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Experiment Safety Review Form
Review Number: PS-ESR-1-180-2012

PRINCIPAL INVESTIGATOR: Ryan Tappero
GROUP: Life & Env Sciences
EXT: 5514 **E-MAIL: rtappero@bnl.gov** **LIFE NUMBER: 24092**

Project Title: Plant Culture, Mineral Synthesis, and Spectroscopy of Metals
Location(s): 0725
Area(s): 0725-FIRST-1-180
Proposed Start Date and Duration: 3/15/2011 - 3 years

SIGNATURES:

Principal Investigator: Ryan Tappero	**Date: 3/2/2011**
Experiment Review Coordinator: Lori Stiegler	**Date: 3/2/2011**
Reviewer: Christopher Weilandics	**Date: 2/25/2011**
Reviewer: Frank Zafonte	**Date: 2/25/2011**
Reviewer: Deborah Bauer	**Date: 3/1/2011**
Approval: Lori Stiegler	**Date: 3/2/2011**
Review/Approval (ERC) Comments: 02/15/2012 4:14 PM No change in scope or hazards from 2011. ESR is extended for one year. 03/02/2011 10:12 AM	
Walkthrough Signature:	**Date:**
Expiration Date (max 1 yr.): 3/2/2013	
FUA Change Required? No	
Fire Rescue Run Card Changes Required? No	
Has a NEPA Review been Performed for this Project? No	
Required Approvals (i.e., IACUC, IBC, etc.):	
Project Termination Acceptance Signature: **Comments:**	**Date:**

I. Define the Scope of the Work

A. Description

A) **Plant culture**: This experiment involves propagation and cultivation of plant tissue for X-ray and infrared imaging at NSLS.

Seeds of model plants (*Arabidopsis, Alyssum, Populus, and Cucurbita*) will be germinated in perlite and mature populations will be maintained in hydroponics as a source of viable tissue for propagation of specimens needed for X-ray and infrared imaging experiments. Plants will be grown in hydroponic cultivation devices and irrigated via an ebb and flow method. A typical ebb and flow mesocosm consists of two nest and stack totes, a water pump fitted with tubing, and fill/drain and return-flow plumbing accessories. Ebb and flow systems hold 1 to 5 L of nutrient solution (i.e. Hoagland's solution) within a sealed reservoir. Ebb and flow systems will be positioned under banks of artificial light. Plant specimens will be cultivated to maturity under the requisite experimental conditions, harvested for bulk chemical analysis, and prepared for microspectroscopic imaging at NSLS beamlines.

A suite of wet-chemical procedures are necessary to conduct these plant experiments and range from the preparation of nutrient solutions from laboratory-grade mineral salts to the synthesis of model soil components (e.g. metal-hydroxide coated quartz sands). For instance, in collaboration with BNL biology department, an experiment to study nutrient (Fe) acquisition mechanisms by Poplar roots will be conducted with Fe-coated sands and used to evaluate feasibility of Biofuels production on marginal (nutrient-poor) lands.

B) **Mineral synthesis**: preparation of nutrient media and synthesis of model soil components (e.g. Iron-coated quartz sands) for use in plant/ root imaging studies.

A typical inorganic nutrient solution contains millimolar quantities of NO_3, PO_4, K, SO_4, K, Ca, and Mg as well as micromolar quantities of Fe, Mn, Zn, Cu, Ni, MoO_4, BO_3 and Cl. Preparation of nutrient media involves weighing small amounts (grams) of the inorganic salts on a balance, dissolving them in water to obtain stock solutions, mixing of the stock solutions and water, and pH adjustment with dilute acids or bases. Additionally, nutrient media preparation involves synthesis of a ferric chelate (e.g. Fe(III)-EDDHA) via the reaction of a Fe(III) solution with an eqimolar quantity of the chelating agent; N2 gas will be used to purge the water used to prepare the Fe(III) solution. Preparation of model soil components involves chemical synthesis of a metal (hydr)oxide phase followed by coating of the solid phase onto quartz sand grains. Synthesis of metal (hydr)oxide minerals typically proceeds via addition of a strong base (e.g. 1 M KOH) to a solution containing the hydrolysable metal cation (e.g. Fe and Al), resulting in precipitation of a stable solid phase (e.g. Goethite, a-FeOOH). The solid phase is separated via centrifugation and the material is dry-coated onto quartz sand grains. Roots and model soil components are retained in the root compartment of plant microcosms until isolated for X-ray and infrared imaging.

