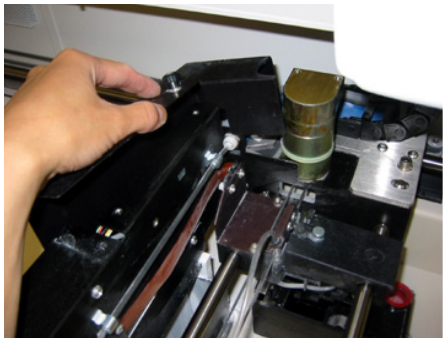

4. Remove the cable enclosure.

5. Disconnect the ribbon cable.

6. Disconnect the head power card.

7. Twist and disconnect fluid supply tubing.

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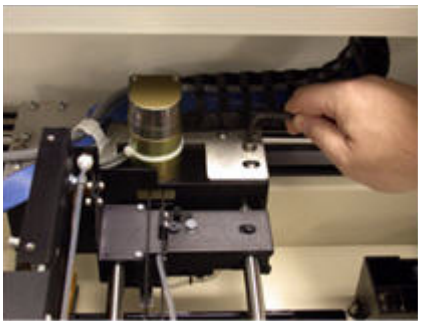
8. Remove the snowplow from the front of the spreader roller. Slide the snowplow away from the edge of the build box until it disengages from the retaining tab. Press on the top edge of the snow-plow until it pops off the spreader roller.

9. Repeat *Step 8* for the snowplow located at the back of the spreader roller.



10. Using the 3/16 hex wrench, remove the mounting screw located on the right side of the motor assembly.

11. Pivot the front of the printer module up while lifting from the rear and remove. Place the printer module on a flat area.

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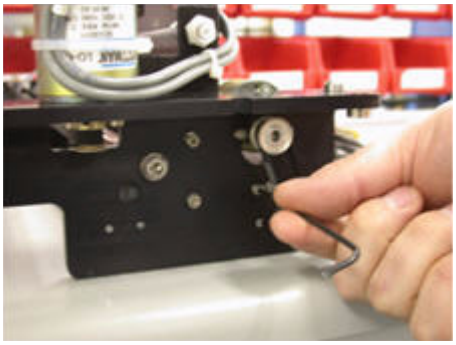
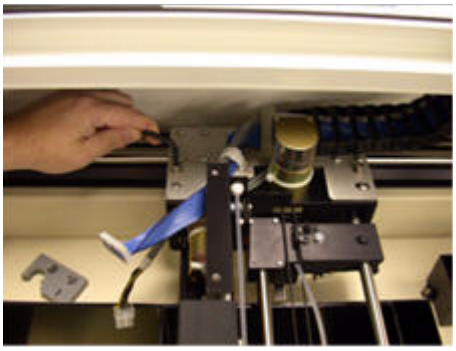
12. Using the 3/32 hex wrench, remove the three hex screws holding the scraper blade retainer and scraper blade onto the printer module.

    - One screw is located in the front



    - Two are in the back (underneath the roller bearing).

13. Replace the printer module onto the printer.



14. Tighten the mounting screws on both sides of the motor assembly.

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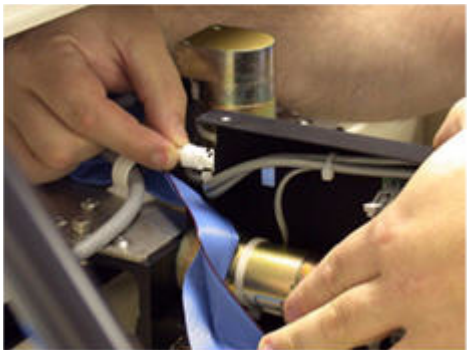
15. Replace the snowplows to the front and back of the roller.



16. Reconnect the fluid line, ribbon cable, and head card power cable.

17. Replace the cable enclosure and tighten up the both screws on top of the enclosure.

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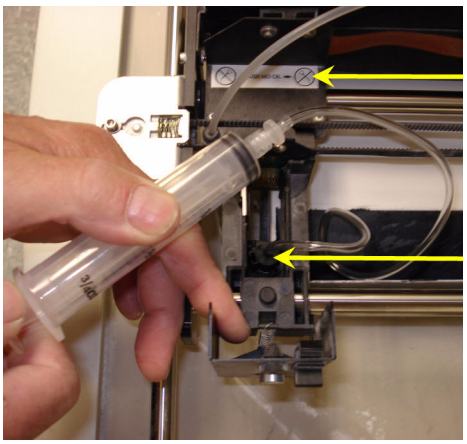
18. Using the syringe provided in the Toolkit, place the tube fitting onto the septum, and slowly draw binder through the fluid system until no bubbles are present in the binder tube.



USE NO OIL Label.

Detail of syringe tube fitting over septum.

7.3.2 Load ZCast Powder

1. Remove all non-ZCast powder from the feed piston, build piston, and overflow bucket.

2. Fill the piston completely with ZCast powder being sure to keep the casting powder “fluffy”. Use the tamper to level off the top of the feed piston but **do not pack** the powder.

7.3.3 Spread Over The Build Bed and Print

DO NOT pack the casting powder. Packing the casting powder into the feed piston increases the density of the powder at the feed piston plate and increases the gripping force that ZCast powder has on the sidewalls of the feed piston.

7.3.4 Set Up ZCast Builds

Take into consideration part orientation verses strength tradeoffs and use Fixtures to control the reduced effects of ‘squash’. For more information, please refer to the ZCast Direct Metal Casting – Design Guide.

7.3.5 Post-Processing

Unlike other Z Corp. parts, ZCast parts require no infiltration. However, ZCast molds must be thoroughly baked in a vented oven at sufficient temperatures to burn out organic materials. Additionally, the user may apply a core wash solution to improve the surface finish of the casting. See the ZCast Direct Metal Casting – Design Guide for bake temperatures, times and additional information.

WARNING: *If using a build plate, remove the part from the build plate before placing in the oven. Failure to do so will damage the build plate.*

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7.3.6 Recycling

Similar to plaster and starch, ZCast can be recycled. Recycle only powder that is unprinted and free of moisture as bonded or printed material will degrade printing performance.

