Best Practices for STREAM Start-up, Operations, Maintenance, and Management Manual

This document provides a guide on how to train users on the Aqua Research STREAM Disinfection Generator. Accompanying this guide is the STREAM operational manual, STREAM quick start guide, and STREAM troubleshooting guide.

The trainer will follow the steps outlined in the sections below during each training session. This training is expected to last roughly 60 minutes. We ask the hospital administrators/in-charges, hospital store managers, chlorine users, biomedical engineers (or whomever will be the technical point of contact for maintenance) and at a minimum three (3) STREAM device users be present for the training. The three device users will participate in a hands-on approach.

Primary users will be identified by hospital administrators and likely be someone from the facility's medical store, a cleaner, or mix of those roles. The primary operator does not need to be a higher-level staff person, such a pharmacist or the in-charge, given the simplicity of operation. A minimum of three operators should be selected and include individuals with alternating schedules such that at least one operator should always be present to operate the STREAM every day.

The training is structured into six sections (i.e., device overview, set-up, device operation, dispensing and dilution, cleaning, and troubleshooting). Each section will involve the trainer first reading and explaining the steps, device users practicing those steps until successfully completed, and finally the trainer and participants reviewing the steps and addressing any questions. Once all steps are successfully completed and questions resolved in the first section, the trainer will proceed to the second section (and so forth). The facilitator will follow this process for each section.

1. Device Overview

Purpose/objectives: Introduce the STREAM to the participants. Describe how the device works, its components, how it will be used and monitored.
Participants: Hospital administrators, hospital store managers, chlorine users, device users.

1. Place the STREAM in a location where all viewers can see. Open the case.
2. Provide an overview of the STREAM device:
    - The Aqua Research Stream Disinfection Generator is an onsite chlorine generator that produces a consistent flow of 0.5% chlorine for disinfection and water treatment. The device uses simple inputs—salt, water, and electricity—to produce chlorine on demand, onsite. The mixed-oxidant solution deactivates all classes of microorganisms, including viruses, bacteria, and protozoan cysts. It is effective in turbid waters and can be operated using 110/220 VAC, or 12 VDC from a car battery or solar panel. Additional information on the Aqua Research Stream can be found in Table 1 below.

Specification	Target
Chlorine Concentration Produced	0.5% free available chlorine
Chlorine Production Rate	4.8 L/hour
Power Flexibility	110/220 VAC,1A/2 A, 50/60 hz 12 VDC, 16 A
Salt Consumption	15 g/L
Expected Life Span	Minimum 5 years
Weight	8.2 kgs
Dimensions	42 x 33 x 17.3 cm
Target Use Mode	Infection prevention and control (primary) Water treatment (secondary)

3. Describe how the STREAM works and its components:
4. The STREAM system produces a 0.5% disinfectant solution by pumping brine (solution of salt and water) from a brine tank into the electrolytic cell. The cell converts the salt and water mixture (brine solution) to a chlorine-based disinfectant. [NaCl + H_2O->NaOCl + H_2+trace oxygen species]. Following this constant reaction, the output solution from the electrolytic cell is a 0.5% chlorine solution that is collected in a bucket, jerry can, or other collection vessel.

5. Introduce users to main components:
   - **Brine solution** – this solution, made up of 15 grams of salt per liter of water, is the main input (along with electricity) for generating the chlorine solution. The brine solution will be mixed and contained in a 20-liter bucket during this study.
   - **Aqua Research electrolytic cell** – a membraneless electrolytic cell that converts the brine to chlorine.
   - **Brine circulating pump** – The blue peristaltic pump that pumps brine solution into the reaction cell. This pump automatically speeds up and slows down to ensure the STREAM constantly produces a 0.5% chlorine solution.
   - **Power converter** – The AC power supply in the system tolerates a lot of AC voltage variation, from 100 to 240 VAC, as well as 50 or 60 Hz power. It is an "auto-ranging" power supply so that it can be plugged into just about any type of home or business power supply anywhere in the world without making any adjustments. The system has a circuit that monitors the power and will shut down and alarm the system of the power feed is too high or too low.
   - **Electrical control box** – this box houses the main electrical components.
   - **Error mitigation guide** – on the electrical control box, users can find a guide to potential errors the system may indicate. Explain each color.
   - **Oxidant solution** – the resulting output solution that comes from the electrolytic cell.

6. Describe how the device will be used and monitored:
   - Identify three (3) principal device users. Bring them to the front as they will be going through each step in a hands-on approach.
   - Describe how the STREAM will be used
     - The STREAM devices will be installed and evaluated between now and December 2020. All input supplies (salt, vinegar for cleaning, etc.) will be provided by PATH.
     - The device users will be expected to operate the STREAM devices daily, producing necessary volumes of chlorine for the healthcare facility. Additionally, the device users will be expected to

manually note the volume of chlorine produced each day and to which wards that chlorine is sent. [Introduce Stream chlorine monitoring form].
    - Every week, PATH Ethiopia staff will call each primary Stream user in each study site each week to ensure the device is being used, ask if any challenges were experienced with the device, and to gauge the need for additional consumable supplies.
    - Should travel permit during COVID-19, in-person visits will occur every 2 weeks to resupply sites with inputs (salt, vinegar), collect Stream chlorine monitoring forms, and inspect the STREAM units.
    - Note: each healthcare facility should continue to receive their allotted chlorine supply from their existing vendors. This supply should be considered back up chlorine volume during this study.
    - At the completion of the study, the device ownership will be transferred to the healthcare facilities.

Once you have read through the steps, ask participants if they have any questions and respond as needed.

Set-up

Purpose/objectives: Instruct users on how to unpack, where to place, and how to assemble the STREAM device, and prepare the brine solution. See section 5.1 – 5.3 in the STREAM operational manual for more information.
Participants: Device users will be active participants and asked to complete the steps outlined below. Hospital administrator and chlorine users can also attend as viewers.

1. Location
    - In consultation with the hospital administrator and in-charge nurse, identify an appropriate location for the devices. The following criteria will be considered when determining a placement location:
        - Access to a reliable source of electricity to power the STREAM
        - Close proximity to a water source
        - Wet area (where brine or chlorine spillage will not affect any equipment or materials)
        - A room with good ventilation
        - A location central within the healthcare facility and convenient to high chlorine using wards (i.e., surgery theatres, maternity wards, obstetric wards, neonatal wards, etc.)

2. Raw materials
    - The following raw materials will be needed to operate the STREAM.

Material	Unit	Unit needed	Assumptions
Salt	Kg	16.46 kg / month	8 hours @ 0.07 Kg/hour = 0.56 Kg/day 7 days @ 0.56 Kg/day = 3.92 kg/week. 4 weeks @ 3.92 Kg/week = 15.68 Kg/month. Monthly + 5% wastage = 16.56 kg
Vinegar	L	2 L / month	1 wash/week
Wooden spoon	Ea	1	Used to mix the salt & water for brine
Plastic, graduated measuring cup (1 L)	Ea	1	Used for measuring chlorine for distribution and other needs
Bucket (20L)	Ea	1	Brine bucket
Jerry can (20L or 30L)	Ea	As needed	Number of jerry cans will depend on the number of wards/locations receiving chlorine.

3. Power source
    - There are two power cables for different power sources. Decide whether you will use a 12 volt battery, solar source, or mains.
    - If using a 12 volt battery or solar, you will use the cables with alligator clips. If you are using mains power, find the cable with the wall mount and remove the velcro strap. Plug the end into a wall socket.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users plug in STREAM power cord.

4. Tubing
    - Find the clear tubing and remove the Velcro strap. The brine suction (smaller tube) and the oxidant tubing (larger tube) should be connected.
    - Unscrew the small tube from the tubing connector. Be sure the small tube supports don't come off of the tube. Leave the connector on the large tube.
    - Place the large tube in the oxidant storage tank.
    - Find the brine suction strainer in the black mesh bag. Connect the brine suction strainer to the small brine tube by screwing them together.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users connect STREAM tubing.

5. Brine solution
    - Collect 1 x 20 liter plastic bucket and 1 or more 20 or 30 liter jerry can. The open bucket will be used to generate brine solution and the jerry cans will be used to collect and transport the chlorine solution to the wards.
    - To prepare a 20 liter brine solution, fill the first bucket with 20 liters of water*.
    - Add 300 grams of salt to the 20 liters of water
    - Stir until the salt is dissolved

    * Note: For larger or smaller buckets just increase or decrease the salt accordingly.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users make a 20 liter batch of brine solution.

6. Review

Review the power source, tubing, and brine solution steps. Answer any questions.

Start Up

Purpose/objectives: Walk participants through steps to begin using the STREAM device and generating 0.5% chlorine solution. See section 5.4 in the STREAM operational manual for more information.
Participants: Device users will be active participants and asked to complete the steps outlined below. Hospital administrator and chlorine users can also attend as viewers.

1. Turning system on
    - Push the ON/OFF button. A green LED circle should appear around the button and the pump will start working.
    - The pump will run for about 45 seconds to make sure that the tubing and the cell is full of brine. After 45 seconds, the system will start monitoring the amperage on the cell and adjusting the speed of the pump to ensure the oxidant output is a consistent 0.5% solution.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users start STREAM device.

