



## FDM Support Removal

SOFTWARE / PRODUCT / FINISHING

### 1. Materials Overview

FDM (fused deposition modeling) Technology™ lets you 3D print parts in a broad range of well tested plastics. FDM materials offer specialized properties like toughness, electrostatic dissipation, translucence, biocompatibility, UV resistance, VO flammability and FST ratings. This makes them perfect for demanding designers and engineers in aerospace, automotive, manufacturing, medical and other industries.

Stratasys offers a diverse variety of model materials (see Table 1-2) which are used in conjunction with two types of FDM support materials. Soluble Release Support (SR) material can be washed away in a solution of heated-water and a cleaning agent, while Breakaway Support Structures (BASS) are manually removed. Notable differences between soluble support and BASS materials are as follows:

### Support Materials Comparison

SOLUBLE SUPPORT	BREAKAWAY SUPPORT STRUCTURES (BASS)
SR-20, SR-30, SR-100, and SR-110	<ul style="list-style-type: none"> <li>• PC_S, PPSF_S, ULT_S, and ULTEM 1010 Support</li> <li>• Supports removed manually</li> <li>• Do not require the use of a tank</li> <li>• Faster for simple support structures, which may require the use of hand tools to reach and remove all support material and may be time consuming</li> </ul>
Supports wash away in a detergent bath	
Build internal cavities/channels	
Hands-free support removal	

Table 1-1

## Materials Highlights

MODEL MATERIAL	SUPPORT MATERIAL
ABSi	Used with SR-20 support material
ABS_ESD7	Used with SR-30 support material
ABS-M30	Used with SR-20 or SR-30 support material
ABS-M30i	Used with SR-20 or SR-30 support material
ASA	Used with SR-30 support material
Nylon 12	Used with SR-110 support material
PC-ABS	Used with SR-20 support material
PC	Used with SR-100 or PC_S support material
PC-ISO	Used with PC_S support material
PPSF	Used with PPSF_S support material
ULTEM 9085 resin	Used with ULT_S support material
ULTEM 1010	Used with U1010S1 support material

Table 1-2

### 1.1 SR vs. BASS

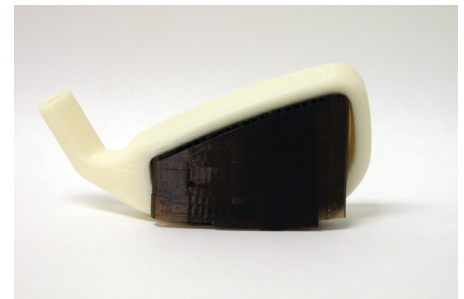
Soluble Release (SR) support materials are very similar; however, they do offer some differences:

- SR-20 tends to discolor the support removal solution faster than SR-30.
- SR-30 is less likely to shatter and dissolves 69% faster than SR-20.
- SR-30 doesn't expand as much as SR-20 in solution. Therefore, fragile parts won't break from support expansion.

#### 1.1.1 BASS Removal Tips

**WARNING** Always wear safety glasses and safety gloves when removing support material by hand. The support material can be brittle and may cause cuts when manually broken off.

Breakaway support structures are removed manually, rather than by use of a tank containing a solution of heated-water and a cleaning agent. This method is ideal for parts built using simple support structures. Depending on the part built it may be difficult to reach all support structures in order to break them away, resulting in a greater amount of time spent removing supports. The following tips will help expedite the process of removing BASS.



SR-20



SR-30



BASS

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## Tools

The use of hand tools can greatly reduce the amount of time spent removing BASS from finished parts (suggested tools shown at right). However, care should be taken to ensure that you do not scratch or gouge parts when using tools. For fragile parts, it is always best to take your time in order to eliminate the risk of damaging the part.

You may find that traditional tools are insufficient for removing supports from your parts. If so, you may need to fabricate custom tools to better suit your support removal needs.



## Heat

ULTEM and PPSF support materials are much easier to remove if heated. (PC\_S does not require re-heating as this material is generally easier to remove than ULTEM and PPSF supports). Placing a finished part into an industrial oven and allowing the part to heat will make support material easier to remove. However, if you decide to heat a part, do not place low temp parts (such as ABS-M30) into a high temp oven (such as 160° C (320° F)). This can damage the part, possibly making it unusable. Please also keep in mind that the more heating/cooling cycles conducted, the more difficult it will be to remove supports. In general, materials should be heated to the temperatures specified in Table 1-3.

Reheating Specifications	
MODEL MATERIAL TYPE	TEMPERATURE
ABS-M30/ABS-M30i*	Up to 80° C (176° F)
PC-ABS*	Up to 80° C (176° F)
PC (with PC_S support material)	Up to 100° C (212° F)
PPSF	Up to 180° C (356° F)
ULTEM	Up to 160° C (320° F)

Table 1-3

\* Model material utilizes soluble support material not BASS. Reheating temperatures are provided as a guideline although support materials are generally not removed by hand.

## 2. WaterWorks Best Practices

### 2.1 WaterWorks Overview

WaterWorks™ (for use with Fortus® printers) in combination with Stratasys' soluble support materials, dissolves soluble support structures with a water based solution (rather than requiring you to manually remove supports). See Table 1-2 for model and support compatibility information.

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Stratasys software automatically creates any needed support structures to build specific parts. When applicable, WaterWorks provides the final step, enabling complex geometries and fully functional assemblies in a single build.

Agitation aids in support material removal; therefore, Stratasys recommends using either a circulation or ultrasonic tank.