7.3.7 Storage

ZCast powder should be stored in a cool, dry environment. See container labels for additional information.

7.3.8 Disposal

ZCast powder is a non-toxic substance. Please consult the Material Safety Data Sheet for product details. Dispose of ZCast powder according to local and state regulations.

7.3.9 Questions and Support

If you have any questions regarding this product, contact the Z Corporation Applications Team for technical support at (781) 852-5050 or via email at applications@zcorp.com.

7.4 Using Z-Snap™ Epoxy

Z-Snap epoxy is a flexible, yet tough epoxy infiltration system specifically formulated for Z Corporation for use with our zp®250 powder. Parts made from zp250 powder and infiltrated with Z-Snap epoxy exhibit the appearance and snap-fit characteristics of plastic. Parts are easily sanded and finished. For detailed instructions on how to use Z-Snap epoxy with zp250 parts see Material Systems.

7.4.1 General Application

- All part surfaces should be clean, dry and free of contaminants prior to applying Z-Snap epoxy.
- The part should be oven dried for 2 - 4 hours at 150°F - 200°F (65°C - 85°C), depending on part volume and wall thickness, to drive out any excess moisture that remains in the part after depowdering.
- Z-Snap epoxy can be sprayed, brushed or drizzled onto parts. Multiple thin coats applied liberally during the product's working time will produce maximum infiltration depth.

7.4.2 Mixing Instructions

- In a clean, plastic, non-porous, container mix Z-Snap Resin to Hardener in a 2:1 ratio by volume, 100:47 ratio by weight. Mix the two parts thoroughly for 2 minutes, stirring in a figure eight pattern. Be sure to scrape the sides and bottom of the container.
- The product has a working time of 85 minutes in a 450 gram mass at room temperature. Mix only what you need. Please be aware that the mixed solution will increase to a maximum temperature of 122°F (50°C) after 40 minutes.

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PLEASE NOTE: *The gel time decreases when preparing quantities of Z-Snap greater than 450 grams*.

7.4.3 Curing Information

- Infiltrated parts should be pre-cured at ambient temperature for 30 minutes.
- After the pre-cure time, cure the infiltrated part for 30 more minutes at (120°F) 50°C and then for 2 hours at (165°F) 74°C on a non-stick surface (wax paper, Teflon®, polyethylene, etc.), or it will adhere to the surface it is sitting on while curing.

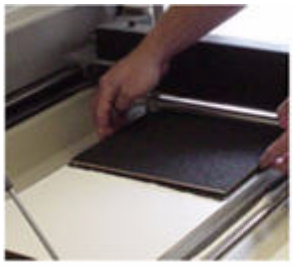
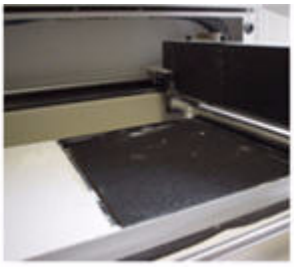
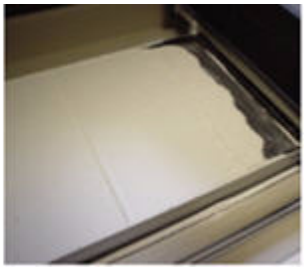
PLEASE NOTE: Z-Snap epoxy should not be cured at temperatures greater than (165-°F) 74°C and no longer than 3 hours because flexibility may decrease, making the parts more brittle.

7.4.4 Clean Up

Any remaining mixed infiltrant beyond the working time should be kept in a well-ventilated area to avoid fumes. Cleaning the spraying apparatus is simple with solvents such as acetone or denatured alcohol that are found at your local hardware store.

7.4.5 Machine Setup

- Remove all powder currently in the printer (feed piston, build piston, overflow bin).
- Remove all powder in the depowdering unit and install a new vacuum bag in the vacuum unit.
- zb56 binder is the required binder system for zp250 powder. Check to see if the binder solution currently being used is zb56. If not, replace the current binder with zb56 binder then flush and purge the fluids system.
- Fill the feed piston with zp250 powder.
- ZPrinter 310 Plus users may want to use the removable build plate to aid in the removal of the printed parts. Place the build plate onto the build piston and lower the build piston until the top surface of the build plate is slightly below the surface of the deck of the printer. This will ensure that the spread roller does not hit the build plate.

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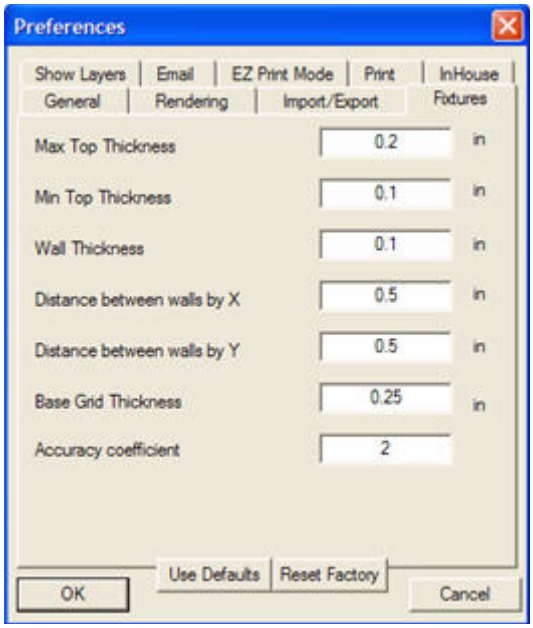
7.4.6 Software Setup

Due to the nature of the open powder matrix of zp250 powder, and its capacity to absorb Z-Snap epoxy infiltrant, the use of a Fixture is recommended for parts with a wall thickness less than 0.25" (6.35mm). For a complete explanation of how to use the **Make Fixture** feature, refer to the ZPrint Software Manual. Fixtures for parts made with zp250 powder should be built with the following parameters:

Clearance	0.125" – 0.25" (3.175 – 6.35 mm)
Top Surface Thickness	0.1" – 0.25" (2.54 – 6.35 mm)
Wall Thickness	0.1" – 0.25" (2.54 – 6.35 mm)
Distance Between Wall by X	0.5" – 1.0" (12.7 – 25.4 mm)
Distance Between Wall by Y	0.5" – 1.0" (12.7 – 25.4 mm)
Accuracy Coefficient	High enough to avoid collisions between the part and the Fixture (e.g. 8)

If you want to change the default Fixture settings in the **Make Fixture** dialog, select **Settings > General Preferences > Fixture** tab. Enter new values, and click **OK**. The new defaults will appear in the **Make Fixture** dialog.



