TECHNICAL NOTE 85.92

Prototype Maintenance Plan

Prepared by/Préparé par	Dr. Michael Stasiak
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TECHNICAL NOTE

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1.Introduction

This document summarizes the required maintenance activities for the Higher Plant Chamber Prototype. The maintenance required for this system primarily involves routine cleaning and system calibrations. A maintenance and repair log book should be kept to record the date, operator, and activity performed.

Task	Maintenance Interval				
	weekly	**monthly**	**quarterly**	**yearly**	**other**
pH/EC calibration	X				
Condensate calibration		X			
Nutrient delivery calibration		X			
CO_2 calibration		X			
Bulb replacement					every 3 years or on failure
NDS system plumbing cleaning			X		
Exterior cleaning		X			
Interior cleaning				X	
Lamp loft glass cleaning		X			
Door sealing surfaces cleaning			X		at each closure
Growing trough cleaning					before and after each experiment

Table 1: Generalized maintenance plan for the prototype higher plant chamber.

2.System Calibration

Most of the HPC1 subsystems require periodic calibration to maintain proper functioning.

2.1. pH and Electrical Conductivity (EC)

1. In the Argus Control System, change the acid, base, and nutrient A/B control settings from 'Automatic' to 'User Override 0.00%'. This is to ensure that the system does not activate during the calibration procedure.
2. Close the two isolation valves on the nutrient system bypass loop (Illustration 1).

3. Pour known standards of pH and EC into 250 mL beakers. Use two point calibrations with solutions of 4.00 and 10.00 pH units, and ~500 and ~3000 uS.

Illustration 1: Location of shut off valves for pH/EC calibration procedure.

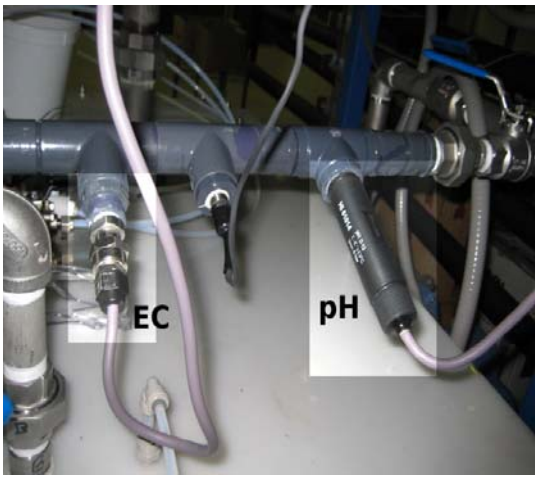

Illustration 2: Location of EC/pH sensors.

4. Carefully unscrew (counter-clockwise to loosen) and remove the EC and pH sensors (Illustration 2).
5. Place the probes into their respective solutions and follow the calibration procedures outlined in the operation manuals (Appendix 1)
6. Rinse the probes, apply Teflon tape to the threads, and screw them back into the nutrient system bypass manifold.
7. Reopen the bypass isolation valves to the same position as they were before calibration.
8. Return the Argus Control System settings to 'Automatic".

2.2. Nutrient Delivery System Calibration

NDS system calibration should be performed at the beginning and end of each experiment.

1. Empty the main NDS tank of all fluid using the drain valve. Leave valve open once drained.
2. Empty and dispose of acid, base, and nutrient stock solutions according to laboratory protocol for hazardous waste materials.
3. At the Argus relay panel, switch the acid, base, nutrient A and nutrient B relays to 'ON'.
4. Fill each reservoir with 3 litres of clean water and allow to drain into the main tank. This is to remove any residual acid/base/nutrient solution.
5. Repeat rinsing two more times with 3 litres of clean water.

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6. Open the top of the NDS reservoir. Ensure that the water has been completely removed from the tank. Use a wet vacuum if required to accelerate the process.
7. Set the acid/base/nutrient relays to the 'OFF' position.
8. Place a clean and dry 2L beaker beneath the acid/base/nutrient outlets within the NDS reservoir.
9. Fill the acid/base/nutrient stock tanks with 3 litres of clean water.
10. Using a timer, switch the acid relay from 'OFF' to 'ON' for 30 seconds.
11. Collect, measure, and record the amount of water released into the beaker using a 100 mL volumetric flask.
12. Repeat 10 until no more water flows from the stock tank into the 2L beaker.
13. Repeat this procedure for each stock tank.
14. Use the collected data to estimate the flow rate for each container.

2.3. Condensate System Calibration

1. At the Argus relay panel, switch the condensate pump relay to 'OFF'.
2. Fill the condensate reservoir with clean water to approximately half full.
3. Disconnect the quick connect pump line from the main NDS reservoir.
4. Place the pump line outlet into a 500 mL volumetric flask.
5. Turn the condensate pump relay to the 'ON' position and time, using a stopwatch, the number of seconds required to fill the volumetric flask to 500 mL.
6. Use the collected data to estimate the pump flow rate.

2.4. CO_2/O_2

CAUTION! Carbon dioxide is a colourless, odourless, faintly acidic-tasting, and non-flammable gas at room temperature.

