



PROJECT LABORATORY SAFETY MANUAL

NEXT-GENERATION ECOSYSTEM EXPERIMENTS

NGEE ARCTIC



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Applicability

This manual is required reading for all NGEE Arctic participants prior to commencing any laboratory work in Barrow, Alaska.

Review the attachments. They contain supplemental information (e.g., directions, maps, contacts, site instructions, emergency directions) Important for the Barrow laboratory space. BE ADVISED THAT THE ATTACHMENTS ALSO INCLUDE CONTROLS PERTAINING TO MANY OTHER ITEMS, SUCH AS FIELD CLOTHING/PERSONAL PROTECTION EQUIPMENT, AND FIRST-AID KITS.

Revision Record

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1	04/23/2014	Minor changes for Annual Review	S. Wullschleger
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Table of Contents

Applicability	iii
Safety Requirement	1
Required Reading	1
Overview	2
Site Conditions	3
Daily Meeting	3
Laboratory Infrastructure Controls	4
Chemical Fume Hood	4
Flammables	4
Disposing of Chemicals	4
Disposing of Sharps.....	4
Laboratory Requirements.....	5
Training	5
Carcinogens	5
Caustic or Corrosive	5
Electrical Energy	6
Compressed Gases	6
Thermal Hazards	7
Hot	7
Cold.....	7
Working Hours	9
Packaging, Transporting, or Shipping of Samples	9
When Things Go Wrong.....	9
Sites of Interest	10
NOTE: UIC now has an updated web site for researchers planning to work in Barrow:	
http://www.polarfield.com/barrow/	10
Referenced Documents	10
Appendix A.....	A-1
Abbreviated Terms.....	A-1
Contact Information.....	A-2
Area Map.....	A-Error! Bookmark not defined.

Safety Requirement

The fundamentals of safety management must be implemented by each institution with participants working on the Next-Generation Ecosystem Experiments (NGEE Arctic) project to ensure the safety and health of all project participants. The institutional representative for each institution is responsible for establishing the proper expectations for safety planning and implementation for all participants from their institutions. The science team leads (STLs) are responsible for ensuring that safety plans are developed and properly reviewed and approved before field and laboratory work begins.

Safety management begins with a clear definition of the scope of work to be performed. Each STL is responsible for a scope of work as defined in the proposal presented to the US Department of Energy (DOE). Each STL is also responsible for defining tasks and task leaders who are, in turn, responsible for developing a scope of work that defines the work to be performed, the participants working on the task, the hazards that will or may be encountered, and the controls to be used by the participants to mitigate those hazards. Hazard identification must be thorough enough to identify all sources of injury or illness and the damage to the environment, equipment, or property that could reasonably be encountered while performing the work. The controls to be used by the participants to avoid or mitigate the hazards must be reviewed and approved for adequacy by the safety professionals at the task leader's home institution.

The task leaders must ensure that the participants on their teams are briefed on the hazards and controls of their work activities, including additional discussions when changes occur. After the participants are briefed on the safety plans, the task leader and participants perform the scope of work using the identified controls.

All participants have the authority to stop work upon observing imminent danger; work must cease and the danger must be reported to project officer of the day. Work must not be resumed until the threat from the hazard is mitigated or removed.

During the preparation and performance of work, all participants must be mindful of the known hazards, use the defined controls, and be observant of changing conditions. Additional review is to be requested before continuing work if a new hazard is encountered. Lessons learned and suggestions for improving hazard controls must be collected by the task lead and must be considered for changes to the safety plan and/or communication to other task teams of the project. Any changes to the safety plan must be reviewed and approved using your institutions work safety planning process and then communicated to the team participants.

Required Reading

The core team of the NGEE Arctic project has developed the *Field Safety Manual* and a *Laboratory Safety Manual*, which define the minimum safety expectations and requirements for participation in field or laboratory work at the Barrow Experimental Observatory (BEO). All participants must comply with these minimum safety requirements while at BEO. The hazards and controls contained within the *Field Safety Manual* and the *Laboratory Safety Manual* need not be repeated in the task safety plan unless additional controls are required because of the work being performed.