2. Errors during start up
    - Review the different LED indicator light errors, their causes, and solutions.
    - If a fault is detected, look at the color of the LED light circling the ON/OFF button and follow the solutions steps. Push the ON/OFF button and restart.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users review the colored LED indicator lights and are able to identify solution.

3. Turning the system off
    - Once you have generated the volume of disinfectant you wish to make, push the ON/OFF button to stop the device. The system will also automatically turn off when the brine bucket is empty.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users turn off the STREAM device.

4. Review
    - Review the steps for turning on, identifying errors, and turning off the device.

Shutdown & storage

Purpose/objectives: Instruct participants on how to shut down and store the STREAM unit.
Participants: Device users will be active participants in the steps to shut down and store the STREAM unit. Hospital administrator and chlorine users can also attend as viewers.

1. Daily shutdown
    - Turn off the STREAM system by pressing the ON/OFF button.
    - The disinfectant solution produced by the STREAM system should be stored in opaque bottles in a cool/dark place.
    - The brine and chlorine tubes can be left in their respective buckets/jerry cans until the device is used the next day.

2. Long term shutdown and storage
    - Unscrew the brine filter from the small brine tube and place it in the filter storage container.
    - Securely close the filter storage container and place in the black mesh bag of the STREAM.
    - Connect the smaller brine tube and larger oxidant tube to make a closed loop. Store the tubing in the STREAM case.
    - Unplug the electrical cord and store in the STREAM case.

- Close the STREAM case and store.

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users turn off the STREAM device and practice the long-term storage steps.

3. Review
    - Review the steps for daily and long-term storage.

Cleaning

Purpose/objectives: Instruct participants on how to run a cleaning cycle for the STREAM. The STREAM system should be cleaned regularly to prevent scale build up in the outlet tubing of the cell. Cleaning will be required when calcium carbonate scaling is evident in the outlet tubing of the cell or no flow is noted coming from the disinfectant tube, or the alarm indicates that it needs to be cleaned.
Audience: Device users will be active participants and asked to complete the steps outlined below. Hospital administrator and chlorine users can also attend as viewers.

1. Running the cleaning cycle
    - Find a 1-liter container and pour in 0.5 liter (1 pint)of acetic acid or white distilled vinegar.
    - Place the smaller brine tube with the filter attached into the 1-liter vinegar container.
    - Place the larger oxidant tubing into the same 1-liter vinegar container.
    - Push the ON/OFF button and let the system run until a fault is indicated.
    - Push the ON/OF button to turn off the system.
    - Repeat three times.
    - Dispose of the vinegar solution and fill with 0.5 liter (1pint) of clean water.
    - Place the smaller brine tube with the filter attached into the 1 liter water container.
    - Place the larger oxidant tubing into a separate container to collect the discard liquid, or let the large tube discharge down a drain.
    - Push the ON/OFF button and let the system run until a fault is indicated.
    - Push the ON/OF button to turn off the system.
    - Dispose of the discard liquid

ASK: Ask the device users if they have any questions and respond as needed.
PRACTICE: Users clean the STREAM device.

Dilution

Purpose/objectives: Instruct participants on how to dilute STREAM oxidant for disinfection, handwashing, and water treatment purposes.
Audience: Device users and chlorine users will be active participants. Hospital administrator can also attend as viewers.

1. Review the dilution table below.

Purpose	Desired Concentration	Volume of Disinfectant	Volume of Water Needed
Disinfection	5,000 mg/L	1L	0L
Handwashing	500 mg/L	1L	10L
Drinking Water Treatment	2.5 mg/L	1L	2000L

Troubleshooting

Purpose/objectives: Walk participants through the various troubleshooting steps and error screens.
Audience: Device users will be active participants. Hospital administrator and chlorine users can also attend as viewers.

Purpose	Desired concentration
Loss of Power to the Cell	- Check power source - Check power cord to ensure device is plugged in - Check ON/OFF button
Leaking Tubes or Fittings	- Turn off power - Identify source of leak. - Ensure connections are tight and small tube support connectors are in the correct orientation.
No Flow Through the Cell	- Clean strainer and hose fitting - Check for leaks in strainer or hoses
Pump Not Working	- Clean hose lines - Remove hose from pump head. Run clean water through tubes - Remove hose from pump and stretch the hose. (The hose can become tight during storage.)
System Over Heating	- Check hoses for scale formation - Clean the cell

*If any issue persists, contact Aqua Research or the *local representative*.