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Project Laboratory Safety Manual

Next-Generation Ecosystem Experiments—NGEE Arctic

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OAK RIDGE National Laboratory

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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 before commencing any laboratory work in Barrow or Nome, Alaska.

Review the attachments. They contain supplemental information (e.g., directions, maps, contacts, site instructions, emergency information) that is important for the Barrow and Nome laboratory spaces. 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

Revision Number	Date	Description	Authorized By
0	03/18/2013	Initial Issue	S. Wullschleger
1	04/23/2014	Minor changes for Annual Review	S. Wullschleger
2	04/09/2015	Annual Review	S. Wullschleger
3	07/12/2016	Annual Review. Document revised and reformatted because researchers in Alaska soon will use multiple lab spaces (BARC and UAF lab).	S. Wullschleger
4	07/12/17	Annual Review. Update “Cryogenic Liquid Controls (p. 6) to include rqm’t for using cryo- gloves.	S. Wullschleger

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Abbreviated Terms

AED	automated external defibrillator
BARC	Barrow Arctic Research Center
DOE	US Department of Energy
ESH&Q	environmental safety, health, and quality
LI-COR	An instrument manufactured by LI-COR to measure soil CO_2 flux
NGEE	Next-Generation Ecosystem Experiments
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
UIC	Ukpeaġvik Iñupiat Corporation
UAF	University of Alaska Fairbanks
SDS	safety data sheet

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. Individual scientists, in consultation with the science team leads and project director, 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 scientist is responsible for a scope of work as defined in the proposal presented to the US Department of Energy (DOE). Each scientist also is 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 damage to the environment, equipment, or property that reasonably could be encountered while performing the work. The controls participants should use to avoid or mitigate hazards must be reviewed and approved for adequacy by the safety professionals at the task leader's home institution.

Task leaders must ensure that participants on their teams know the hazards and controls of their work activities, including additional discussions when changes occur. After safety plan briefings, 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 the project officer of the day (OOTD). Work must not resume until the threat from the hazard is mitigated or removed.

During the preparation and performance of work, all participants must be mindful of known hazards, use defined controls, and be observant of changing conditions. Participants who encounter a new hazard must request additional review before continuing work. The task leader must collect lessons learned and suggestions for improving hazard controls; these lessons and suggestions must be considered for changes to the safety plan and/or communication to other project task teams. Any changes to the safety plan must be reviewed, approved, and communicated to team participants.

Safety Training Requirements

The core team of the NGEE Arctic Project has developed the *Project Field Safety Manual* and the *Project Laboratory Safety Manual*, which define the minimum safety expectations and requirements for participation in field or laboratory work in Alaska. All participants must comply with these minimum safety requirements. The hazards and controls contained within the *Field Safety Manual* and the *Laboratory Safety Manual* do not need to be repeated in the task safety plan unless additional controls are required because of the work being performed.

These documents are available with other project safety information at the project website (**http://ngee-arctic.ornl.gov**) under the Resources/NGEE Team Files/Safety tab. They are reviewed annually for currency and applicability, and significant changes will be communicated to all participants.

A login account is required to access the following required safety materials:

- ✓ **Project Orientation and Safety Video**
- ✓ **Staying Safe in Bear Country Video**
- ✓ **Polar Bear Safety Video**
- ✓ **Project Field Safety Manual**
- ✓ **Project Laboratory Safety Manual**
- ✓ **NGEE Arctic Phase 2 Proposal & Plan**

Overview & General Requirements

Safety at Arctic field and laboratory sites will be an integral component of the team's research planning and execution. Whereas 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 participants who use the laboratories 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 training materials will be made available for review. Project participants will receive both printed, on-site documentation and electronic resources.

Risk assessment will be a continuous process, closely tied to risk management, training, and management oversight. Because laboratory activities will be performed in laboratory space 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 for project participants who are handling chemicals. Minimum PPE includes safety glasses with side shields (at all times) and nitrile gloves (when handling chemicals). NGEE Arctic participants comply at a minimum with their home institution's Chemical Hygiene Plan requirements when performing NGEE Arctic lab activities in Alaska.

Each identified hazard will be addressed before laboratory activities begin 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. NGEE Arctic leadership is 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 experiencing negative consequences or retaliation. A stop work action triggers immediate review by knowledgeable personnel until issues are resolved. Although this authority rarely is 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.

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; environment, safety, and health support staff; and the ORNL laboratory shift superintendent).