WaterWorks concentrate comes in 1 liter bottles, which cannot be shipped by air. Each bottle treats 42 liters (11 gallons) of water.

This chapter details the recommended guidelines for using WaterWorks. Refer to the WaterWorks User Guide, available from the Stratasys Resource Center website, for more information.



## 2.2 Safety Guidelines

When using WaterWorks soluble concentrate and a support removal tank observe the following safety guidelines:

- Follow the manufacturer's documentation on tank operation and safety. Understand how to properly and safely use the tank before operation.
- Always wear safety goggles (indirectly vented and chemical splash resistant).
- Use rubber gloves that can withstand the high solution temperature and high alkaline solutions. (Gloves that are cuffed at the elbow are recommended.)
- Follow your company and local regulatory statutes regarding safety practices.
- Never place hands in a tank filled with solution and/or hot water.
- Never turn on power to the heater or ultrasonics without water/solution in the tank.
- Always use a proper tool to remove parts from the tank. Plastic or stainless steel removal tools are recommended that can withstand the high solution temperature and high alkaline solution in the tank.
- If using a basket, remove the entire basket from the tank before removing parts.

## 2.3 Choosing a Support Removal Tank

A variety of support removal tanks can be utilized to aid in the process of removing support materials from finished parts. Tank options vary depending on whether you're using a circulation or ultrasonic tank. Agitation aids in support material removal; Stratasys recommends using either a circulation or ultrasonic tank. The tank must be able to withstand various water temperatures (see Table 2-1 for details) and high alkaline solutions with a pH up to 12.6.

# FDM SUPPORT REMOVAL

Parts can be secured in the tank using stainless steel, porous baskets or other containers, which lessens the chances of parts being damaged. A stainless steel tea infusing ball (3 inches), or similar container, works well for small parts. Larger parts with fine feature details can be secured to a basket with plastic cable ties. See “Placing Parts in the Tank” on page 9 for more information.

## 2.3.1 Circulation Tanks

- Uses heat and circulation.
- Circulation amount and strength varies for each tank.
- Generally used with lids, and therefore has less evaporation than ultrasonic tanks.
- Quieter than ultrasonic tanks.
- Secured parts may need to be checked periodically to ensure that they are fully submerged/stay submerged in the tank.

## 2.3.2 Ultrasonic Tanks

- Uses heat and sound waves to create scrubbing bubbles, which gently clean parts.
- Generally not used with lids to avoid over-heating.

**WARNING** Bath solution will have a high pH, use caution to avoid contact with skin.

- Louder than circulation tanks.
- Best for small or fragile parts with fine features, and parts with thin channels or small holes.

## 2.4 Recommended WaterWorks Compatible Tanks

The following third-party support removal tanks are recommended for use by Stratasys. As this list is subject to change, always see your Regional Sales Representative for recommendations. Stratasys does not manufacture, sell, or service these tanks.

### 2.4.1 Omegasonics

Two Omegasonics Ultrasonic Parts Washers are available for use with WaterWorks solution.

#### **Omegasonics 1900 BT**

The Omegasonics 1900 BT is a 28 gallon (106 liters) capacity tank. Typical water level height is 6 inches (15.2 cm) from the top of the tank lip, which provides 20 fluid gallons (75.7 liters); therefore, 2 bottles of WaterWorks should be used to charge the tank.



Omegasonics 1900 BT

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- Overall dimensions: 28.75 in. (73 cm) wide x 22 in. (55.9 cm) deep\* x 27 in. (68.7 cm) high  
\* add 3.5 in. (8.9 cm) for drain.
- Electrical requirements: 1 Phase / 120 VAC / 15 Amp.
- Power cord location: 7 in. (17.8 cm) from back left corner, 4 in. (10.2 cm) from ground.
- Plumbing: 1 in. (2.54 cm) drain valve located 3.75 in. (9.52 cm) from back right corner, 5.5 in. (14 cm) from ground.

### **Omegasonics SST4030**

The Omegasonics SST4030 is a 207 gallon (783.5 liters) capacity tank. Typical water level height is 8 inches (20.3 cm) from the top of the tank lip, which provides 175 fluid gallons (662.45 liters); therefore, 16 bottles of WaterWorks should be used to charge the tank.

- Overall dimensions: 64.75 in. (164 cm) wide x 35.75 in. (90.8 cm) deep x 54.25 in. (138 cm) high\*  
\* add 22.25 in. (56.5 cm) with doors open.
- Electrical requirements: 3 Phase / 240 VAC / 50 Amp.
- Power cord location: 11 in. (27.9 cm) from back left corner, 4 in. (10.2 cm) from the top.
- Plumbing: 1.5 in. (3.81 cm) drain valve located 7 in. (17.8 cm) from right corner, 8 in. (20.3 cm) from ground (left side of machine).

### **CleanStation XL Plus**

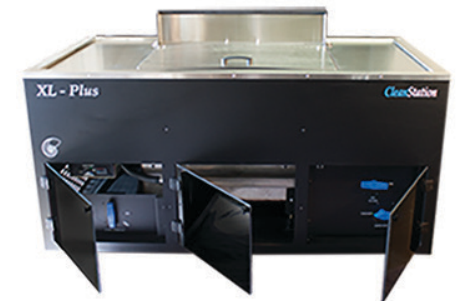
The CleanStation XL Plus is the largest regular production CleanStation available. This part cleaning system is designed to remove WaterWorks soluble support material from finished parts, using jet action cleaning. Refer to the CleanStation XL Plus User Guide, available from the Stratasys Resource Center website, for more information.

