



## OPERATING INSTRUCTION MANUAL

# Mark 3000 Silver Recovery Unit



Hallmark Refining Corporation  
1016 Dale Lane  
PO Box 1446  
Mount Vernon, WA 98274  
Phone 360/428-5880  
Toll Free 800/255-1895  
Fax 360/424-8118  
[www.hallmarkrefining.com](http://www.hallmarkrefining.com)  
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## **Statement of Warranty and Liability**

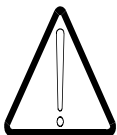
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## Attention!

### Important Safety and Regulatory Information



**TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE UNIT TO RAIN OR MOISTURE. TO PREVENT POSSIBILITY OF INJURY OR DAMAGE TO THE UNIT, DO NOT OPERATE WITH ANY COVERS OR PANELS REMOVED UNLESS INDICATED IN OPERATING INSTRUCTIONS.**

**Read and Follow Instructions** - Read and follow all safety and operating instructions before operating the unit.

**Heed Warnings** - Heed all warnings on the equipment and in the operating instructions.

**Power Sources** - The Mark 3000 should only be operated from the type of power source indicated on the label outside the unit. If there is uncertainty regarding the type of power supply that should be used, consult Hallmark Refining Corporation (HRC) or your local power company.

**Power Cord Damage** - Avoid damage to the power cord. If damage should occur, replace it with the specific cord for this unit.

**Power Cord Protection** - Power cords should not be routed so that they are likely to be walked on or pinched by items placed upon or against them. Particular caution should be paid to the security of the power cord at the three prong plug, receptacle and at the point where the power cord leaves the unit. The unit should be located near the proper power receptacle.

**Grounding** - The unit is equipped with a three-prong grounding type plug. If the unit will not plug into an existing outlet, contact an electrician to replace the outlet with a three-prong grounding type outlet. This is a requirement for safety and reliable operation.

**Attachments** - Do not use attachments that are not recommended. The use of non-recommended attachments may cause hazards and serious damage to the equipment.

**Dust** - Excessive dust levels may damage internal parts.

**Overloading** - Do not overload power outlets. This can result in a risk of fire or electric shock.

**Damage Requiring Service** - Unplug the unit from the wall outlet and refer all servicing to qualified service personnel under the following conditions:

- When the power supply cord or plug is damaged.
- If the equipment has been exposed to rain or water.
- If a unit does not operate normally by following the operating instructions. Adjust only those controls that are covered by the operating instructions.
- If a unit has been dropped or the housing has been damaged.
- When the system exhibits a distinct change in performance.

**Replacement Parts** - When replacement parts are required, be certain the service technician has used replacement parts specified by the manufacturer, or parts which have the same characteristics as the original parts. Unauthorized substitutions may result in fire, electric shock or other hazards.

**Safety Check** - Upon completion of any service or repairs to the unit, ask the service technician to perform safety checks to determine that the unit is in proper operating condition.

## **Regulatory Information**

The Hallmark Mark 3000 Silver Recovery Unit was designed to be operated with access to the inside components. Although a number of design features were incorporated to reduce the likelihood of injury, safe work practices should always be followed whenever working with the Mark 3000. There are NO USER SERVICEABLE PARTS under the protective top cover. Always follow workplace safety procedures as they pertain to electrical components, moving parts and chemical handling.

**DO NOT OPERATE OR SERVICE THE  
HALLMARK MARK 3000 SILVER RECOVERY UNIT  
WITHOUT READING THIS ENTIRE MANUAL FIRST.**

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## Introduction to the Mark 3000 Silver Recovery Unit

What is the Hallmark Mark 3000 Silver Recovery Unit?

The Hallmark Mark 3000 Silver Recovery Unit (Mark 3000) is designed for the treatment of silver-bearing solutions generated by film and paper processors. The Mark 3000 uses a precipitation method and patented equipment to recover silver to levels typically less than 1 mg/L (ppm).

The Mark 3000 concept is based on the use of TMT (trimercapto-s-triazine, trisodium salt), a chemical that forms an insoluble salt with silver. In the Mark 3000, TMT is used in a liquid form, available as Silver Recovery Solution (SRS) Part A. The precipitation reaction between SRS Part A and silver is enhanced by the application of an additional reagent; Silver Recovery Solution (SRS) Part B. SRS Part B promotes the size of the precipitate particles and enables a more efficient separation. As a result of this precipitation technology, silver can be economically recovered from photo processing solution overflows in a user friendly, continuous process, which consistently yields 99.9% recovery.

The Mark 3000 is designed to treat combined silver-bearing overflows directly from the film and paper processors at a near neutral pH. (If this process effluent contains small amounts of aluminum-hardened fixer, the use of a Mark 3000 in its standard form is not recommended. Call the Hallmark Customer Service Department for more information at 1-800-255-1895.) This technology can replace virtually all other silver recovery equipment, both primary and secondary. For example, if your recovery operation uses an electrolytic cell followed by metallic replacement cartridges, both systems can be replaced with a Mark 3000. The Mark 3000 is easier to use and it will produce lower and more consistent silver concentrations in the lab effluent.

The silver-rich sludge produced by this precipitation process is separated in a filter column. The sludge accumulates in the housing while the relatively (99.9%) silver-free liquid passes through the filter column and to the drain. When the filter column becomes filled with sludge, it is replaced with a new filter column using a clean, simple procedure. The sludge-filled column is then shipped to HRC for refining.

Because the Mark 3000 operates as a continuous process, it is highly automated. Typically, all that needs to be done is reagent tank refills and filter column changes. In general, the Mark 3000 requires less operator attention than other silver recovery equipment. This feature alone is a significant advantage, especially for small photo processors.