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 ceasing 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. Prompt reporting after the event by the involved individual or another participant to inform the OOTD 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 the **NGEE Arctic Contacts** Listing).

Laboratory Infrastructure Controls

Chemical Fume Hood

The NGEE Arctic project core team ensures that fume hoods are inspected and certified annually. Participants must confirm that the flow indication device is affixed to the fume hood and must verify flow before use.

Participants must verify that the hood is turned on and functional before relying on it for safe ventilation. To do this, use a tissue (or Kimwipe) taped to the sash to confirm airflow visually. Pull the sash down to maximize airflow and to provide maximal protection.

It is the responsibility of each home institution to evaluate the specific chemicals its workers will use in the laboratory spaces. However, the minimum PPE for lab work includes safety glasses with side shields and nitrile gloves unless the worker's home institution documents exceptions. Lab coats are also recommended to meet chemical safety best practices to cover unprotected skin when working with hazardous chemicals.

Disposing of Chemicals

Consult with resident laboratory staff and/or the facility manager before disposing of any chemicals in the drains and/or for other waste labeling and handling instructions.

Disposing of Sharps

Dispose of all sharps in appropriate sharps biohazard containers. Sharps containers are generally located on the bench top for the disposal of sharp blades and needles. Do not fill the container beyond the fill line.

Do not directly recap needles using two-handed operations. Instead use safer alternative methods (i.e., direct disposal, foam block technique, etc.) to avoid the potential for punctures or needle sticks.

Laboratory Requirements

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

Training

- Your home institution's chemical hygiene plan
- Your home institution's general hazard communication training
- OSHA laboratory standards training, including site-specific training

NGEE Arctic participants working in the Barrow Arctic Research Center (BARC) and/or the University of Alaska Fairbanks (UAF) lab space will use some chemicals (such as soda lime and Drierite) and compressed gases.

The principal investigator or a delegate should conduct site-specific training concerning use of lab space shall be conducted by before lab use.

Chemical safety data sheets (SDSs) are available on line at **www.msds.com**, through each chemical vendor's web site, or in printed form.

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

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, SDSs.

Carcinogens, Flammables, Caustics/Corrosives, etc.

Lab work may involve a variety of chemical classes including flammables, caustic/corrosives, toxic compounds, etc. (e.g., the International Agency for Research on Cancer lists a component of Drierite as a suspected human carcinogen). Any chemical brought into the laboratory must be approved by the project director. Each home institution's ESH&Q point of contact also must evaluate chemical use. Additional chemical safety PPE and exposure assessments may be required.

More information on labeling is available on the **Labeling of Hazardous Chemical Containers** safety document.

Electrical Energy

Some instruments use rechargeable batteries or must be plugged in to power strips (sometimes called multi-strips), and batteries often need to 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 because 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.

NGEE Arctic participants shall NOT open an electrical panel or reset a circuit breaker unless they hold the appropriate training qualification. Workers 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 need to 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 someone with the appropriate training qualification may repair or replace cords integral to the equipment.

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

NOTE: Non-NRTL approved items shall not be used for laboratory activities. Contact your institution's 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 multi-strips (power strips) shall not be plugged into one another. This is often referred to as "daisy chaining."

Compressed Gases

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.

NGEE Arctic participants typically use compressed gases in large cylinders (such as methane in argon, hydrogen, purified air, or helium) and small lecture bottles (such as methane in air, CO_2, and N_2O in nitrogen).

A cylinder user must read 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 cannot be stored with oxidizers. Users must determine to the best of their ability that cylinders are not defective or leaking. Knowledgeable personnel will place and inspect regulators.

Small packaged gas cylinders containing reference gases may be used. Cylinders of all sizes must be protected from falling or stem breakage during use and storage.

NOTE: All requirements and guidance on compressed gas cylinder use can be found in the **Compressed Gas Handling and Use** safety document.

Thermal Hazards

Hot

Drying ovens will be used and should be turned off when not in use. Protective thermal gloves and tongs must be used to remove, handle, or manipulate items/samples where the operating temperature is greater than 60°C.

In addition, before workers can add or remove samples, the oven must be allowed to cool down to ~100°C.

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

Heat Producing Appliances Exhibit

If heat-producing appliances require modifications, the electrical and/or fire protection authority having jurisdiction must approve the modified appliance before its use.

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

Cold

Liquid nitrogen and low temperature freezers will be used within the lab space. A walk-in cold room at 4°C and three walk-in freezers at –20°C, –40°C, and –80°C are available at the Barrow laboratory. Freezers are also available at the UAF lab space. Appropriate PPE must be worn to mitigate the hazards.