- The **Field Safety Manual** is required reading prior to participation in any field research at Barrow Experimental Observatory (BEO).
- This Laboratory Safety Manual is required reading prior to participation in any laboratory work in the NGEE Arctic's laboratory at Barrow Arctic Research Center (BARC).
- The **Project Manual** is required reading for all project participants.
- The **Project Orientation and Safety Video**.
- The **Polar Bear Safety Video**.

These documents are available at the project website (ngee-arctic.ornl.gov) under the Safety tab with other project safety information.

- These documents will be reviewed annually for currency and applicability.
- Significant changes to these manuals will be communicated to all participants upon implementation of the change(s).

Overview

Safety at the BEO will be an integral component of the team's research planning and execution. While each partner organization (DOE national laboratories, universities, and subcontractors) must establish safety requirements for its staff, the NGEE Arctic leadership team will promote discussions of hazards and best practices for work in the field and in the laboratory and will recommend personal protective equipment (PPE) that mitigates hazards. As the lead institution for this project, Oak Ridge National Laboratory (ORNL) will establish guidelines for laboratory safety that all project laboratory users must review and acknowledge. We expect that specific activities and equipment will require additional training and that such training will be provided on site by subcontractors or qualified staff. This training will be documented, and any training materials will be made available for review. Both printed, on-site documentation and electronic resources will be provided to project participants.

Risk assessment will be a continuous process, closely tied to risk management, training, and management oversight. Because laboratory activities will be performed in a leased-space laboratory that is shared with other organizations and projects, our laboratory users need to maintain a vigilant awareness of the activities of others in the laboratory. Personal protective equipment is required in the laboratory when anyone in the laboratory is handling chemicals.(Figure 1).

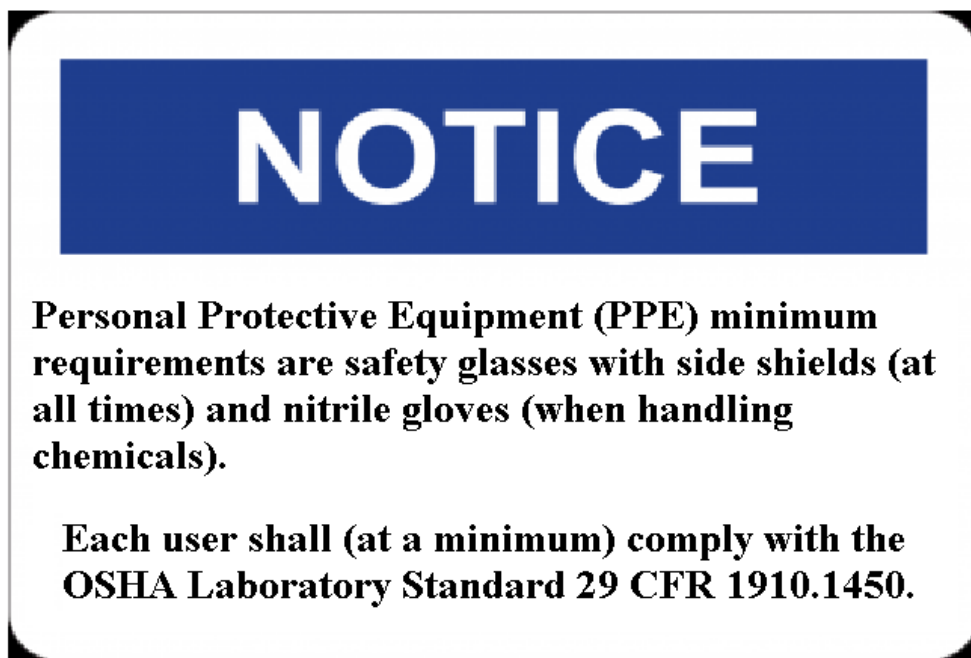


Figure 1. Become familiar with all postings and documentation at the NGEE Arctic project laboratory.

Each identified hazard will be addressed prior to the commencement of laboratory activities through work controls, training plans, checklists, safeguards and PPE provisions. However, it is essential that participants have a mechanism to stop unsafe situations in the laboratory. Both the national laboratories and the Ukpeaġvik Iñupiat Corporation (UIC) are committed to a "stop work authority" policy. Through this mechanism, all workers are empowered to stop activities that may be unsafe to human health or the environment without negative consequences or retaliation. A stop work action triggers immediate review by knowledgeable personnel until issues are resolved. Although this authority is rarely exercised, it is an essential component of safety plans that enlist individuals and teams to share responsibility for safety. The team will also recognize an individual's decision not to pursue approved activities based on different levels of experience and physical condition.