## Description

### Major components of the Hallmark Mark 3000 Silver Recovery Unit

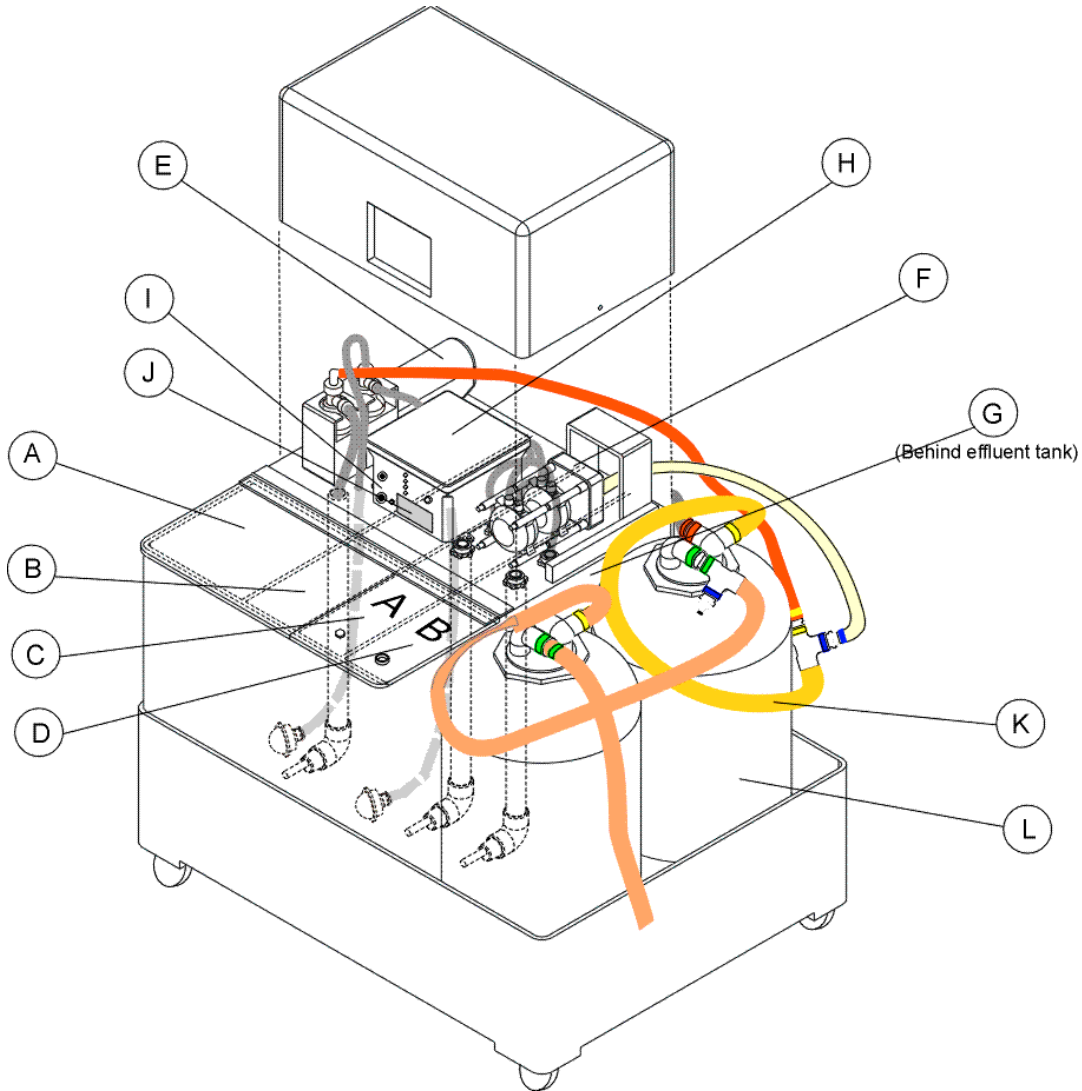


Illustration 1: The Mark 3000 Silver Recovery Unit and its components

#### **A – Effluent Collection Tank**

The Mark 3000 is equipped with a 10 gallon tank to collect silver-bearing solutions. The system will automatically turn off when there is 1 gallon remaining in the collection tank.

#### **B – Stabilizer Collection Tank**

The Mark 3000 is equipped with a 5 gallon tank to collect stabilizer. The system regulates the addition of stabilizer into the Effluent Collection Tank to maintain a consistent silver concentration. This tank also serves as an emergency overflow tank for the Effluent Collection Tank.

### **C – Reagent Tank A**

This tank holds approximately 4 gallons of Silver Recovery Solution Part A (SRS Part A). Under average conditions, this is sufficient to treat about 240 gallons of effluent.

### **D – Reagent Tank B**

This tank holds approximately 4 gallons of Silver Recovery Solution Part B (SRS Part B). Under average conditions, this is sufficient to treat about 120 gallons of effluent.

### **E – Pump 1**

This pump is a tandem bellows-metering pump, similar to replenishment pumps found on mini-lab processors. A single 110 V AC drive operates two different bellows, enabling a simultaneous, metered flow of process effluent and stabilizer. Additional pump information, including instructions for calibration, is provided in **Appendix D**.

### **F – Pump 2**

This pump is a double head peristaltic metering pump. A single 110 VAC drive operates both pump heads, enabling a simultaneous, metered flow of SRS Part A, and SRS Part B. This pump **does not** require periodic calibration. However, the hose inside each pump head should be replaced annually. Maintenance information can be found in **Appendix D**.

### **G – Pump Select Valve**

The Pump Select valve has two positions. When calibrating the double bellows pump, the valve is used to divert the flow into a graduated cylinder.

### **H – Controller**

The controller or circuit board is the brain of the Mark 3000 and enables the unit to operate automatically, with little need for operator interaction.

### **I – Pump Test Button**

When pressed, the Mark 3000 will stop all operations for 15 seconds, run both pumps for 60 seconds, pause for 15 seconds and then return to what it was doing before the button was pressed. This function is used to calibrate the double bellows pump.

### **J – Digital Display**

This display, located on the front of the electrical control panel, indicates the operating conditions the controller is reading. An interpretation of the digital display can be found in **Appendix F**.

### **K – Reaction Tube**

The three feet of tubing leading to the first filter provides time for the chemical reaction between the silver-bearing effluent and SRS Part A. SRS Part A is injected at the beginning of the length of tubing, at a tee originating from Pump 2. SRS Part B is injected at the top of the filter, at the end of the length of tubing, at a second tee originating from Pump 2. **There must not be any air bubbles in this line.**

**L – Filter Column**

This column is a capped fiberglass housing containing a filter element. It is equipped with inlet and outlet ports. The filter element in the column separates the silver rich precipitate from the treated effluent. When the filter column becomes filled with precipitate, it is removed and replaced with a new or recycled filter module. The inlet and outlet ports of the full module have quick disconnects that stop the flow of liquids. The filter column is shipped, as is, to Hallmark Refining for reclamation and replacement. A filter column has the capacity to collect 40-50 Troy Ounces of silver.

## How the Hallmark Mark 3000 Silver Recovery Unit Works

This section briefly describes how the Hallmark Mark 3000 Silver Recovery Unit works. Specific information on operating the unit is provided later in this manual.

Silver-bearing solutions to be treated by the Mark 3000 are accumulated in the collection tank. This effluent is pumped from the collection tank into the reaction tube at an approximate rate of 174 mL/min. As the solution enters the reaction tube, SRS Part A is injected at a rate of 3 mL/min. At this point, the silver precipitate begins to form. The three-foot long reaction tube provides the mixing and residence time to complete the initial reaction. Evidence of the reaction can be seen in the hose by the presence of fine yellow particles. In fact, at this phase of the process, the solution has the appearance of yellow milk.

As the solution enters the filter housing, SRS Part B is injected at a rate of 4 mL/min. The precipitate particle size increases almost immediately.

The filter separates the liquid from the solid phase, allowing the liquid to pass through the filter. The liquid stream will be essentially free of silver (typically less than 1.0 mg/L) and is discharged from the Mark 3000 to a drain. The silver-rich solid phase is collected as sludge in the filter column. Eventually, the filter column is filled completely with sludge and a new filter column will need to be installed. The filter column containing the silver-sludge is sent to Hallmark Refining for reclamation and replacement.

## Installing the Hallmark Mark 3000 Silver Recovery Unit

### Site Specifications

The best place to locate the Hallmark Mark 3000 Silver Recovery Unit depends on several factors; the availability of an electrical outlet, **an environment of at least 70° F**, accessibility to a drain, proximity to the film and paper process solution collection system and the amount of floor space available. A receptacle outlet should be installed near the equipment and should be easily accessible.

If the Mark 3000 is being used to replace existing silver recovery equipment, such as an electrolytic cell and/or metallic replacement cartridges, the space made available by removing that equipment is probably a good location for installing the Mark 3000.

If the Mark 3000 is being installed in a new lab, the following guidelines should be followed:

Decide which method will be used to add the silver-rich effluent (not developer overflows) to the silver recovery unit collection tank. The Mark 3000 is designed for direct connection from the processors or it can be filled by manually pouring the effluent into the collection tank. Locate the Mark 3000 near the processors if it is going to be directly connected to the silver-rich processor overflows (a hose can be routed from the processors to the Mark 3000 if this isn't possible).