To generate a Fixture, first raise the part in ZPrint on the Z-Axis to at least 0.5" (12.7 mm) from the bottom of the build plate. If the part is not raised enough, it may not be fully supported by the Fixture after depowdering.

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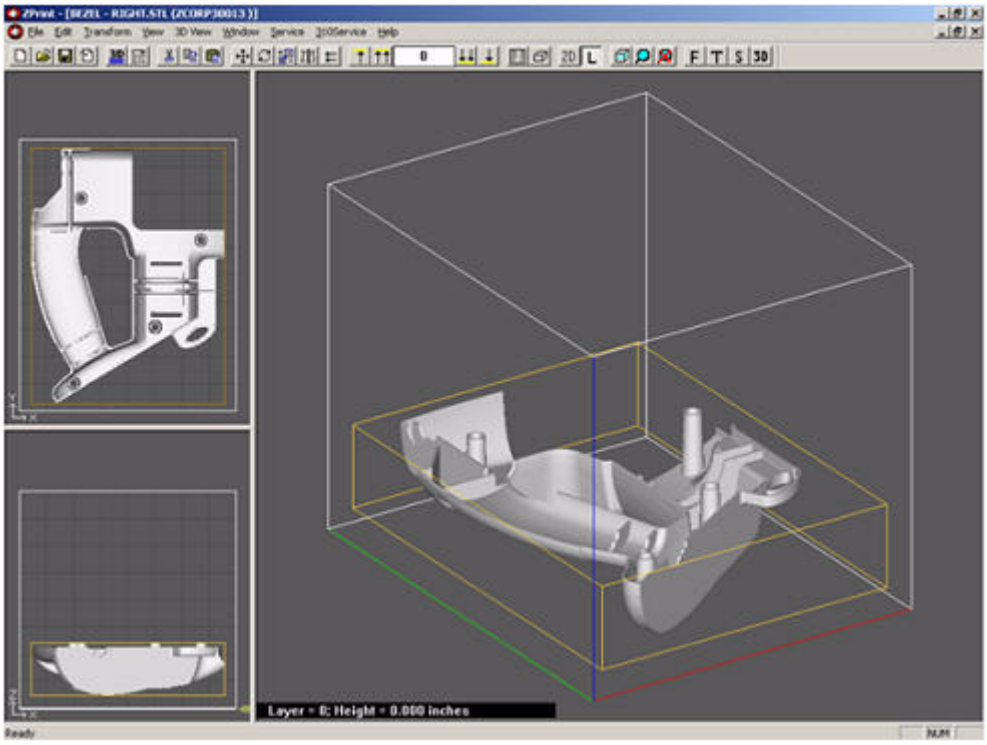
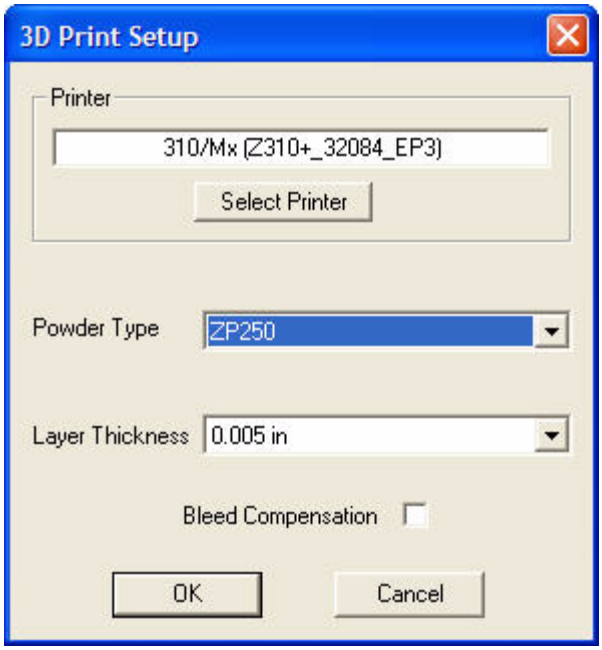


Select **File > 3D Print Setup** and choose **zp250** as the powder type. Click **OK**.



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7.4.7 Part Removal and Post Processing

1. When printing parts that can be manually handled, allow the part and Fixture to dry in the build bed for 2 hours before removing. Parts with large unsupported overhangs that are difficult to manually handle without breaking should be left on the Fixture. Remove as much powder as possible from the top and side surfaces while the part is on the Fixture. Lightly infiltrate the exposed top surfaces of the part with Z-Snap. **DO NOT** apply too much infiltrant. You want to prevent the infiltrant from wicking through to the bottom side of the part. Cure the part for one hour at 165°F (74°C). **Do not place on the build plate.**

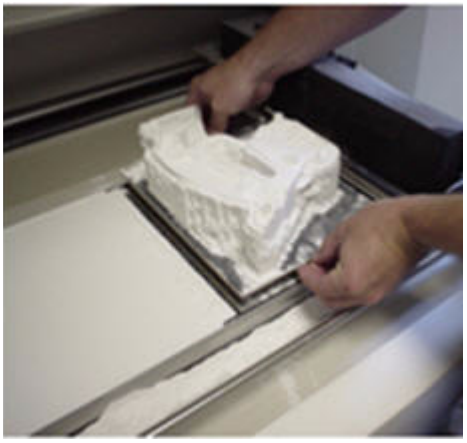
   For more information, please contact one of our applications engineers at applications@zcorp.com.

