Risk Assessment
Safety Plan

Project information:

Automated Microalgae Photobioreactor	2/22/2016
Name of Project	Date of submission

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Faculty mentor	**Phone Number**	**e-mail**
Dr. Juan Ordonez	850 644 8405	ordonez@caps.fsu.edu
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I. Project description:

The aim of this project is to develop and automate a continuous and scalable microalgae photobioreactor. The automation of this process has the potential to increase biomass production and reduce production time. The three main objectives are to develop a biomass production system that is continuous, automated, and versatile; to develop a system which effectively separates produced biomass and clarified water; and to develop a sustainable system that minimizes space, energy, and resource consumption.

II. Describe the steps for your project:

1. Cultivate Scenedesmus Obliquus algae in test tubes and erlenmeyers with UV lights and air pump circulation.
2. Construct airlift photobioreactor with plastic, epoxy cement, air pumps, screws, screwdriver and hand drill.
3. Build LED - phototransistor sensors for system automation.
4. Build and test pulsed electric field lysis chamber for algae treatment.
5. Build separation stage to separate the produced and lysed biomass from the medium.
6. Scale the entire process from lab scale airlift to pilot scale mini photobioreactor.

III. Given that many accidents result from an unexpected reaction or event, go back through the steps of the project and imagine what could go wrong to make what seems to be a safe and well-regulated process turn into one that could result in an accident. (See examples)

1. Cultivation: Shelf holding cultivation could tip over, broken glass/other sharps, burns from sanitizing glass.
2. Construction of airlift: lack of appropriate ventilation when using epoxy, bare skin epoxy exposure, physical harm from sharp metal edges raw from being bored out.
3. Build sensor for automation: Electrical shock, small electrical fire?
4. Build/test of PEF lysis: arc flash, electrical shock
5. Separation of biomass: lysed oil fire, liquid spill
6. Scale of process: All dangers aforementioned apply.

IV. Perform online research to identify any accidents that have occurred using your materials, equipment or process. State how you could avoid having this hazardous situation arise in your project.

Electrical shock video shows a man with no protective equipment (not even gloves) getting shocked and a small blast- To avoid this exercise discretion when working with electrical components, cut power and be sure to wear appropriate personal protective equipment like high voltage certified gloves.

Woman touches high voltage line, gets electrocuted- To avoid this one should not touch live wires or any conductive portion of the system when electricity is being supplied. If for some reason something must be adjusted, cut power and ensure proper discharge.

There have been several accidents where lab personnel have been injured by broken glass or other sharps within the lab - To avoid this make sure to wear gloves and potentially goggles when dealing with fragile materials, clean up broken glass and dispose of these materials properly. Be sure to wear appropriate PPE when fitting flexible tubing to glass tubes.

People have also been burned by touching hot glass, this could have been avoided by wearing appropriate PPE and also allowing for appropriate cool down time, or in the event a 3rd party was burned, then labeling or communicating that a lab area contains hot glassware.

V. For each identified hazard or "what if" situation noted above, describe one or more measures that will be taken to mitigate the hazard. (See examples of engineering controls, administrative controls, special work practices and PPE).

1. Cultivation:
   a. Shelf holding cultivation could tip over - make sure shelf is stable, do not put excess weight on shelving unit (leaning on it etc.) and make sure weight is evenly distributed over shelves.
   b. Broken glass/other sharps - Do not carry more glassware than is appropriate, exercise caution when moving glassware, if glassware is dropped or broken be sure to clean it up and dispose of it in sharps container, wear gloves when handling fragile or thin glass or glass tubing.
   c. Burns from sanitizing glass - allow appropriate cool down time of glassware during sanitation, turn off hot plate when not in use, utilize appropriate PPE (thick heat resistant gloves) when handling glassware that could potentially hot.

2. Construction of airlift:
   a. Lack of appropriate ventilation when using epoxy - use epoxy near lab exhaust vent or in otherwise well ventilated area, if user feels light headed or has been in close contact with uncured epoxy leave the area and find a well ventilated area.
   b. Bare skin epoxy exposure - wear gloves and use applicators to minimize skin exposure to epoxy. If contact does occur wash generously with water.
   c. Physical harm from sharp metal edges raw from being bored out - Make sure all edges are sealed or have been sanded appropriately, refrain from making direct physical contact with an edge which could be potentially sharp.