Site Conditions

The NGEE Arctic project's Laboratory is 133 Laboratory E at the BARC (Figure 2).

No food, gum, cosmetics applications, sandals, open-toed shoes, or open-heeled shoes are permitted in the laboratory at any time.

Work conditions at the site may be different from what you expected. Consult your institution's safety, health, or environmental professionals if you have questions. If necessary, ORNL resources will be available to you (e.g., your supervisor, subject matter experts (SMEs), environment, safety, and health support staff, and the Laboratory Shift Superintendent (LSS)).

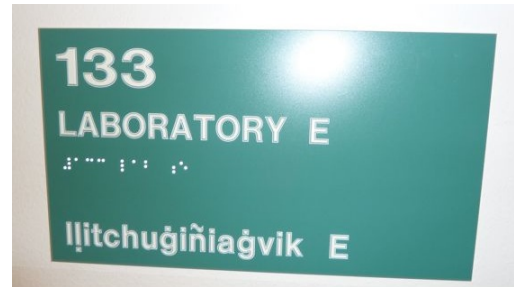


Figure 2. Home of the NGEE Arctic project laboratory, located in the Barrow Arctic Research Center.

Anyone who believes that working conditions are unsafe must attempt to stop the work and resolve the concern. If that is not possible, then the participants are responsible for removing themselves from the situation and not continuing to work until the issue is resolved.

An individual involved in a work-related off-site injury or illness will immediately seek the appropriate level of medical care as required by the event. Prompt reporting to inform the officer of the day after the event by the individual or another participant is required for proper follow-up and reporting.

Personnel must have the emergency services phone numbers for the location and the numbers for the site point of contact immediately available (see attachments).

Daily Meeting

Each day, prior to starting any field or laboratory work in Alaska, the project participants present in Barrow must meet to discuss the day's activities and weather conditions. This meeting is organized and led by the OOTD. After establishing who is working where and on what, and after gathering expected return times for those performing field work, the OOTD confirm that participants have reviewed the hazards and required PPE. The following questions can be helpful to ensure that new and known hazards are controlled:

- What can go wrong (what keeps you up at night?)
- What measures or controls are in place to prevent that from happening?
- How do (or which of) the most important controls depend on human actions or behavior?
- Where might an error or omission impair the effectiveness of an important control?
- What change has been made (e.g., to process, equipment) that could inadvertently increase risk in another area?

Error precursors are conditions or attitudes that increase the chances of an error during the performance of a specific task by a particular individual. Participants must consider whether there are precursors that, if reduced or eliminated, would make the controls more likely to be effective.

Laboratory Infrastructure Controls

Chemical Fume Hood

A laboratory fume hood is present within the lab space (Figure 3).

The NGEE project core team ensures that the fume hood is inspected and certified on an annual basis. Participants must confirm that the flow indication device is affixed to the fume hood and must verify flow prior to use.

Verify that the hood is turned on and functional before relying on it for safe ventilation. Use a tissue (or Kimwipe) taped to the sash to visually confirm airflow. Pull the sash down to maximize airflow and to provide maximal protection.



Figure 3. Chemical fume hood.

Flammables

A cabinet for the storage of flammable liquids is located underneath the gas chromatograph (red warning sign) (Figure 4). A telephone and fire extinguisher are located near the far door of the laboratory. Fire alarm boxes are located in the hallway. (Figure 5).

Disposing of Chemicals

Consult with laboratory staff and the BARC facility manager before disposing of any chemicals in the drain (Figure 6).

Disposing of Sharps

Sharps containers are located on the bench top for the disposal of sharp blades and needles (Figure 7). Do not recap syringe needles.



Figure 4. flammables cabinet.

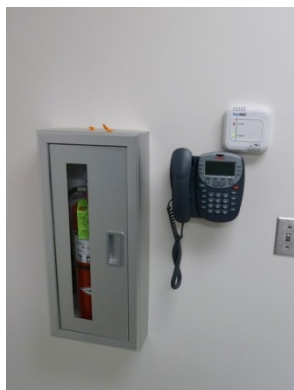


Figure 5. Phone and fire extinguisher.