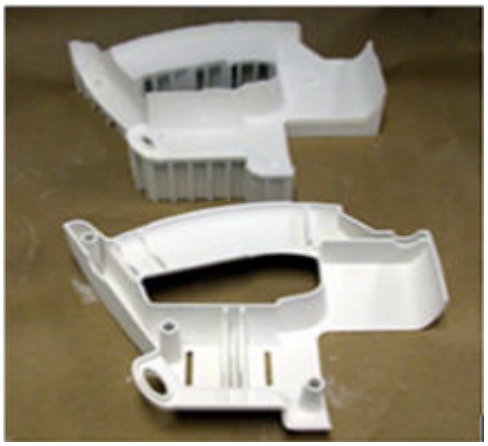
   Parts built deeper than 2 inches (50.8 mm) into the build box may require longer drying time before handling. If the removable build plate was used, the part can be gross depowdered and removed prior to two hours and placed in an oven at 150°F (66°C) for at least 2 hours or longer depending on the mass/volume of the part.

2. If a Fixture was used during the printing process it should also be used during the infiltration and curing steps as well.

3. Depowder the part and the Fixture.

4. Remove the part and Fixture from the build plate and place it on a clean surface. Now separate the part from the Fixture.





5. Apply a silicone mold release (such as IMS Paintable Neutral Oil Mold Release – *www.imscompany.com* or Hapco GREASE-IT FDG - *www.hapcoweb.com*) liberally onto the top surface of the Fixture where the part will make contact with the Fixture. Doing this prevents the infiltrated part from adhering to the Fixture during infiltration.

6. Gently apply Z-Snap epoxy to the bottom surface of the part and carefully place the part back onto the Fixture.

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7. Apply Z-Snap epoxy to the rest of the part. Do not apply excess epoxy as pooling will occur. Several thin coats are better than one thick coat. Use a paper towel to remove excess epoxy that may have pooled on the surface of the part.



8. Z-Snap parts should sit for 30 minutes at room temperature to allow excess epoxy to drain or wick into the Fixture.

9. For Z-Snap epoxy, place the part with its Fixture into an oven for 30 minutes at 120°F (49°C). This step reduces the occurrence of bubbling or pooling.

10. Parts infiltrated with Z-Snap epoxy should then be cured for an additional two hours in the oven at 165°F (74°C). **Do not place on the build plate.**

11. Let the part sit for 30 minutes at room temperature to cool before handling.

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8 Maintenance and the Service Menu

This chapter covers routine maintenance steps and procedures that are recommended to keep the printer operating in optimal condition. It includes procedures on changing the print head, when to oil/not oil the Fast Axis, filling the wash fluid reservoir, and greasing the Slow Axis and Piston Screws. It also explains the process of changing binder fluid and bleeding air from the binder line.

The ZPrint **Service** menu is the primary interface from the computer desktop when performing routine maintenance functions on the printer. On the ZPrint **Settings > General Preferences > General** tab, be sure to enable the **Activate Maintenance Reminder** option to have ZPrint prompt you to perform occasional maintenance on certain printer components.

For information and guidance on additional maintenance steps, please contact the Z Corporation Service Department at (781) 852-5050, toll-free at (877) 88-ZCORP or via email at service@zcorp.com.

8.1 Unpark

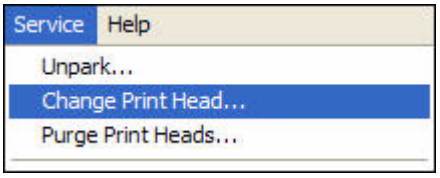
Unpark moves the printer Carriage from its parked position in the Service Station. When the Upark command is performed, the user can manually move the gantry and carriage in order to perform routine cleaning.

8.2 Change Print Head

Signs of a worn print head are weak parts, rough surface finish, or visibly uneven printing in the build. ZPrint will display a warning message when the print head will exceed the expected print head life during the build. A print head should be able to print at least 1.2 liters of binder (about 30 Billion pixels, equivalent to about 2500 cubic centimeters of parts). Print head life can depend upon the geometry of the parts printed, so some print heads may last longer.

Technical Tip

If you fill the binder tank when you change the print head, you will not have to fill it again until the next time you change the print head.



1. Select **Service > Change Print Head** in ZPrint. Press **Start** to begin the process.

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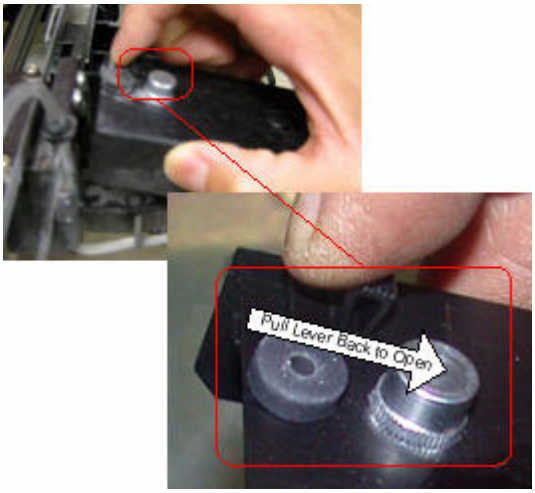
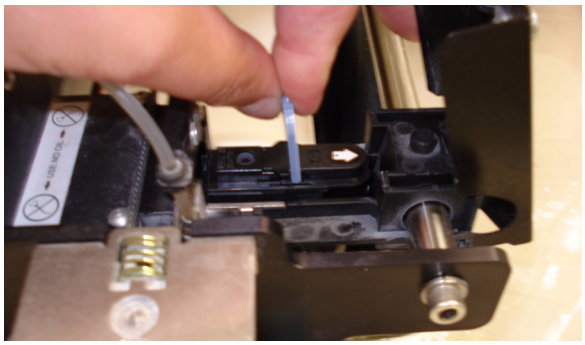
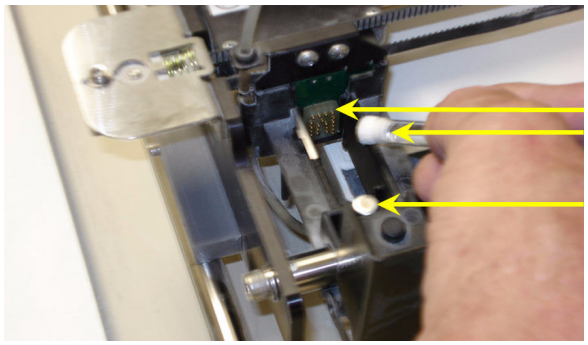


2. Wait for Carriage to unpark, then open the Carriage cover by sliding the latch back to disengage.



3. Remove the print head by lifting the handle and pulling directly up.



4. Take an alcohol crush tube swab and thoroughly wipe the pogo pins clean.

Pogo Pins
Alcohol Crush Tube Swab

Septum

5. Place the new print head in the Carriage and push down to seat the print head. The print head should seat firmly in the Carriage.

