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	Emptying, Cleaning, and Refilling of the Computer Controlled Flow Simulator		
	Investigator: Jan Markowski	Location:	Revision: 00

1.0 PURPOSE:

Proper maintenance measures should be taken to ensure the safe operation, performance, and high accuracy of the Computer Controlled Flow Simulator (CCFS) used in the calibration of clinical devices and the study of vascular haemodynamics.

2.0 SCOPE:

The emptying, cleaning, and refilling of the UHDC Flow System are manual processes that are performed on location of the system. The system is comprised of a variety of electrical components controlled by CompuFlow v2.15 software. It is suggested that the user of the system be familiar with the software in order to execute these procedures. How to use the software will not be outlined.

3.0 RESPONSIBILITIES:

An individual with working knowledge of the hazards associated with electricity should perform this procedure.

4.0 DEFINITIONS:

CCFS – Computer Controlled Flow Simulator

CompuFlow – software that allows the control of various electrical components to set specified flow rates

Drain ports – external openings located beneath the cylindrical pump used for draining fluid

Piston – the black cylinder in the pump that is responsible for the flow of fluid

Reservoir – the container used to hold excess fluid located behind the IO button

Tray – the slide-out piece whereby all components of the UHDC Flow System are attached

5.0 REFERENCES:

Holdsworth, D. W., D. W. Rickey, et al. (1991). "Computer-controlled positive displacement pump for physiological flow simulation." Medical & Biological Engineering & Computing **29**(6): 565-70.

6.0 MATERIALS AND EQUIPMENT:

6.1 MATERIALS

- Glycerol
- Water (distilled)

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6.2 EQUIPMENT

- UHDC Flow System
- 3/16" PVC tubing
- Absorbent cloth
- Empty storage container.

7.0 PROCEDURES:

⚠ **WARNING:** Electrical equipment can be hazardous if misused. Wait 10-15min after shutting down the UHDC system to allow time for the large capacitors to dissipate stored voltage. Anything marked with yellow tape has high voltage and current and should be avoided.

None of the internal components are moved or controlled manually. All references to the control of flow rates are done using the CompuFlow software. Use 3/16" PVC tubing for all connections unless otherwise specified.

7.0.1 START UP

Make sure that the tray is completely inside the encasement and that the front panel is secured with screws before turning ON the UHDC Flow System.

1. Press the IO switch on the front panel. This will start the magnetic stirring mechanism located behind the IO switch just below the reservoir.

7.0.2 EMPTYING

The external hose assembly is numbered in order. Tube piece #1 is connected to the OUT port. There are two stages involved with emptying the contents in the UHDC Flow System. Stage one removes most of fluid from the system. Stage two removes remnants of the fluid.

A. STAGE ONE

1. Remove screws in the corners of the front panel.
2. Turn ON the CCFS. Wait a few moments for everything to load.
3. Place an absorbent cloth under the OUT port.
4. Remove the hose from the OUT port and promptly point the hose upwards to avoid causing a spill. The fluid will begin to flow back into the reservoir.
5. Drain the hose assembly piece by piece. Be cautious to avoid damaging the flow meter during this step.
6. Once everything is drained, disconnect the tubing from the IN port.
7. Connect tube piece #1 into the OUT port and lead it into a clean and empty 2L container.
8. Start a steady flow rate of 5-10mL/s. Allow for the piston to complete a couple of cycles (until no more fluid is emptying).
NOTE: Listen for a click sound. This will indicate that the piston has reversed direction.
9. Press F1 to stop the flow rate.

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B. STAGE TWO

1. Slide out the tray.
2. Place an absorbent cloth under the two drain ports.

△WARNING: Be careful not to spill any of the fluid on the electrical components. Doing so may damage the CCFS and could cause injury.

3. Connect two small PVC tubes together. Connect each end of the combined tube to a drain port. Perform the connections quickly to avoid causing a spill.
4. Lead the connection interface of the combined tube into an empty storage container. Disconnect the interface. The leads should be inside the container.
5. Start a steady flow rate of 5-10mL/s. Allow for the piston to complete a couple of cycles (until no more fluid is emptying).

NOTE: Listen for a click sound. This will indicate that the piston has reversed direction.