The XL Plus features a 100 gallon (378.5 liters) capacity tank. Typical water level height is 3 inches (7.62 cm) from the top of the tank. 9 bottles of WaterWorks should be added into the tank; most will dissolve in 3 to 5 minutes.

- Work envelope dimensions: 25 in. (63.5 cm) x 37 in. (94 cm) x 25 in. (63.5 cm).
- Electrical requirements: 3 Phase / 240 VAC / 70 Amp, 51FLA, 3 wire with a ground and no neutral.
- Power cord location: Facing the rear of the machine, the power cord connection is located at the middle right of the unit.
- Plumbing: Facing the rear of the machine, the drain is located at the left rear of the unit.



Omegasonics SST4030



CleanStation XL Plus

### CleanStation SRS II

The CleanStation SRS II is a heavy-duty, professional-grade support removal system designed to remove WaterWorks soluble support material from finished parts, using jet action cleaning. To protect delicate parts, the system is equipped with active cooling to prevent warping and de-lamination due to overheating. The SRS II is also available with a variable flow option which allows operators to control jet flow rates.

The SRS II features a 17 gallon (64.35 liters) capacity tank. There is a low level cut-off switch approximately 4 in. (10.2 cm) from the top of the tank; the machine will not operate if the solution level falls below this switch. One and a half (1.5) bottles of WaterWorks should be added into the tank once water temperature reaches 150° F (65.6° C); most will dissolve in 3 to 5 minutes.

- Work envelope dimensions: 16 in. (40.6 cm) x 14 in. (35.6 cm) x 16 in. (40.6 cm).
- Electrical requirements: 1 Phase / 240 VAC / 20 Amp.
- Power cord location: Facing the rear of the machine, the power cord connection is located at the lower right of the unit.
- Plumbing: Quick disconnect, appliance style plumbing.

### SCA-1200

The SCA (support cleaning apparatus)-1200 can be used in conjunction with any support removal concentrate (WaterWorks or Ecoworks packets) in order to remove soluble support material from finished parts. The SCA-1200 uses an optimized nozzle which circulates the heated cleaning solution in and around parts to dissolve away soluble support material.

The SCA-1200 features an 8.3 gallon (31.5 liter) tank which is ideal for removing support material from large parts. 850 grams (roughly 4/5 of a bottle) of WaterWorks should be added to the tank.

- Physical dimensions: 16 in. (40.6 cm) x 19 in. (48.3 cm) x 26.5 in. (67.3 cm).
- Basket capacity: 10 in. (25.4 cm) 10 in. (25.4 cm) x 12 in. (30.5 cm).
- Electrical requirements: 100-120V~ 60Hz 15A.

**NOTE** The SCA-1200 can use either WaterWorks concentrate or Ecoworks packets. When using Ecoworks, the entire contents from 4 packets (2 A packets and 2 B packets) should be added to the tank. See “SCA-1200” on page 16 for details.



CleanStation SRS II



SCA-1200

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## 2.5 Removing Support Material

**WARNING** Always wear safety glasses and safety gloves when removing support material by hand. The support material can be brittle and may cause cuts when manually broken off.

Some parts have support materials that are hard to remove (e.g., parts with thin, deep channels), resulting in longer dissolving times. While some parts have support material that cannot be removed (e.g., hollow parts with non-accessible interiors). Therefore, it is suggested but not required that you remove some support by hand in order to save tank time and water life span, except when using SR-100.

When using SR-100 it is required that you manually remove small amounts of support material prior to placing parts in the tank. This will help eliminate any likelihood of part breakage while in the tank. Thin-walled or small feature part geometries (less than or equal to 0.02 in. (0.50 mm)) with encapsulated regions of support may be susceptible to breakage or cracking. This is due to slightly faster thermal expansion of the SR-100 soluble support material compared to the thermal properties of the polycarbonate (PC) model material.

### 2.5.1 Adding Solution to the Tank

**WARNING** Always wear safety goggles and heat, alkaline, and water-resistant safety gloves when handling WaterWorks soluble concentrate.

To begin, fill the tank with water.

- The ratio of water needed is 11 gallons (42 liters) of water per one bottle (2.1 lbs/950g) of soluble concentrate.

Make sure to fill the tank according to the operating instructions set by the manufacturer to avoid burning out the tank's heater (or transducer in ultrasonic units).

Carefully open one bottle of soluble concentrate (per 11 gallons of water) and slowly spread the powder over the entire water surface in the tank.

**NOTE** Always add the soluble concentrate to the water; never add water to the concentrate. Use caution to ensure that you do not breathe in powder when mixing soluble concentrate with water.

When finished, seal and store bottles with remaining concentrate. Dispose of empty bottles appropriately.

**NOTE** Soluble concentrate bottles are made of recyclable plastic and can be recycled according to local recycling programs.





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Over time evaporation can occur; periodically check for evaporation of water. If evaporation occurs add more water, do not add more soluble concentrate.

## 2.5.2 Tank Temperature

**CAUTION** Never turn on power to the tank heater or ultrasonic units without water or solution in the tank.

Always power the tank ON according to the operating instructions set by the manufacturer.

When dissolving support material, set the tank's temperature according to the information listed in Table 2-1. Verify that the tank's temperature configuration is correct for the type of support material being removed before placing parts in the tank. Always allow the solution to reach proper temperature before placing parts into the solution. Support material dissolves the fastest at the designated support material temperature. Filling the tank with hot tap water will help accelerate the time needed to reach designated operating temperatures.