To operate the Mark 3000, it is necessary to add two chemical reagents into the on-board tanks. As one of these requires dilution and mixing, a water supply will need to be accessible.

Aside from the floor drain and 110 VAC electrical requirements, access to the top and front of the Mark 3000 must be available during normal operation.

### Making the Connections

This section includes guidelines to connect process overflows to the Hallmark Mark 3000 Silver Recovery Unit.

The collection tank on the Mark 3000 is equipped with three ½" NPT x 3/8" hose barb fittings which are located on the back of the unit. If the silver bearing process overflows are going to connect directly to the Mark 3000, connect flexible PVC hose(s) to carry the process overflow to one or two of the barbed fittings and secure it with a clamp. Be sure the collection tank overflows are positioned so that gravity will carry the solution flow to the Mark 3000. Use the other barbed fitting to provide a controlled emergency overflow. This can be accomplished by connecting a length of PVC hose at the fitting and placing the other end into a plastic container. If, for some reason, the liquid level in the Mark 3000 collection tank rises too rapidly, the unit will overflow into the additional container.

The Mark 3000 requires one connection to a 110 VAC outlet. Before making the electrical connection, be certain that the power switch on the unit front panel of the unit is in the OFF position. A receptacle outlet should be installed near the equipment and should be easily accessible. Then, simply plug the power cord from the power supply box into the selected outlet, making sure that no one can trip over the cord.

*Note: The Mark3000 performs best when the effluent to be treated has a consistent pH and silver concentration. Fortunately, the combination of mini-lab silver-bearing effluents in “as replenished” proportions results in an ideal mixture for treatment by the unit. If solutions must be poured into the unit manually, a consistent mixture must be achieved. The stabilizer tank is designed to reduce variations in the effluent characteristics by slowly metering the stabilizer into the effluent collection tank. If silver bearing effluents are collected and poured manually into the silver recovery unit, be sure to put the stabilizer solution into the stabilizer tank. If a consistent effluent mixture is not used, it can adversely affect the economy and/or performance of the Mark 3000 recovery process.*



**Initial Start-up Procedures are to be performed only by Qualified Service Personnel.**

To set up the Mark 3000 Silver Recovery System, the following items will be needed:

1. The Mark 3000 processor
2. The Mark 3000 containment unit
3. At least 1 cubitainer of SRS Part A and 1 packet of SRS Part B
4. At least one filter column (Two are supplied with the unit and are recommended to assure environmental compliance.)
5. An easily accessible electrical outlet equipped with a GFI for a three-prong plug
6. A drain

Refer to **Site Specifications** in this manual for specifics on where to locate the unit in the photo lab.

*As with any chemical handling, use proper safety precautions, particularly as they relate to personal protective equipment. Complete information regarding the handling of these chemicals is provided in the Material Safety Data Sheets (MSDS) provided with each chemical. Review the MSDS before proceeding with the following steps.*

To assemble the Mark 3000 Unit, follow the procedure below:

1. Remove the containment unit from its package and install the swivel casters with the enclosed screws.
2. Place the Mark 3000 processor in the containment unit. The containment is designed so that the unit can be configured vertically or horizontally depending on space available.
3. Remove the top cover on the unit to familiarize yourself with the location of pumps, plumbing and electrical buttons, switches and alarm lights.
4. Remove any rubber bands from the four float switches in the collection tanks and make certain they operate freely.

5. Set a filter column in the containment unit.
6. Refer to the following hook up diagram for the filter columns. The columns are hooked up one after another by using color-coded quick disconnects. The Mark 3000 will operate with only one filter, but two are recommended for optimal performance.

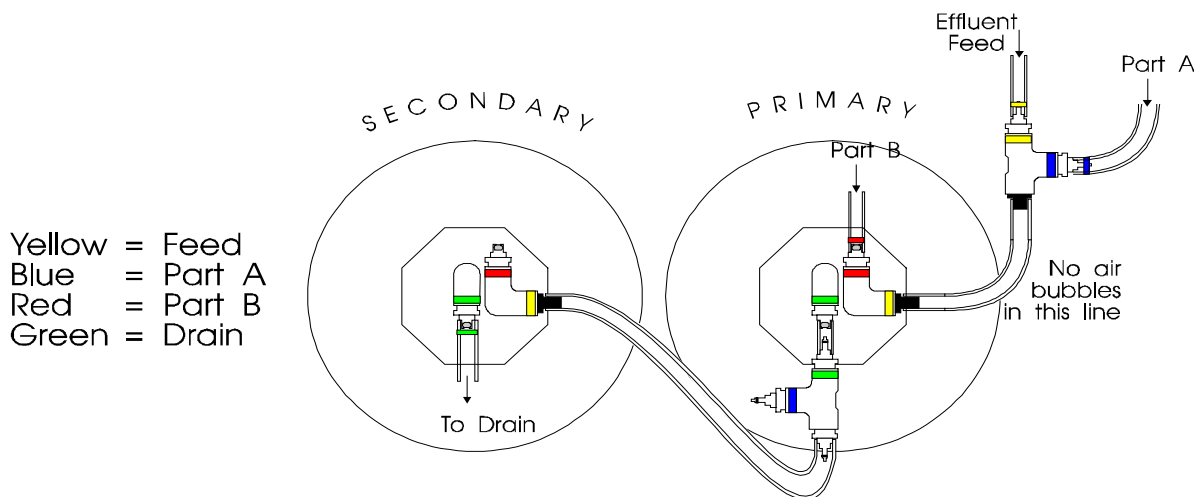


Illustration 2: Orientation and Hookup of the Filter Columns

7. Attach the chemical feed lines to the back of the Mark 3000 processor.
8. Attach an emergency overflow line to the back of the Mark 3000 processor, and run it to a suitable location.
9. Plug the unit into an electrical wall outlet. **Never “pull the plug” without turning off the power switch first.** The Mark 3000 is equipped with a circuit board for the automation of the unit. “Pulling the plug” without turning off the unit could damage the circuit board.
10. Turn on the power switch:
  - a) A momentary beep will be heard.
  - b) The LED lights will illuminate sequentially.
  - c) The ADD PART A and ADD PART B lights will come on along with the alarm. Press the Cancel Alarm switch. The red LED lights should stay on, but the beeper will stop. If this doesn’t happen, the machine is defective.
  - d) The program version number will be momentarily visible on the digital display.
  - e) If the float switches are not activated (there is no SRS in the tanks), the digital display will show **noA** .

11. Add the cubitainer of SRS Part A to the compartment labeled **A**. Do NOT remove the screw holding the A/B lid in place. The screw greatly reduces the chances of operator error and spillage. The SRS Part A is packaged ready-to-use in a 2-½ gallon cubitainer. To fill the Mark 3000 with SRS Part A, position the cubitainer, with spigot attached, on top of the unit so the flow of reagent is directed into the Part A tank. It has proven useful to attach a short length of tubing to the spigot to reduce the chance of spills or spatters. The empty tank will hold the entire contents of the cubitainer. The **ADD PART A** LED will go out. The **noA** display will become **nob**.
12. The SRS Part B concentrate is packaged in 10 mL packets. This concentrate must be diluted and carefully mixed for use. Complete instructions for mixing Part B are provided in **Appendix A**. The end result of the mixing will be a 2 ½ gallon container of working strength SRS Part B. This solution is then added to the Part B reagent tank in the same manner as described above for SRS Part A. The empty tank will hold the entire contents of the cubitainer. Do NOT remove the screw holding the A/B lid in place. The screw greatly reduces the chances of operator error and spillage. The **ADD PART B** LED will go out. When the float switches are activated (there is SRS in the tanks), the digital display will show the number of hours the bellows-metering pump has run.