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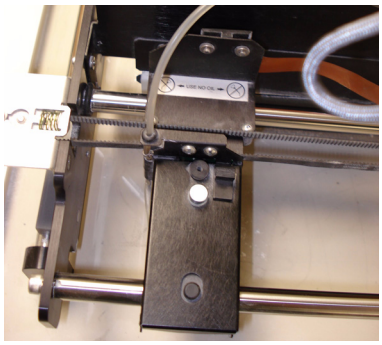

6. Close the Carriage cover and press on it until it clicks to ensure the cover is properly secured.
7. Close the printer top cover.
8. Press **Online** on the printer control panel or click **Done** in ZPrint.
9. Follow the steps in **8.3** to purge the new print head of its black ink.

8.3 Purge Print Heads

New print heads must be purged to remove the black ink.

1. Fill up the Binder bottle.
2. Make sure the Waste bottle is empty.
3. Choose **Service > Purge Print Head**. When the purge cycle is completed, the printer stops beeping.
4. Press the **Online** button on the printer.

Tip

You can continue purging the print head even if you need to work in another ZPrint dialog box. Click the **X** located on the upper right-hand corner of the dialog box to close it. *DO NOT* click the **Done** or **Cancel** button.

8.4 Check Powder Level

Select **Check Powder Level** to check if the printer has enough powder in the feed piston to complete the current build.

8.5 Drop Feed Piston

Select **Drop Feed Piston** to drop the feed piston to its lowest position. Use the **Drop Feed Piston** command when you need to add additional powder to the printer or when you need to gross depowder a part.

8.6 Fill Bed

Select **Fill Bed** to fill the build bed with powder prior to printing. This is the equivalent of selecting **Fill Bed** on the printer control panel.

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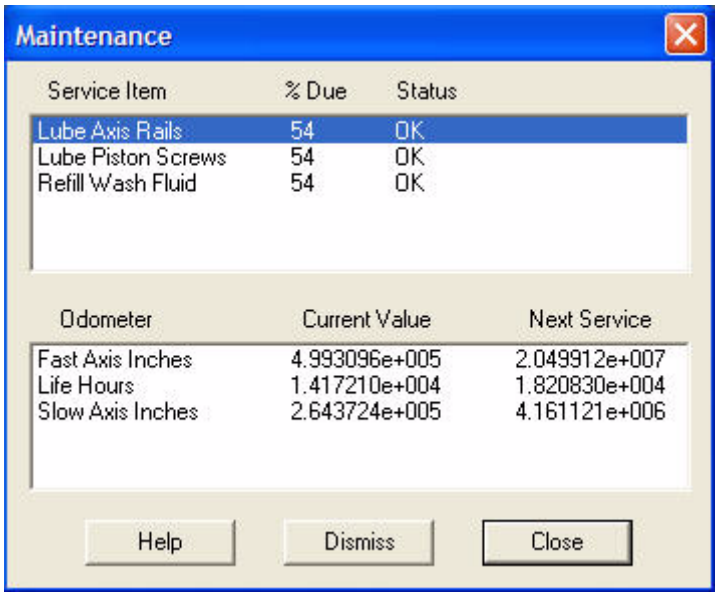
8.7 Preheat Printer

Select **Preheat Printer** to heat the Printer to the proper temperature before printing. Preheating the printer will add more time to your overall print time.

8.8 Maintenance

Select **Maintenance** to have ZPrint remind you when it is time to lubricate the Fast and Slow Axis rails, to lubricate the piston screws, or to refill the wash fluid. See *Section 8.8.2 - When to Oil/Not Oil the Fast Axis* for important information when you are prompted in ZPrint to Lube Axis Rails.

Sections 8.8.1 - 8.8.9 describes each maintenance procedure for the printer. Follow the instructions in this section to properly perform printer maintenance.



8.8.1 Clean The Pogo Pins

In general, clean the pogo pins whenever you replace or remove the print head. Doing this will reduce errors in communication between the print head and the printer (such as *Head ROM* errors).

To clean the pogo pins, follow these instructions:

1. Use an alcohol swab, which can be ordered from Z Corporation.
2. Remove the alcohol swab from the packaging.

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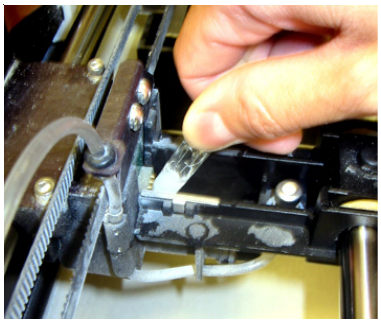
3. Crush the plastic casing to release alcohol into the swab.
4. Open the Carriage cover.
5. Remove the print head.



6. Wipe the pogo pins with the swab.
7. Reinsert the print head and close the Carriage cover.

8.8.2 When To Oil/Not Oil 310 Fast Axis Assemblies

ZPrinter 310's manufactured **after September 2006** and the Fast Axis Assemblies rebuilt/manufactured after this same date, **DO NOT** require oiling of the Fast Axis rails or bearings. This is the result of changing the bearings on the Fast Axis to those that *do not* require oil.

The carriage of these new units and assemblies carries a prominent **USE NO OIL** label on the Carriage assembly. Oiling units with this label may cause them to malfunction. If oil is applied by accident, you should wipe it off completely with a paper towel before operating the printer.

If your carriage has the **USE NO OIL** label, ZPrint will still prompt you to lubricate your printer axis rails. Grease the Slow Axis in the usual way (see *Section 8.8.5*), but **DO NOT** oil the Fast Axis. To close the dialog, click **Dismiss**. When the prompt *"Did you lube Axis Rails?"* appears, click **Yes** to close the prompt to reset the maintenance counters.