Figure 6. Laboratory sink.



Figure 7. Sharps containers.

Laboratory Requirements

This operation involves work conducted under the Occupational Safety and Health Administration (OSHA) Laboratory Standard (OSHA) Laboratory Standard, (Figure 1).

Training

- Chemical Hygiene Plan Rev 6 RRD
- General Hazard Communication
- Hazard Communication Job Specific Training
- OSHA Lab Standard Training - Includes site-specific

Some chemicals (such as soda lime and Drierite) and compressed gases will be utilized by ORNL/UT-Battelle staff within the Barrow lab space.

Site-specific training concerning use of the lab space in Barrow shall be conducted by the principal investigator or a delegate prior to lab use.

Chemical material safety data sheets (MSDSs) are available on line at www.msds.com, through the chemical vendor's web site, or in printed form (if shipped).

All ORNL participants working in the NGEE project laboratory must be trained to the ORNL Chemical Hygiene Plan (CHP) and have site-specific training to the space(s). More detailed information regarding work controls and specific PPE requirements can be found elsewhere in this document. However, unless otherwise noted, the minimum PPE for lab work include safety glasses with side shields and nitrile gloves. Lab coats are also recommended as one means to meet the CHP requirement to cover unprotected skin when working with hazardous chemicals.

Site-specific environmental safety, health, and quality (ESH&Q) training shall include the following:

1. the physical and health hazards of chemicals in the work area, including signs and symptoms of exposure;
2. methods and observations that may be used to detect the presence or release of hazardous chemicals;
3. measures employees can take to protect themselves from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and use of PPE; and
4. location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory, including, but not limited to, MSDSs.

Carcinogens

This operation involves chemicals or wastes that are known or suspected human carcinogens (e.g., a component of Drierite is listed by the IARC as a suspected human carcinogen). Any chemical brought into the laboratory must be approved by the Project Director, and:

- Chemical use must be evaluated by your ESH point of contact.
- Additional chemical safety PPE and exposure assessments may be required.

Caustic or Corrosive

This operation involves chemicals or wastes that are caustic or corrosive (e.g., acids or bases; e.g., pure soda lime is considered a caustic material).

- Chemical Safety PPE is required.
 - Gloves are required (contact SME for guidance).
 - Lab coats are recommended.
 - PPE: Safety glasses with side shields are required for laboratory operations involving hazardous chemicals.
 - Goggles shall be worn where there is a potential for splash of corrosive liquids.

Electrical Energy

This operation involves the potential for electrical shock.

Some instruments use batteries or plug into power strips, and batteries must be recharged.

The lab environment may have corded electrical equipment, flexible power cords, and/or power strips in use.

Sealed LI-COR batteries will be charged in a designated area. Batteries will not be charged when frozen, as this increases the likelihood of fracturing the battery casing. Batteries that have visible signs of damage will not be connected to the charger and will be taken out of service for proper disposal.

While at work, staff/guests shall NOT open an electrical panel or reset a circuit breaker contact the UIC laboratory manager or their representative. We must also keep areas in front of electrical panels and/or disconnects clear of any storage or equipment: OSHA requires that areas in front of electrical panels and/or disconnects be kept clear a minimum of 36 in. to the front and 30 in. horizontally.

Users shall visually inspect electrical cords for defects (e.g., loose parts; deformed or missing pins; pinched, crushed, or deteriorated outer insulation) before initial use and periodically, such as when relocating plugged-in office equipment. Cords shall be removed from service if a defect or damage is observed. Only a "Qualified Person" shall repair or replace cords integral to the equipment.

Flexible cords, cables and other off-the-shelf electrical equipment, such as electrical multi-strips, shall be approved by a nationally recognized testing laboratory (NRTL). The "UL listed" label is a common example of NRTL approval. For illustrations of NRTL marks and symbols, please review the following link: <http://www.osha.gov/dts/otpca/nrtl/nrtlmrk.html>

NOTE: Non-NRTL approved items shall not be used for laboratory activities. Contact your institutions safety professionals if you have questions regarding approved/unapproved equipment.