*Note: SRS Part B has a shelf life of approximately one year. The packet has a born on date and should be discarded if the date exceeds one year from the born on date.*

13. Lift the float switch in the main holding tank for about 6 minutes. Both pumps will run, but only SRS Part A and B will be pumped. (At this point in time, the Stabilizer and Effluent Collection Tank should be empty.) When Parts A and B are observed entering the filter hose, release the float switch and add silver bearing effluents to the collection tanks. The Silver Recovery Solutions must be present at the quick disconnect fittings before any silver laden chemicals reach the filter. The digital display will alternately flash between **run** and the number of hours the bellows-metering pump has run.

*Note: Both pumps will continue to run for one minute after the main tank float switch is released.*

14. Turn the 3-way valve at the rear of the machine so that the pump output will go out the short hose. Momentarily press the "Pump Test" button on the front of the controller. When pressed, the Mark 3000 will stop all operations for 15 seconds, run both pumps for 60 seconds, pause for 15 seconds and then return to normal operation.
15. Place a graduated cylinder under the hose and measure the flow for the sixty seconds the pump will run. This test must be done at least three times to verify the pump output.
16. The pump was calibrated to 174 mL/min at the factory. This flow rate corresponds to an effluent silver concentration of 2100 mg/L (ppm). Refer to **Appendix C** to determine if your flow rate needs to be adjusted. The required pump output is determined by the silver concentration of the chemicals to be treated. Refer to the chart below for the proper flow rates. Additional calibration information is contained in **Appendix D**.

Silver Concentration in ppm	Pump Rate in mL/min	Minus Turns from Full Stroke
1800	203	1.5
1900	192	1.95
2000	183	2.3
2100	174	2.5
2200	166	2.7
2300	159	2.9
2400	152	3.1
2500	146	3.4
2600	141	3.6
2700	135	3.7
2800	131	3.9
2900	126	4.1
3000	122	4.3

Illustration 3: Calibration Reference Chart for the Mark 3000 Bellows Pump

*Note: This chart is also located on the underside of the pump cover.*

17. Once the pump is calibrated, replace the control box cover and turn the 3-way valve back to the normal position. The system is now ready for fully automatic operation.

After following the **Initial Start-up Calibration** outlined above and in **Appendix D**, the Mark 3000 will be ready to treat silver-bearing solutions. If a unit is installed to collect overflows directly from the processors, this flow can be directed to the Mark 3000 collection tank. Similarly, the Mark 3000 is now ready to accept solutions that are poured in manually. Remember to follow the guidelines specified previously regarding the preferred effluent mixture.

When the level in the collection tank rises above the low-level sensor, the pump will start automatically and the Mark 3000 will begin recovering silver without further intervention.



**CAUTION—Do not operate the pumps with the protective lid removed except during the calibration procedure.**

## Operating the Hallmark Mark 3000 Silver Recovery Unit

The Hallmark Mark 3000 Silver Recovery Unit design incorporates interlock control functions to ensure high performance of the system while minimizing operator involvement. This type of control permits automatic operation of the unit as long as certain process conditions are met. In the Mark 3000, the following five conditions are automatically signaled to the controller or circuit board:

1. Sufficient level in the SRS Part A tank
2. Sufficient level in the SRS Part B tank
3. System pressure below 12 psi
4. Sufficient level in the effluent collection tank
5. High level (alarm) in the effluent collection tank

The Hallmark Mark 3000 indicates the status of each of these conditions and will **NOT** operate if any of the first three conditions fail. For example, when the consumption of SRS Part A results in a low level in the reagent tank, the main pump will automatically stop and the red Add Part A light will illuminate. **noA** will be displayed on the digital monitor. In the case of a low-level condition, the pump will start again as soon as reagent is added.

If the system is shut down by high pressure, the red Change Filter LED will illuminate. **PrS** will be displayed on the digital monitor. The Mark 3000 must be turned off and then back on again to reset the high-pressure interlock. Normally, a high-pressure condition results from an accumulation of precipitate in the filter column. The main power must be turned off for at least thirty minutes before disconnecting the quick disconnects in order to replace the filter column to relieve pressure built up in the system.

Unlike the low-level conditions in the reagent tanks, the initial detection of a low level in the collection tank (the fourth condition above) does not immediately stop the pump. The unit will continue to operate for one additional minute. The level switch is located in the tank so that one-gallon of silver-bearing effluent remains in the collection tank when the unit is shut off. The one-minute delay prevents the pump from repeatedly starting and stopping during a refilling of the tank and helps assure that the mix of effluents remains as consistent as possible. If, after this one-minute delay period, the solution level is still below the low-level sensor, the pump will stop. Only the number of hours the double bellows metering pump has run will be visible on the digital display.

The fifth condition, a high level in the collection tank, might result if the unit is not operating and silver-bearing solutions continue to flow from the processors to the collection tank. If this condition did not have an alarm associated with it, there would be the potential for the loss of silver-bearing effluent to the drain from the collection tank overflow. In the event a high level of solution occurs, an audible alarm will sound. The digital display will read **T1F**. A high level of solution in the collection tank will not stop the pump. An extra collection tank may have to be added to accept any overflow.

The Mark 3000 circuit board or controller also contains a light-check procedure. When the machine is first turned on the alarm is momentarily sounded and each LED is turned on and off.

## Replacing the Filter Column

The Hallmark Mark 3000 Silver Recovery Unit Filter Column must be replaced when it becomes full with silver-TMT precipitate. When the filter column needs replacement, the **Change Filter** LED on the panel will turn on. This indicates that the system pressure has exceeded 12 psi. On the digital display, **PrS** will be visible. When the panel indicator LED is lit, the main pump automatically stops. The yellow precipitate in the module will have essentially filled the filter body.

When the **Change Filter** light comes on:

1. Turn OFF the power switch on the Mark 3000. **The main power must be turned off for at least thirty minutes before disconnecting the quick disconnects to relieve pressure built up in the system.**
2. Remove all four quick disconnect fittings from the filter modules. All of the quick disconnects are equipped with a shut off valve. This valve ensures the quick disconnects will only leak a drop or two. Have a paper towel ready to clean up these drops as they appear.
3. Lift the 1<sup>st</sup> column from the containment. This filter column is expired and should be boxed up and returned to Hallmark Refining with the appropriate paperwork found in the new filter column box. **DO NOT** disconnect the hose that is clamped to the filter. Be sure to place the foam on top of the column so it will not be damaged in shipping. Ship this filter column to Hallmark Refining for refining and replacement.
4. Slide the second filter to the first position.
5. Install a new filter column in the place where the 2<sup>nd</sup> column was.
6. Refer to Illustration 1 of this manual for the proper orientation of the filter columns on the Mark 3000 System.