C) **Spectroscopy of Metals:** speciation and localization of metals in the plant tissue and metals fixed into model soil components will be determined using X-ray microspectroscopy (Beamlines X26A, 27A and X1A) and bulk X-ray Absorption Spectroscopy (Beamlines X11A and X15B); plant biomass characterization will be performed with FTIR microspectroscopy (Beamline U10B). In most instances plant material will be imaged in a fresh, hydrated condition; however, some imaging experiments will require tissue to be flash frozen in LN2. Work with X-ray and IR sources at the NSLS will be performed in a safe manner following procedures established at the NSLS (safety review, interlock system, ES&H coordination).

Equipment manuals or procedures that are controlled documents:

N/A

B. Human Performance Factors

For plant culture experiments, water pump failures in the hydroponic cultivation devices are a main concern because these events can lead to a catastrophic loss of plant germplasm and of experimental specimens. Pump failures can typically be avoided by proper maintenance and the use of an uninterrupted power supply (UPS). For mineral synthesis experiments, a spill of inorganic chemical salts or strong mineral acids or bases is a primary concern. To minimize chances of a spill or injury all work with strong acids and bases will be in a chemical fume hood and use the required PPE (safety goggles or chemical splash face shield, lab coat, chemical

splash apron, closed toed shoes and long pants); materials used as neutralizers for strong mineral acids (e.g. Sodium bicarbonate) and bases (e.g. Citric acid) should be readily available.

C. Waste Minimization/Pollution Prevention

Waste generation will be minimized by i) conducting a minimum number of experiments, ii) utilizing a minimum amount of materials (solids, aqueous), and iii) choosing analytical methodology which uses the least amount of hazardous chemicals.

D. Materials Used /Waste Generated

Materials Used	Disposal Method	Amount per Use	Amount per Year	Comments
Potassium nitrate (0.005 M) macro-nutrient solution	Other	5.00 ltr	100.00 ltr	Used by plants - not waste
Aqueous solutions containing Fe, Mn, Co, Ni, Cu, Zn micro-nutrients (< 10 micromolar each)	Other	5.00 ltr	100.00 ltr	Used by plants - not waste
Aqueous solutions containing toxic metals (e.g. As)	Hazardous	10.00 ml	5.00 ltr	
Compressed gases (nitrogen)	Fugitive	20.00 ft3	2000.00 ft3	
Bases- potassium hydroxide	Other	50.00 g	500.00 g	Stored - or used in experiments
Acids- nitric acid	Other	50.00 ml	500.00 ml	Stored - or used in experiments

II. Identify and Analyze Hazards Associated with the Work

The following hazards were identified:

Physical Hazards:

- Cryogens (any substance or device capable of producing temperatures <= 170K) (Area: 0725-FIRST-1-180)
- Compressed gases (lecture bottles, cylinders, gas lines) (Area: 0725-FIRST-1-180)

Chemical Hazards:

- Corrosives
- Toxic metals (e.g., As, Ba, Be, Cd, Cr, Hg, Pb, Se, Ag) (Area: 0725-FIRST-1-180)

Ionizing and Non-ionizing Radiation Hazards:

- None

Biological Hazards:

- plants (Other)

Offsite Work:

- None

Other Issues (Security, Notifications, Community, etc.):

- None

Significant Environmental Aspects

- Any amount of hazardous waste generation (Area: 0725-FIRST-1-180)