### Tank Temperature Settings

(SOLUBLE) SUPPORT MATERIAL TYPE	TEMPERATURE
SR-20	70° C (158° F)
SR-30	70° C (158° F)
SR-100	80-85° C (176-185° F) or 70° C (158° F) with a longer dissolve time
SR-110	Thin wall mode parts: 50° C (122° F) ' Normal mode parts: 60° C (140° F) Brick mode parts: 70° C (158° F)

Table 2-1

**NOTE** Setting or allowing the tank temperature to reach a higher than indicated temperature is likely to damage printed parts.

## 2.5.3 Placing Parts in the Tank

**CAUTION** Make sure that parts are fully immersed in the solution. Parts can crack if they are not fully immersed or are 'bobbing' in and out of the solution. This is especially critical for small parts.

Follow the operating instructions set by the tank manufacturer as to where parts can be placed within the tank (e.g., free moving or secured in a basket or other porous container). In some tanks, for example, parts cannot be placed on the bottom. Multiple parts may be placed in the tank but there must be sufficient room within this tank to allow for adequate agitation.

Enclosures should be used to ensure that fragile parts are not damaged while in the tank. Always keep parts fully submerged within the tank's solution; if parts do not stay fully submerged grime can build-up on the part's surface.

Sparse filled parts will absorb solution; therefore, adding holes for draining is advised. Sparse filled parts will float within the tank's solution so they should be anchored within the basket or tank to ensure they stay fully submerged.

### 2.5.4 Material Specific Guidelines

#### **PC Material**

PC parts left in a tank for excessive time may see a 5-15% drop in mechanical properties. It is good practice to allow PC parts to soak in the tank for 4 hours, and then check parts frequently to ensure that they are not left in the tank for too long.

#### **Nylon 12 Material**

Nylon 12 may be brittle out of the oven. A very specific process should be followed when placing Nylon 12 parts into a tank containing WaterWorks solution.

1. After removing a Nylon 12 part from the printer's oven, always leave the part on the build sheet. Allow the part to cool on the build sheet until it is room temperature.
2. Carefully pull the part off of the build sheet once it is room temperature. The part may be fragile so care must be taken.

All Nylon 12 parts must be placed into a WaterWorks solution bath; a minimum of 4 hours of re-hydration is suggested.

### 2.5.5 Inspecting Parts and Solution

Support material can be washed away from part geometries in 0.5 to 3.0 hours, given the support removal tank's solution maintains proper temperature (see "Tank Temperature" on page 9) and pH levels.

Various factors determine how long it takes to remove support material in the tank. To ensure timely and efficient support removal:

- Minimize the volume of support material on the part prior to placing it into the tank (see "Removing Support Material" on page 8).
- Minimize the amount of time parts spend in the solution tank.
- Minimize the amount of dissolved solids in the solution tank.
- Maximize the pH level in the solution tank.
- Maximize solution agitation around parts.

For best part quality, inspect parts after 2 hours and then periodically until their clean cycle is complete.

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**NOTE** Polycarbonate parts left in the tank for excessive periods of time may see a 5% to 15% drop in mechanical properties. It is highly recommended that you check PC parts every 4 hours, and avoid leaving PC parts in the tank solution longer than 24 hours. This will alleviate any potential degradation of the part's mechanical property.

Due to air pockets and circulation patterns it is recommended that you rotate the basket or free moving parts to dissolve support material faster. Inspect the tank periodically for over- heating and solution evaporation. The solution level must always cover the parts. Add more water if necessary; do not add more soluble concentrate.

## 2.5.6 Removing Parts from the Tank

**WARNING** Always wear safety goggles and heat, alkaline, and water- resistant safety gloves when handling the concentrate.

To begin, turn OFF power to the tank. Allow the tank's cover to drip for a few moments before removing the lid completely. Carefully remove parts from the tank; plastic or stainless steel removal tools (such as tongs) are recommended for removing parts. Removal tools need to be able to withstand high water temperature and high alkaline solution.

Parts must be rinsed after they're removed from the tank, rinse parts as follows:

- White Parts: Rinse parts thoroughly with water until part surfaces are no longer slippery (1-2 minutes). To reduce the possibility of staining, some white parts may need to soak for an hour to help pull soluble concentrate from part surfaces. Also, soaking parts in a dishwasher rinsing aid and water and then rinsing the parts will break the surface tension.
- Color Parts: Soak parts in water for one hour to dissolve and pull soluble concentrate from part surfaces. Also, soaking parts in a dishwasher rinsing aid and water and then rinsing the parts will break the surface tension.
- Soft Water or Deionized Water: Sparse parts need to be drained and re-rinsed. A vacuum chamber can be used to pull solution out of the part.

**NOTE** Failing to rinse or soak parts long enough can leave them with a white residue and/or streaks. If this occurs, rinse or soak the parts again to remove the residue. Part surface aesthetics can also be negatively impacted as a result of inadequate tank solution. Check the tank's solution and change it if necessary (see "Changing Solution in the Tank" on page 12).



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For parts built using the sparse build style, allow parts to drain fully as solution can get trapped inside the part. Allow parts to dry thoroughly and then rinse parts (for 1-2 minutes) under hot water, once again making sure that you do not allow any water to get trapped inside the part.

Dry parts with paper towels, compressed air, or let them air-dry. If colored parts turn slightly white after drying, rinse them under hot water or soak them again as previously instructed.

## 2.5.7 Changing Solution in the Tank

How often the solution is changed is dependent on the tank used, how it is maintained, and the complexities of the parts built. Stratasys recommends changing a tank's solution after it has been used to remove approximately 25 cubic inches (410 cc) of support material (~ 2lbs/ 9kg) per 11 gallon (42 liter) tank, or the pH falls to 11.5. The following conditions indicate that the solution should be changed:

- The tank begins to cloud or exhibit low clarity. Some white parts (ABS) may turn brown or yellow.
- Parts have a sticky residue and/or stick together in the tank due to excess dissolved solids in the tank.
- Functional parts with moving features are not functioning properly.
- Support material is not fully removed after a long cleaning cycle.
- The tank's solution exhibits a low pH (this can be determined by checking pH level using a test strip or meter).

## 2.5.8 Disposing of Soluble Concentrate

The soluble solution has been specially formulated to be safely disposed after dilution and neutralization to an acceptable pH level. The pH level of fresh solution is similar to that of typical laundry detergents, dishwasher detergents, and common household cleaners.

pH Levels Comparison	
PRODUCT	PH LEVEL
Fresh soluble solution	12.6
Laundry detergent	11 - 12
Dishwasher detergent	10 - 11
Common household cleaners	9 - 12

Table 2-2

Check your local, state, and/or international regulatory statutes for what pH level is acceptable for disposal. Stratasys recommends that disposal procedures be verified by the proper authorities in

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your region. Stratasys cannot anticipate local, state, or international regulatory statutes. Stratasys cannot be held liable if the solution is not handled and disposed of properly. You may need to document how you dispose of the used solution.

### 2.5.9 Soluble Solution Drain Effluent

Dilute the solution with water using the appropriate ratio to meet acceptable pH levels. The Drain Effluent data below is based on a dilution of 1 part soluble concentrate to 5 parts water containing approximately 28 cubic inches (459 cc) of soluble release material dissolved in 11 gallons (42 liters) of water, resulting in a pH of 11.8.

Drain Effluent Specifications				
PARAMETER	TEST METHOD	UNITS	TANK VALUE	DILUTED VALUE*
pH	EPA 150-1	EPA 150-1 --	12.6	11.8
COD**	EPA 410-1	mg/L	14,000	2,400
BOC***	SM 5210B	mg/L	820	250
Total Solids	EPA 1603	mg/L	27,000	4,500
Total Suspended Solids	EPA 160.2	mg/L	430	54
Cadmium	SW-846, 6010A	µg/L	<5	<5
Chromium	SW-846, 6010A	µg/L	<5	<5
Copper	SW-846, 6010A	µg/L	<10	<10
Nickel	SW-846, 6010A	µg/L	<10	<10
Lead	SW-846, 6010A	µg/L	<40	<40
Zinc	SW-846, 6010A	µg/L	<20	<20
Mercury	SW-846, 7470A	µg/L	<2	<2

Table 2-3

\* These values remain constant if the same ratios apply (e.g. 5.5 gallon cleaning device containing approximately 14 cubic inches of soluble release material with the same dilution ratio of 1 part soluble concentrate to 5 parts water).

\*\* Chemical Oxygen Demand

\*\*\*Biological Oxygen Demand

Check your local, state, and/or international regulatory statutes for what pH level is acceptable for disposal. Stratasys recommends that disposal procedures be verified by the proper authorities in your region. Stratasys cannot anticipate local, state, or international regulatory statutes. Stratasys cannot be held liable if the solution is not handled and disposed of properly. You may need to document how you dispose of the concentrate.

### 2.5.10 Neutralization

The soluble solution can be further neutralized to lower the pH level by slowly adding acid (e.g., malic acid) to the tank before draining the solution.

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To successfully neutralize a solution of soluble concentrate dissolved in 11 gallons (42 liters) of water to a pH level below 11:

1. Check local codes. Refer to the MSDS sheets for proper safety precautions and possible hazards for malic acid.
2. Slowly add 14 ounces (397 grams) of malic acid to the tank solution (this amount is based on starting pH level); pH will reduce from 11 to 8. Please note that the tank will foam.

### 2.5.11 Tank Cleaning

In the event your tank needs to be returned to the manufacturer for service/repair, you may be required to thoroughly clean the tank to remove all concentrate residue prior to shipment.

To clean the tank:

1. Drain, dilute, and/or neutralize the tank solution. See “Disposing of Soluble Concentrate” on page 14 for instructions.
2. Re-fill the tank with clean tap water and operate a few minutes to circulate clean tap water throughout the system.
3. Drain the tank and wipe down all surfaces to remove traces of the soluble concentrate.

## 3. Ecoworks Best Practices

### 3.1 Ecoworks Overview

Ecoworks™ cleaning agent is designed to remove SR-30 support material from parts built using the FDM process with soluble support material. See Table 1-1 and Table 1-2 for model and support compatibility information. The cleaning agent is both user- and eco-friendly (with a pH of 10). Ecoworks comes in tablet or packet form and usage varies by tank type.

No personal protection equipment is required when handling the cleaning agent and disposal of the used solution requires only dilution with clean water to meet generally acceptable world-wide disposal standards.

This chapter details the recommended guidelines for using Ecoworks. Refer to the Ecoworks User Guide, available from the Stratasys Resource Center website, for more information.

### 3.2 Safety Guidelines

When using Ecoworks and a support cleaning system observe the following safety guidelines:

- Follow the manufacturer’s operation and safety documentation. Understand how to properly and safely use the cleaning system before operation.
- Follow your company and local regulatory statutes regarding safety practices.
- Make sure the appropriate voltage range for your region has been selected. Avoid overloading the electrical outlet with multiple devices.