6. Press F1 to stop the flow rate.
7. Disconnect the connectors between the pump and the valve. Connect larger PVC tubing to the pump leads. Lead this tubing into an open air space so that it may freely draw in air.

△WARNING: Never disconnect the pump-valve connection when the reservoir or pump is full. This will cause the fluid contents to explode on the circuitry and will permanently damage the flow system and could cause a serious injury to the user.

8. Connect PVC tubing to the drain ports. Lead this tubing into an empty storage container.
9. Start a steady flow rate of 5-10mL/s. Allow the piston to complete one cycle.
10. Press F1 to stop the flow rate.
11. Label the container with the name of the fluid and the date it was made.

7.0.3 CLEANING

A. PUMP

1. Move the piston to one end of the pump.
2. Attach PVC tubing to the drain port closest to the piston. Lead this tubing into an empty storage container.
3. Lead the pump connector closest to the piston to a water faucet with PVC tubing.
4. Let water flow for several seconds.
5. Repeat steps 2-4 with the piston on the other end of the pump.
6. Remove all tubing and place drain plugs back into the drain ports; Reconnect everything as it was.

B. VALVE

1. Remove valve from pump using an allen key. Three screws attach it.
2. Remove the valve from the manifold.
3. Place the valve upside down on a counter.

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4. Unscrew the pegs and screws from the valve. (make a note of where everything goes)
5. Disassemble the valve into its pieces.
6. Clean each piece.
 - **Solenoid pieces** (black) – clean inside with soap and water.
 - **Seals** (black) – clean with soap and water. One seal is found at each piece interface including the manifold.
 - **Valve piece** (teal) – Take out and clean the plastic piston-centering cups with water. Remove and clean the piston with varsol. Clean all crevices and holes of the valve with soap, water, sandpaper and other tools that will aid in the cleaning process.
NOTE: The piston is the **ONLY** piece that is to be cleaned with varsol.
 - **End pieces** (teal) – Clean all crevices and holes with soap, water, sandpaper and other tools that will aid in the cleaning process.
7. Clean the manifold in the same manner as the valve piece.
8. Check the screws that attach the valve to the manifold. If there are any signs of rust, apply WD-40 to the rust and oil on the screw. Use a tap to clean out the screw holes if there are any signs of dirt. This is very important because the valve must be firmly sealed on the manifold.
9. Assemble the valve back together.
10. Tightly secure the valve back on the manifold. Remember to place the seal at the interface.

7.0.4 REFILLING

1. Fill an external container with 2L of fluid.
2. Ensure that the hose assembly is connected to the OUT port.
NOTE: A hose/connector assembly must be inserted into the OUT port prior to executing the **FILL** option. If this is not done, the over-pressure shut-off may be triggered as the piston moves toward the home limit switch.
3. Ensure that the free end of hose assembly is inserted into the external container.
4. Select the **FILL** option from the control menu.
5. You will be asked if you want to exit the fill option. If you are ready to fill the reservoir and the pump, select **NO**.
6. Fill the pump and reservoir. In the reservoir, allow for the fluid to fill just past the capacity line before the overflow port.

7.0.5 STORAGE

In order to clean and extend the lifetime of the components, a mix of a glycerol/water fluid should be stored inside the pump when not in use.

1. Mix 2L of 40% glycerol and 60% water by weight. The density of glycerol is 1.261 g/mL. The density of water is 1.000 g/mL.
2. Refill the pump with the glycerol/water mix. (Section 7.0.4: Refilling)

7.1 RISKS TO PERSONNEL AND PRECAUTIONS FOR RISK REDUCTION:

- 7.1.1 Large internal capacitances exist on the CCFS. These capacitances can be dangerous if they are tampered with shortly after powering down a system. Let

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the energy dissipate by allowing the UHDC system to rest for 10-15 minutes after shutdown.

7.1.2 Wearing an anti-static bracelet can help discharge any static electrical buildup on your body that could potentially damage any internal electrical components on the CCFS.

7.2 CONTINGENCIES:

7.2.1 PUMP BREAKDOWN

Contact a technician to help repair problem.

8.0 REPORTING AND DOCUMENTATION:

N/A

9.0 REVIEWS AND REVISIONS:

This procedure shall be reviewed for compliance and effectiveness and revised as necessary.

10.0 ATTACHMENTS

ATTACHMENT A. BMF-US(Jet-Dry)

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