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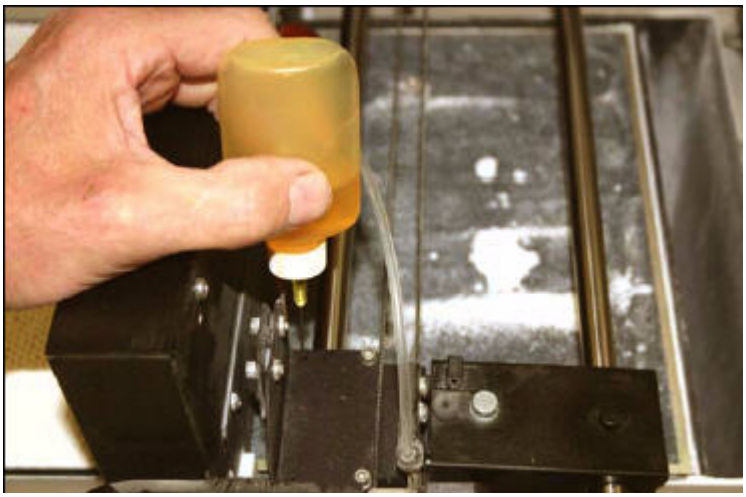
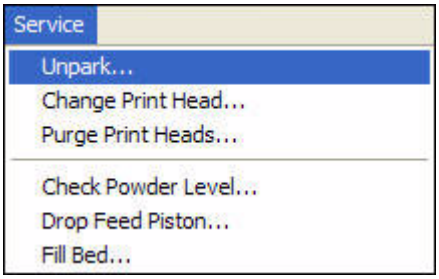
IMPORTANT!

If your ZPrinter 310 was manufactured **before September 2006**, ZPrint will prompt you when it is time to *oil* the Fast Axis, provided the maintenance reminder feature is enabled on the ZPrint **Settings > General Preferences > General** tab. *Do not oil the Fast Axis unless prompted to in ZPrint.*

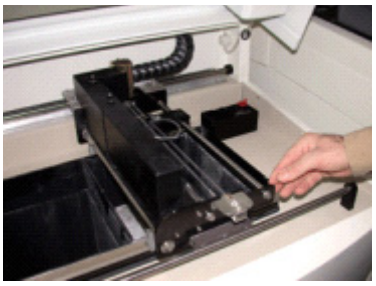
Fast Axis lubrication is required only for ZPrinter 310 machines with the old Fast Axis assemblies like the one shown below, (no label is covering the bearings). If your machine has an older Fast Axis assembly, follow the instructions in *Section 8.8.3* when ZPrint prompts you to lubricate the Fast Axis.



8.8.3 Fast Axis Rails and Bearings Lubrication



1. Select **Service > Unpark**.
2. Take the printer offline by pressing the **Online** button on the 310 control panel and lift the printer top cover.



3. Manually move the gantry to the middle of the printer.

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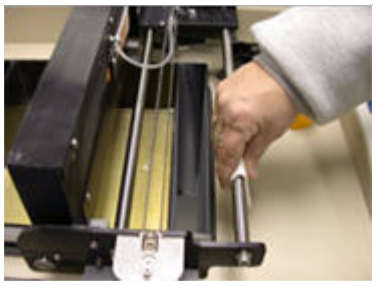
4. Apply a very small amount of oil on a paper towel.

5. Locate any residue buildup on the Fast Axis rails.



6. Wipe both of the fast axis rails with the paper towel to remove the residue. Make sure to move the carriage and wipe the back of the rail.

7. To oil the bearings, place the tip of the oil bottle into a fitting. Apply oil for **1 (one) second** to the bearing. Repeat for the second bearing. **DO NOT OVER OIL!** If any excess oil flows out of either fitting, wipe up the excess with a dry paper towel.

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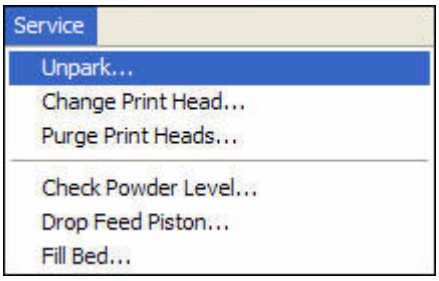
8.8.4 Refill the Wash Fluid Reservoir

Refill the wash fluid reservoir with zc10 wash fluid when alerted by the software, or refill if the wick on the service station has dried out. One bottle of wash fluid will fill up the entire reservoir. ZPrint will prompt you when it is time to refill the wash fluid when the maintenance reminder feature is enabled on the ZPrint **Settings > General Preferences > General** tab. *Do not refill the reservoir unless prompted to in ZPrint.*



1. Select **Service > Unpark**.
2. Take the printer **Offline**.

3. Lift the printer top cover and manually move the gantry to expose the Service Station.

4. Remove the red wash fluid reservoir cap.

5. Refill the reservoir using the wash fluid supplied in the Toolbox. One bottle will fill up the reservoir. Remember to reorder zc10 Wash Fluid.
6. Close the printer top cover.
7. Place the printer Online.

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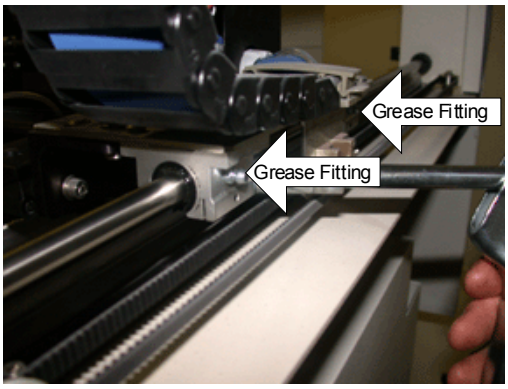
8. Click **OK** in the ZPrint **Unpark** dialog to repark the gantry.

8.8.5 Slow Axis Lubrication

The Slow Axis will need to be greased occasionally to prevent slow axis errors. When the Maintenance Reminder feature is enabled on the ZPrint **Settings > General Preferences > General** tab, ZPrint will prompt you when it is time to grease the Slow Axis. *Do not grease the Slow Axis unless prompted to in ZPrint.*

1. If this is the first time greasing the Slow Axis, assemble the grease gun included with the printer toolbox. Follow the instructions on the packaging.