3. Build sensor for automation:
   a. Electrical shock - exercise caution when handling electrical components, make sure power supply is disconnected before touching conductive components.
   b. Small electrical fire - do leave live electrical components unattended, do not run inappropriate power through components which may not be capable of accommodating power. If the fire is small, utilize a fire extinguisher only if you are trained to operate it and you can position yourself between the fire and the exit door to avoid being trapped. Put out fires in small vessels by covering the vessel loosely. NEVER pick up a container of burning material. Notify co workers so that they may assist you. In the event of a more serious fire, evacuate the laboratory and activate the nearest fire alarm. When emergency personnel arrive, tell them what hazardous substances are in the laboratory.

4. Build/test of PEF lysis:
   a. Arc flash - de-energize the power source before performing any work on the system, wear protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, wear rated rubber insulating gloves where there is a danger of hand or arm contact with live parts or possible exposure to arc flash burn.
   b. Electrical shock/burn : exercise caution when handling electrical components, make sure power supply is disconnected before touching conductive components. Do not touch electrodes or leads during testing or operation, be sure to use appropriate PPE.

5. Separation of biomass:
   a. Lysed oil fire - Keep any sparks or potential fire sources away from separation tank, have sand available for use as flame

retardant, do not attempt to put out oil fire with water.

b. Organic liquid spill - Clean up any liquid spills and dispose of organic appropriately. Use available epoxy sealant to fix leak if possible.

6. Scale of process:

a. All dangers aforementioned apply.

VI. Rewrite the project steps to include all safety measures taken for each step or combination of steps. Be specific (don't just state "be careful").

1. Cultivate Scenedesmus Obliquus algae in test tubes and erlenmeyers with UV lights and air pump circulation.

Be careful to maintain equal weight distribution on shelving and to wear gloves when fitting flexible tubing to glassware. During sanitation of glassware heat resistant gloves will be used to minimize possibility of incurring burns.

2. Construct airlift photobioreactor with plastic, epoxy cement, air pumps, screws, screwdriver and hand drill.

Ensure epoxy is only used with ventilation and gloves, if direct skin contact is made be sure to wash generously.

3. Build LED - phototransistor sensors for system automation.

Do not leave live electrical components unattended and exercise caution when working with components which are connected to power.

4. Build and test pulsed electric field lysis chamber for algae treatment.

Use proper PPE equipment (gloves, rubber shoes) and ensure no water is present nearby. Use caution when working with components and do not touch the electrodes.

5. Build separation stage to separate the produced and lysed biomass from the medium.

Perform regular system inspection to ensure no active leaks.

6. Scale the entire process from lab scale airlift to pilot scale mini photobioreactor.

All aforementioned procedures apply.

VII. Thinking about the accidents that have occurred or that you have identified as a risk, describe emergency response procedures to use.

In the event of an accident, the emergency procedures are:

1. If life or severe injury is at risk, call Emergency Services (911)
2. If the accident is minor and can be taken care of (such as spills, glass, etc.), use proper equipment to clean up
3. If there is a fire, use a fire extinguisher and call 911 if it is out of control
4. Report all accidents to responsible faculty member.

VIII. List emergency response contact information:

- Call 911 for injuries, fires or other emergency situations
- Call your department representative to report a facility concern

Name	Phone Number	Faculty or other COE emergency contact	Phone Number
Kaelyn Badura	386 315 3187	CAPS Safety Manager - Michael Coleman	850 644 5197
Yuri Lopes	561 339 4145	CAPS Facility Manager - Ferenc Bogdan	850 644 1579
Dr. Juan Ordonez	850 644 8405	FSU Police	850 644 1234

IX. Safety review signatures

- Faculty Review update (required for project changes and as specified by faculty mentor)
- Updated safety reviews should occur for the following reasons:

1. Faculty requires second review by this date:
2. Faculty requires discussion and possibly a new safety review BEFORE proceeding with step(s)
3. An accident or unexpected event has occurred (these must be reported to the faculty, who will decide if a new safety review should be performed.
4. Changes have been made to the project.

Team Member	Date	Faculty mentor	Date
Yuri Lopes	*02/22/2016*		
Courtnie Garko	*02/22/2016*		
Tomas Solano	*02/22/2016*		
Kaelyn Badura	*02/22/2016*		
Benjamin Bazyler	*02/22/2016*		

Report all accidents and near misses to faculty mentor.