Cryogenic Liquid Controls

At a minimum, safety glasses with side shields are required in the presence of cryogenic liquids any time such liquids are exposed to the atmosphere. Goggles provide the best protection for the eyes. A full-face shield shall be used when a cryogenic liquid is being transferred to an open container where there is a potential for bubbling. Cryogen gloves (Cryo-gloves) are also required when handling liquid nitrogen. These gloves are designed to protect the wearer from both the extreme cold of the cryogenic liquid and the contact hazard (frozen skin/flesh). Open weave extreme temperature gloves are not to be used for this task.

“Cryo-gloves”, other “extreme temperature gloves” or tongs are available and must be used when handling extremely cold (–40°C) freezer items.

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

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

Freezer Contact Control

Direct skin contact with objects stored in the cold and ultracold 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 is as follows:

- Cold room—Wear appropriate clothing and watch for spilled materials that could cause slipping.
- –20°C freezer—Wear appropriate clothing, including protective gloves.
- –40°C freezer—Wear appropriate clothing, gloves, and safety glasses with side shields.
- –80°C freezer—Wear appropriate clothing, gloves, and safety glasses with side shields.

Planning Laboratory Work

Before You Travel

Before you go, collect as much information as possible about the work you will be doing and about the site where you will be working. This information will help with planning.

Be aware that when you reach your destination, work conditions may be different from what you expected. If necessary, call your science team lead or your institutional representative for guidance to prepare properly. The resources of your institution still will be available to you (e.g., your supervisor; subject matter experts; environmental, safety, and health support staff).

Prepare an emergency phone list to bring with you, including your supervisor, project **contacts**, subject matter experts whom you may need to contact, local emergency numbers, and the ORNL laboratory shift superintendent at (865) 574-6606.

Verify that your emergency contact information is current at your institution and that your supervisor has your contact information for the off-site location.

Officer of the Day

The project director will assign a participant the role of OOTD on any day that project participants are performing project work in Alaska. The OOTD is responsible for

- planning the daily meeting;
- gathering weather, bear, and other reports relevant to the day's activities;
- ensuring that all participants attend the meeting;
- ensuring that new participants have completed the required reading and acknowledgement;
- ensuring that someone is responsible for carrying the first aid kit, communication equipment, and/or other survival gear (e.g., compass/global positioning system device, whistle, map, emergency survival supplies, lighting, provisions for emergency shelter, fire-starting materials);
- ensuring that all participants have a buddy and are in good physical health; and
- ensuring that any known hazards for the day's work are discussed and that hazard controls are understood.

The OOTD also has the authority to cancel field or laboratory activities because of weather conditions, bear activities, and other unmanageable hazards. In an emergency, the OOTD is responsible and must take action to ensure the safety of the participants.

In the event of an injury or illness, participants must notify the OOTD. If an injury has occurred, the OOTD must ensure that any unsafe conditions are corrected or mitigated to prevent further injury, confirm that appropriate medical care has been received, and record that circumstances and actions leading to the injury. Before the close of business on the day of the injury or illness, the OOTD must report it to the injured or ill participant's institutional lead and to the ORNL laboratory shift superintendent at (865) 574-6606. Additional actions may be assigned after these notifications are made.

Preparing for Laboratory Work

Readiness

Plan for communication:

- Bring your emergency phone list with you.
- Make sure that you have some means of communication available in the lab. At the end of each day, OOTDs will communicate to account for each team and person.
- If you are in an unsafe condition, attempt to stop the work and resolve the concern. If that is not possible, you are responsible for removing yourself from the situation and ceasing work until the issue is resolved.

Daily Meeting

Each day, before starting any field or laboratory work in Alaska, the OOTD organizes and leads a meeting with project participants to discuss the day's activities and weather conditions. After assigning participants to job teams and work sites and after gathering expected return times for those performing fieldwork, the OOTD confirms 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 an individual's performance of a specific task. Participants must consider whether there are precursors that, if reduced or eliminated, would make the controls more likely to be effective.

Specific Hazards

Participants must consider special precautions necessary in unusual environments. Local work control processes and health and safety requirements must be followed when working at other facilities.

Participants must use sharps such as box cutters, scalpels, or razor blades in a manner that keeps the cutting blade away from fingers and the body. Cut-resistant gloves should also be used whenever possible.