2. Release the power cord from the cord clip at the bottom of the printer back cover. Remove the printer back cover by removing the seven screws.



3. Locate the two grease fittings on the Slow Axis.

4. Snap the grease coupler onto the fittings.

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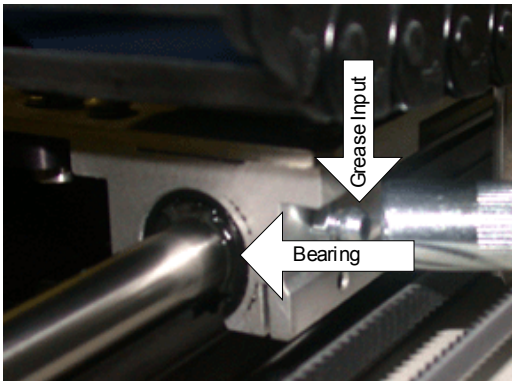
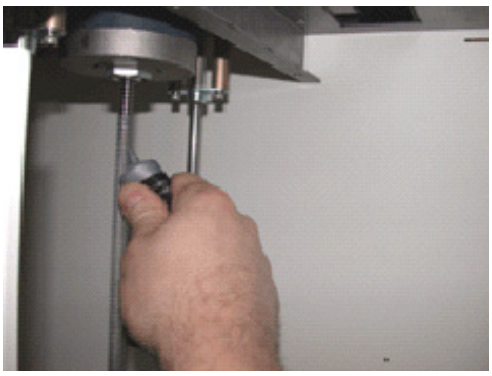


5. Add grease until it begins to come out the side of the bearing (typically two pulls on the trigger). Wipe any excess grease off the bearing with a dry paper towel.
6. Clean any powder that has been deposited on the back of the top deck.
7. Replace the printer back cover.
8. Store grease gun for future use.

8.8.6 Piston Screws Lubrication

ZPrint will prompt you when the build and feed pistons need to be greased provided the Maintenance Reminder feature is enabled on the ZPrint **Settings > General Preferences > General** tab. *Do not grease the pistons unless prompted to in ZPrint.*

1. Lower both the feed and build pistons all the way down.
2. Turn Off and unplug the printer.
3. Remove the overflow bucket and locate the two piston screws.



4. Take the grease tube supplied in the Toolkit and apply grease to the entire length of both feed and build piston screws.

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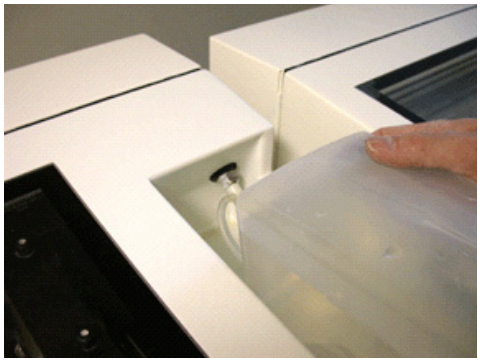
5. Take a paper towel and lightly wipe the feed and build piston screws in order to distribute grease.

6. Replace the overflow bucket.

7. Plug in the printer and then turn the printer On. Raise and lower the feed and build pistons a couple of times to work in the grease and then return both pistons to their proper positions.

8.8.7 Change the Binder Tank

At times, you may choose to change the binder in your printer. You can use a second binder tank to facilitate the changeover procedure.



1. Carefully lift and move the binder bottle towards the front of the printer.

2. Press the release latch and pull the tubing out.

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3. Insert the tubing into the latch from the new binder bottle and secure the binder bottle in place on top cover.

4. Perform the Bleed Air procedure to remove old binder and air from the binder line. See *Section 8.8.9* for instructions.

5. Purge or change the print head to flush the remaining old binder from the printer.

8.8.8 Change the Binder Color

Add the following mixtures of color binder to the printer feed bottle (3/4 full with clear binder) to achieve your desired color. These ratios are based on the 1.5 liters of clear binder in the feed bottle prior to adding any color. Please review the following chart for quantities.

	Quantity of Color Binder Added to Feed Bottle with Clear Binder			
Desired Color	Cyan	Magenta	Yellow	Black
Red	-	18 Squirts	9 Squirts	-
Magenta	-	18 Squirts	-	-
Orange	-	3 Squirts	12 Squirts	-
Yellow	-	-	18 Squirts	-
Green	3 Squirts	-	12 Squirts	-
Blue	18 Squirts	3 Squirts	-	-
Violet	9 Squirts	18 Squirts	-	-
Gray	-	-	-	6-12 Squirts

Hold the color binder bottle, with pump attached, up to the opening of the printer feed bottle and add the desired amount of color binder. Each full squirt is approximately one ounce of binder.

Darker or lighter shades of colors can be achieved by adding more or less of the corresponding desired color ratio (pink can be achieved by cutting the quantity of total color binder added by two). The final color will be more vibrant after infiltration.

IMPORTANT: Higher concentrations of color binder than those stated above will reduce print head life (less than 30 billion pixels). The reduction of print head life will lead to *head over temp* errors and color striping on printed parts.

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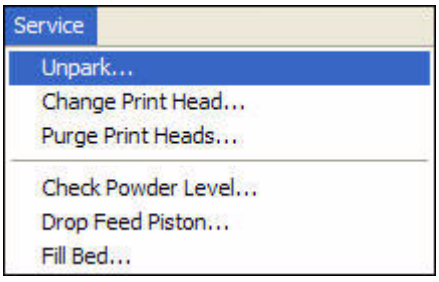
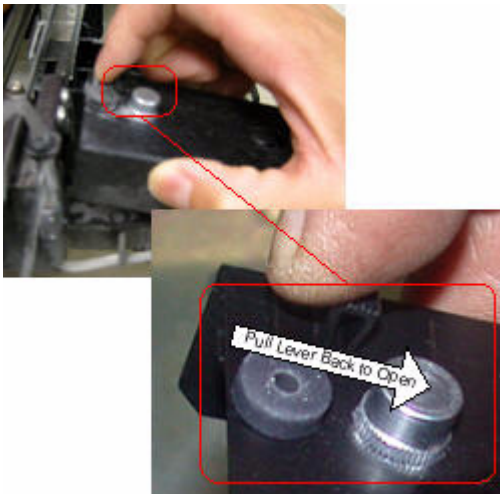
8.8.9 Bleed Air from the Binder Line