Flexible cords shall not be

- permanently attached to building surfaces (e.g. stapled or zip-tied);
- run through holes in or concealed in walls, ceilings, or floors;
- run through doorways, windows, or other pinch points unless adequately protected; spliced, tapped, or modified, unless specifically permitted by the National Electric Code; or
- used as a substitute for fixed wiring of a structure.

Cords that can be stepped on by pedestrian traffic shall be protected to eliminate physical damage and minimize tripping hazards.

Electrical power strips shall not be plugged into one another. This is often referred to as "daisy chaining"

Compressed Gases

Pressures of both flammable and nonflammable gases used in the laboratory can be greater than 100 psi. The cylinder valves must be closed when not in use (Figure 8).

This includes compressed gases in large cylinders (such as methane in argon, hydrogen, purified air, or helium) and small lecture bottles (such as methane in air, CO₂, and N₂O in nitrogen).

A cylinder user reads the cylinder label to verify the identity of the compressed gas and to ensure that the proper type and concentration of gas is used. The cylinders must be secured and stored in an appropriate area until needed.

Flammable gas cylinders are not stored with oxidizers. Users will determine to the best of their ability that cylinders are not defective or leaking. Regulators will be placed by knowledgeable personnel and inspected if their integrity is questioned.

Small packaged gas cylinders containing reference gases may be used with the GC (Figure 8). Cylinders should be protected from falling or stem breakage during use and storage.

NOTE: All requirements and guidance on compressed gas cylinder use can be found at:

<http://ngee-arctic.ornl.gov/sites/ng ee.ornl.gov/files/data/NGEE Team/Safety/CompGasHandUse.pdf>



Figure 8. Left: Cylinders of compressed gases are stored near the GC. Right: Small packaged gas cylinders.



Figure 9. Drying Oven.

Thermal Hazards

Hot

A Blue M drying oven rests on a table near one door, Figure 9. The exhaust line (galvanized steel elbow) will be hot during use. The oven should be turned off when not in use. Heat-protective gloves and/or tongs must be used when working with a hot oven.

Before adding or removing samples, oven shall be allowed to cool down to ~ 100°C.

Protective thermal gloves and tongs shall be used to remove, handle, or manipulate items/samples where the operating temperature is or has been greater than 60°C.

Other safety considerations include identifying emergency cutoffs, guarding/shielding hot surfaces, and posting warnings on hot surfaces prior to commencing work. Prospective users of equipment that poses thermal hazards in the laboratory must review the additional documents for applicable controls:

Heat Producing Appliances Exhibit

Fire Protection for Ovens, Furnaces and Environmental Chambers

If modifications to heat-producing appliances are required, the modified appliance shall be approved by the electrical and/or fire protection authority having jurisdiction prior to use.

NOTE: Thermal devices should be turned off when users leave Barrow or no longer need them.

Cold

Liquid nitrogen and-low temperature freezers will be used within the lab space, including a walk-in cold room at 4°C, a walk-in freezer at each -20°C, -40°C, and -80°C , (Figure 10). Appropriate PPE must be worn to mitigate the hazards.

Cryogenic Liquid Controls

At a minimum, safety glasses with side shields are required any time cryogenic liquids, exposed to the atmosphere, are present. Goggles provide the best protection for the eyes. A full face shield shall be used when a cryogenic liquid is transferred to an open container where there is a potential for bubbling.

“Cryo-gloves,” “extreme temperature gloves,” and tongs and other tools are available and will be used when handling extremely cold (-40°C) freezer items, pouring liquid nitrogen, and removing samples from liquid nitrogen.

Only containers specifically designed for the purpose of holding cryogenic liquids will be used when freezing samples with liquid nitrogen.