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- Prior to operation, ensure that the system is placed on a flat and stable surface that is capable of supporting the system's weight.
- Ensure the system is well-grounded. Failure to ground the system may result in electrical shock, fire and susceptibility to electromagnetic interference.
- Use only the power cord supplied. Do not damage, cut or repair the power cord. A damaged power cord has risk of fire and electric shock. Replace a damaged power cord with an approved power cord.
- Do not allow metal or liquids to touch the internal parts of the system. Doing so may cause damage, fire, electric shock or other serious hazards.



Packets (for use with WaveWash)

### 3.3 Recommended Ecoworks Compatible Tanks

The following cleaning systems are recommended for use by Stratasys. As this list is subject to change, always see your Regional Sales Representative for recommendations. Stratasys manufactures, sells, and services the WaveWash and WaveWash 55 systems.

#### 3.3.1 WaveWash / WaveWash 55 Overview

The WaveWash and WaveWash55 Support Cleaning Systems are specifically developed to provide efficient removal of SR-30 soluble support material from parts built using the FDM process. These systems remove support material by immersing finished parts in a bath of water with a specific amount of cleaning agent (in either tablet or packet form) added to the cleaning agent receptacle. The system heats and circulates solution around the parts in the cleaning tank.

The solution dissolves the support material without harming the underlying model material. Over time, depending on geometry and the amount of support material, all the support material is dissolved and the parts are ready to be removed, dried and used for their intended purpose. Refer to the WaveWash User Guide/WaveWash 55 User Guide, available from the Stratasys Resource Center website, for more information.

#### 3.3.2 WaveWash

The WaveWash Support Cleaning System comes in the uPrint SE and uPrint SE Plus 3D Print Packs, and is also sold separately. This system is designed to wash away support materials, rinse parts, and drain automatically.

The WaveWash system is used in conjunction with Ecoworks packets. These packets consist of two pre-measured dissolvable pouches (labeled A and B) which are placed into the WaveWash tank. Once exposed to water within the tank, these packets mix together to form the solution used to remove support material. One set of packets treats one WaveWash tank, or 3.6 gallons (13.5 liters) of water.



Tablets (for use with WaveWash 55)



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- Dimensions: 17.25 in. (43.8 cm) x 18.24 in. (48.33 cm) x 17 in. (43.18 cm).
- Basket capacity: 8 in. (20.3 cm) x 8 in. (20.3 cm) x 6 in. (15.2 cm).
- Electrical requirements: 100-120 VAC / 50/60Hz / 1200W.
- Plumbing: Incoming water source and drain connection required.

### 3.3.3 WaveWash 55

The WaveWash 55 Support Cleaning System comes in the Mojo 3D Print Pack, and is also sold separately. This system automatically turns off heating and agitation at the end of a cleaning cycle.

The WaveWash 55 system is used in conjunction with Ecoworks tablets. One tablet will treat a WaveWash 55 carafe, or up to 1.3 gallons (5 liters) of water.

- Dimensions: 13.2 in. (33.5 cm) x 13.2 in. (33.5 cm) x 13.2 in. (33.5 cm).
- Basket capacity: 5 in. (12.7 cm) x 5 in. (12.7 cm) x 5 in. (12.7 cm).
- Electrical requirements: 100-120 VAC / 6 Amp / 60Hz or 220-240 VAC / 2.5A / 50Hz
- Plumbing: No plumbing required.

### 3.3.4 SCA-1200

The SCA (support cleaning apparatus)-1200 can be used in conjunction with any support removal concentrate (Ecoworks packets or WaterWorks) in order to remove soluble support material from finished parts. Stratasy does not manufacture, sell, or service this system.

The SCA-1200 uses an optimized nozzle which circulates the heated cleaning solution in and around parts to dissolve away soluble support material.

The SCA-1200 features an 8.3 gallon (31.5 liter) tank which is ideal for removing support material from large parts. When using Ecoworks, the entire contents from 4 packets (2 A packets and 2 B packets) should be added to the tank.

- Physical dimensions: 16 in. (40.6 cm) x 19 in. (48.3 cm) x 26.5 in. (67.3 cm).
- Basket capacity: 10 in. (25.4 cm) 10 in. (25.4 cm) x 12 in. (30.5 cm).
- Electrical requirements: 100-120V~ 60Hz 15A.

**NOTE** The SCA-1200 can use either WaterWorks concentrate or Ecoworks packets. When using WaterWorks, 850 grams (roughly 4/5 of a bottle) of WaterWorks should be added to the tank. See “SCA-1200” on page 7 for details.





### 3.3.5 Ecoworks Packets & WaveWash

Ecoworks packets are used in conjunction with the WaveWash Support Cleaning System, and provide efficient removal of SR-30 soluble support material. Each packet consists of two pre-measured dissolvable pouches (labeled A and B) which are placed into the WaveWash tank.

The system removes support material by immersing parts in a bath of water with a specific number of Ecoworks packets added to the clean tank. The system heats and circulates solution around the parts in the cleaning tank. The solution dissolves the support material without harming the underlying model material. Over time, depending on geometry and the amount of support material, all the support material is dissolved and the parts are ready to be removed, dried and used for their intended purpose.

### 3.3.6 Tank Level and Ecoworks Amounts

The WaveWash system allows for a user-selectable clean tank level. A full clean tank level is approximately 4 gallons (15.14 liters) of water, while a half clean tank level is approximately 2 gallons (7.57 liters) of water. The system will automatically fill with water based on the selected clean tank level.

- One Ecoworks packet (one A and one B pouch) should be used for a half clean tank level. The entire contents of the package should be used.
- Two Ecoworks packets (two A and two B pouches) should be used for a full clean tank level. The entire contents of each package should be used.