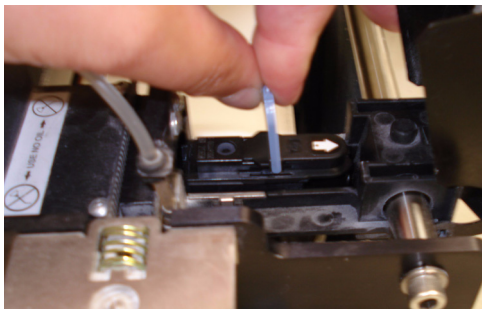
If air gets into the binder line due to inadequate supply of binder, or by removing the binder bottle, then the air must be bled out to prevent damage to the print head.



1. Select **Service > Unpark**.
2. Lift the printer top cover.



3. Open the Carriage cover to expose the print head.



4. Remove the print head.

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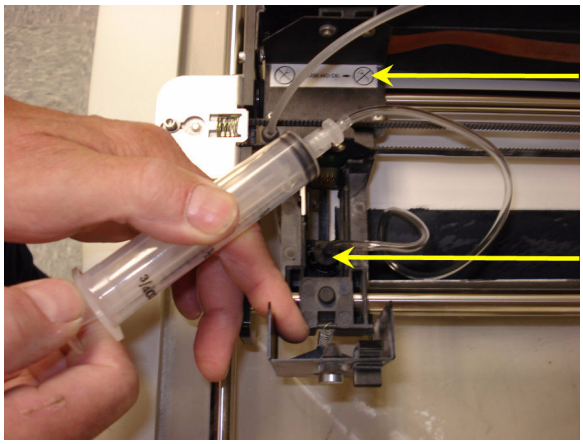

5. Insert the syringe tube fitting over the septum and remove the air and approximately 10 cc's of binder.

USE NO OIL Label.

Detail of syringe tube fitting over septum.

6. When finished, re-insert the print head, close the Carriage cover, close the printer top cover, and click **OK** on the **Unpark** dialog to repark the gantry.

8.9 Service Print Head

(Shortcut Key: **F3**) Select to service the print head if it is not printing well.

8.10 Stripe Test

Select to print a stripe test to check the functionality of the print heads.

8.11 Toggle Roller On/Off

(Shortcut Key: **F4**) Select to independently access the roller for easy cleaning.

8.12 Check Status

(Shortcut Key: **F1**) Select to check the status of how much powder is in the Feed Piston, of how much room is remaining in the Build Box, and to see which version of the ZPrint Firmware you are running.

8.13 Print Head Report

Select to view a report of the number of pixels printed, temperature levels, and flow rates for the current print heads.

8.14 View Printer Log

Select to view a report of the number of pixels printed, temperature levels, and flow rates for the current print heads.

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8.15 Upload New Firmware

Select to upgrade the Firmware for your 3D Printer. The Service Department will provide you with the required upgrades and instructions for installing. You can also check our user Website at **www.3dpuser.com**.

8.16 Upload New Printer Configuration

This feature is used during diagnosis. It should only be modified under the instruction of the Z Corporation Service Department or an authorized Service representative.

8.17 Edit .INI File, Send File and Receive File

This feature is used during diagnosis. It should only be modified under the instruction of the Z Corporation Service Department or an authorized Service representative.

8.18 Machine Status

If you see an error on the printer LED, press the Online button to recover. If the error is unrecoverable, the printer will reboot.

State	Power LED	Online LED	Error LED	Beep
Off	off	off	off	off
Booting	solid	off	off	off
Online	solid	solid	off	off
Offline	solid	off	off	off
Printing	solid	solid	off	off
Sleeping	solid	slow flash	off	off
Error[1]	solid	off	solid	off
Booted, can't find network[2]	solid	off	solid	off
Cover open – close to continue	solid	fast flash	fast flash	solid
Cover open – print head not parked	solid	on or off	off	once every 30 seconds
Auto parking	solid	on or off	off	3 fast beeps
Piston auto dropping	solid	medium flash	off	off
Filling bed	solid	medium flash	off	off
Changing the print head	solid	medium flash	off	off
Purging the print head	solid	medium flash	off	slow

[1] Press the online button to recover from an error. If the error is unrecoverable, the printer will reboot.
[2] Press the online button to revert to serial port communication.

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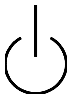
9 System Details

This chapter covers some system details and specifications. For more information, please contact the Z Corporation Service Department at (781)852-5050 or Toll-Free at (877)88-ZCorp. Or, visit the 3DP User Website at www.3dpuser.com.

9.1 Symbols Used

The following symbols are used on the ZPrinter 310 Plus Printer:

- This is the international symbol for **Standby Power**. It is visible on the printer power switch. The printer is partially powered as soon as you plug it in. The power switch is a momentary contact and toggles the machine from idle mode to full power-on mode.



- This is the international symbol for **Warning** or **Caution**. When it appears on the exterior of the equipment, it indicates the need to consult the manual or your service provider for further information.

- This is the international symbol for **Hot Surface**. It appears on the exterior of the equipment and indicates that caution should be used in that area to reduce the risk of injury.

9.2 System Specifications

System Dimensions	32.0” x 29.8” x 43.2” (81 x 76 x 110 cm)
Operating Conditions	68 to 85ºF (20-29ºC), 20 to 60% Relative Humidity, non-condensing.

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Lithium Battery

Inside the printer is a lithium coin cell type battery. This may be any one of the following type: CR2032, either Maxell, Panasonic, Renata, Sanyo, or Sony.

> **PLEASE NOTE:** This battery is **not** in a user accessible area and is *not user replaceable*. The expected lifetime of the battery is in excess of five years. Replacement will be handled by your authorized service representative.

FCC Notice

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

CENELEC Class A Warning

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to EN 55022. Class A devices are for office and light industrial environments, and are not generally suitable for home use.

WARNING

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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