Stop Work

EVERYONE HAS STOP WORK AUTHORITY: Anyone who is placed in an unsafe condition while off site or in a lab must attempt to stop the work and resolve the concern. If that is not possible, participants are responsible for removing themselves from the situation and stopping work until the issue is resolved.

The Buddy System

No one is permitted to work alone at any of the NGEE Arctic field or laboratory sites. Always have someone with you. Each group of buddies must have some means of communication in case of emergency or for notification of changing conditions and hazards.

Mandatory General Emergency Controls

1) When in the field and laboratory, participants will have access to, and know how to operate, some means for getting timely emergency help (e.g., radio or phone and contact numbers). Personnel must have the emergency services phone numbers for the location and the numbers for the site point of contact immediately available (see the **NGEE Artic Contacts** Listing).
2) The "buddy system" is required at all times. At no time shall participants be permitted to be at the laboratory site alone.
3) An individual involved in a work-related laboratory or off-site injury or illness must immediately seek the appropriate level of medical care required by the event. As soon as reasonably possible after the event, inform the OOTD for proper follow-up and reporting.
4) A first aid kit must be taken to or maintained at the laboratory sites for basic first aid needs. The Red Cross First Aid course is recommended for all participants.
5) Participants working in Barrow also can maintain and be trained on the use of an automated external defibrillator (AED). Ukpeaġvik Iñupiat Corporation Science (UIC) will provide an AED at the field site and/or a centralized location. An AED will not be available at sites on the Seward Peninsula.

This safety manual and applicable SDSs for chemicals used by participants must be maintained by personnel at the laboratory or field site.

Barrow Specific NOTE: The UIC Science 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 vendor and shipped to the site. Some items, such as plant and soil samples, may be shipped from the work location back to ORNL or other NGEE Arctic collaborating institution.

Plant and soil samples are collected under the related *Field Safety Manual* and processed within the labs. Samples to be sent to ORNL or other collaboration institutions will be shipped as luggage or separate air cargo (dry ice will not be used for sample preservation). Such samples must be non-hazardous and contain no hazardous preservatives.

If questions arise about transporting or shipping materials, research staff members must contact ORNL Transportation Management or the shipping department of their home institution.

When Things Go Wrong

EVERYONE HAS STOP WORK AUTHORITY: Anyone who is placed in an unsafe condition while working on this project should attempt to stop the work and resolve the concern. If that is not possible, then staff members 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 laboratory or 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 OOTD 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 the **NGEE Arctic Contacts** Listing).

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

A first aid kit will likely be present in each working lab; alternately, the NGEE Arctic workers need to ensure that they have access to one. The shared NGEE Arctic lab spaces will include safety shower and eyewash units. Information and instructions for use of the individual units should be discussed during site-specific training. In general, however, you will need to hold eyelids open so water can get under the lids, and you will need to roll the eye to expose it to a stream of water for at least 15 minutes. In the case of safety showers, remove contaminated clothing and use for at least 15 minutes. Do not block the shower with equipment or materials.

If a snorkel vent is available, verify that the vent is operational before relying on it to exhaust gases.

Sites of Interest

- Additional information about the climate and related safety issues is available at **www.arm.gov/sites/nsa/visit**.
- Barrow Bulletin: **www.barrowbulletin.com/**

Referenced Documents

All documents are archived under Resources/NGEE Team Files/Safety on the NGEE Arctic website at **http://ngee-arctic.ornl.gov**.

Compressed Gas Handling and Use

Contact Information for NGEE Arctic Team and Sites

Cryogenic Liquids and Related Components

Field Safety Manual

Fire Protection for Ovens, Furnaces, and Environmental Chambers Guideline

Heat Producing Appliances Exhibit

NRTL Marks and Symbols
www.osha.gov/dts/otpca/nrtl/nrtlmrk.html

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

Appendix A

Barrow Artic Research Center (BARC) photos and information

BARC facility photos showing lab safety features (fume hood, fire extinguisher, emergency eyewash and safety shower, etc.) and major pieces of equipment and infrastructure.







Bally


Bally
UMIAQ ON-CALL
CONTACT


BlueM

Appendix B

University of Alaska Fairbanks (UAF) Northwest Campus photos and information

UAF facility photos showing lab safety features (fume hood, fire extinguisher, emergency eyewash and safety shower, etc.) and major pieces of equipment and infrastructure.


SHARPS


FLAMMABLE
KEEP FIRE AWAY
CORROSIVES
CORROSIVES