*Note: A full filter module can weigh over 65 pounds. Safe lifting techniques must be used during this operation. Work close to the module in a comfortable position that does not stress your back.*

## Appendix A

# Mixing Instructions for Silver Recovery Solution Part B (SRS Part B)

The following items are needed to prepare the working strength solution of SRS Part B. All of these items are included the accessory kit supplied with a precipitation Silver Recovery Unit:

- Black & Decker Cordless Mixer, or equivalent.
- A 3 Liter plastic pitcher (DO NOT use the same pitcher used for mixing Sodium Carbonate rinse solution).
- A cold (60<sup>0</sup> F – 22<sup>0</sup>C or less) water supply.
- An empty 2 ½ gallon cubitainer or mixing vessel. (Do not use the cubitainer in which the SRS Part A was shipped unless it is rinsed thoroughly to remove ALL THE SRS Part A.)

To dilute SRS Part B concentrate to the proper working strength, follow the procedure outlined below. (Review the Material Safety Data Sheet for Silver Recovery Solutions before proceeding for the first time.)

Instructions:

1. Add approximately 800 mL of clean, **cold** (60°F/22°C or less) water to the pitcher. If more than this is added, it might spill out during mixing. *Note: If the ambient water temperature is higher than 60°F/22°C, add ice cubes to the water and allow them to melt, to cool the water. The temperature must be cool in order for the SRS Part B to mix properly.*
2. Cut open a 10 mL packet of SRS Part B concentrate\*\*\* and add the entire contents to the water in the pitcher.
3. Lower the whisk on the mixer into the water and start mixing at low speed.
4. Position the whisk in the pitcher so a big swirl is not created in the middle of the solution. Switch the mixer to high speed and mix for 2 to 4 minutes. This should leave a rather even consistency of a bluish mixture with no lumps, strings, or gobs.
5. Add the mixture to the empty 2 ½ gallon container. Add clean, cool water to increase the volume to 1 ½ to 2 gallons. Cap and shake well to mix thoroughly. The Part B solution is now ready for use in the precipitation unit. ***Note: The above procedure MUST be followed to mix the solution properly.***
6. **DO NOT** add the 800mL premix solution directly to the Part B reagent tank and then follow it with six Liters of water. *This method does **NOT** work.*

7. **DO NOT** try to mix the packet of SRS Part B directly into 1 ½ gallons of water without premixing it with 800 mL of water. *This method does **NOT** work.*

*Note: If the yellow precipitate is not clumping in large “scrambled eggs”, try mixing Part B using distilled bottled water.*

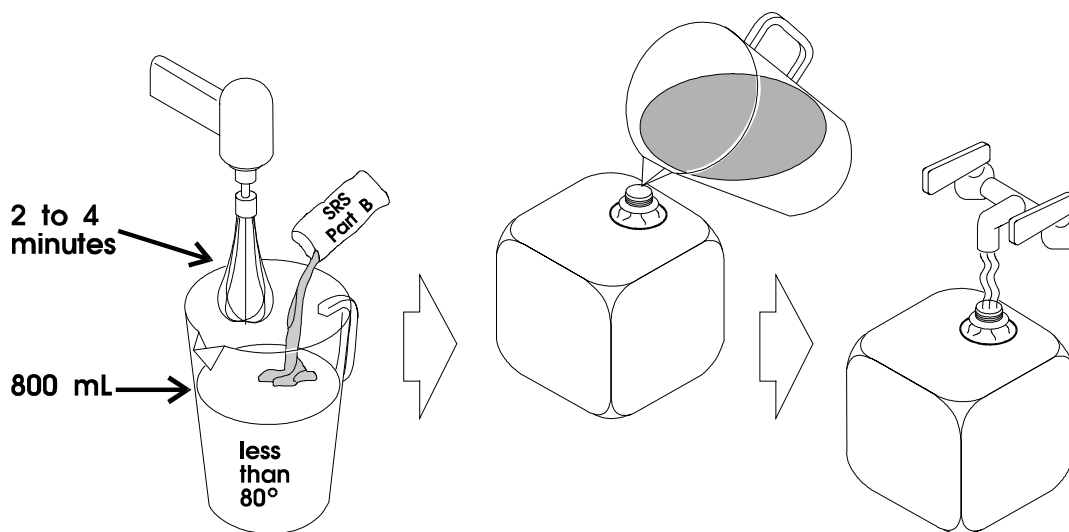


Illustration 4: Preparation of a working strength solution of SRS Part B

\*\*\*SRS Part B concentrate has a one year shelf life. The date on the packet is the “born on” or manufactured date. If the SRS Part B is more than one year old, it will not mix properly.

\*\*\*One packet of SRS Part B concentrate is enough to make a 2 ½ gallon working strength solution, however, research indicates that mixing a stronger concentration with less volume (i.e. 1 ½ to 2 gallons) will make your silver recovery equipment work more effectively. This will promote more “eggs” and less gobs and strings. Eggs are good. Eggs do not clog the filter.

## Appendix B

### Specifications for the Hallmark Mark 3000 Silver Recovery Unit

<b>Capacity</b>	De-silvers up to 45 gallons of effluent in a 24-hour period. (The practical capacity is 30 - 45 gallons per day as limited by the size of the reagent tanks and the filter module capacity.)	
<b>Dimensions</b>	<b>Height -</b>	38 inches
	<b>Width -</b>	32 inches
	<b>Depth -</b>	22 inches
<b>Weight</b>	<b>Empty -</b>	86 pounds
	<b>Full -</b>	310 pounds
<b>Connections</b>	<b>Feed -</b>	½" NPT to accept a variety of fittings (or solution is manually added to the collection tank)
	<b>Discharge -</b>	3/8" inch ID flexible tubing routed to the drain
	<b>Overflow -</b>	½" NPT to accept a variety of fittings
	<b>Power -</b>	3 prong grounded 110 V AC outlet
<b>Volumes</b>	<b>Feed Tank -</b>	9.8 gallons above the control level switch
	<b>Reagent Tanks -</b>	SRS Part A and SRS Part B: 3.9 gallons above the low-level switches
	<b>Stabilizer Tank</b>	5.7 gallons
<b>Access</b>	Hinged tank hatches, removable top cover. Unit may be positioned along walls in the back and on the left or right side.	
	<b>Portability -</b>	Mounted on swivel casters
<b>Site Specifications</b>	<b>Floor Space -</b>	Approximately 10 ft <sup>2</sup> (4-5 ft <sup>2</sup> footprint plus 5 - 6 ft <sup>2</sup> to allow access to the front)
	<b>Power -</b>	110 VAC, 60 Hertz, 15 amp service
	<b>Effluent Feed -</b>	Flexible tubing from the process overflow, or silver-bearing solutions are manually added from top
	<b>Unit Discharge -</b>	To drain where permitted
	<b>Emergency Overflow -</b>	To an overflow collection vessel

**Performance Specifications**

Recommended starting point flow rates in mL/min (pump calibration) for feed silver concentrations of approximately 2.1 g/L:

**Effluent Feed -** 174 mL/min (adjustable)  
**SRS Part A -** 3.0 mL/min (fixed)  
**SRS Part B -** 4 mL/min (fixed)

*Note: When the silver concentration varies from 2.1 g/L, the flow rate of the effluent feed may be adjusted for more economical operation. See Illustration for more details.*

**Supplies**

**Silver Recovery Solutions**

**Part Number**

**Silver Recovery Solution Part A**

2 ½ gallons ready to use

SRSPARTA

**Silver Recovery Solution Part B**

Ten 10 mL concentrated packets  
 (Each packet is enough to make 2 ½ gallons of working strength solution – approximately two packets of SRS Part B should be used for each 2 ½ gallon container of SRS Part A)

SRSPARTB

**Silver Recovery Filter Cartridge**

Each filter may treat up to 180 gallons of effluent

MK3000FILT

**Mark 3000 Accessory Kit**

The kit includes equipment to start and maintain the Mark 3000:

A cordless mixer, a 3 Liter pitcher, a 2.5 gallon container for mixing Part B, 2 quick-serve cubitainer taps, a graduated cylinder, a beaker, two sets of poppet valves, instructions for mixing Part B and tubing for peristaltic pump maintenance.

