The PPE required for the procedure are safety glasses, gloves, long pants, and lab coats. This PPE will be sufficient for all stages of the bench-scale operation. First, the pump will be turned on and the 20ppm orthophosphate solution will be run through the RO unit from 20 liters of solution down to 1 L of solution at approximately 41 ml/min on the dirty side. The dirty water and the clean water exiting the RO unit will be collected in separate containers, depending on the membrane performance the one liter of dirty water should be around 260 ppm orthophosphate. This will take a total of about 45 minutes. Next, 0.211 grams of ammonium chloride will be added to the dirty water from the RO, and NaOH will be added to this solution until the pH reaches 8.5 (This starting pH is still being explored and may be lowered to 7.5 at the competition). This solution will be poured into the plug flow reactor up to 0.5 liters. The reactor will be turned on to 3V (Current will be less than 150 mA and will fall over time) and allowed to sit with the solution stagnant for 10 minutes. From there, the inlet and outlet peristaltic pumps will be turned on and run via at a flow rate around 20 mL/min. The reactor will be run until all of the solution has passed through which should take about 1 hour. Once all of the solution is removed from the reactor, the power source will be turned off. Now the 1 L of solution will be run through filter paper over a vacuum flask to collect the solid struvite particles on the filter paper. It should take 10 minutes to empty the reactor onto the filter paper and then another 10 minutes to dry the struvite through vacuum filtration.

Stepwise Procedure:

1. Turn on centrifugal pump to pump the 20 ppm orthophosphate solution from its container to the RO unit and set a back pressure of 60 psi for the RO unit using an attached ball valve.
2. Collect clean RO outlet stream in a container capable of holding 19 L of water and recycle the dirty outlet back to the container holding the feed to the RO unit.
3. Run RO unit until 1L remains of retentate, then turn off the pump to stop flow to the RO unit.
4. Add 0.211 grams of Ammonium Chloride to the 1L of retentate.
5. Using a pH meter and sodium hydroxide, bring the pH up to 8.5 for the retentate forming the completed reaction mixture.
6. Pour the 1L solution into the plug flow reactor until there is 0.5 L in the reactor.
7. Turn on the power source and set the voltage to 3V. Let this run without any flow for 10 minutes.
8. Pump the solution from the remaining 0.5 L of feed through the reactor at 20 ml/min.
9. Continue operation until no more feed remains and the reactor is nearly empty of solution.
10. Once all of the 1 L solution has been pumped into the reactor turn off the pumps for the reactor inlet and outlet.

11. Turn off the power source
12. Collect contents remaining in the reactor with the reactor outlet.
13. Slowly pour the reactor product solution into the vacuum filter until all of the solution has been filtered.
14. After all solution has been filtered keep the filter paper on the vacuum filter to force air through through to dry the struvite for 10 minutes.
15. Turn off the vacuum filter
16. Remove the filter paper from the filter and scrape the precipitate off of the filter paper into a small container such as a centrifuge tube.

The ammonium chloride, sodium hydroxide, and dihydrogen ammonium phosphate used for the experiment will be purchased from the University of New Mexico's chemistry storeroom. The 0.21 grams of ammonia chloride will be removed from the container using a scoopula and placed on a weighing tray on a scale to ensure the correct mass. The weighing tray will then be transported to the 1 L solution post RO and added in. NaOH will be added to the solution using a pipette pulled straight out of the bottle of NaOH. The dihydrogen ammonium phosphate can be used to prepare extra orthophosphate solutions if needed.

There are several hazards to take note of during the procedure. Sodium Hydroxide is used to bring the dirty RO water to a pH of 8.5. Sodium hydroxide is a corrosive material and should not be stored in a secondary plastic container and should not be added to highly acidic solutions. The reaction is facilitated electrochemically in wet conditions. There should be no contact with the reactor, its contents, electrodes, or wires while voltage is being supplied.