Further information can be found in the **Cryogenic Liquids and Related Components** document.:

[http://ngee-](http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/CryogenicLiquids.pdf)

[arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/CryogenicLiquids.pdf](http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/CryogenicLiquids.pdf)

This operation involves cryogenics in quantities greater than 1 gallon. PPE includes gloves, safety glasses, and a face shield. See "Cryogenic Materials" in **Recognized Industrial Practices Involving the Storage, Handling and Use of Hazardous Chemicals**:

[http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE Team/Safety/RecIndPracChem.pdf](http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/RecIndPracChem.pdf)

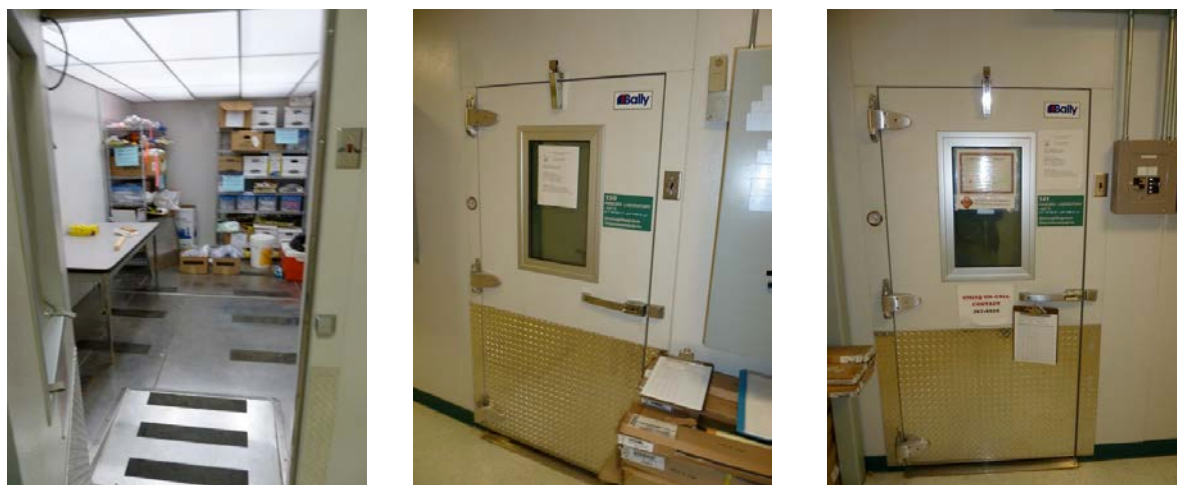


Figure 10. Left: The walk-in cold room (4°C). Center: Walk-in freezer (-20°C) in room 139. Right: Walk-in freezer (-40°C) in room 141.

Freezer Contact Control

Direct skin contact with objects stored in the cold and ultra-cold freezers or the inside structure of the freezers should be avoided. Cryo/thermal gloves are available for use when extended handling time is required while inside the freezers or while removing items from the freezers. Gloves (cotton, leather, or other material) that eliminate the direct contact and minimize temperature transfer between the objects being handled and the skin may be used when more dexterity is needed and handling time is minimal.

PPE for entering the cold room and freezers in addition to required safety glasses with side shields are as follow:

- Cold room—Wear appropriate clothing and watch for spilled materials that could cause slipping.
- -20°C freezer—A. Wear appropriate clothing, including protective gloves.
- -40°C freezer—Wear appropriate clothing, gloves, face shield.
- -80°C freezer—Wear appropriate clothing, gloves, face shield.

Working Hours

This operation involves work performed outside normal working hours (6am to 7 pm).

Use of the "Buddy System" may be required.

When conducting hazardous operations after hours, contact the Officer of the Day and provide the location and nature of the activities.

Work hours will vary in Alaska, and lab work may be conducted outside of what is considered normal working hours.

At no time will any participant be permitted to conduct hazardous operations within the laboratory alone.

NOTE: The UIC 24 hour on-call duty manager can be reached at (907) 229-6567.

Packaging, Transporting, or Shipping of Samples

Materials are ordered directly from the lab site in Barrow and are shipped directly to the lab site by a vendor. Additionally, some items, such as plant and soil samples, will be shipped from the work location back to ORNL.

Plant and soil samples are collected under the related *Field Safety Manual* and processed within the BARC lab. Samples that will be shipped back to ORNL will be shipped as luggage or separate air cargo (dry ice will not be used for sample preservation).

If questions should arise concerning the transporting or shipping of materials, research staff must contact the ORNL Transportation Management Organization (TMO).

When Things Go Wrong

EVERYONE HAS STOP WORK AUTHORITY: If anyone is placed in an unsafe condition while working on this project, attempt to stop the work and resolve the concern. If that is not possible, then staff is responsible for removing themselves from the situation and not continuing to work until the issue is resolved.

An individual involved in a work-related off-site injury or illness must immediately seek the appropriate level of medical care as required by the event. As soon as reasonably possible after the event, inform the officer of the day for proper follow-up and reporting.



Figure 12. Safety shower.

Personnel must have the emergency services phone numbers for the location and the numbers for the site point of contact immediately available (see Appendix A).

The Red Cross First Aid course is recommended for all participants.

A first aid kit is located on the bench top near the entry door (Figure 11). Safety glasses are located in the top drawer. Protective gloves are located in the glass cabinets above the bench.

An extendable emergency eyewash station is located near the sink. To use, pull hose toward you, push the black handle toward the stem, and flush eyes. You will need to hold eyelids open so



Figure 11. First aid kit.

water can get under, and you will need to roll the eye to expose it the a stream of water for at least 15 minutes.

A safety shower and controls are located near the entry door to the laboratory (Figure 12). Follow the instructions on the green-and-white placard for emergency use. Remove contaminated clothing and use for at least 15 minutes in an emergency. Do not block the shower with equipment or materials.

A snorkel vent is available near the side wall opposite fixed benches (Figure 13). Verify that the vent is operational before relying on it to exhaust gases.



Figure 13. Snorkel vent.

Sites of Interest

Additional Information about the climate and related safety issues may be obtained from the follow site:

<http://www.arm.gov/sites/nsa/visit>

NOTE: UIC now has an updated web site for researchers planning to work in Barrow:

<http://www.barrowbulletin.com/>

Referenced Documents

Field Safety Manual

<http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/FieldSafety.pdf>

NRTL Marks and Symbols

<http://www.osha.gov/dts/otpca/nrtl/nrtlmrk.html>

Compressed Gas Handling and Use

[http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE Team/Safety/CompGasHandUse.pdf](http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/CompGasHandUse.pdf)

Heat Producing Appliances Exhibit

<http://ngee-arctic.ornl.gov/elFinderhttp://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/HeatProducingAppliances.pdf>

Fire Protection for Ovens, Furnaces and Environmental Chambers Exhibit

<http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/OvensFurnaces.pdf>

Cryogenic Liquids and Related Components

<http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/CryogenicLiquids.pdf>

Recognized Industrial Practices Involving the Storage, Handling and Use of Hazardous Chemicals:

[http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE Team/Safety/RecIndPracChem.pdf](http://ngee-arctic.ornl.gov/sites/ngee.ornl.gov/files/data/NGEE%20Team/Safety/RecIndPracChem.pdf)

Appendix A

Abbreviated Terms

BARC	Barrow Arctic Research Center
BEO	Barrow Experimental Observatory
CHP	Chemical Hygiene Plan
DOE	US Department of Energy
ESH&Q	Environmental safety, health, and quality
LSS	Laboratory Shift Superintendent
MSDS	material safety data sheets
NRTL	Nationally Recognized Testing Laboratory
OOTD	Officer of the Day
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
SBMS	Standards-Based Management System
SME	subject matter expert
STL	science team leader
TMO	Transportation Management Organization
UIC	Ukpeaġvik Iñupiat Corporation

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National Weather Service, 1018 Kiogak St. Barrow Alaska,			907-852-6484
Weather within 100 miles of Nome, AK	http://nomeweather.com/public.php?radius=100		

Emergency Notification Contacts

Emergency 911 or Hospital/Emergency – (907) 852-4611

ORNL Laboratory Shift Superintendent – (865) 574-6606

Location Information (shown on map with icon)

 Police, 1068 Kiogak St, Barrow, AK 99723	(907) 852-0311
 Fire Department, 4374 Laura Madison St, Barrow	(907) 852-0234
 Hospital, 7000 Uula St, Barrow, Samuel Simmonds Memorial Hospital	(907) 852-4611
 North Slope borough Search and Rescue	(907) 852-2822
 North Slope Borough, 1689 Okpik St., Barrow	(907) 852-0320
 Wiley Post-Will Rogers Memorial Airport	(907) 852-6199
 Barrow Arctic Science Consortium	(907) 852-4881
 Project Laboratory	(907) 229-6567
 Project Sleeping Quarters	

Samuel Simmonds Memorial Hospital 7000 Uula St.