TMTACC3000

## Appendix C

### Determining the Effluent Feed Silver Concentration

It is vital to the proper operation of the Mark 3000 Silver Recovery Unit that the effluent feed silver concentration be determined and the flow rate be adjusted accordingly in order to ensure the discharged liquid stream will be essentially free of silver (typically less than 1.0 mg/L).

The following items are required to determine the effluent feed silver concentration:

- A 50 mL graduated cylinder with stopper
- A small squirt bottle filled with SRS Part A

Instructions:

1. Take a sample of the solution to be tested and place 48 milliliters of it into the graduated cylinder.
2. To be accurate, the temperature of the sample should be 78°F plus or minus 2 degrees.
3. Add 2 milliliters of the SRS Part A, using the small squirt bottle to bring the total volume to 50 milliliters in the graduated cylinder.
4. Place the stopper in the graduated cylinder. Invert and shake the solution rapidly for 60 seconds. Be careful not to hit anything while shaking.
5. Place the graduate on a level, vibration free shelf and let it settle for 15 or 30 minutes. At the exact moment when time has expired, read the level of sludge in the graduate. Use the table below to convert the measurement to a silver concentration reading. This procedure is accurate to within +/- 200 mg/L (ppm).

Sludge Level	After 15 minutes Silver in mg/L (ppm)	After 30 minutes Silver in mg/L (ppm)
3 mL	600	700
4 mL	750	975
5 mL	925	1200
6 mL	1100	1400
7 mL	1275	1600
8 mL	1425	1800
9 mL	1575	1925
10 mL	1700	2050
11 mL	1850	2200
12 mL	1925	2300
13 mL	2000	2450
14 mL	2075	2650
15 mL	2150	2850

Illustration 5: Determination of the Effluent Feed Silver Concentration

*Note: If too much sludge is present after the proper waiting time, retest using 24 ml of sample, 24 ml of water and 3ml of test agent. Determine the silver content of the solution being tested and multiply results by two for final reading.*

**The temperature, amount of agitation and timing will directly affect the ability to obtain an accurate reading.**

The Mark 3000 performs best when the effluent to be treated has a consistent pH and silver concentration. Fortunately, the combination of mini-lab silver-bearing effluents in “as replenished” proportions results in an ideal mixture for treatment by the unit. If solutions must be poured into the unit manually, a consistent mixture must be achieved. The stabilizer tank is designed to reduce variations in the effluent characteristics by slowly metering the stabilizer into the effluent collection tank. If silver bearing effluents are collected and poured manually into the silver recovery unit, be sure to put the stabilizer solution into the stabilizer tank. If a consistent effluent mixture is not used, it can adversely affect the economy and/or performance of the Mark 3000 recovery process.



**Since silver recovery reagents and photo chemicals are handled during the previous steps, use proper personal protective gear, including approved safety goggles and gloves.**

## Appendix D

### Calibrating & Maintaining the Pumps

**The following procedures must be performed by Qualified Maintenance Personnel.**

The first pump is a tandem bellows-metering pump, similar to the replenishment pumps found on mini-lab processors. A single 115 VAC drive operates two different bellows, enabling simultaneous, metered flow of effluent through the Mark 3000 Silver Recovery Unit and gradual stabilizer addition to the effluent collection tank.

The flow rates delivered by this pump are determined by the pump drive motor speed (rotations per minute, RPM), the size of the bellows, and the length of the bellows stroke. The large bellows should be preset to operate at or near 115 mL/minute. The small bellows is set at 100 %.

The reagents are pumped using a second pump. This pump is a tandem peristaltic pump. The flow rate of this pump is fixed. The Part A is metered at approximately 2 mL/min and the Part B is metered at approximately 4 mL/min.

### Initial Start-up Calibration

The recommended flow rates at initial start-up are:

Effluent Feed -	174 mL/min
SRS Part A -	3.5 mL/min (fixed)
SRS Part B -	4 mL/min (fixed)
Stabilizer Feed -	100% of stroke

The Mark 3000 is preset to treat effluents that have a silver concentration of no more than 2.1 grams per liter (2100 ppm or 2100 mg/L). If you know the highest silver concentration that will be treated, use the table below to set the output of the effluent feed bellows.

Silver Concentration in ppm	Pump Rate in ml/min	Minus Turns from Full Stroke
1800	203	1.5
1900	192	1.95
2000	183	2.3
2100	174	2.5
2200	166	2.7
2300	159	2.9
2400	152	3.1
2500	146	3.4
2600	141	3.6
2700	135	3.7
2800	131	3.9
2900	126	4.1
3000	122	4.3

Illustration 6: Calibration Reference Chart for the Mark 3000 Bellows Pump

If you do not know the silver concentration of the effluent, it can be determined by following the instructions outlined in **Appendix C**.

The flow rate of the bellows can be verified by the following procedure:

1. Place a 250mL graduate under the test hose on the back of the Mark 3000.
2. Press the “Pump Test” button on the front of the controller.
3. Turn the 3-way valve to divert the flow into the graduate.
4. When the pump stops running, turn the 3-way valve to the normal operating position.
5. Read the amount of liquid collected in the graduate.
6. Pour the collected liquid back into the Effluent Collection Tank.
7. Repeat this procedure at least three times to verify it is an accurate reading.



**Since the reagents during the previous steps may have to be handled, use proper personal protective gear, including approved safety goggles and gloves.**

## **Adjusting the Stroke Rate of the Effluent Flow**

If the silver concentration of the effluent to be treated is higher or lower than 2100 ppm, the flow rate of the effluent can be adjusted by following the procedure outlined below:

1. Disconnect the electrical power and remove the front cover on the pump.
2. With the screwdriver, turn the bellows stroke adjustment screw clockwise until it can be turned no further. At this time, the stroke rate should be at 100%. Turn the screw counter-clockwise the indicated number of turns to decrease the flow rate to the proper output. Use the chart as indicated in Illustration 5 as a guide.

*Note: The higher numbers on the scale correspond to higher flow rates.*

3. Depending on the position of the adjustment screw on the crankshaft, the pump motor may need to be “bumped” to rotate the screw to a more accessible position. Manually rotate the crankshaft to a more accessible position so the stroke rate can be adjusted.
4. Replace the pump cover and then reconnect the electrical power. Measure the new flow rate using the procedure outlined above. When calibrating the effluent rate, several adjustments may need to be made to fine-tune the flow rate.



**CAUTION—Before removing the protective cover of the pump or adjusting the bellows stroke length, always disconnect the electrical power from the Mark 3000. Press the power button on the front panel of the unit to turn the system OFF. Do not operate the pump with the protective cover removed except during the calibration procedure.**

## Maintenance

The bellows pump utilized in the Hallmark 3000 Silver Recovery Unit does not require routine maintenance. Nevertheless, the valves may have to be cleaned or replaced on occasion if pump problems occur.

The peristaltic pump utilized in the Hallmark 3000 Silver Recovery Unit only requires annual replacement of the pump hoses.



**CAUTION—Before working on the pump, always disconnect the electrical power from the Hallmark Mark 3000 Silver Recovery Unit. Turn the system off at the power switch on the front panel of the unit. Do not operate the pump with the lid removed except during the calibration procedure.**

The double bellows pump is equipped with poppet valves to prevent back flow, maintain prime, and ensure pumping accuracy. Poppet valves and O-rings are installed in all four clear elbows to pump the effluent and stabilizer solutions.

### Tools Needed:

- Screwdriver
- Small plastic beaker or container
- Absorbent material for solution drips and minor spillage

## Poppet Valve Removal—Effluent Bellows

1. Verify that the power to the unit is off. Remove the pump cover.
2. Disconnect the elbow at the pump head inlet. The tubing should not have to be disconnected from the elbow. Hold a plastic container underneath to catch any effluent, which might drip from the tubing or the pump head inlet. The inlet poppet valve can be easily removed using thumb and forefinger (with a protective glove). In this way, the O-ring will be removed along with the poppet valve.
3. Disconnect the elbow at the pump head outlet. Be careful to contain any spillage, which might result and promptly clean up any spills that occur. Remove the poppet valve and O-ring by inserting a small screwdriver into the inlet of the bellows body, and gently guide the poppet valve upward. Be careful not to damage the poppet valve or the O-ring behind it.
4. Inspect the poppet valves and O-rings for particulate matter, deformation, cuts, or nicks which might prevent the valve from sealing or seating properly. The poppet valves should be washed with hot soapy water to cleanse them. If they appear to be defective, they should be replaced before reassembling the pump.

5. Re-install the poppet valves and O-rings. Reconnect the elbows. Be sure that the poppet valves and the O-rings are in the correct direction while securing the threaded connections to ensure an adequate seal. Refer to the diagram below for the proper poppet valve orientation.

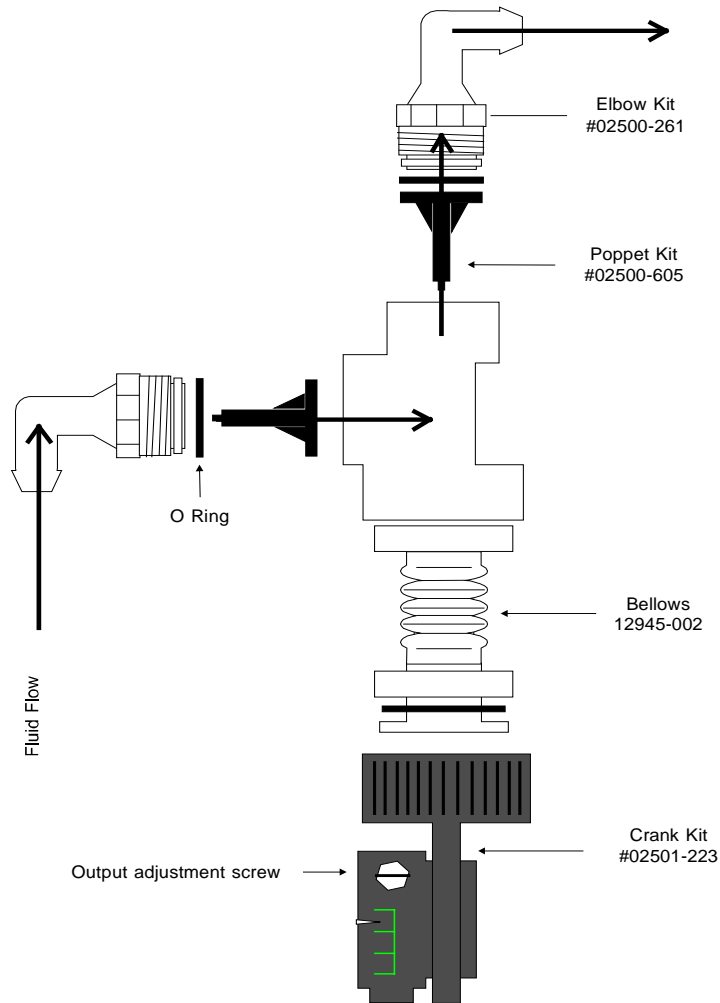


Illustration 7: Poppet Valve Orientation of the Bellows Pump

*Note: Any spillage that was collected during the valve maintenance procedure to the feed tank may be poured back into the holding tank if it is kept pure. However, if the effluent and reagents are mixed or contaminated during collection, they should be disposed of.*

## Replacing the Tubing on the Peristaltic Pump

The peristaltic pump utilized in the Hallmark 3000 Silver Recovery Unit does not require regular maintenance. However, the squeezing motion of the pump will eventually wear the tubing out if it is not replaced **annually**. Sections of this tubing are supplied with the Mark 3000 Accessory Kit. **Replace both tubes at once; even if only one tube appears to be problematic.** Additional tubing can be purchased from Hallmark Refining Corporation at 1-800-255-1895.

Follow the instructions outlined below:



### TURN THE POWER OFF AND UNPLUG THE UNIT!!

1. Using a magic marker, label the right hand side of both pump heads as the inlet.
2. Unscrew the four wingnuts holding the pump heads in place onto the motor and slide the pump heads off the bolts.
3. Separate the pump halves. Hold the pump head as shown in Figure 1, with the rollers in the 2, 6, and 10 o'clock positions.
4. Wrap the tubing around the rollers as shown in Figure 1.
5. Pull the hose tight over the rollers and guide the tubing deep into the cavity as shown in Figure 2.
6. Place the second half of the pump on the rotor shaft.
7. Squeeze the halves together simultaneously until the pump halves are touching on all sides. Be careful not to pinch the tubing between the halves.
8. While grasping the assembled pump in one hand use a flat blade screwdriver to rotate the rotor shaft. The shaft should turn freely with a lumpy feel.
9. Line-up the rotor shaft with the gear motor shaft and slide together.

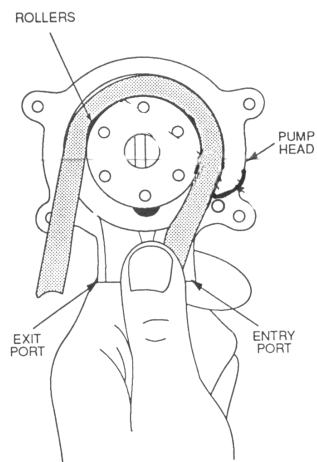


Figure 1. TUBING START POSITION

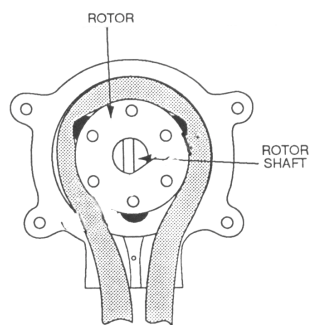


Figure 2. TUBING LOADED

Illustration 8: Replacement of the Tubing on the Peristaltic Pump

## **Appendix E**

### **Troubleshooting Reference Numbers**

Contact Hallmark Refining Corporation for replacement filter cartridges, silver recovery solutions, refining information, Material Safety Data Sheets, technical support or shipping documents and containers.

Hallmark Refining Corporation  
1016 Dale Lane  
Mount Vernon, WA 98274  
Phone: (800) 255-1895 or (360) 428-5880  
Fax: (360) 424-8118  
[www.hallmarkrefining.com](http://www.hallmarkrefining.com)

Contact Computrol Manufacturing Corporation for warranty service, spare parts and equipment related questions.

Computrol Manufacturing Corporation  
6290 147<sup>th</sup> Avenue North  
Clearwater, FL 33760  
Phone (727) 532-0878  
Fax (727) 532-0440

Contact Chemtrec with any questions regarding emergency health and safety information for Silver Recovery Solutions or silver sludge.

Chemtrec  
Phone: (800) 424-9300 or outside the U.S. (703) 527-3887

The following table is provided as a general troubleshooting guide. If additional assistance is required, please refer to the above list of telephone numbers.

## Hallmark Mark 3000 Silver Recovery Unit Troubleshooting Guide

Condition	Possible Cause	Possible Solution
The unit does not operate	Power cord is not plugged in.  Main switch on Mark 3000 is in the OFF position.  Circuit breaker is tripped.	Verify that the cord from the power supply is plugged into a functional 110 VAC power outlet.  Toggle the power switch on front panel of unit to ON position. The alarm should make a short beep and the LED's should light sequentially.  Reset the circuit breaker.
The unit does not operate. The LEDs sequenced properly when power was applied.	Solution level in the effluent collection tank is low.	This is part of normal operation. Corrective action does not need to be taken. The low sensor automatically shuts down the Mark 3000 when there is about 1 gallon remaining. The digital display will show the number of hours the double bellows pump has run.
The unit does not operate. The Main Power switch is on.	Part A Low LED is lit (stopping the system). The digital monitor reads <b>noA</b> .  Part B Low LED is lit (stopping the system). The digital monitor reads <b>nob</b> .	Add SRS Part A.  Add SRS Part B.
The pump is operating, but flow through the unit seems to be reduced.	The strainer on the pump suction line in the collection tank is plugged.	Clean the screen. Be sure to follow recommended safety procedures related to chemical handling. The strainer should be able to be cleaned without removing it, but be very careful not to damage the nearby float switch. If frequent plugging occurs, the collection tank may need to be cleaned periodically.

Condition	Possible Cause	Possible Solution
<p>The pump is operating, but flow through the unit seems to be reduced. (Continued)</p>	<p>There is a precipitate plugging a connector or tubing.</p> <p>The effluent bellows is not operating properly.</p>	<p>Do a pump calibration test to verify flow rate is reduced from the pump. If this is the case, determine what caused the flow reduction. See <b>Appendix D</b>.</p> <p>Remove and examine the poppet valves in the bellows pump head. Clean the valves with hot soapy water to remove any particles, which could prevent proper seating of the valve.</p>
<p>There is not much yellow precipitant in the line leading to the Mark 3000 Filter.</p>	<p>The silver level of the untreated effluent is low.</p> <p>The effluent being treated is not a consistent mix. The silver content varies over a wide range.</p> <p>The SRS Part A, SRS Part B, or effluent pump is not delivering the proper dosage.</p>	<p>The Mark 3000 performs best when treating a consistent silver concentration. Over replenishment can cause low silver levels. Dump large portions of stabilizer into the proper holding tank. In this way the stabilizer tanks that are periodically dumped will be treated by the Mark 3000, and blended into the main tank solution gradually with the other overflows.</p> <p>The Mark 3000 performs best when the effluent is consistent in both pH and silver content. If possible, plumb the processor overflows directly to the Mark 3000. If solutions are added manually, avoid adding large volumes of any one solution.</p> <ol style="list-style-type: none"> <li>1. Check for kinks or bends in the delivery hose.</li> <li>2. Make sure the quick disconnects are fully inserted.</li> <li>3. Replace the pump hoses.</li> </ol>

*Note: The LED lights should flash on and off by raising or lowering the corresponding float switch. If it does not, there is a problem with the circuit board wiring or float switch.*

Condition	Possible Cause	Possible Solution
<p>There is not much yellow precipitant in the line leading to the Mark 3000 Filter. (Continued)</p>	<p>The solution being treated contains components not compatible with treatment by the Mark 3000.</p>	<p>Except in rare cases, developers should not be included in the effluent to be treated. Be sure that the processor discharge lines are properly labeled. Hardened fixers containing aluminum salts, such as the RA-3000 and RP X-OMAT fixers, are incompatible. The aluminum rapidly plugs the filter.</p>
<p>High pressure (<b>PrS</b>) is indicated, but the filter column is not full.</p>	<p>Faulty pressure switch.</p> <p>The reactor coil is plugged.</p> <p>The filter is plugged.</p>	<p>Call Computrol @ 727/532-0878 to order a new one.</p> <p>Check for tubing kinks, particularly at the inlet and outlet of the filter column. Look for blockages of yellow or white precipitate.</p> <p>Replace the filter module. Verify that the flocculated precipitate is formed before entering the filter module. Very small or little visible precipitate will or can cause premature plugging of filters. Refer to previous troubleshooting title: "There is not much yellow precipitant in the line leading to the Mark 3000 Filter."</p>

*Note: Even small reductions in SRS Part A can have a significant effect on the final silver concentration of the treated effluent. Although the adjustment represents the typical relationships between dosage and performance, the characteristics of your effluent may differ somewhat. Therefore, make the reductions in dosage in small increments and allow enough time to observe the effect of any change.*

*Note also that the final silver concentration tends to be higher following the installation of a new filter cartridge. The concentration then falls as the sludge level builds up in the module. Eventually, the sludge itself helps remove any fine precipitate particles, which may be suspended in the mixture.*

Variations in operating conditions and in solutions treated may affect performance of the Hallmark Mark 3000 Silver Recovery Unit. Hallmark Refining Corporation cannot control how the unit is used, and cannot be held responsible for its performance. However, a properly operated unit can achieve effluent silver concentrations that range generally less than 1 ppm.

## Appendix F

### Interpreting the Display

The three character digital display on the front of the electrical control panel monitors the Mark 3000 Silver Recovery Unit.

<b>run</b>	Indicates the pump is running normally and all conditions are satisfactory.
<b>123</b>	A three digit number indicating the number of hours the double bellows metering pump has run since it was last reset.
<b>noA</b>	Indicates the SRS Part A tank is empty. The system will not run until SRS Part A is added.
<b>nob</b>	Indicates the SRS Part B tank is empty. The system will not run until SRS Part B is added.
<b>PrS</b>	Indicates there is high pressure present in the system. <u>Normally</u> , a high-pressure condition results from an accumulation of precipitate in the filter column. Refer to the troubleshooting guide of this manual for more information.
<b>T1F</b>	Indicates the main holding tank is too full. The top float switch was activated. When this condition is present, the pump will continue to operate, but an alarm will sound.
<b>Err</b>	Indicates the top float switch started the pump. When this condition is present, the pump will continue to operate, but an alarm will sound. When the solution level has dropped, the bottom float switch must be investigated, as it is not working properly.

Under normal operating conditions, the digital display will alternately flash between **run** and the hour meter for the double bellows-metering pump.

When there is not sufficient effluent to activate the Mark 3000 to run, the digital display will show the hour meter for the double bellows-metering pump ONLY.

### Resetting the Hour Meter

Press and hold the "Pump Test Button" until a beep is heard. The hour meter will return to 000 and the pump test will be aborted.

**Hallmark Refining Corporation  
1016 Dale Lane  
Mount Vernon, WA 98274  
Phone (800) 255-1895  
Fax (360) 424-8118  
[www.hallmarkrefining.com](http://www.hallmarkrefining.com)**

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