**NOTE** Do not use more than the specified number of Ecoworks packets. Doing so will exceed pH levels for wastewater disposal.

As general practice to optimize support removal and meet generally acceptable pH levels for waste water disposal, one packet of Ecoworks should be used for every 2 gallons (7.5 liters) of water. For each additional two gallons (7.5 liters) of water, add an additional packet of Ecoworks. For example, an 8 gallon (30 liter) tank requires 4 packets of Ecoworks. With the above ratio of Ecoworks and water, the pH level of clean solution will be approximately 9.8.

### 3.3.7 Clean Cycle

The WaveWash system allows for 3 user-selectable clean cycle lengths (Short, Medium, and Long). Factors such as model geometry, small support filled crevices, small blind holes, support styles other than SMART, or low water temperature coming into the system can impact the length of time required to clean parts. Table 3-1 should be used as a general guideline for selecting cycle lengths for most parts.

**NOTE** When cleaning more than one part in the same clean cycle, use the combined build times of all the parts to determine the correct cycle length. Combined build time means the sum of the individual build times of each part in the tank.

## Cycle Length Settings with SR-30 Soluble Support Material

COMBINED BUILD TIMES	CYCLE LENGTH SELECTION	HALF TANK CYCLE TIME	FULL TANK CYCLE TIME
≤ 4 hours	Short	3.5 hours	5 hours
4 to 12 hours	Medium	6.5 hours	8 hours
> 12 hours	Long	12.5 hours	14 hours

Table 3-1

After the clean cycle is complete, the system drains and then refills with clean water for a final rinse and drain cycle. Once finished, the lid will unlock and parts can be removed. Allow the solution to drain off of the parts for a few minutes before removing them. Wash off any remaining solution and dry parts with a clean cloth or paper towel. Repeat the clean cycle if needed.

### 3.3.8 Temperature

The WaveWash system automatically sets and maintains water temperature within the clean tank. However, water temperatures between 70 - 75° C (158 - 167° F) are most effective for dissolving support materials. Temperatures above 75° C (167° F) may cause parts to distort. Dissolve times with temperatures below 70° C (158° F) will take longer.

### 3.3.9 Solution Life and Disposal

How often you change the solution is dependent on the tank you use, how you maintain it, and the complexity of your parts. As support materials are dissolved over time, the pH level will decrease and dissolve times will increase. For optimal effectiveness, the solution should be changed after 1.5 lbs. (0.68 kg) or approximately 40 cu. in. (655 cu. cm) of support material has been dissolved. If you suspect that the solution's pH is low, test the solution using a test strip or meter.

A Waste Water Profile is available for SR-30 soluble support material. This profile is based on the dilution of used solution with an equal amount of fresh water. For example, when disposing of 4 gallons (15 liters) of used solution, dilute with 4 gallons (15 liters) of fresh water. Check your local, state, and/or international regulatory statutes for what pH level is acceptable for disposal. The WaveWash system utilizes an automatic water drain feature; therefore, it is imperative that the correct ratio of Ecoworks packets to water be maintained when operating the system.

Stratasys recommends that disposal procedures be verified by the

proper authorities in your region. Stratasys cannot anticipate local, state, or international regulatory statutes. Stratasys cannot be held liable if the solution is not handled and disposed of properly. You may need to document how you dispose of the used solution.

### 3.4 Ecoworks Tablets & WaveWash 55

Ecoworks tablets are used in conjunction with the WaveWash 55 Support Cleaning System, and provide efficient removal of SR-30 soluble support material. The system is environmentally friendly, allowing for municipal sewage disposal of used solution. The system removes support material by immersing parts in a bath of water with a specific number of Ecoworks tablets. The system heats and circulates solution around the parts in the carafe. The solution dissolves the support material without harming the underlying part material. Cleaned parts should be air dried before being used for their intended purpose.

#### 3.4.1 Ecoworks Amounts and Water Level

One Ecoworks tablet should be added to the carafe before any water is added to the carafe. One tablet will treat one carafe, or up to 1.3 gallons (5 liters) of water.

**NOTE** Do not use more than the specified number of Ecoworks tablets. Doing so will exceed pH levels for wastewater disposal.

Once a tablet has been added to the carafe, carefully place part(s) with soluble supports in the bottom of the carafe. All parts must be free to agitate in the cleaning solution. Do not overload the carafe with parts.

**NOTE** Delicate parts can be protected by first placing the baffle in the bottom of the carafe and locking it in place. The baffle is designed to lessen agitation and prevent delicate parts from being damaged during the cleaning cycle.

Manually fill the carafe with hot water. Always use hot water when filling the carafe; this will help dissolve the support structures more quickly. Fill the carafe so the water level is at least 3 in. (7.62 cm) above the part(s) or a maximum of 1 inch (2.54 cm) from the top of the carafe, whichever is less. Part(s) must be fully submerged during the cleaning process.

#### 3.4.2 Clean Cycle

The WaveWash 55 system features a user initiated 8 hour automated clean cycle. Before starting a clean cycle ensure that the lid is on the carafe and the carafe is securely seated on its base. Once the clean cycle is complete, parts must be manually rinsed with hot water.

To rinse parts following a clean cycle, empty the Ecoworks solution

from the carafe into a drain ensuring that parts remain in the carafe. Remove the lid and manually fill the carafe with hot water. Parts should be fully submerged. Allow parts to soak for approximately 5 minutes before emptying the water from the carafe. Allow water to drain off of the parts for a few minutes before removing them the carafe. Wash off any remaining residue with warm water and then dry parts with a clean cloth or paper towel. Repeat the clean cycle if needed.

### 3.4.3 Temperature

The WaveWash 55 system automatically sets and maintains water temperature within the clean tank. However, water temperatures between 70 - 75° C (158 - 167° F) are most effective for dissolving support materials. Temperatures above 75° C (167° F) may cause parts to distort. Dissolve times with temperatures below 70° C (158° F) will take longer.

### 3.4.4 Solution Life and Disposal

How often you change the solution is dependent on the tank you use, how you maintain it, and the complexity of your parts. As support materials are dissolved over time, the pH level will decrease and dissolve times will increase. For optimal effectiveness, the solution should be changed after 1.5 lbs. (0.68 kg) or approximately 40 cu. in. (655 cu. cm) of support material has been dissolved. If you suspect that the solution's pH is low, test the solution using a test strip or meter.

A Waste Water Profile is available for SR-30 soluble support material. This profile is based on the dilution of used solution with an equal amount of fresh water. For example, when disposing of 4 gallons (15 liters) of used solution, dilute with 4 gallons (15 liters) of fresh water. Check your local, state, and/or international regulatory statutes for what pH level is acceptable for disposal. The contents of the WaveWash 55 carafe are intended to be emptied into a drain for disposal; therefore, it is imperative that the correct ratio of Ecoworks tablets to water be maintained when operating the system.

Stratasys recommends that disposal procedures be verified by the proper authorities in your region. Stratasys cannot anticipate local, state, or international regulatory statutes. Stratasys cannot be held liable if the solution is not handled and disposed of properly. You may need to document how you dispose of the used solution.

## 4. Appendix A: Quick Reference & Tips

### 4.1 Material Reheating Temperatures

MODEL MATERIAL TYPE	TEMPERATURES
ABS-M30*/ABS-M30i	Up to 80° C (176° F)
PC-ABS*	Up to 80° C (176° F)
PC (with PC_S support material)	Up to 100° C (212° F)
PPSF	Up to 180° C (356° F)
ULTEM	Up to 160° C (320° F)

\* Model material utilizes soluble support material not BASS. Reheating temperatures are provided as a guideline although support materials are generally removed by hand.

(SOLUBLE) SUPPORT MATERIAL TYPE	TEMPERATURES
SR-20	70° C (158° F)
SR-30	70° C (158° F)
SR-100	80-85° C (176-185° F) or 70 C (158° F) with a longer dissolve time
SR-110	Thin wall mode parts: 50° C (122° F) Normal mode parts: 60° C (140° F) Brick mode parts: 70° C (158° F)

Neutralization: 11 gallon tank = 14 ounces (397 grams) malic acid

### 4.2 Ecoworks Quick Reference

The Ecoworks cleaning agent is designed to remove SR-30 support material from parts built using the FDM process with soluble support material. The WaveWash and WaveWash55 Support Cleaning Systems are designed to remove SR-30 support material using Ecoworks.

### 4.3 WaveWash & Ecoworks Ratio

The WaveWash Support Cleaning System comes in the uPrint SE and uPrint SE Plus 3D Print Packs, and is also sold separately. This cleaning system is used in conjunction with Ecoworks packets. These packets consist of two pre-measured dissolvable pouches (labeled A and B) which are placed into the WaveWash tank.

One set of packets treats one WaveWash tank, or 3.6 gallons (13.5 liters) of water.

### 4.4 WaveWash 55 & Ecoworks Ratio

The WaveWash 55 Support Cleaning System comes in the Mojo 3D Print Pack, and is also sold separately. The WaveWash 55 system is used in conjunction with Ecoworks tablets.

One tablet will treat a WaveWash 55 carafe, or up to 1.3 gallons (5 liters) of water.

## Material Quick Reference

	STANDARD					ENGINEERING			HIGH PERFORMANCE					
	ASA	ABSplus	ABSI	ABS-M30	ABS-M30I	ABS-ESD7	Nylon 12	PC	PC-ABS	PC-ISO	PPSF /PPSU resin	ULTEM 9085 resin	ULTEM 1010 resin	
Mojo														
uPrint SE														
uPrint SE Plus														
Dimension 1200es SST														
Dimension 1200es BST														
Dimension Elite														
Fortus 250mc														
Fortus 360mc														
Fortus 380mc														
Fortus 400mc														
Fortus 450mc														
Fortus 900mc														
Support Structure	Soluble	Soluble, Breakaway <sup>1</sup>	Soluble	Soluble	Soluble	Soluble	Soluble, Breakaway	Soluble, Breakaway	Soluble	Breakaway	Breakaway	Breakaway	Breakaway	
Support Material	Soluble	SR30, P400-SR, ABS-Breakaway <sup>1</sup>	SR20	SR20, SR30	SR20, SR30	SR20, SR30	SR30	SR110	SR110, PC-Breakaway	SR20	PC-Breakaway	PPSF-Breakaway	ULTEM 9085 resin Breakaway	ULTEM 1010 resin Breakaway

<sup>1</sup> Dimension 1200es BST is only compatible with ABS-Breakaway support, Mojo, uPrint, and Fortus250mc are only compatible with SR-30; Dimension 1200es SST and Dimension Elite are only compatible with P400-SR.

# FDM SUPPORT REMOVAL

## CONTACT

For questions about the information contained in this document, contact Stratasys at [www.stratasys.com/contact-us/contact-stratasys](http://www.stratasys.com/contact-us/contact-stratasys).

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