Releasing carbon dioxide gas in a confined or unventilated area can lower the concentration of oxygen to a level that is immediately dangerous to life or health.

Follow laboratory safety protocols when working with bottled gases.

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Operation and maintenance of the gas analyzer should be performed according to the manufacturers user manual (Appendix 2). The MFC operation manual is presented in Appendix 3.

3.Basic Maintenance Tasks

3.1. Bulb replacement

CAUTION! Lamps can be extremely HOT if they have been recently on. Before attempting replacement, wait at least one hour for lamps to cool sufficiently.

CAUTION! Lamp replacement requires the use of ladders and working at an elevated level. Use proper safety procedures. Never work alone when changing lamps.

When required, bulbs should be replaced by following this procedure:

1. Turn off lighting system main circuit breaker and lock out according to laboratory protocol.
2. Using an approved mobile warehouse step, climb to a point where your knees are level with the lamp loft handle (Illustration 3).
3. Lift the lamp loft using the handle and carefully raise and push it back until it is securely in place.
4. Unscrew the lamp(s) and replace with a new lamp. Use gloves to avoid transferring oils to the lamp surface (Illustration 4).
5. Carefully pull back on the lamp loft handle and gently lower it back into place.
6. Remove the mobile warehouse step.
7. Unlock and turn on the lamp lighting main electric circuit.

Illustration 3: Location of the lamp loft and lifting handle (yellow arrow).

Illustration 4: Lamp locations within the lamp loft.

3.2. Cleaning

CAUTION! Cleaning chemicals can be extremely dangerous. Be sure to read and understand your MSDS and follow all laboratory safety protocols when handling chemicals.

CAUTION! Bleach, alcohol, and ozone can be dangerous in confined spaces. Be sure the air handling system is operational and all exterior and interior air lock doors are open when working within the chamber. NEVER work inside HPC1 without adequate supervision.

To ensure a minimal level of contamination with algae, biofilms, and other microorganisms, thorough cleaning should be performed at the end of each experiment or minimally once every 3 months.

3.2.1. **Exterior**

Exterior surfaces can be cleaned with warm water, mild dish washing soap, and a soft cotton cloth. After cleaning with soap/water, surfaces

should be dried with a new clean cloth and clean water to remove soap residue.

3.2.2. **NDS Plumbing system**

1. Empty the main NDS reservoir and fill with 180 litres of a 10 ppm ozone solution. (Note: a 0.5% bleach solution can be substituted for ozone, however ozone is the preferred method).
2. Run the NDS system with plant troughs in all positions for a period of 24 hours.
3. Drain the NDS reservoir and fill with clean water.
4. Run the NDS system for up to 24 hours.
5. Drain the NDS system and fill with clean water.
6. Run the NDS system for 6 hours.
7. Drain the NDS system and fill with clean water.
8. Run the NDS system for 1 hour.
9. Drain the NDS system.
10. Open the NDS reservoir cover and wipe down the inside surfaces with clean a clean cloth.

3.2.3. **Interior**

The interior stainless steel surfaces should first be cleaned with a mild dish washing soap in warm water, followed by disinfection with a high-concentration alcohol mixture (i.e. 80% ethanol + 5% isopropanol).

Access to the main interior is through the two air locks. First remove all the growing troughs and main collection trough, then remove the bottom floor air distribution plates. This will allow a person(s) to step inside the chamber for cleaning and/or servicing.

Access to the blower housing, also a major component of the chamber interior, is through the panel below the centre unit. Remove all the brass fastening bolts around the perimeter of the panel and then pull outwards. Reassembly is the reverse of this process.

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Illustration 5: Blower housing panel. Arrow indicates position of one of the brass bolts that secure the panel to the main housing.

3.2.4. Growing Troughs

Growing troughs should be removed from the chamber and cleaned with warm water containing mild dish washing soap. Surface disinfection to remove algae contamination can be done with a 5 ppm ozone solution (85% alcohol or 0.5% bleach in water can be substituted). Ideally and when possible, troughs should be soaked for a 12 hour period in a 5 ppm ozone solution. Troughs MUST be adequately rinsed prior to return to service.

3.2.5. Lamp Loft Glass Panels

The glass panels in the lamp loft should be cleaned with warm water and mild dish washing soap on a monthly basis. Rinse with clean water and dry with a clean cloth.

3.2.6. Sealing Surfaces

Door gaskets and magnetic seals should be cleaned with warm water and mild dish washing soap on a quarterly basis. During experiments, these seals should be wiped with a damp cotton cloth prior to each closure.

4.Appendix 1 - Operation Manual - CO_2/O_2 analyzer

The User Manual will not be available until the analyzer is delivered to UAB in Fall/Winter 2008/2009.

5.Appendix 2 - Operation Manual - Mass Flow Controller

Electronic File: MFC.pdf

6.Appendix 3 - User Manuals - pH and EC probes

Electronic File: manHI8614_ph_tranmitter_manual.pdf
manHI8931-2_EC_transmitter_manual.pdf

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