III. Develop and Implement Hazard Controls and Assess Risk

A. Physical Hazards, Tasks and Controls

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Cryogens (any substance or device capable of producing temperatures <= 170K)** **Default Controls:** General Requirements: • Evaluate location oxygen deficiency • Store/transport only in approved containers (i.e. DOT/ASME or BNL LESHC) • Never pour from above chest level • PPE: Long Sleeve Shirt (or Lab Coat), long pants (or skirt covering ankles) and closed shoes Pressurized transfer to open (vented) container; Or-Pouring > 5 liter volumes of LN2 between open containers: • Face shield along with either Safety Glasses (w/side shields) or Goggles • Gloves (Cryo or Heavy Leather) Pouring small (5 liters or less) volumes of LN2 between open containers: • Safety Goggles (face shield recommended if possible) • Gloves (Cryo or Heavy Leather) Work with samples immersed in LN2 in small (~1 liter) dewars: • Use Tongs (tools) to manipulate/handle cryogenic samples (do not touch with gloves)• Use insulated non-absorbent gloves with dexterity (cotton/nylon gloves under disposable nitrile gloves) • Safety Goggles	**Negligible (0-20)**
Hazard: **Compressed gases (lecture bottles, cylinders, gas lines)** **Default Controls:** • Any systems >15psi must be SME Approved • Transport cylinders using a cylinder cart • Secure cylinders to a fixed object/wall • Use regulator, hoses, and components compatible with gas • Use hoses and clamps rated for maximum regulator output or use pressure relief device • Wear safety glasses with side shields when installing/removing/or adjusting regulator • Label piping/tubing	**Negligible (0-20)**

B. Chemical Hazards, Tasks and Controls

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Corrosives** **Default Controls:** Use hazardous chemicals controls plus: - Unobstructed access to Emergency Eyewash and Shower	**Negligible (0-20)**
Hazard: **Toxic metals (e.g., As, Ba, Be, Cd, Cr, Hg, Pb, Se, Ag)** **Default Controls:** As for chemicals, plus need for SHSD and OMC monitoring and surveillance must be evaluated BURF for Beryllium operation **Task Specific Info:** Toxic metals are in very low concentrations and/or quantities. Monitoring is not required.	**Negligible (0-20)**

C. Environmental Hazards, Tasks and Controls (include on/off site transportation and products/services)

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Any amount of hazardous waste generation**	**Negligible (0-20)**

Default Controls: Engineering Controls • Waste will be accumulated in chemically compatible containers that appropriately contain/protect the waste. • Waste containers will be closed in a tray (secondary containment) in the Satellite Accumulation Area (SAA). Administrative Controls • All hazardous waste containers will have a (red) “Hazardous Waste Label” that has the generator’s name and the chemical contents (trade name/formula not acceptable). • All waste will be accumulated in closed containers and kept in an established and posted SAA until ready for transfer to the 90-Day Haz Waste Area for pick-up by Waste Management. • For pick-up by Waste management, complete the Nonradioactive Haz Waste Control Form and consult the 90-Day Area Manager to gain access/transfer the waste to the 90Day Area. Training: Hazardous Waste Gen. (HP-RCRIGEN3). PPE: When handling waste materials follow PPE requirements specified for the specific materials. Comply with the SBMS Subject Area: “Hazardous Waste Management”.	

D. Radiation Hazards, Tasks and Controls

None

E. Biological Hazards, Tasks and Controls

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **plants (Other)** **Default Controls:** **Task Specific Info:** Proper posting	**Negligible (0-20)**

F. Offsite Work Hazards, Tasks and Controls

None

G. Other Issues (Security, Notifications to Other Organizations, Community Involvement, etc.)

None

H. Recommended Exposure Monitoring

- None

Description or comments:

I. EPHA Determination

Chemical Name	Quantity (lbs, gal)	Location (Bldg/Room#)

IV. Perform Work Within Controls

A. Recommended Training and Medical Surveillance Summary

- Laboratory Standard (HP-IND-220)
- Cryogen Safety (HP-OSH-025)
- Hazardous Waste Generator (HP-RCRIGEN3)
- Compressed Gas Safety (TQ-COMPGAS1)

B. Personnel Training, Qualification, and Authorization List

Employee/Guest Name	Life/Guest#	Dept	Required Training Course(s)	Signed
Ryan Tappero	24092	PS		2/25/2011 10:22:47 AM
Lisa Miller	22045	PS		

C. Emergency Procedures

See emergency plan for Bldg. 725 (National Synchrotron Light Source). Indoor spills over five gallons must be reported to x2222 and to NSLS Operations or Safety Staff. If any acids or bases are spilled into the eye proceed to the eye wash station (inside 1-180) and rinse thoroughly before visiting a doctor. Spill control supplies are located outside Room 1-171.

D. Transportation

None

E. Logistical Interactions

None

F. Termination/Decommissioning

This is an on-going work space. All chemicals and equipment will be transferred or dispositioned when work is completed.

V. Provide Feedback

None

VI. Attachments

Attached Files: